An Investigation of Uncertainty Dynamics within Project Management: Theoretical and Empirical Insights

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Doctor of Philosophy

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Abstract

Traditional normative approaches to managing uncertainty in projects have proven to be unable to support the uncertainty conditions in novel projects today. While practitioners have developed pragmatic new approaches to handling projects with volatile boundary conditions and large inherent volumes of uncertainty, for example through agile project management, scholars are searching for a stronger theoretical foundation for project and project uncertainty management which can explain and advance these empirical approaches.

This thesis exposes a link between uncertainty and the concept of information. Using detailed definitions of information, a stratified information layer instrument was constructed, which forms the basis for the presentation of a theoretical model of uncertainty.

Following the confirmation of the utility of the information paradigm and the layer model through a series of semi-structured interviews, the information paradigm lens is applied to overt non-participant observational research under the Critical Realist paradigm. This produced empirical findings of uncertainty symptoms, indicators and coping mechanisms, and resulted in the abstraction of six information themes, which appear to offer a more precise understanding of underlying uncertainty dynamics in projects than previous academic contributions.

These theoretical and empirical foundations are used to inform a paradigm switch from task to information, and the subsequent redefinition of projects under the information paradigm. A conceptual framework was constructed from the six information concepts and the information layer model, which creates a more precise understanding of project uncertainty dynamics, and makes uncertainty an intrinsic consideration of project management.
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Glossary

**Hard project** – Traditional view of a project, where sufficient upfront information is available to be able to establish goals and develop project plans upfront, and little anticipated new information or change of boundary conditions is experienced throughout the project life cycle so that the project can be implemented by deconstructing goals into tasks and implementing these; Such projects exhibit a limited amount of known unknowns.

**Information Paradigm** - School of thought within the discipline of Project Management, which considers the reduction of uncertainty to be the key task of Project Management and focuses on uncertainty reduction in projects through information management.

**Known Unknown** – Identifiable event that impacts projects in the form of a threat or an opportunity.

**Layer-1 (L1) Information** - Physical reality; observer independent information existing in the physical world.

**Layer-2 (L2) Information** - Cognitive image or representation of Layer-1 Information, achieved by transforming Layer-1 Information into mental artefacts.

**Layer-3 (L3) Information** - Individual’s system of meanings which directs an active search for information and determines which new cues from the physical world are taken in.

**Layer-4 (L4) Information** - Systems of meanings; internal concepts and reference systems.

**Layer-1 Uncertainty** - Fully observer independent and objective; e.g. decay of radioactive atom.
Layer-2 Uncertainty - Misrepresentation or oversimplification of Layer-1 Information during transformation process into Layer-2 Information; creates uncertainty due to lack of information

Layer-3 Uncertainty - Appears where an incomplete, faulty, or wrong Layer-3 concept is applied to direct the search for Layer-1 Information, or where there is no concept to anchor any of the information

Layer-4 Uncertainty – Inability of individuals to represent concepts on Information Layer 4, or use of faulty, incomplete, or incorrect concepts, and subsequent inability to reflect on these to change them; uncertainty arising due to the lack of ability to process information within a sound conceptual framework

Project (traditional definition under the task based paradigm) - “...an endeavor in which human, material and financial resources are organized in a novel way, to undertake a unique scope of work of given specification, within constraints of cost and time, so as to achieve unitary, beneficial change, through delivery of quantified and qualitative objectives.”. (Turner 1999 p.3)

Project (definition under information paradigm) - A temporary information management formation, which has the aim of producing new information on either one or more of the four information layers

Project Control – Checks during project execution that the outcomes of project tasks and work packages match the progression of the project plans

Project Goal - Projected project end-point and outcome, intended to be achieved through project planning and control of implementation

Project Life-Cycle (PLC) - Development sequence of a project, structuring the organisation of the project by dividing it into phases or stages which are progressively run through from initiation to completion

Project Management Body of Knowledge (PMBOK) - The sum of knowledge within the profession of project management that is standardized by ISO
**Project Planning** - Defines and co-ordinates activities over time, in order to identify the most efficient approach to achieving project goals

**Project Risk / Known Known** – Exposure to events that impact projects in the form of a threat or an opportunity, which are identifiable and their likelihood can be assessed

**Project Risk Management (PRM)** - Structured process that allows individual risk events and overall project risk to be understood and managed proactively, optimising project success by minimising threats and maximising opportunities

**Project Scope** - Encompasses the requirements or specifications of “The work that needs to be accomplished to deliver a product, service, or result with the specified features and functions” (PMI 2004)

**Project Stakeholder** - Entities within or outside an organization which sponsor a project or have an interest or a gain upon a successful completion of a project

**Unknown Unknown** – Event that impacts a project in the form of a threat or an opportunity, and is not identifiable in advance

**Soft Project** – Project characterized by volatile and changing, often intangible goals, or unclear goals, with incremental availability of information and carrying different degrees of the different types of uncertainty, with complex boundary conditions, and a large number of external project influences and stakeholders

**Task based / Traditional paradigm** – Rational and normative school of thought in the discipline of Project Management, focused on project goal achievement through co-ordinating efforts and resource in a disciplined, planned and controlled way through a quantitative, top-down methodology; this paradigm assumes uncertainties as threats to the plan, manifesting in deviations, with defined methods and tools to manage these in order to bring a project back on track to the plan.
Chapter 1 – Introduction

1.0 Research Focus

The research presented in this thesis examines uncertainty in projects. In particular, it attempts to offer an understanding of what constitutes uncertainty in the context of a project, how it is experienced and managed by project members, and how these dynamics can be better understood in view of developing more adequate methods to manage it effectively. It also aims to provide an alternative to the traditional paradigm for building a consistent and sound theoretical basis for the discipline of Project Management (PM) and project uncertainty research in particular.

The term 'project' is used to describe undertakings across various industries and disciplines. Due to the multidisciplinary nature of this topic, different definitions of projects exist, as will be discussed in Chapter 2. For the purposes of this study, a traditional project under the task based paradigm is understood along the lines of Turner’s (1999) definition as:

“...an endeavor in which human, material and financial resources are organized in a novel way, to undertake a unique scope of work of given specification, within constraints of cost and time, so as to achieve unitary, beneficial change, through delivery of quantified and qualitative objectives.”

(p.3)

Based on the findings of this study, a revised definition of a project is presented in section 8.1.1 under the information paradigm. There are also a myriad of definitions of the terms 'uncertainty' and 'risk', most often context and paradigm specific. The various interpretations of these concepts are explored in section 2.5. However, the current thesis defines uncertainty as unknown events which may create threats or opportunities to the
project scope and plan. When the likelihood of these events can be assessed, these are defined as risk. Following the literature study, refined definitions for different types of uncertainty are constructed in section 4.3, which are subsequently applied in the field research.

The discipline of PM has experienced significant changes recently, in that projects have developed into new fields of application, such as energy, logistics, software development, research and development, product launches, education and training. These new business areas and settings create a number of novel characteristics and boundary conditions for projects. In particular, these may include volatile environments where change is not linear, where business structures are complex, with a global dissemination, dynamic of fuzzy goals, abstract value expectations, higher stakeholder involvement, and faster development cycles. This increasing speed of change and volatility, as well as the recent trend to grow and extend into new practice environments, has created a new volume and intensity of uncertainty which the traditional PM principles, methods and tools have not anticipated.

Traditionally, PM models have been normative with a strong emphasis on quantitative planning, scheduling and control techniques, as these were developed for specific types of traditional “hard” engineering projects with clear goals, where the majority of information is readily available. Although models prescribe and impose uncertainty management methods and tools, such as project risk management, various scholars, such as Atkinson et al. (2006), argue that uncertainty management is often not addressed at all in PM practice or formalized into explicit, sometimes mechanic or overly quantitative procedures under the limited umbrella of project risk management. The practitioner-focused Project Management Institute’s Guide to the Project Management Body of Knowledge (PMI BoK) (PMI 2004) offers a number of control systems and procedures to manage uncertainty (e.g. PM methodology, Earned Value Analysis, Expert Judgments, etc). However, their application is largely limited to a particular type of foreseeable uncertainty in the form of risks. Unknown risks are only addressed by the PMI BoK (PMI 2004) in a brief comment, stating these “…cannot be managed proactively, and a prudent response by the project team can be to allocate general contingency against such risks…” (240).

Beyond these criticisms of uncertainty management methods and tools, an intense scholarly discussion has emerged amongst academics and practitioners on more fundamental
shortcomings of the traditional paradigm (Smyth and Morris 2007; Morris 2010; Koskela and Howell 2002; Söderlund 2002; Sauer and Reich 2007). These relate to the inadequacies of prescribed methods and tools to manage uncertainty, particularly for today’s new “soft projects”. The fundamental requirement of the traditional paradigm for upfront planning, separation of planning and implementation, as well as deconstructing approaches for task breakdowns, cannot be fulfilled due to high levels of uncertainty stemming from complexity of interaction of large numbers of project influencing factors, or from impacts which cannot be known at the start or throughout the project. These points, discussed in more detail in the following chapter, expose the uncertainty challenge the discipline currently faces, and underline the need for more attention to this topic.

PM practitioners and scholars have produced first attempts to develop methods and tools to tackle these uncertainties and their related issues around upfront planning, goal volatility, etc. in soft projects. However, the literature reviewed in the following chapter will establish that attempts so far are often inconsistent, unproven, or limited to specific circumstances or contexts. Chapter 2 will also demonstrate the inability of current practitioner-driven, as well as academic endeavours, to provide answers to these new uncertainty challenges, by presenting studies that demonstrate how these concerns can manifest in significant project delay and failure rates. This leaves uncertainty management in projects still as a key issue, which is still insufficiently addressed and therefore a key critical success factor. Some authors go as far as arguing that the entire purpose of a project is the management of uncertainty (e.g. Turner 2009). Such statements highlight the fundamental importance of this topic to project management. This study aims at contributing towards a solution of this issue.

PM is an applied science, focused on solving practical problems, which, following a trend of other young disciplines, tends to build on the theoretical foundations of other fields and often lacking clear articulation of these. As a result, a new generation of PM scholars has started to question the coherence of the field, the soundness of its theoretical basis, and the adequacy of its employed concepts to be able to keep up with the developments the discipline is experiencing ((Smyth and Morris 2007; Söderlund 2002; Koskela and Howell 2002; Winter et al. 2007; Cimil et al. 2006)). This community brought forth the argument that PM research has traditionally adopted a positivist scientific, rational approach, following a deductive reasoning based on assumptions and partial analysis, so that
subsequently models and tools are imposed on PM practice, which are either irrelevant, or become self-fulfilling instead of providing a sound theoretical basis. Based on this assessment, various scholars propose a switch from a normative to an interpretive approach, arguing that PM research should take a step back to investigate the “actualities” of projects to understand and explain in a bottom-up approach the contemporary challenges and dynamics in project practice, as opposed to the traditional top-down approach of imposing theories based on deductive reasoning, which may be reliant on potentially biased assumptions, and partial analysis (Cimil et al. 2006; Jugdev 2008). In this context, the switch to a new philosophical underpinning of PM research, away from the positivist tradition, is proposed (Smyth and Morris 2007). In line with this fresh tendency in PM research, this thesis takes an explanatory approach to the topic to contribute through these explanations of the uncertainty mechanisms at play in projects adopting a critical realist philosophy. The approach, model, and instrument proposed in this thesis constitute a social scientific interpretive model which forms a frame under which to study uncertainty in PM.

The lens of information processing has shown potential for uncertainty discussions in an organisational science context, and has been introduced to the PM discipline with initial benefits being apparent. These have not yet consistently applied or explored however. Thus, the current research initially establishes the suitability of this paradigm relating to whether it is able to facilitate greater and increasingly precise insight into uncertainty dynamics in projects. The paradigm is then applied to the core research. In line with this information paradigmatic approach, the aims and objectives of this research are to:

- Explore whether the information paradigm provides a more adequate and scientifically sound theoretical platform for the investigation of uncertainty than the task-based paradigm currently offers.

- Develop an instrument based on the information paradigm that offers a better way of studying uncertainty in projects by facilitating insights beyond the symptoms, at a deeper level of the underlying structures and causal powers.
- Develop a better understanding of these underlying structures and causal powers, to offer the PM research and practitioner community insights into how uncertainty manifests in projects, so that more adequate methods and more practical and realistic management tools can be designed.

These aims and objectives reflect the intent of developing a better understanding of uncertainty in projects through a particular paradigmatic lens, not to formulate a new approach per se. Approaching the understanding and managing of uncertainty in projects from this new angle, rather than following the normative tradition of imposing new frameworks, attempts to establish an understanding of the underlying issues. The novelty of this approach is further achieved by employing the information paradigm, which is relatively new to the PM discipline and entirely new to empirical PM research. The results of this study establish that the findings could only be made through this particular paradigm and with the systematic application of an information layer model. They demonstrate the merits of this particular interpretation of the paradigm. The use of an epistemological position which is also relatively new to PM - critical realism - further facilitates new insights.

1.1 Chapter Overview

Chapters 2, 3 and 4 examine the literatures on PM and Information to provide the intellectual context for an examination of uncertainty in projects.

Chapter 2 introduces core concepts and definitions that shape traditional PM. This normative tradition is critically reviewed in the light of arguments considering whether projects are standardised or unique. As projects have developed into new fields of application recently, these new contexts tend to create environments that underlie greater change and novelty, causing such projects to be increasingly unique, compared to those in the traditional engineering disciplines. The hard - soft project categorisation by Crawford and Pollack (2004) is used to distinguish and characterise such traditional and novel projects. The different uncertainty implications for both are subsequently explored,
disclosing that uniqueness and novelty of soft projects appear to entail different types and degrees of uncertainty. Definitions for different types of project uncertainty identified in the pertinent literature are subsequently contrasted.

In distinguishing and contrasting soft and hard projects, Chapter 2 concludes that the development of new soft projects creates a chasm with the traditional discipline grounded in the engineering industries, as in these hard projects change was a linear process and technology grew in an incremental predictable manner, to which the traditional PM discipline is geared. This point is expanded in the following chapter in order to establish the degree to which the dominating traditional discipline is able to support project practice for new soft projects with the management of their increased and new types of uncertainty, and to support research into new uncertainty management approaches.

Chapter 3 critiques the traditional normative PM concepts outlined in the previous chapter in terms of applicability to novel soft projects and their uncertainty conditions. The discussion concludes that the tendency for projects to develop into new fields with new uncertainty conditions has not been paralleled by a development in PM theories and tools to support these new conditions. In this vein it is also established that PM as an applied science tends to build on the theoretical foundations of other fields, often merely implicitly referring to these rather than clearly articulating them. These considerations conclude that PM as a discipline currently lacks a sound theoretical basis and is built on inadequate concepts to be able to keep up with the developments the discipline is experiencing, as theory is unable to adequately guide practice. Hand in hand with these epistemological and ontological questions go considerations around the paradigms that shape the discipline for practitioners and academics, and by extension their tools and methods. Different paradigms are then outlined, identifying the information paradigm as being of value for this study due to its focus on project uncertainty. The concerns around the theoretical foundation of PM, and the diverging paradigms, prompted the research community to argue for a switch of research perspective to consider individuals’ actions and interactions in projects to generalise theoretical models and concepts from those, in contrast to the traditional deductive approach of analysis and imposing new models, the effectiveness of which was hard to establish.
In the last part of Chapter 3 novel approaches to managing uncertainty in soft projects developed by practitioners and scholars are critiqued. The information paradigm is introduced as one of these novel approaches, with particular promise of uncertainty management in soft projects. Overall, in conjunction with the epistemological and paradigmatic considerations established in this chapter, this new social scientific interpretive perspective to the investigation of uncertainty, based on an information paradigm is proposed as a research path that may have the potential to offer new insights into project uncertainty dynamics.

Chapter 4 follows on from the identification of the information paradigm as a potential research perspective. It considers the utility of adopting the information perspective by establishing the theoretical basis for the application of this paradigm, and by establishing the potential approach and benefits of this lens for the purpose of this study in further detail. The theoretical basis is formed by a thorough review of the concept of information, lacking in other information paradigm-related literature identified in the literature review. Consequently, precise information definitions for the purpose of this research are derived, and related to each other in a stratified model, in order to obtain a more comprehensive and tailored information lens for studying uncertainty in projects. In this context it is established that different information definitions entail different types of uncertainty. This model serves as an instrument for a more distinguished and precise study of information, hence uncertainty in projects. This is prepared with a view not to impose theory on practice, but to use it as a paradigmatic prism allowing observing and understanding the practicalities of uncertainty dynamics in projects in the primary data collection and analysis phases of this study.

Chapter 5 examines the research methodology. It discusses the ontological and epistemological position adopted for this research and demonstrates how this relates to the chosen methods for data collection and analysis. Initially different philosophical stand points are discussed and contrasted, focusing on the qualities and applicability of positivism in the context of this research, as the positivist philosophy is traditionally adopted for Management research and PM research in particular. Critical realism is introduced and it is illustrated how this position adds value for the chosen research topic, allowing an investigation of independent objective dimensions, as well as abstract meanings, that may contribute to uncertainty management which cannot be captured in a positivist approach.
Following the argument for critical realism, the case study approach and its application under the critical realist paradigm are critically discussed. The second half of chapter 5 explains the choice of research design, consisting of preliminary semi-structured interviews and overt non-participant interviews. The case study is then introduced. The observation method, case context and the key stakeholders are explained and the data collection process is detailed. Analysis methods for both the interviews and the observation data are discussed in detail, and finally ethical aspects of this research are carefully considered.

Chapter 6 is aimed at establishing the utility of the information paradigm and the information layer model to achieve the aims and objectives of this study. This is achieved by applying the lens and model to a proprietary study through semi-structured interviews, the findings of which are presented in this chapter. These interviews also constituted an exploratory scoping exercise, seeking to provide a topical overview, and identify the uncertainty-related themes with which current PM practice is struggling due to lack of a solid paradigm. The interview findings present PM approaches outlined by respondents, and in particular uncertainty challenges interviewees faced throughout their projects. Similar problems, uncertainty management tricks, and insights were discussed by respondents, confirming the existence of critical issues around the understanding and management of uncertainty, providing a topical overview and confirming the value of this study. The interview findings also confirm the utility of the information paradigm for the main study, in that this lens was able to offer richer causal uncertainty insights in comparison to the traditional task-based view. From a critical realist point of view, it could be concluded that the information paradigm offers better access to the domain of the real for project uncertainty dynamics. The full benefit of this paradigmatic lens, however, could not apply in the interviews, as the quality of the data collected is not sufficiently rich and naturalistic. Therefore, insights from the interviews were used to gain experience with this perspective and the information layer instrument, with a view to employing these in the observational side of this study. Based on the insights from this proprietary study, four research questions relating to the identification of uncertainty and coping mechanisms, as well as conceptual redefinition of projects under the information paradigm, were devised, which are investigated in chapters 7 and 8.

Chapter 7 examines the findings from the observation conducted within the NX programme at DHL Global Mail. These are structured to answer three of the four research
questions regarding the indicators, identification, and coping mechanisms for uncertainty. If the indicators were known, earlier realization and acknowledgement of uncertainties would be likely, so that opportunities for managing these to a project’s advantage would increase. From these findings, six key themes transpired, in the form of informational validity, informational relevance, information synchronization, informational transparency, informational structure and information pace. These form concepts which facilitate the understanding and identification of information states and information dynamics in projects, hence facilitating insights into the underlying uncertainty events and mechanisms of projects from observed or experienced symptoms. Overall, the observation findings, together with the six information themes, confirm that more and more precise uncertainty insights could be developed under the information paradigm and with the information layer model, than previous research was able to establish under different paradigmatic lenses.

In Chapter 8, these six themes identified from the observation analysis are constructed into a conceptual framework for a better understanding of uncertainty in projects under the information paradigm. This addresses the fourth research question on how to replace the task-based paradigm with an information-based paradigm to re-frame underlying concepts in order to better understand uncertainty in the domain of the real with its underlying structures and causal powers. Away from the normative and prescriptive tradition of the traditional paradigm, this framework should provide the concepts and the terminology to support academics and practitioners to grasp uncertainty dynamics in projects more clearly and more precisely. These concepts should also provide a more suitable theoretical basis for the development of more adequate management methods and tools. Chapter 8 then reviews the limitations of the thesis’s findings and establishes its contribution to knowledge. Lastly, it discusses prospects and implications for future research which may further enhance the findings of this study.
Chapter 2 - Project Management and Uncertainty in Projects

2.0 Introduction

Projects are undertaken because people and organisations recognise that certain objectives cannot be achieved by continuing with routine processes (Turner 2009; PMI 2004; PRINCE 2 1998). Meeting these objectives usually requires identifying and co-ordinating an appropriate approach, along with the individuals involved in implementing this approach (Cleland and King 1983, p.12). The discipline of PM intends to offer concepts and methods to do so efficiently and effectively.

When considering projects and PM, the academic literature and professional community in the main refers to the traditional body of knowledge consisting of a common set of widely acknowledged core concepts and principles of the discipline. This chapter discusses the literature on these core PM concepts in the traditional view of the discipline, and then critically explores the relationship between this traditional approach to PM and project uncertainty.

The first sections detail definitions of project and PM, followed by a discussion of the application area and development of PM, to understand its origins and the challenges faced today. Next, literature on the core concepts of projects and their management are discussed. These concepts from the traditional body of knowledge are contrasted with the characteristics and management requirements of projects undertaken today. It is established that projects in new fields of application today are dominated by novelty, change and complexity which result in new types and levels of uncertainty. A classification
of projects into a spectrum from hard to soft is introduced reflecting this development, and
the different types of uncertainty occurring in hard and soft projects are examined,
contrasted, and defined, and typical sources of project uncertainty are discussed.

2.1 Defining “Project” and “Project Management”

The term 'project' is identified in similar ways throughout the PM literature, though the
definitions show varying degrees of complexity and detail. The Nordic Project
Management Terminology defines a project generally as “an organized undertaking, limited
in time to achieve specific objectives.” (NORDNET 1985). Baker and Baker’s (1992)
definition of a project follows along the same lines, define a project as “...a unique venture
with a beginning and an end, undertaken by people to meet established goals within
defined constraints of time, resources, and quality”. This definition also assumes that
project goals have to be established; however, this may not always be the case (cf. 3.1.3).
In fact, Morris (2004) argues that the only thing projects have in common which
distinguishes them from operational work is that they go through a common life-cycle
development sequence. Notwithstanding this, most definitions imply that the objectives of
a project are usually defined in terms of time, cost and scope or quality specifications, often
referred to as the T-C-S triangle, or 'Iron Triangle'. Rosenau (1988) defines a project based
on this triangle as “an organized undertaking utilizing human and physical resources, done
once, to accomplish a specific goal, which is normally defined by a Triple Constraint.”.
The most widely acknowledged definition by the PMI (2004) picks up on the time
limitations and describes a project as “a temporary endeavour undertaken to create a
unique product or service”. Turner (1999) adopts a similar approach and picks up on the
unique aspects of a project, describing it as:

“...an endeavor in which human, material and financial resources are organized in a novel way, to
undertake a unique scope of work of given specification, within constraints of cost and time, so as
to achieve unitary, beneficial change, through delivery of quantified and qualitative objectives.”.
(p.3)
This definition is adopted when relating to a projects under the traditional task based paradigm, throughout this study. It should be clarified though that, while a “scope of work of given specification” may be intended as the project is approved and initiated, this may be very high level, or may in fact turn out to be inadequate as the project proceeds.

Similar to Turner’s (1999) definition, the Association for Project Management (APM) (2002) focuses on uniqueness and change, describing projects as “unique, transient endeavours undertaken to achieve a desired outcome. Projects bring about change”. Such emphasis on uniqueness and change, as well as the challenge of co-ordination of activities and management resources under these circumstances are mentioned in various other definitions (Turner 2009; Martin and Tate 1997). All these definitions describe the essential features of a project as a unique piece of work, undertaken in the form of a novel organizational structure, to deliver change.

These qualities of uniqueness and inability to predict the future imply that projects carry uncertainty (Turner 2009, p.5). Pich et al. (2002) argue that projects which carry particularly high levels of uncertainty cannot be adequately represented in such traditional definitions that often assume the existence of pre-determined goals and a strict breakdown into different phases and tasks, because too many factors influence the project, which cannot all be modelled. Pich et al. (2002) offer a definition which they argue caters to project settings with high uncertainty by modelling a project “…as a payoff function that depends on the state of the world and the choice of a sequence of actions”. They describe this function as a cause-effect relationship of the impact of project members’ actions to effects on the world and argue that the project team’s understanding of the cause-effect relationship depends on the available information, i.e. the amount of uncertainty in the project.

Based on the definitions of a project, PM can be defined as the management of these undertakings. Standard definitions of PM tend to centre on the process, outcomes, and sometimes on the art of handling projects. For instance Kerzner (2009) defines PM as planning, organizing, directing, and controlling an organisation’s resources to implement a relatively short term objective that has been established to complete specific organisational goals. So PM is "... the application of knowledge, skills, tools, and techniques to project
activities to meet project requirements (PMI 2000, p.6). Tahir et al. (2009) provide more detail to the PM definition and adopt a PLC-based view (cf. 2.3.1):

“The manner of implementation, of expertise, paraphernalia, knowledge and modus operandi to an extensive range of activities for the fulfilment of prerequisite of the specific project. Project management knowledge and practices can be defined upon individual processes. These individual processes can be: Initiating, Planning, Executing, Controlling and Closing”.

Wideman (1995) and others (Baker and Baker 1992; PRINCE 2 1998) base their definition on the T-C-S triangle defining PM as "the application of modern management techniques and systems to the execution of a project from start to finish, to achieve predetermined objectives of scope, quality, time and cost, to the equal satisfaction of those involved.” (Wideman 1995). The PRINCE 2 (1998) PM method of the Office of Government Commerce (OGC) defines PM as “the planning, monitoring and control of all aspects of the project and the motivation of all those involved in it to achieve the project objectives on time and to the specified cost, quality and performance”. This definition adds the dimension of people management and hints at the role of the project manager, discussed in the following section. The APM (2002) places more emphasis on efficiency and effectiveness of the project deliverables in defining PM as “…the process by which projects are defined, planned, monitored, controlled and delivered such that the agreed benefits are realised. ... and project management is recognised as the most efficient way of managing such change”.

All of the above definitions commonly highlight the focus of PM on controlling and coordinating the unique and change-prone settings and undertakings. Therefore, Atkinson et al. (2006) argue that “much good project management practice can be thought of as effective uncertainty management” (p. 688). Under conditions of increased uncertainty, the more process and outcome focused definitions of PM may be less applicable, and some of the more complex definitions discussing the management of people, timing, focusing on benefits, etc. may be more appropriate.
2.1.1 The project manager

One of the earliest formal descriptions of the project manager role can be found in Gaddis (1959) as part of early attempts to understand the new organisational form of projects, following a unique period of development in the NASA and Apollo missions. Gadis (1959) describes a project manager as the “man inbetween” the requirements of the technologists and the expectations of the executive management, who has to ensure that the deliverables are produced within the agreed schedule and budget. This view has remained in traditional PM until today. Turner (1999) describes the project manager as the central figure in a project who coordinates the internal and external project forces, such as the project context with political economical social and legal pressures, the stakeholders influence and support, intra-organisational pressures around resources, as well as core project drivers around resources, organisational and structural factors for planning, controlling, reporting, quality and people management (p. 70).

A great stream of literature discusses qualities and responsibilities of project managers. Many definitions (Rational Software Corporation 2002; Wideman 1995) focus on the fact that project managers merely have the task of applying PM tools and techniques to plan and monitor a project and bring it to completion. These definitions focus on the application of technical skills. Wilemon and Cicero (1970) argue that project managers have to have both, technical and people managerial skills (p. 276). Cleland and King’s (1983) description of project managers furthermore adds a leadership dimension. The PMI BoK (2004) describes three dimensions of PM competency: PM knowledge, performance competency (application of PM knowledge), and personal competency (attitudes and characteristics). Prince 2 (1998) similarly refers to PM competency, as well as the personal skills in describing the requirements for a project manager. Various research attempts to identify a set of skills and qualities for successful project managers (Turner and Müller 2005; Fabi and Pettersen 1992). However, the approaches used in these studies show little convergence with regard to how such qualities and abilities can be researched. Different studies focus their investigation on different research frameworks, using distinct parts of the PLC, or looking at distinct behaviours or tasks (Fabi and Pettersen 1992).

While it may not be feasible at this point to precisely determine the skills or the cognitive qualities of a project manager, it can be generally derived, based on the definitions of
projects and PM provided above, that the role of the PM is to facilitate the structuring of projects, as well as to co-ordinate and support people by applying the mindsets, methods and tools offered by the discipline. This includes co-ordination and support in managing uncertainty stemming from complexity, uniqueness and constant change. The more of these a project faces, the more complex skills, beyond the application of PM tools and methods, will be required. Seymour et al. (1992) support this conclusion by arguing that one of the key tasks of project managers is to encourage and cultivate flexibility, adaptability and supporting project members to accept and manage permanent change.

2.2 Development of the Discipline and Fields of Application

The discipline of PM has grown enormously since the middle of the last century, from sporadic use in large engineering and construction projects to ubiquitous and global practice in various industries. In order to appreciate the current shape of the field and its challenges, it is helpful to explore the state of the discipline, and how it has evolved over the last decades.

Most sources identify the 1950s and 1960s as the start of the current PM paradigm (Shenhar et al. 1997; Morris 2004). During that time, the American Defence Industry advanced the field profoundly (Urli and Urli 2000) with an initial focus on activity network techniques, such as the Program Evaluation and Review Technique (PERT) and the Critical Path Method (CPM), which allowed project managers to find the critical path of pre-defined and sequenced tasks (Lockyer 1969). The assumption was that implementing these tasks along these paths would lead to the successful completion of a project. Common PM language, practice, and techniques used today, such as CPM and PERT occurred in that period (Morris 1997). Then early algebraic risk analysis was applied to these PM tools (Elmaghraby 1964). During that time PM was merely a sub-set of tools and techniques learned and applied by Engineers.

In the 1970s the Apollo Mission promoted and progressed PM practices dramatically. Increased focus was placed on functional use of breakdown structures and project planning
During that time project planning also explored a shift away from exclusively pre-defined tasks. Alternatively, tasks were seen as the outcomes of decisions, and their times were revealed as the project progressed by applying sequential decision making tools, such as dynamic programming or decision trees (Marschak and Radner 1972). Morris (2004) argues that the approaches developed during that time had some fundamental limitations, in that they were designed for programmes, such as the Apollo Mission, which were largely protected from the influence of external factors, such as threats to funding or stakeholder opposition. Projects today are much more prone to a wide variety of external influences, which implies potential inadequacy of these tools in many of today’s project settings.

In the following decade, increased emphasis was placed on project risk management (Shenhar 1996), exploring mostly numerical risk assessment and control models and tools (Boehm 1989; Chapman and Cooper 1983; Cooper et al. 1985; Armin 1987; Perry 1986). This research stream developed to critically investigate numerical risk management and extended into research on project uncertainty in the 1990’s (Schrader et al. 1993), investigating similar numerical approaches to uncertainty management as explored for risk management, applying for instance decision theory and game theory (Jovanovic 1999) or algorithms to reduce uncertainty and optimize traditional PM tools, such as the CPM or PERT (Arsham 1993; Mummolo 1997).

In the last decade, a wider range of project uncertainty has been investigated, with increasing focus on qualitative aspects, as well as investigation of the different phases where uncertainty impacts projects and to what extent, with the aim of developing methods of addressing these (De Meyer et al. 2002; Pich et al. 2002). Furthermore, the various sources of uncertainty, such as stakeholders, project objectives, project context, etc. are considered (Jensen et al. 2006; Ward and Chapman 2003; Perminova et al. 2008).

Since the 1990’s the field of PM has seen rapid and significant developments into new disciplines and industry sectors (Urli and Urli 2000). Turner (1999) lists a wide range of application areas for projects today, such as water, energy, transport and telecommunications projects in a range of sizes - from large projects with teams working across multiple organisations, to smaller ones, such as construction, engineering, facilities maintenance, software development, IT infrastructure, new technologies, research and
development, product launches, to education and training. Archibald (2006) categorises the current sectors where PM is applied based on the PMI Special Interest Groups (SIGs) (see Table 1), which are dedicated to and named after specific project categories. The top five areas of PM application and industry, represented by 165,000 members of PMI in 120 countries, are “computers/software/data processing, information technology, telecommunications, business management, and financial services” (PMI 2003, p 3), though the construction and aerospace/defence industries show the most mature PM areas of application (Archibald 2004, p.2).

<table>
<thead>
<tr>
<th>PMI SIGs relating to project categories</th>
<th>PM areas of application</th>
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<tbody>
<tr>
<td>Aerospace and Defence</td>
<td>Automation Systems</td>
</tr>
<tr>
<td>Automotive</td>
<td>Design-procurement-construction (across all economic sectors)</td>
</tr>
<tr>
<td>Dispute Management</td>
<td>E-Business</td>
</tr>
<tr>
<td>Environmental Management (pollution remediation and prevention)</td>
<td>Financial Services (banking, investment)</td>
</tr>
<tr>
<td>Government</td>
<td>Healthcare Project Management</td>
</tr>
<tr>
<td>Hospitality Management (major events, such as the Olympic Games)</td>
<td>Information Systems (software)</td>
</tr>
<tr>
<td>Information Technology and Telecommunications</td>
<td>International Development (infrastructure, agriculture, education, health, etc., in developing countries)</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>Marketing and Sales</td>
</tr>
<tr>
<td>New Product Development</td>
<td>Oil/Gas/Petrochemical</td>
</tr>
<tr>
<td>Pharmaceutical</td>
<td>Retail</td>
</tr>
<tr>
<td>Service and Outsourcing</td>
<td>Urban Development (potential SIG)</td>
</tr>
<tr>
<td>Utility industry (generation and distribution of electric power, water and gas)</td>
<td></td>
</tr>
</tbody>
</table>

Table 1: The specific interest groups (SIGs) within PMI® that relate to project categories and specific areas of application of PM, taken from Archibald (2006)

In reviewing a number of studies that present overviews on PM topic coverage or points of emphasis for PM, various studies commonly list a coverage of the topics of information management (Themistocleous and Wearne 2000; Zobel and Wearne 2000; Betts and Lansley 1995) and Project Risk (Morris et al. 2000; Themistocleous and Wearne 2000; Zobel and Wearne 2000), indicating that these represent two of a number of core interest points of PM.
2.3 Defining Elements of Projects and their Management

The following sections discuss a number of PM constructs and structures related to project development sequences, planning and control, staff structure and participation, and views on project success. These constructs are focused on as they constitute the core elements which shape a project. The discussion of these details how projects are understood, structured, and managed. This provides the frames of reference for understanding how uncertainty is captured and addressed within these structures.

2.3.1 The Project Life-Cycle

The PLC describes the development sequence of a project. It facilitates the organisation of a project by dividing it into phases or stages which a project runs through from initiation to completion. For each phase, the discipline offers various tools and techniques (PMI 2004; Association for Project Management. 2002; Kerzner 2009; Turner 2009). The majority of authors hold in common that PM is used throughout the entire PLC, from the initiation and definition stages, through to hand over and post-project reviews, such as “lessons learned” (Morris 1997; Turner 2009; Kerzner 2009).

While various PLC models exist (British Standards Institute 1996; PMI 2004; Forsberg et al. 2005; Turner 2009; Kerzner 2009; Pinto 2007; Morris 1997), most follow a similar structure, starting in its simplest form with a Conception or Initiation phase where the business need for a project is confirmed (for example through a business plan), funding is put into place, and the project is initiated. This is typically followed by a Definition or Planning stage where the project plan would be created. During the Planning stage work packages are traditionally broken down with a WBS based on available budgets and overall planned activity, and the project duration is estimated. Project schedules are produced which, together with the project budget, form project constraints and provide a roadmap against which delivery of the project is managed (Shenhar and Dvir 1996). In the subsequent Execution or Implementation phase the focus lies on the delivery of the project objectives and the function of PM is to track and control progress against the plan. In these phases cost profiles and staffing curves tend to peak. (Turner 1999) In the Closure and Review phases the project deliverables are handed over to the customers or to the
operations business team, and a “lessons learned” analysis of the project and its management identifies areas of improvement for future projects. Within each of these phases another PLC may be embedded similar to a sub-project (Morris 2004).

Each of the phases has a set of performance criteria associated, and the completion of each stage denotes the completion of a particular set of deliverables (PMI 2000, p.11) which need to be fulfilled to complete that particular phase. The number of PLC stages is determined by the project context. Usually projects were identified to have four to five phases (PMI 2000, p.13), however, this number may vary from three to over ten (Stretton 2000, p.4). Usually, stages are linked in a linear order with a "... generally sequential logic ..." (PMI, 2000, p.11), so that a preceding phase is completed prior to initiating the following stage, as the deliverables from the previous stage may form the basis for the initiation of the following phase.

Atkinson et al. (2006) argue that “many significant sources of uncertainty that need to be managed in projects are associated with the fundamental generic management process that makes up the project life cycle” (p. 689). Chapman and Ward (2003) offer an overview of uncertainty issues per PLC phase (see Table 2), highlighting the diversity of sources and contexts in which project uncertainty arises. They argue that all of these should be addressed very early in the project and throughout the PLC, by understanding the stakeholders, their goals and motivation, required resources and time scales.

<table>
<thead>
<tr>
<th>Stages of the PLC</th>
<th>Uncertainty management issues</th>
</tr>
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| Conceive the product              | Level of definition  
Definition of appropriate performance objectives  
Managing stakeholder expectations |
| Design the product strategically  | Novelty of design and technology  
Determining ‘fixed’ points in the design  
Control of changes |
| Plan the execution strategically  | Identifying and allowing for regulatory constraints  
Concurrency of activities required  
Capturing dependency relationships  
Errors and omissions |
| Allocate resources tactically     | Adequate accuracy of resource estimates  
Estimating resources required  
Defining responsibilities (number and scope of contracts)  
Defining contractual terms and conditions  
Selection of capable participants (tendering procedures and bid selection) |
| Execute production | Exercising adequate coordination and control  
| | Determining the level and scope of control systems  
| | Ensuring effective communication between participants  
| | Provision of appropriate organizational arrangements  
| | Ensuring effective leadership  
| | Ensuring continuity in personnel and responsibilities  
| | Responding effectively to sources which are realized  
| Deliver the Product | Adequate testing  
| | Adequate training  
| | Managing stakeholder expectations  
| | Obtaining licences to operate  
| Review the Process | Capturing corporate knowledge  
| | Learning key lessons  
| | Understanding what success means  
| Support the product | Provision of appropriate organization arrangements  
| | Identifying extent of liabilities  
| | Managing stakeholder expectations  

Table 2: Typical uncertainty management issues in each stage of the project life cycle (adopted from Chapman and Ward 2003)

While in the traditional PM literature argues that the linear PLC outlined above is common to all projects (Herbst 2004; Morris 2004), a number of alternatives can be found in the literature which deviate from the linear understanding, offering iterative loops (PMI 2000, p.6; Cooper 1994, p.12), spiral models, ladders (Stretton 2000, p.4), or a series of overlapping stages for fast tracking (PMI, 2000 p.12). Such different patterns determine varying ways of how planning, controlling, and implementation activities are undertaken and managed. In fast tracking, the stages described above may be overlapped, so that completion of one phase is not required to start the next, instead the following phase may be started as soon as sufficient output is available. This approach offers a way of reducing the length of a project (PMI 2000, p.12), as the detailed planning of the workpackages of later phases is postponed until required, “so that as much of the current information as possible is used to derive activities” (Turner 1999, p.114). In iterative loops, the PLC described above may be run through several times, as planning of the entire project may not be possible at the project start, just as implementation of the project in one go may not be possible. Instead, planning of the next steps may be based on the output of the previous loop. Nevertheless, some features of the PLC can generally be recognised as standardised in projects, such as the fact that the capacity of stakeholders to influence the project outputs decreases throughout the PLC. Furthermore, cost and staffing curves tend to apply in that both tend to be lowest at the project start, while risk and uncertainty are highest at the start of the project and decrease over time. (PMI 2000, p.12; Winch 2004)
2.3.2 Project goals

The various definitions of projects and PM outlined in section 2.1, all of which directly or indirectly centre on project goals, highlight the importance of this concept for PM. Goals shape projects and direct their management. Traditionally it is assumed that project goals are pre-determined, clearly defined, and stable (Hobbs and Miller 2002; Crawford and Pollack 2004) from the project start. They would be defined based on clear requirements from the business stakeholders or the project customers, for example in a business plan. The project planning exercise then de-constructs the goals into work packages and project tasks which can be implemented to deliver the project. Traditional PM tools and techniques, such as CPM and PERT, build on this approach. (Koskela and Howell 2002) Therefore, it is not surprising that goal clarity is a factor commonly linked to project success (White and Fortune 2002; Pinto and Slevin 1988; Posner 1987). Crawford and Pollack (2003) define such well established goals as “tangible goals”. They argue that goals are more likely to be clearly defined when they are tangible and vice versa, and explain that this is more likely to be the case for construction and other engineering projects, as opposed to projects with abstract intangible goals, such as organisational change projects which are more prone to rely on judgment and subjective interpretations. While many of the definitions of projects and PM call for clearly defined goals (cf. 2.1), Crawford and Pollack (2003) and Neil (1995) for example, detail that it is accepted that the degree of goal definition necessary for different types of projects differs. Clearly defined goals are, however, a prerequisite for the application of various traditional PM tools and techniques, such as CPM or PERT. Therefore, the early reduction of uncertainty into certainty is a focus of many PM methods and techniques (Turner and Cochrane 1993; Winch 2004). Hence, where the project goals cannot be clearly defined it is not possible to use these (Turner and Cochrane 1993, p.98). Therefore, many of the traditional PM tools become inapplicable in volatile, complex, or unique projects with uncertain goals.

One of the key assumptions in PM is that the change of established project goals is prevented and they will only be reviewed if a significant external factor, such as a changed customer requirement, or policy change, requires a re-direction of the project. It is assumed that the project members do not initiate change. This assumption represents a traditional view on project goals that they are relatively straight-forward to identify or pre-
defined, and that changes would be rare and have to be averted, which may be unrealistic in today’s conditions of fast change.

2.3.3 Planning and Control

The function of planning in PM is to define and co-ordinate activities over time, in order to identify the most efficient approach to achieving project goals. There is broad recognition of the benefits of a "... focus on planning processes, broken down and analyzed ..." (Melgrati and Damiani 2002, p.371). The majority of the PM BoK is dedicated to planning processes (PMI 2004).

Though a lot of PM literature already discusses planning, Atkinson et al. (2006) still argue that “a common source of difficulty in projects is a failure to carry out the design and plan stages thoroughly enough” (p.689) and, hence, an increasing trend towards planning and controlling can be found in the PM literature, as it is believed that these help handling the complexities of projects (Kloppenborg and Opfer 2000; Couillard 1995). According to a survey executed by the Standish Group International (2000), 80% of project successes or failures may be linked to planning. Similarly, Posner (1987) found that inadequate planning was frequently identified by project managers as problematic, particularly around resource allocation. If the project has not been well planned and defined upfront, this will in the view of the traditional PM paradigm cause difficulty during execution, resulting in additional planning and design development requirements which negatively affect the T-C-S performance criteria (Atkinson et al. 2006).

Turner (1999, p.69) contends that project managers allocate insufficient time to planning at the project start. This may be attributed to the fact that project managers tend to feel pressure to progress (Ramsay 1996) and to adhere to the typically tight schedules most projects tend to be forced into (Dumont et al. 1997). According to Atkinson et al. (2006) insufficient planning “...can be most acute in novel, one-off projects involving new technology, particularly when key stakeholders attempt to impose unrealistic completion dates or cost targets” (p.689) due to politically motivated performance criteria, too small budgets or intangible and ill-defined goals.
Estimating

Estimating project activities is a critical part of the planning process (Atkinson et al. 2006). For instance, project staffing is derived directly from estimates by dividing the person-day cost estimate by the project schedule. Particularly in software projects, the correct forecast of staff numbers was shown to be critical to project success. Overstaffing can lead to increased communication and coordination overheads, which reduces productivity. Understaffing in contrast, can cause project delays, volatile priorities, and inadequate testing of the software (Lehder et al. 1988). Buehler et al. (2002) and Armor and Taylor (2002) discuss the various causes of uncertainty around the development of estimates and plans. Factors, such as novelty, complexity from interdependencies, or large numbers of factors impacting a project, emerging factors which were not known at the project start, or optimism bias by the estimators are listed as causes. This highlights that reliable up-front project planning and estimating in highly uncertain project environments is a great challenge.

Control

After a project plan has been developed and baselined, PM then focuses on its execution. During execution the use of control mechanisms serves to check that the outcomes of project tasks and work packages match the progression of the project plans and ultimately that the progressing of these tasks leads to achieving the project goals with the planned resources (Hackman and Walton 1986; Pinto 1988; Mohrman et al. 1995; Steckler and Fondas 1995; Trent 1996; Kloppenborg and Petrick 1999; Zaccaro et al. 2001). The approach of project implementation control based on a pre-determined plan has been associated with a traditional view of PM (Remington and Crawford 2004). Under the traditional PM lens, increased level of detail in project plans is linked to an increased level of project control (Turner 1999).

The PLC is also considered a control tool, as it structures the progress of a project (PMI, 2000, p.11). The division into separate stages allows allocating particular tasks to each stage, and it can then be checked that these are completed at the end of each stage gate, and that the stages are passed through in the planned time and with the estimated and allocated resource.
The feedback stemming from control processes provide the basis for the determination of corrective actions where there are deviations between planned and measured performance. Yeo (1993) argues that establishing "... control mechanisms [is] one of the most important ingredients in successful project management" (p.113). Early control was found to be most beneficial, as early deviations are easier and less costly to bring back on track as projects usually apply budget and staffing curves, or alternatively the project can be terminated early (Turner 1999, p.320). Traditional PM thinking is dominated by these principles of creating control, over the idea of learning, knowledge creation, and improvement (Crawford and Pollack 2004).

2.3.4 Project organisation

Traditional PM tends to adopt a clear top-down cascaded organisational structure where equally top-down and centralised control structures and processes can be applied. In this set-up the management gives orders, which are cascaded and implemented by the lower levels of the project organisation, assuming “…that the central project manager knows 'best'" (Williams 1997, p.221). This is a traditional mechanistic approach to the organisation of project members, which appears to assume that the tasks that are planned and triggered are fully understood by the management who orders them, and that they are started and implemented in line with the forecast (Koskela and Howell 2002). This approach aligns with the traditional functional paradigm where projects are considered a means of achieving goals which are fully understood and accepted by all members (Cleland and King 1983). Kerzner (1989) describes the advantages of such a classical hierarchical organisation. These include easier budgeting and cost control, more resource flexibility as well as a broad resource base to work with, easily definable and understandable lines of responsibility, good control over personnel due to clear reporting structures, and purely vertical and clearly established communication channels. On the other hand, such a structure makes co-ordination complex and increases decision times, as approval must be thought through the hierarchies, motivation and innovation are decreased, and no integrating function or focus on functional relationships across the hierarchical silos are present. (Kerzner 1989, pp.100–101).
In larger or more complex projects organisational breakdown structures (OBS) are specified to define the authoritative and reporting relationships among members. These are detailed in diagrams to provide a contextual overview and define and communicate the reporting and control structure. Such OBSs cannot represent the complex informal project structures that are bound to exist among project members. But both, the formal and the informal structures, affect projects. While plans, policies and procedures formally prescribe "how the elements are to relate. On the human side, the informal organization prescribes how the people want to relate" (Cleland and King, 1983) and what teams they form. The formal structure is controllable, and can hence be project-managed to maximise project outcomes. The traditional PM literature tends to discuss the optimisation of the design and the lines of control for OBSs to be as beneficial as possible, while generally paying little attention to human factors, evolving interaction patterns among project members, and group or team dynamics.

Kerzner (1998) discusses the fact that the requirements for organisational structures to be more dynamic are increasing, as environmental conditions may demand rapid restructuring due to technological changes, competition, changes in customer demands, etc. At the same time staff turnover is more rapid; suppliers and competitors join and leave the market in shorter intervals; and customer requirements and expectations change and evolve rapidly. In such an environment, projects are under intense pressure to deliver customer and stakeholder satisfaction, with market and financial success (Nogueira and Raz 2006). As a result, the effects of uncertainty and organisational structure on people’s performance may be quite significant. In some industry sectors, such as pharmaceuticals or software development, project members tend to be more specialised, so that more empowering structures than the traditional hierarchy may be of more value (Bourne and Walker 2005). Nogueira and Ratz (2006) found that centralized and highly structured organizational structures as described above are more effective under low uncertainty conditions, while decentralised flexible team based project structures are more valuable under such conditions of high uncertainty. They conclude that

“In uncertain environments, when the goals and tasks are not fully defined, it is best to avoid a highly structured and tightly controlled project team structure. Maintaining a loose organizational structure with significant flexibility is even more important in dynamic situations where tasks are not only ill-defined, but also change and evolve over time” (p.8).
This allows easier communication and control, and shared authority and responsibility (Kerzner 1989, Bourne and Walker 2005), and maximises the capability to identify and execute value adding tasks (Nogueira and Ratz 2006). However in the traditional PM view increased participation and empowerment can be seen as a reduction of project control for a central project manager, and thus a threat, because it could be argued that individuals at specific project levels do not have a large enough information horizon for their decision making (Williams, 1997, p.220).

2.3.5 Communication: Information management in projects

Project communication essentially is a means of information management. The purpose of it is to support the information requirements of the stakeholders, and to support the information exchange among project members and stakeholders to shape and progress a project (PMI 2004). This includes the “timely and appropriate generation, collection, dissemination, storage and ultimate disposition of project information” (PMI 2000, p.117) to convey information in a clear, concise and traceable way. Project communication and reporting planning should determine which information adds value to whom, i.e. which audience requires what type of project information, in which intervals and in what form (Baker 2005; Hartley 2003; Schwalbe 2005). In relation to that Baker (2005) explains that timing, channel, medium and stakeholder selection varies throughout the PLC.

In the traditional project organisation with a hierarchical chain of command (cf. 2.3.4), formal communication flows vertically through clear channels (Burns and Stalker 1961). This implies that, the further down in the hierarchy project members are, the less of an informational overview on the project they will have. The design of a steep hierarchical structure means that the majority of people are low in the hierarchy, and will hence have a restricted view on the project information and communication. In these highly structured settings, the communication channels are likely to be restricted and the amount of available information limited (Duncan 1973; Huber et al. 1975). Häggren and Manninen-Olsson (2005) found that where project goals are not fully clear or prone to change, or where projects deviate from the plan, a holistic and complex understanding of the project is
important. In such situations they found that there is a need for interaction and networking, giving importance to communication management.

While the larger part of project communication management is often related to effective document production and distribution, another important part of project communication relates to the management of meetings. International Organization for Standardization (ISO) (2003) outlines the formalisation of appropriate meeting standards, including agendas sent out in advance, meeting minutes with decision outcomes, actions, and assignments with agreed deadlines. However, this norm does not address requirements for meeting preparation, conducting meetings, and reviews of meeting effectiveness and improvements. In other words, points that can make communication more purposeful and minimize time are not addressed.

According to the PMI (2003) project communication includes:

- Determining the information and communication requirements of the project stakeholders.
- Implementing methods to monitor project progress, such as status meetings and reports; Developing a communications plan detailing who will receive information, what information, when, and in what format; how the information is gathered and stored.
- Making required information available to project stakeholders in a concise and timely fashion, using verbal, textual and graphical reporting tools.
- Setting and re-setting stakeholder expectations if required.
- Managing client and stakeholder relationships to ensure commitment and involvement, and to encourage effective collaboration.
- Reporting on the progress of project schedule, cost and scope. Comparing present status to the baseline and forecast future trends using earned value analysis. Warning stakeholders if changes will affect them.
- Managing business process changes as necessary.
- Generating, gathering and disseminating information to formalize phase and project completion.
- Conducting a post-project audit and ensure that the actuals, risks, general findings and 'lessons learned' are documented and disseminated to support a continuous learning culture. (PMI 2003)
The traditional PM body of knowledge does not provide in-depth information or guidance about project communication. The formal methods traditionally discussed in the literature (e.g. PM BoK 2003) may not always be purposeful in supporting a project's needs, as for instance it was found that more focus on the formal communication in the form of reporting may hinder project progress and hence increase project duration, as "Spending time gathering information on the project and writing technical or schedule reports means less time to be spent on the project, thus causing more delays" (Couillard 1995). While the formal guidance of the project literature may help setting up traditional overarching information management structures for reporting purposes, communication driving the project content-wise may be taking place at a more granular interpersonal level, and may be of a more dynamic nature. It has been found that many project success factors are linked to interpersonal relations (Couillard, 1995). Hällgren and Maaninen-Olsson (2005) found that “…formal [project management] methods were more time-consuming than the use of informal communication and interaction with the parties concerned.”

Bourne and Walker (2005) argue that the PMI BoK (2003) focuses on traditional PM competencies involving planning and controlling, and does not provide the same focus on topics, such as project communication management. However, communication in a wider sense of information exchange has been found by various studies to be of great importance for project success (Barry and Pascale 1999; Pinto and Harbanda 1995; Standish Group 2001; Ritchie and Jorgensen 2007). For example in a study of 50 projects, Ritchie and Jorgensen (2007) found that the management of communication improved stakeholders satisfaction, reduced project risk levels, and increased overall project success. Pinto and Slevin (1988) state that communication with the client throughout the project is a vital success factor. However, Muller and Turner (2002) state that projects "... often lack good communication beyond the boundaries of the project team ..." (p.387) and project managers tend to focus on the traditional T-C-S factors, while neglecting communication and information flow requirements (Bourne 2003). White and Fortune (2002) note that effective communication with diverse stakeholders can be challenging for the project manager. Turner (1999) argues that though it is in the project manager's interest to facilitate communication among the project parties, this topic is not identified in the literature as one of the core and most commonly named tasks when looking at the tasks of a project manager.
Following the above review of the traditional definitions, history, and application areas of PM, and having defined the core elements of projects and their management, the following section examines the paradox of projects being unique ventures by definition, versus the standardisation of such unique undertakings into the relatively uniform PM methods and tools outlined above. The consideration of projects as standardised or unique has implications for the uncertainty conditions in projects, as uniqueness would imply more uncertainty, and vice versa.

2.4 The Paradox of Project Management Standardisation vs. Project Uniqueness

The PM discipline is experiencing a conflict between uniqueness and standardisation. Projects follow standardised definitions, patterns, methods and tools, which implies generality. On the other hand, projects are by definition unique (cf. 2.1) (Atkinson 1999; Soderlund 2004). Therefore, Melgrati and Damini (2002) question: "To what extent ... it [is] possible to think of a unitary discipline and a standard body of knowledge if the output from a project is by definition 'unique'" (p.372).

Understanding this paradox is important for this study, as it has direct implications for project uncertainty; uniqueness implies greater uncertainty. If projects are not unique, but to a certain extent standardised and repeated, uncertainty would be expected to be lower, and easier to manage, as it should be possible to resort to experience from previous projects or to common learnings, in order to cater for and apply similar risk and contingency planning. Secondly, the question arises that if there is little or no commonality among projects, how can they be effectively managed by a generic set of traditional PM methods and project uncertainty management tools.

2.4.1 The commonality argument

The majority of PM publications argue that projects are profoundly similar (Shenhar and Dvir 1996). The PMBOK® Guide (PMI, 2000, p.5) recognizes the "...presence of
repetitive elements..." in project work, which lead to an assumption of generalities in terms of rules, structures, processes, methods and tools to manage these. Along these lines, most PM literature defines PM as a set of standard activities (Shenhar 1996). This argumentation drives the standardisation of PM as a homogeneous professional discipline (Dean 1997).

The development of PM competency standards has implicitly facilitated calibrating the common understanding of the 'generic' project and its management standards. This is evidenced in the numerous standards and Bodies of Knowledge for PM worldwide, such as the ECITB (2004), P2M (2004), OSCEng (1997), PMI (2004), PMSGB (2002), PSETA (2000), V-Modell XT (2006). It is also reflected in Wang’s (2001) statement that shared "... work-related values and beliefs ..." (p.16) among PM professionals exist. However, this idea of commonality appears to mainly relate to the common language, methods, and tools discussed throughout the PM literature.

Kloppenborg and Opfner (2000) found that the "... most frequently considered future trend was support for increased standardization ..." (p.55) in anticipation that this would be likely to contribute to the rate of project success. It has been argued that the notion of project uniqueness could be destructive, or at least impeding to the development of the discipline, as this view denies the opportunity to accrue generalisable PM insights (Cooper 1994).

2.4.2 The uniqueness argument

Notwithstanding the argument above, concurrently projects are frequently defined as “unique endeavours” in the PM literature (PMI 2000, APM 2002, Turner 1999, Shenhar 1996) (cf. 2.1). In line with these definitions, Shenhar and Dvir (1996) argue that in the majority of cases projects exhibit significantly more differences than they share similarities. If PM was one single coherently defined discipline, it could be expected that its description in the different bodies of knowledge shows obvious and ample similarities, but "... amazingly, the professional PM societies currently have quite different versions of the BoK" (Morris et al. 2000, p.156).
The dissimilarities among projects may stem from the fact that they are used in different contexts, for example in different industries. Such differences would consequently put different emphases on the different areas of the BoKs (Morris et al. 2000) and would adhere to different PLCs which match each field’s requirements (Stewart and Fortune 1995). An example of this would be using an iterative PLC for the development of new software solution, compared to a classic waterfall model dominant in the construction industry. A great amount of research also associates differences in projects with differing practice across the world (Al-Arjani 1995; Munnsa et al. 2000; Andersen et al. 2002; Chan et al. 1999; Cheung and Chuah 1999; Yang et al. 1997). On these grounds, it is explicable that an adaptation of PM processes to suit the unique requirements of the circumstances of each project was identified to be necessary by various studies, such as McElroy (1996) or Shenhar (2001).

A great number of project categorization and classification systems have been proposed to identify and comprehend the differences among them, because for every different project category "... a whole different set of problems and potential project management techniques may apply" (Evaristo and Van Fenema 1999, p.280). Classification frameworks use properties, such as:

- Degree of goal definition (Turner and Cochrane 1993).
- Risk management (Floricel 2001).
- Industry and area of application (Archibald 2004; Pinto and Slevin 1988; Zobel and Wearne 2000).
- Degree of project hardness or softness (Crawford and Pollack 2004), further discussed in 2.4.4.

2.4.3 Changes to the PM discipline

The uniqueness-similarity paradox can be analysed in view of developments in the field outlined in 2.2. The expansion of the application of PM beyond the traditional construction and aerospace industries into a variety of new fields today has "... changed the scope of what is now termed a 'project"" (Stewart and Fortune 1995, p.279). Yet, the "... wide deployment of projects in organizations today, has not been accompanied ... by a
parallel development in project management theory" (Shenhari and Dvir, 1996, p.607), further discussed in section 3.2. The conflict between uniqueness and similarity arguments may epitomize the standpoints of different practitioner groups: Those professionals who apply PM in new fields and hence experience the deviation of their novel projects from traditional practice, which causes the feeling of inadequacy of PM standards; and those practitioners who employ the traditional PM approach to the original fields, hence experiencing adequacy and applicability of standards.

The application of PM has expanded rapidly over the last decades. Projects are applied in almost every field and for a vast variety of problems. The Standish Group (2000, p.1) declares the “project gold rush in full swing”. However, projects may have become a victim of their success and there is empirical evidence of the predominance of project failure. The PMI declares that more than 70% of projects in large organisations do not meet their established objectives. Miller and Lessard’s (2001) study yielded that only 45% of the projects they studied met most of their objectives, and 19% only met some of them, 16% had to be restructured fundamentally, and as much as 20% were discontinued. In the context of software projects Beck (2004) argues that “Projects fail to deliver, and fail to deliver value” (p.3). As a reason he states that “The basic problem of software development is risk” (bid) and the management thereof with the traditional approaches discussed in the first part of this chapter.

As the application of projects has evolved beyond the traditional engineering fields, a number of new characteristics and boundary conditions have appeared which are hard to reconcile with the traditional perspective on PM. When the traditional engineering industries were the primary users of PM, project delivery focused on delivery within the parameters of the T-C-S triangle, change was a linear process, and technology grew in an incremental predictable and proportional manner (Bourne and Walker 2005). Bourne and Walker (2005) note that “When the world of business ‘discovered’ projects to deliver business outcomes and organisational change ...” PM became more complicated, as organisations developed from simple functional structures into complex matrix structures where “... the idea of change as a linear process gave way to the idea of change as non-linear where the ‘whole’ was not just the sum of its parts because the relationships between the parts had to be included into the equation”. Projects grew faster, bigger, more complex in content and technical challenges. PM has to handle a more global dissemination, more
dynamic or fuzzy goals, more unstable requirements and conditions. Today projects have to be successful in an increasingly dynamic environment: with new products, technologies, capabilities becoming available and obsolete in faster cycles. Customer requirements and expectations evolve and change in short lead times, so there is more pressure to deliver customer and stakeholder satisfaction. Relating to these conditions, De Meyer et al. (2002) point out that “... it’s obvious that ... in an era of rapid change, uncertainty is a rule, not an exception” (p.67) as all these factors contribute to projects being increasingly hard to define and carrying increased amounts of intangible and often qualitative metrics. Variables set at the outset may become fuzzy again (Jaafari 2001). Sometimes project stakeholders “get a better understanding of their needs and improved ability to express the needs” (Olsson 2006, p.66) late into the project. Goals may not be entirely clear, neither is the most efficient way in which to achieve them or the understanding of sometimes still immature technologies and their utilization. Turner (2009) summarises the factors that cause project uncertainty as “uniqueness, novelty, and transience” (p.5). In summary, such projects may exhibit the following characteristics:

- Be embedded in volatile environments (less mature environments).
- Use more qualitative critical success factors (and key performance indicators).
- Have various solution options (no clear requirements / specifications).
- Have higher stakeholder involvement with more abstract value expectations.
- Have intangible and shifting goals, priorities, inputs, performance metrics, and results.

The above discussion shows that while a project can be considered a standardised pattern to a certain extent, with a defined start, end and some form of aim to create value, some projects may be more standardised in terms of following a traditional project life-cycle, involved stakeholders, and technologies. On the other hand, there are projects which take place in new sectors or use novel technologies which traditional PM has not been developed for. These projects might be more unique as they are applied in new fields, or environments, or to achieve new strategic organisational benefits where choosing the organisational form of a project is sensible, but it may not initially be clear how to structure it, or what the concrete goals are and who all stakeholders are. Crawford and Pollack (2004) have developed a scale to measure the degree of standardisation or uniqueness of projects, outlined in the following section.
2.4.4 The hard – soft spectrum to measure project uniqueness

Crawford and Pollack (2004) provide a research-based framework for the analysis of project processes and outcomes with regard to their degree of softness. This framework constitutes of seven dimensions, classifying hard and soft projects, detailed in Table 3. Examples for both ends of the spectrum would be typically well-defined, predictable calculable engineering or construction projects which can be easily copied, at the highly standardized end of the spectrum vs. fundamentally novel projects exploratory Research and Development (R&D) projects, organizational change or Merger and Acquisition (M&A) projects at the unique end of the spectrum.

<table>
<thead>
<tr>
<th>Dimension</th>
<th>Description</th>
<th>Project at the hard end</th>
<th>Project at the soft end</th>
</tr>
</thead>
<tbody>
<tr>
<td>Goal/ objective</td>
<td>Relating to the clarity of the project specification/requirements and/or the uncertainty level related to the way in which to achieve these</td>
<td>Assuming that goals are clearly defined in advance, are clear to the people involved in the project, and do not have to be revisited throughout the project. They provide a stable planning direction. The task of PM in this scenario is to optimize the implementation of these goals.</td>
<td>Project goals may be vaguely defined, or not at all. Those involved in the project may not share the same understanding of the goals. The goals may change throughout the project and are subject to interpretation. The project is not about finding the one best way to provide a solution. The process must be managed through exploration, negotiation, creativity and learning.</td>
</tr>
<tr>
<td>clarity</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Goal / objective</td>
<td>Relating to the ability to clearly describe the desired result in objectively measurable entities in order to develop a clear understanding for all involved vs. goals which leave room for interpretation and judgment, involving qualitative and relative measures</td>
<td>Objectives can be well described and clearly represented.</td>
<td>The project starts out with fuzzy specifications, requiring goal clarification throughout. Continuous sense-making and checking mutual understanding by those involved is required.</td>
</tr>
<tr>
<td>tangibility</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Success measures</td>
<td>Use of quantitative or qualitative measures to judge project progress and success. These generally tend to require a high tangibility level. Under low tangibility conditions, in soft projects, they tend not to work effectively.</td>
<td>The hard paradigm works mainly with quantitative data e.g. EVA, PERT or Gantt charts. Which analysis framework is applied, is usually decided in advance. The interpretation of quantitative data leaves little room for projects which cannot be clearly defined – because of its simplification of reality, the choice of the right success measures may influence uncertainty levels in the project.</td>
<td>Working with vague or fuzzy situations in soft projects requires more reliance on holistic and abstract success measures, i.e. qualitative success measures, as quantitative measures cannot cover complex circumstances and are hence, not able to represent them adequately. This approach allows patterns of relevant information to appear, as opposed to an a-priori decision of which data to compile.</td>
</tr>
</tbody>
</table>

34
Project permeability: Factors influencing the project lie within the control of the project vs. lying outside the control of the project. To what extend is the project isolated or under external influence, which cannot be managed from within the project. This relates to scope, project size in terms of people and organization, boundary permeability and boundary fixity (i.e. boundary changes).

“Projects of short duration in stable environments and well developed fields might be seen as isolated from their environment, with an impermeable boundary, being unchanging in response to environmental changes.” (Crawford and Pollack 2004:648). In such cases, little or no environmental uncertainty must be dealt with by the project. Attention can be focused on a plan, implement and control approach.

Projects being subject to strong influence from their environment or lacking experience of determining clear boundaries will be more affected by changes of external conditions. In such cases, increased environmental uncertainty must be managed by acknowledging emergent information, exploration, exchange and negotiation, as well as exploiting opportunities which may arise through a change of external factors. Such projects require constant and active information gathering in order to monitor the environment.

Number of solution options: Efficient delivery of one single solution option vs. exploration of solution alternatives.

Those responsible for implementing the project may not always be involved in the goal setting process. Rather, they are required to implement pre-defined objectives. Such well defined projects focus on effective and efficient implementation of that requested solution.

“Where the opportunity for questioning the assumptions about goals occurs, it can be profitable to explore alternatives and seek innovative solutions” (Crawford and Pollack 2004). In such projects there is not one solution, but room for interpretation which option to choose. This approach allows for emerging options.

Degree of participation and practitioner role: Top-down approach with clearly defined WBS, task boundaries and roles vs. an integrated participative collaborative interdisciplinary (i.e. boundary crossing) team approach where project members work towards the bigger picture.

“An expert, non-participative approach may encourage faster project completion, but it increases the risk of ignoring potential innovation and contribution by stakeholders. Furthermore, assumption of expert status has been found to align with a reduction in learning and lower amenability to change” (Crawford and Pollack 2004).

“A participative approach can be more time consuming [57,58], but is suited to situations where it is necessary to negotiate between multiple perspectives or where participant ownership is necessary to the delivery of project objectives.” (Crawford and Pollack 2004).

Stakeholder expectations: Required interaction intensity between stakeholders.

Less stakeholder interaction required

Increased management of stakeholder expectations and information

Table 3: The 7 dimensions of hard- and softness in projects according to Crawford and Pollack (2004) and their link to uncertainty levels
Crawford and Pollack (2004) suggest the tool depicted in Figure 1 to clarify where on the hard – soft spectrum (left to right) a project is likely to be.

![Figure 1: Depictions of the hard and soft dimensions framework (Crawford and Pollack 2004, p.650)](image)

The discussions around the degree of standardization of projects (cf. 2.4) and their mapping into a hard and soft spectrum, discussed in the previous section 2.4.4, helps to differentiate the quality and extent of uncertainty along this spectrum, discussed in the following section.

### 2.5 Project Uncertainty in Hard and Soft Projects

As projects at the hard end of the spectrum show a higher degree of standardization, they can refer to more knowledge about project conditions, technology, stakeholders influence, etc. They have a greater repeatability, which means they can refer to a greater pool of prior experience. Events that could threaten such projects are, hence more likely to be known and the chance of them impacting the project can be estimated by resorting to previous experience, or knowledge among peers. When such threatening events can be identified, the PM literature refers to them as “known unknowns” (Cleden 2009; Loch et al. 2006; Winch 2010). Known unknowns are what the PM literature terms uncertainty (Winch...
threatening events can be identified but a meaningful probability cannot be assigned to their occurrence. When the likelihood of these events can be assessed, these turn into “known knowns” (Winch 2010, p.350), and are termed project “risk” in the PM literature (Chapman and Ward 2002; Kerzner 2009; PMI 2004; Conrow 2003). Often, probability theory is applied to assess these project risks. Hence, a project risk is often defined in the standard PM literature as “the product of the probability of an event’s occurrence and the extent of its impact.” (Loch et al. 2006, p.2; Conrow 2003). Winch (2010) distinguishes four schools of thought on the definition of project risk from the literature, and its relation to the concept of probability:

- The **objectivist school** represents a frequentist statistics view, where the probability of the occurrence of an event can be deduced from information held about previous occurrences from a known population. This school represents a predictive approach, attempting to “predict future events from known data about risk sources” (p.ass348)

- The **logical** school focuses on the probability of a failure event in engineered systems. While there may be either none, or only a limited data set available for the failure event which is not usable for statistical methods, the expert’s understanding of the system and the principles this system is based on, can be used to identify sources of risk and probable failure events. This approach is also of a predictive nature.

- The **subjectivist** school employs a Bayesian statistics approach, using the degree of belief held by the risk assessor for a certain event. This school forms the basis for the traditional PRM tools. In essence, this school is prescriptive, providing tools and techniques for how decisions should be made.

- The **behavioural** school emphasises actual behaviour under uncertainty. Empirical research techniques summarised under this school comprise a variety from ethnographic to experimental, with a **descriptive** goal.

Winch (2010) adds the **cognitive** school to this list, drawing on features of the subjectivist school and parts of all of the above, but retaining the distinction between uncertainty and risk, where a probability distribution can be applied to the occurrence of a risk event. The cognitive model is presented in Figure 2, where the occurrence of a future event is somewhere between certain or impossible.
If a data set is available, and changes in that data set would not happen, objectivist probability can be assigned as one specific point in the certainty – impossibility continuum. However, in practice it is unlikely that such conditions would exist. So usually, the project members would be somewhere in the space between the two axes of certainty-impossibility, and information amount. In this space, “the perception of the project manager about the sources of risk in that space, and the occurrence of risk events given those risk sources is fundamental to the sense made ... by the project manager” (Winch 2010, pp.349–350). This model makes explicit that the handling of risk and uncertainty is fundamentally about perceptions of risk events based on the available information. It is not a phenomenon that exists independent of human observers. The model highlights the difference in perceptions between conditions where a probability distribution can be assigned to an event by a project member, based on available data, and where this cannot be done.

Beyond known unknowns (uncertainty) and known knowns (risks), there are events that can impact the project which cannot be identified, or if they can be identified there is not
enough information available to assess their likelihood\(^1\). The PM literature terms these “unknown unknowns” or “unforeseeable uncertainty” (Loch et al. 2006; De Meyer et al. 2002; Cleden 2009; Winch 2010). Winch (2010, p.350) describes these as “...the cognitive condition of uncertainty where the risk source has not been identified and therefore the risk event cannot be known”. Taleb (2008) for instance describes the black swan as such an unknown unknown – a high improbability and high impact event. In projects on the harder end of the scale, there will be less of such unknown unknowns, due to their degree of standardization and knowledge about the factors impacting the project. They are traditionally managed through contingencies. However, such strategies counteract the traditional PM notion of plan, implement and control.

For projects towards the softer end, a lot of events may be identified and assessed, leading to a lot of risks. But additionally, a lot more unknown unknowns will also be present (Loch et al. 2006; Pich et al. 2002; De Meyer et al. 2002; Winch 2010), due to project novelty, in the form of new project environment, or use of new technology for example. In this case contingency planning is not useful, as the contingencies cannot be sensibly assessed.

A further factor that can cause unforeseeable uncertainty is complexity stemming from unanticipated interactions of a large number of project factors, such as project tasks or stakeholders, so that “…the whole is more than the sum of the parts in the weak but important pragmatic sense that, given the properties of the parts and the laws of their interaction, it is not a trivial matter to infer the properties of the whole” (Simon 1996, p.184). This complexity is dependent on the size of the project and the number of interactions among its parts. A large project does not have to be complex if there is little interaction among its tasks or stakeholders. From Simon’s (1996) definition of complexity, it becomes evident that unforeseeable uncertainty is caused as the interactions among the influencing factors of a project and its tasks are either not fully known or understood. Even if unknown unknowns could be foreseen, if there are many known unknowns with a lot of interactions, this complexity also leads to unknown unknowns as it cannot be

\(^1\) While the subjectivist view on probability suggests that a probability can always be assigned, this statement refers to a situation where there is no valid theoretical or empirical basis to confidently assign meaningful probabilities.
practically predicted and managed, so it would also be impossible to develop contingency plans.

Cleden (2009, p.13) adds a fourth category of uncertainty, which he terms the “unknown knowns”. These refer to information that would be available for the project or within the project, but has not been researched or communicated. Winch (2010, p.350) also discussed unknown knowns, but describe these as “...uncertainty where somebody knows about the risk source and associated probabilities, but is keeping that information private”. As Winch’s (2010) work focuses on construction projects, this more intent-focused definition may be tailored to those specific conditions, where contractors working on the same project may conceal potentially damaging information from each other. However, for the purpose of this study, Cleden’s more general definition of unknown knowns is adopted.

While other subject disciplines may define uncertainty differently, the above definitions are consistent with the majority of publications in PM on project uncertainty management (Loch et al. 2006; Pich et al. 2002; De Meyer et al. 2002; Cleden 2009; Perminova et al. 2008; Häggren and Maaninen-Olsson 2005; Turner 2009; Kerzner 2009; PMI 2004; Winch 2002; Chapman and Ward 2002), and will be adopted for the purpose of this study.

### 2.6 Sources of Uncertainty in Projects

Various authors have attempted to detail sources of uncertainty in projects. Ward and Chapman (2003) for instance distinguish sources of uncertainty in five areas throughout the PLC:

1. Uncertainty associated with estimates, due to lacking clarity of specification for tasks, novelty, inexperience, complexity of interfering factors and inter-dependencies, and limited analysis.

2. Uncertainty about the assumptive basis of estimates, with problems of relying on subjective, potentially biased, estimates in the absence of objective probabilities which can only be scrutinized to a limited extent.
3. Uncertainty about design and logistics during project execution with regard to the coordination of efforts.

4. Uncertainty about the nature of objectives, performance criteria; priorities, and acceptable trade-offs and their understanding by different stakeholders.

5. Uncertainty about the relationships between project parties, resulting from complexity and ambiguity with regard to responsibilities, roles, communication, capabilities, contractual conditions, and mechanisms for coordination and control.

Atkinson et al. (2006) identify similarly three sources of uncertainty:

1. **Uncertainty in estimates**, which appear to be similar to Ward and Chapman’s (2003) points 1 and 2 above. These relate to:
   - “lack of a clear specification of what is required;
   - Novelty, or lack of experience of this particular activity;
   - Complexity in terms of the number of influencing factors and associated inter-dependencies;
   - Limited analysis of the processes involved in the activity;
   - Possible occurrence of particular events or conditions which might affect the activity;
   - Emerging factors unknowable at the start of the project;
   - Bias exhibited by estimators, typically optimism bias” (Atkinson et al. 2006, p.688)

2. **Uncertainty associated with project parties**, which resembles point 4 and 5 above. This source concerns:
   - “uncertainty about the level of performance that will be achieved;
   - The objectives and motivation of each party;
   - The quality and reliability of work undertaken;
   - The extent to which each party’s objectives are aligned with the project owner’s objectives, and the scope for moral hazard where one party is motivated to do things which are not in the best interests of the project owner;
   - The actual abilities of the party;
   - Availability of the party.” (Atkinson et al. 2006, p.688)
3. *Uncertainty associated with stages in the PLC*, which partly relates to point 3 above. This source of uncertainty assumes a traditional PLC structure, and discusses the uncertainties emerging due to the inadequacies of this structure for uncertainty management, which are caused by complexities that cannot be managed adequately. Here, uncertainty around the planning stage, estimates, and specifications is discussed, as in Ward and Chapman’s (2003) points 1 and 2 above. Risks and uncertainties are also attributed to the development of the project structure. During the execution stage of the PLC Atkinson et al. (2006) identify design changes as a common uncertainty source. However, it could also be argued that a change is a result of uncertainty management, rather than a source; though changes may introduce new uncertainty around estimates, co-ordination, and execution.

Various research publications address a specific source of uncertainty, such as task uncertainty, environmental uncertainty, or stakeholder uncertainty. Task uncertainty, which is part of Atkinson’s et al. (2006) point 1 and 3 above, has also been a central concept in research on organizational design and in the field of new product development (e.g. Mullins and Sutherland 1998; D’Avino et al. 2005). Task uncertainty is common in specific types of projects that often involve a high degree of softness. Tatikonda and Rosenthal (2000) in the field of new product development link task uncertainty to quality of task outcome, stating that: “Higher task uncertainty implies high variability in and unpredictability of exact means to accomplish the task, in turn leading to poorer task outcomes”. Hence, Tatikonda and Rosenthal (2000) believe that uncertainty is inherent in the task. This definition from a new product development perspective particularly finds tasks are rarely standardised, especially in very soft projects. Tatikonda and Rosenthal (2000) identify “technology novelty” and “project complexity” to fundamentally contribute to task uncertainty.

Jensen et al. (2006) discuss the sources of uncertainty in projects from environmental determinants which influence project processes and outcomes. Similarly, Collyer and Warren (2009) do not directly discuss uncertainty, but indirectly identify the project environment as a source of uncertainty by discussing issues around highly dynamic project environments. Jensen et al. (2006) provide a model to classify uncertainty in projects, into what they term, “interactional uncertainty”. Projects are strongly interdependent and
dependent on their environment in terms of resource and support. Jensen et al. (2006) “…argue that there is a need of a demarcation between uncertainty related to institutional norms and values on the one hand, and uncertainty related to relationships between involved actors on the other hand”. They believe that environmental uncertainty has a more direct impact on a project because it influences the project member’s task performance. Such an argument connects environmental uncertainty in a project to task uncertainty. Jensen et al. (2006) distinguish vertical and horizontal uncertainty, the former relating to hierarchy-related issues, such as funding, and planning and control, and the latter refers to interaction with actors in the project environment. Vertical relations between the project and its principals are argued to cause uncertainty by diverging objectives, interests and information which they reduce to lacking trust. With regard to the horizontal dimension, they stress that uncertainty changes over time and that actors in different kinds of projects can influence uncertainty through their behaviour. This type of uncertainty appears to correspond largely with Ward and Chapman’s (2003) point 5. Whereas vertical uncertainty appears to reflect points 1 – 3 of Ward and Chapman’s (2003) categorisation. Daft and Armstrong (2009) and Duncan (1972) demonstrated that a dynamic project environment with a great frequency of changes is a source of uncertainty. Such changes in combination with high complexity create increased uncertainty.

Ward and Chapman (2008) discuss stakeholders as a major source of uncertainty in projects, with regard to their identification, their scope of influence over the project, and the motivations that drive their actions. In this context they characterize uncertainty indirectly in their definition of risk, which is identified as “the implications of uncertainty about the level of project performance achievable” (Chapman and Ward 2003, p.12). Karlsen’s (2002) study yielded that project stakeholders play a major role in project execution and create a lot of uncertainty during this phase due to outstanding decisions, sudden changes in project specifications, clients being too focused on details, not understanding their role in the project, change of political guidelines, and end-users not knowing their needs. Their analysis did not identify any particular group of stakeholders more likely than another to cause more uncertainty. Clients, suppliers, line organisation, public authorities and end-users appear to have contributed equally to create project uncertainty.
The preceding discussion highlights that there is no consistent understanding of project uncertainty across the literature. However, the uncertainty sources described and addressed in the different literatures show common themes around sources of uncertainty relating to:

a) Project planning and control, including fundamental unknowns around project goals or approach, carrying uncertainty into project tasks and implementation, which highlights difficulties regarding the use of the traditional upfront PM planning and control approach for soft projects;

b) Use of novel technologies or working in new contexts where little experience can be resorted to, which highlights the difficulties for novel projects;

c) Stakeholder interaction and impacts, as described in Crawford and Pollack’s (2004) soft project measures;

d) Complexity around co-ordination, tasks, structure and logistics, as discussed in this section.

The above discussion highlights that uncertainty sources in projects are identified from a traditional PM perspective in the majority of the literature. This becomes evident by the traditional project concepts, phases, and PM activities it is identified in relation to, such as estimates, planning, and control. For example, across the literature, there appears to be a tendency of identifying more sources of project uncertainty related to the project start (e.g. around estimates, objectives, planning, project structure, etc.). This highlights the threat of uncertainty for the traditional PM approach which requires upfront planning, and hence the reduction of uncertainty at the start of the project.

2.7 Conclusions

This chapter defined projects, highlighting the unique and change prone nature of these undertakings, and hence the importance of uncertainty management in this discipline. It also defined PM as a specific traditional mind-set and methodology with common core
concepts and methods. These core elements of PLC, project goals, planning and control, project organisation and communication were described as they shape a traditional project, and also shape how projects are understood, structured, and managed. It was described how the discipline developed, having experienced an enormous growth from sporadic use in clearly defined conditions of engineering and construction projects, to a global practice used in a wide variety of industries and settings.

The chapter then discussed the uniqueness paradox, arguing that on the one hand projects are per definition unique undertakings, but on the other hand, they are summarised under a standardised discipline and addressed with a generic set of methods and tools, which form the basis of most professional bodies today. This discussion was concluded in the argument that a project can be considered a standardised pattern as it has a start, an end, and some form of value creating activity inbetween. However, the degree to which it is able to follow the clearly defined traditional structure can depend on the stability of its environment, novelty factors, stakeholder influence, change, and various other factors. This conclusion on project uniqueness led to the introduction of the hard – soft spectrum of projects to as a measurement of project uniqueness. These were linked to different degrees of uncertainty. Projects on the harder end of the spectrum are more standardised and can hence refer to more knowledge about project conditions, stakeholders, technology, etc. so that they carry less uncertainty. And for the remaining uncertainty there is sufficient experience to build in meaningful contingencies. Soft projects may be able to identify a lot of uncertainties, but additionally, a lot more unknown unknowns will be present due to project novelty, which leads to further uncertainty from the complexity of unanticipated interactions, so that the application of traditional standardised patterns of upfront planning and implementation control is less functional. This makes soft projects more unique and the application of traditional uncertainty management methods less purposeful.

In the context of this discussion, project risk is defined, and different schools of thought on the definition of project risk are distinguished, from frequentist to subjectivist, and prescriptive to descriptive views. Different types of uncertainty are distinguished where probability distributions can either be assigned, or where not enough information is available to assign meaningful probabilities - from known knowns to unknown unknowns. This is followed by an analysis of the literature on the sources of project uncertainty. This analysis leads to the conclusion that uncertainty sources are identified largely from a
traditional PM mind set, and the focus on its disturbance of a traditional PM pattern from estimate, upfront planning, to implementation control.

While the above chapter discussed the traditional view of projects and PM, and described and defined the types of uncertainty which can exist in projects, the following chapter will critically challenge the ability of this paradigm to adequately manage all levels of uncertainty across the spectrum of hard and soft projects.
Chapter 3 - Critique of Approaches to Project Uncertainty Management

3.0 Introduction

Chapter 2 introduced the traditional body of the PM discipline, which form the majority of PM approaches and academic contributions. This was contrasted by the more recent expansion of the PM discipline into new sectors, and the increased amounts of uncertainty in these new soft projects, in comparison to the hard projects for which the traditional PM methods and tools were developed.

The following chapter firstly expands on the shortcomings of the traditional PM approach for the management of uncertainty in soft projects. This is followed by a critical review of the theoretical underpinning of the discipline, highlighting the tensions between the traditional theoretical foundations on the one hand, and the novel theoretical and paradigmatic considerations which have been used in the search for better ways of managing soft projects with their high levels of uncertainty. This discussion draws out the difficulties in reconciling and integrating such new approaches with the traditional theoretical foundation of the discipline, which led scholars to question the adequacy of this traditional theoretical core to support all types of hard and soft projects.

Finally, this chapter describes and critiques novel approaches to managing uncertainty in soft projects, and a case is made for adopting the information processing view to progress this topic. This proposal is then detailed in the subsequent chapter 4.
3.1 Challenging Traditional Management Approaches for the Handling of Uncertainty in Soft Projects

Firstly, the suitability of the core uncertainty management method in traditional project management (PRM) will be critically examined for the management of the uncertainty levels within soft projects. As the application of PRM presumes the application of other traditional methods and tools as prerequisite, such as traditional project planning, project control, project goals, and project information structures, sections 3.1.2 to 3.1.4 will then critically review the shortcoming of these to adequately support the management of uncertainty through traditional PRM for soft projects.

3.1.1 Shortcomings of Project Risk Management to address uncertainty in soft projects

Risk Management in itself appears not to be the problem for managing uncertainty; rather it is the universal application of PRM to the entire spectrum of projects and their inherent uncertainties. PRM is well established. It is clearly defined, and formalised PRM strategies are described by the PM bodies (Association for Project Management. 2002; PMI 2004) and handbooks (Kerzner 2009; Turner 2009; Winch 2002; Pinto 2007). However, various literatures assert that PRM is not particularly effective for soft projects due to the different types and intensities of uncertainties occurring (DeMeyer et al. 2002, Pich et al. 2002, Loch et al. 2006, Crawford and Pollack 2004) (cf. 2.5). Project Managers trained in the traditional standard PM thinking tend to have no grasp of understanding that there are different degrees of project softness, and apply the standard PRM methods.

PRM is firmly established in the traditional PM paradigm. It was introduced into the discipline as early as the 1960s (Elsner 1962; Elmaghraby 1964) and has since formed an integral part of PM with well defined and formalised methods (Chapman and Ward 2003; Wideman 1992). Project risk is traditionally defined as “the product of the probability of an event’s occurrence and the extent of its impact.” (Loch et al. 2006, p.2). This definition points at the approach of PRM, to identify these events, and assess their potential impact on the project. Once identified and impact assessed, project risks are then usually prioritised, and monitored, and preventive or mitigating strategies are put into place (PMI
2004). Under the traditional PM paradigm, it is assumed that the aim of using PRM is to identify all unknown unknowns and turn these into risks (Royer 2001). The underlying idea is that PRM “...attempt(s) to create a project infrastructure and environment that can flexibly respond to events in order to bring the project back under control, should events, both foreseen and unforeseen, arise.” (Loch et al. 2006, p.3). For foreseen events risk can be identified, assessed, and preventive or mitigating action can be put in place. For unforeseen events, contingencies can be put into the project plan.

While many authors focus entirely on the negative impacts of risks, PM scholars have lately suggested that these impacts can also be positive and provide an opportunity for the project (Atkinson et al. 2006; Pich et al. 2002; Perminova et al. 2008; Ward and Chapman 2003). However, the analyses throughout the literature are argued to be incomplete still, for example Atkinson et al. (2006) claims:

“Effective uncertainty management needs to address uncertainty in a broad sense, with the early consideration of all sources of significant uncertainty and associated responses. Even when integrated with project management, formal project risk management processes that adopt a focus on threats will not adequately address many sources of variability and ambiguity. Risk management processes concerned with threats and opportunities will do better, but will still tend to be focused on uncertain events or circumstances. This does not facilitate consideration of aspects of variability that are driven by ... lack of information” (p.690)

In order for PRM to work, a traditional project plan is required, as PRM is based on identifying and managing risks against such a plan. This approach is based on the separation of planning and implementation, as it assumes the task of PRM to be ensuring any threats to the plan are prevented or mitigated. This approach works for hard projects, where there is sufficient information available at the project start to plan a project. However, it is not purposeful for soft projects as either no plan can be put in place, and this is either recognised, so that PRM cannot be applied, or plans are nevertheless put in place, but these are not useful as they are not based on sufficient stable information. This problem is discussed in the following section.
3.1.2 Reconsidering project planning for soft projects

One of the main limitations of traditional PM is its deterministic character, where it is assumed that the project goals and scope are fully knowable at the project start, an appropriate project plan can be developed to deliver these, and the challenge of project control only relates to keeping the progress to the forecast (Winch 2004). This approach only considers uncertainty to a very limited extent (Cleland and King 1983), as it is assumed that all possible alternative outcomes can be determined in advance. Traditional techniques, such as PERT, build on this assumption. However, as discussed in 2.5, there are various sources of uncertainty which complicate this, such as lack of clear goals, novelty or lack of experience in a particular area, complexity of impacting factors and their interdependencies, unforeseen events or conditions that can affect the project, and optimism bias from the project planner (Atkinson et al. 2006).

In PM, the use of a project plan is expected, as it provides a reference that allows stakeholders and project members to commonly understand and agree the direction of a project, as well as helping project managers to co-ordinate resource and implementation steps (Turner, 1999). As discussed in 2.3.3, increased detail of a plan traditionally assumes increased control. Conversely, detailing plans requires more effort and so a balance has to be found between the level of detail and planning effort. It needs to be considered to what further level of detail value is still added to the plan and to what degree of detail controlling is sensible and feasible, as overly detailed plans can lead to the over-management of projects (Turner, 1999) and increase cost disproportionately (Cleden 2009). Such intense planning focus can distract attention from addressing and progressing the actual project contents (Koskela and Howell 2002) and may lead to project failure, as it is challenging to keep detailed plans updated at all times (Yeo 2002).

Traditional PM tends to assume a formal up-front planning approach in a deconstructive manner, breaking the project down into work packages and tasks and optimising their sequence and execution at the start of a project. However, this approach has been questioned, as optimising the elementary parts of a project may disregard overarching and holistic aspects (Liu and Leung 2002). Therefore, less decompositionalist perspectives have been suggested by Taiwo et al. (1996), who furthermore explains that it is difficult to identify upfront which tasks have to be completed throughout the PLC, as the planning of
the later activities may depend on the outcomes of previous ones. Therefore, the entire project cannot be planned upfront, but instead requires a step-by-step approach reviewing the tasks as the project progresses. Abdel-Hamid et al. (1999) note that

“... initial plans merely show what was thought of as best when the plans were made. Since actual events on a software project almost always differ from the assumed events that the plans were designed to meet, project managers must react continuously to real world events that actually occur, and not to those that might have occurred had the real world been kind enough to conform to the initial planning assumptions.”

Thus, the need to adopt a more step-by-step approach to planning increases with project novelty which in turn increases uncertainty. Here, Turner (2003) and Loch et al. (2006), question how much upfront planning is sensible under such conditions where the future cannot be predicted and it can hence not be confirmed that a planned approach can deliver the objectives. Where project goals cannot be set at the start of a project and activities have to be identified and changed along the way to manage new information arising throughout the PLC, formal up-front project planning could be less useful to PM practice today than the traditional body of the discipline suggests. Cleden (2009) notes that “Many project plans are based on a static view of the world... Consequently, the plan only remains valid as long as the model of the future holds true.” (p.28). Turner (2003) and Cleden (2009) still argue for a project plan as a framework for co-ordination, but explain that there must be a preparedness to change that plan, for example in order to accommodate positive opportunities arising from change or from new information. Dynamic and continuous planning approaches to find the balance between insufficient and too much planning may be more adequate. Cleden (2009) suggests different types of plans: an initial base line plan detailing the project objectives and milestones and deliverables; a nominal plan which forecasts the project based on a current model of the world; and a representational plan, which incorporates strategies for uncertainty management and is constantly adapted in response to change. However, managing three plans may be just as impractical as managing one detailed plan in the traditional way. While these views may attempt to improve the planning process, they still show the strong influence of traditional PM thinking. Loch et al. (2006 p.2) argue that this traditional thinking, where “...one cannot have a project without a plan”, forces the project team to produce a plan. However, this plan is “...but a starting point, an illusion, a simple sketch... [it] does not really exist” (ibid),
as the project as it was planned may not be feasible. The project team may improvise but still not get the project back on track, and would eventually realise that their project plan was an illusion, wondering how they got to this point, rather than taking an approach from the start where the project context, goals, and approach are being investigated, forcing insufficient information into a deterministic up-front project plan. (Loch et al. 2006)

### 3.1.3 Contesting the traditional view of project goals for soft projects

The traditional view that clear project goals can be set at the early stages of a project and remain clear and steady throughout the PLC is being challenged in the literature for the new intangible, novel, and change-laden context in which PM is often applied today. Halman and Burger (2002) found that after project kick-off workshops more than half of all project managers did not yet grasp their project's purpose or scope entirely. In some fields where PM is applied today goals are of an abstract nature (Crawford and Pollack 2004; Turner 1999) causing individuals to feel uncertain about the project. An example for this would be organisational change projects, or highly end-user removed IT projects.

Traditional PM approaches are not equipped to handle such projects where goals are not clear and steady, as a pre-requisite for up-front planning. In such situations, the traditional stream argues for investing effort into defining the goals as soon as possible, to then applying the traditional planning and control methods. However, attempts to define goals may force an otherwise organic process that takes time and requires information conditions to unfold, resulting in overly simplified goals, or goals that do not represent the actual needs of an organisation. Defining goals too soon may also close down opportunities where a project would have benefitted if the goals had been kept flexible for longer (Daniel 1990, Cleden 2009, Turner 2003).

At the beginning of many soft projects, their scope, stakeholder group, or objectives may be poorly defined, intangible, or even conflicting (Abdel-Hamid 1999, Crawford and Pollack 2004). Different stakeholders may have conflicting goals, such as maximising functionality versus reducing cost. Concentrating on one of these may cause other goals to suffer (Boehm and Ross 1989). Boehm (1981), hence, argued that a constant process of goal reconciliation and management is required. Similarly Neal (1995), De Meyer et al.
(2002), and Cleden (2009) explain that goals may change a lot in fast changing project environments, even where requirements were assumed to have been finalised. As a stakeholder’s grasp of the project develops, their ideas of the requirements may develop as well. This process can lead to changes of project goals and requirements. Crawford and Pollack (2004) in this context discuss goal stability and management of these changes through exploration, negotiation, creativity and learning (cf. Table 3). Furthermore different stakeholders may have differing perceptions, from different backgrounds and consequently many use different language and concepts within an organisation or across involved organisations and parties. These may complicate understanding and pursuit of the goals in a converging way, and hence hamper project progress (Butterfield and Pendegraft 1996). In such cases, a purposeful definition of goals may be an iterative process of definition and adaptation (Turner and Cochrane 1993).

3.1.4 Challenging the traditional project organisation for soft projects

The traditional approach to projects, as described in section 2.3.4, assumes a highly structured project organisation, often with steep hierarchies. Duncan (1973) and Huber et al. (1975) explain that in such highly structured organisational environments, communication channels are likely to be restricted and the amount of available information limited (cf. 2.3.4). In contrast, Hällgren and Maaninen-Olsson (2005) and Crawford and Pollack (2004) conclude, that uncertainty is ideally handled by taking an explorative approach, which implies a requirement for an open information structure. (Hällgren and Maaninen-Olsson 2005) found in their study of project uncertainty that “…formal [PM] methods were more time-consuming than the use of informal communication and interaction...” for the management of uncertainty. Their research yielded that most communication in cases of uncertainty happened through informal channels, highlighting that the formal project structures were inadequate in handling the information needs. This corroborates Duncan’s (1973) research, which found that “When individuals are faced with uncertainty ... and strategies dealing with this uncertainty are not clearly covered by pre-established rules and procedures, greater reliance must be made on the informal network of relationships.” In order to improve this information constraint of traditional project structures, (Hällgren and Maaninen-Olsson 2005) suggest quarterly project reviews to increase communication, reflection, interaction and learning (less for control purposes).
However, this may be merely a limited remedy for a symptom, rather than a comprehensive solution to the underlying problem.

While in many situations the required information may not be available within the project context, Schrader et al. (1993) also discuss the problem where information is available within the project, but not accessible for those who need it to progress their work. Schrader et al. (1993) note that “...the structure of existing information channels may not link the problem solver to this information.” (p.85). They found that project members will focus their efforts along those paths where information is readily available, and if some information is easier to access than other, this can influence the direction of the project. Burns and Stalker (1961) offer a solution to this in the form of lateral communication networks, which facilitate information flows outside the direct scope of the problem solver’s work. Structures, such as the strict hierarchical traditional silo project structures do not provide a lot of horizontal communication linkages, and hence inhibit free information exchange. The flip side to this is that because such tight structures are not designed to provide a lot of freedom of information exchange, high uncertainty is less likely to be accepted, as these structures do not support the acquisition of information (Schrader et al. 1993). Furthermore, Schrader et al. (1993) note that “Information filters often inhibit the flow of information that contradicts existing expectations”.

Hällgren and Maaninen- Olsson’s (2005) research found that once a project deviates from the plan as a consequence of uncertainty, this is managed through gathering and processing information, for example through networking. Along these lines, De Meyer et al. (2002) argue, that the more uncertainty there exists in a project, the more the information and communication style must be adapted, away from the “Exchange of structured information along defined interfaces [towards an] exchange of unstructured information along emerging interfaces” (p.66). In contrast, Daft and Lengel (1986) argue that managers have to limit the amount of information that is processed to reduce uncertainty because not all information about the world can be processed:

“Managers try to find decision rules, information sources, and structural designs that provide adequate understanding to cope with uncertainty. One challenge facing organizations is to develop information processing mechanisms capable of coping with variety, uncertainty, coordination, and an unclear environment.”
In summary, it appears that projects with high uncertainty may benefit from a communication and information culture that is:

- “organic and informal, supplementing formal”
- “egalitarian with a flat management hierarchy“
- “supporting of experimentation“
- “sharing of rewards for experimentation”
- “tolerant of failure”
- “valuing experimentation and the elimination of ‘dead ends’ “ (Collyer and Warren 2009)

3.2 Exploring the Theoretical Foundation of Project Management

The discrepancy of uncertainty conditions in novel projects, and the inadequacies of the traditional theories, tools and methods to support these, as critiqued in the previous sections, is the cause of recent controversy among scholars with regard to the theoretical foundation of the PM discipline (Geraldi et al. 2008; Turner 2006a; Turner 2006b; Turner 2006c; Winch 2004), and the scientific solidity of PM research (Smyth and Morris 2007). Therefore, the following sections examine the theoretical foundation of the discipline, and the philosophical underpinning and paradigms that support it.

PM is an applied discipline (Morris 2002, p.31), created out of practical pressures and needs (Betts and Lansley 1995), and therefore developments are often driven by PM professionals. Moody and Bruist (1999) argue that scientifically, PM classifies itself as an applied science, employing theory from other disciplines in order to solve practical problems, rather than developing its own theoretical foundation. Jugdev (2008) argues that young disciplines typically tend to use other theoretical foundations from established disciplines, such as the social sciences or engineering disciplines, until they develop their own. And so a diverse collection of concepts from various social and natural sciences is applied to understand and manage projects better (Smyth and Morris 2007). Because PM is resorting to insights from various disciplines, "... project management has been more often compared to a heterogeneous toolbox than to a body of knowledge in elaboration" (Urli
and Urli 2000, p.33). This leads various scholars to question the field’s coherence (Cimil and Hodgson 2006, Winch 2004). Subsequently, professional PM associations’ BoK’s are based on different concepts and theoretical foundations, causing confusion as to the theoretical basis of the discipline. Subsequently, various scholars argue that the PM discipline is currently lacking a sound theoretical basis (Shenhar 1996; Geraldi et al. 2008; Söderlund 2003; Winch 2004) and that the concepts are inadequate for robust development (Morris 2002, p.31). Moreover, it is argued that due to this lack of a sound theoretical foundation, the understanding of what is actually happening in projects is “insubstantial” and theory is unable to adequately guide practice (Blomquist et al. 2010).

Judgev (2008) argues that “the use of theories in project management is more implied than explicit and the theoretical foundations used need to be more clearly articulated” (p.177). This is in line with a study presented by Smyth and Morris (2007) that reports that only a small number of PM authors explicitly discuss the philosophical underpinning of their research. Consequently, many scholars assessing the scientific PM journals call for more sound theory development (Betts and Lansley 1995; Engwall 2003; Meredith 2002; Morris 2001; Packendorff 1995). Remington and Crawford (2004) argue, however, that PM practice "... is indeed underpinned by a rich theoretical base, which has been informed by prevailing trends in philosophy. Nevertheless the philosophical underpinnings remain unacknowledged by a profession which is focussed on practice." (p.1).

It is argued that a more explicit statement of the PMI BoKs theoretical foundations, as well as researchers explicitly stating the theories they use (Judgev 2008), and the research paradigms that are applied (Smyth and Morris 2007), would help to develop the theoretical foundations of PM. Beyond that, Judgev (2008), Koskela and Howell (2002), and Morris (2010) argue that a comprehensive analysis of existing research can provide an understanding of which theories form the foundation of PM.

Blomquist et al. (2010) approach this issue from the opposite end, arguing that PM research should go back to investigating what is actually happening in project practice in a bottom-up manner, to build an understanding of what is done and why, and what tools and interactions are used, rather than imposing new models onto practice where it is not clear how adequate they are. The latter, standard top-down approach, imposes theories based on deductive reasoning, potentially biased assumptions, and partial analysis, which may
therefore be irrelevant in practice, or self fulfilling if used to guide practice. Instead, Blomquist et al. (2010) suggest that “the interplay between practitioners, the episodes they create, and the tools they use are the basic building blocks that need to be understood and explained.” (p.13). Facilitating a dialogue between practitioners and theorists in this way will advance the value and relevance of PM theory (Blomquist et al. 2010; Cimil et al. 2006; Jugdev 2008), as “the ultimate judge of good theory in an applied field is primarily its practice” (Lynham 2000, p.169). This approach may be better equipped to “add considerably to understanding the profound project management challenges in contemporary organizations.” (Blomquist et al. 2010, p.14).

3.2.1 Paradigms of Project Management

Apart from the epistemological and ontological foundations that inform research, a discipline, such as PM, creates schools of thought, “… embodying systems of ideas and beliefs” (Smyth and Morris 2007, p.424). These paradigms shape the discipline for practitioners and academics and by extension their tools and methods. The predominant traditional PM paradigm, the concepts of which were outlined in 2.3, is rational and normative. It is focused on goal achievement, by purposefully co-ordinating efforts and resource in a disciplined, planned and controlled way. This represents a functional paradigm, which is informed by a quantitative, top-down methodology, where it is assumed that the complexity of a project can be simplified by deconstructing it into smaller parts which can be implemented (Remington and Crawford 2004). This view is reflected in the use of deconstructing methods and tools, such as the WBS and OBS, with the assumption that a co-ordinated and planned completion of the deconstructed parts progresses and completes the entire project.

In the search for a clearer understanding of the theoretical foundation of PM, various scholars suggest slightly different paradigmatic categorisations of the field, dependent on the purpose of the categorisation (Hodgson and Cimil 2006; Söderlund 2002; Bredillet 2007; Artto and Kim Wikström 2005), for example the purpose of PM, the management approach, the research focus, or project context. Winter et al. (2006) for instance identify six schools of thought:
1) The traditional rational deterministic paradigm of systems analysis - most dominant in PM research and teaching (Smyth and Morris 2007),
2) Organisational design – focusing on the features of the ad hoc and temporary project organisation;
3) Project-based structures - considering strategic and other external factors that impact projects;
4) Strategic direction – extending the understanding of projects to be tools for implementing organisational strategy, with a focus on organisational context and competencies;
5) Information processing – focusing on uncertainty reduction through information management; and
6) Critical management – employing critical social theories to understand PM as a means of social control.

Pryke and Smyth (2006) offer a categorisation based on project context. Beyond the traditional and functional paradigms, they distinguish the relationship approach, where PM is viewed to be about managing social relationships in order to add value. This paradigm understands people to be the core value in projects, as it is the people who progress the project, and has a process oriented focus. This paradigm does not have to be exclusive, but can be complementary to others.

Pryke and Smyth (2006) also distinguish an information processing paradigm, as discussed by Winter et al. (2006) above. They detail this paradigm, based on Winch (2010) who introduced and developed this in the field of PM adopted from Galbraith (1977), which employs social theory and focuses on efficiency by employing managerial sociology to understand information management with the aim of reducing uncertainty.

Notwithstanding these paradigmatic developments, Blomquist et al. (2010) find that the field is still predominantly informed by a rational perspective where theoretical models and concepts are developed from which actions are derived for project practice. They argue that these “...normative and traditional contributions are [...] insubstantial when it comes to understanding what is really occurring in projects” (p.6). Traditional project research starts with overall models and concepts from which action is derived. This scientific and rational approach disregards human interaction, as it follows a deductive reasoning based on
assumptions and partial analysis. The result is that models and tools are imposed on PM practice, which are either irrelevant, or become self-fulfilling, instead of providing a sound theoretical basis (Ghoshal 2005). A critical review of these dynamics prompted the research community to change their approach, and an increasing number of scholars are now arguing for a research perspective that looks at individual’s actions and interactions in projects and generalises theoretical models and concepts from those (Blomquist et al. 2010; Cimil et al. 2006). In this approach, research is beginning to develop a bottom-up perspective by studying what project members are doing, how they interact, and what approaches they use to solve their problems, in order to build better understanding of a greater number and type of contexts.

3.3 Critique of Alternative Approaches to Managing Uncertainty in Soft Projects

The discussion in this chapter so far has demonstrated that the PM discipline has evolved to include soft projects, which may be less efficiently managed using traditional PM techniques and wisdom. This is because uncertainty in projects is traditionally identified by setting standards (goals, scope, plans) and comparing the standards to the progress (e.g. Earned Value Analysis), then applying corrective actions if necessary (Hällgren and Maaninen-Olsson 2005). If clearly definable standards are lacking in soft projects (unclear goals, use of novel technology, etc.) then classic PM approaches appear to be less useful. Soft types of projects may require management that is more abstract than providing isolated and standardised toolkits and procedures in the style of PRM (Atkinson et al. 2006). For instance, Thiry (2000) suggests increasingly abstract and holistic approaches with increasing uncertainty.

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2 It may be argued whether soft projects should at all be projects, or rather be nurtured to the point where they can be conducted as hard projects. However, practice shows that the circumstances of planning, budgeting, strategic pressure, or misjudgement of softness level lead to such projects regularly being conducted, or projects which started off as hard projects change their uncertainty levels during their implementation.

3 While uncertainty in traditional hard projects may be manageable more successfully with the traditional techniques, it cannot be assumed that there is no more efficient and effective approach for hard projects, too.
The discrepancy between the uncertainty conditions prevailing in soft projects and the traditional theories, tools and methods applied to attempt and control these (cf. discussed in 3.1) is one of the reasons that led scholars to question the adequacy of the current theoretical basis of the discipline, as discussed in the preceding section 3.2, and led practitioners and scholars to seek more adequate answers for the management of soft projects. These novel approaches are discussed in the following sections.

3.3.1 Agile Project Management

The lack of accommodation for a wider range of uncertainty in traditional PM has lead to the development of empirical-based alternative approaches that reduce up-front planning through the use of iterative planning cycles. In this context, the software industry is a good example where novel and progressive methods have been tested, starting with Scrum in the 1980's and Extreme Programming (XP) (Robinson and Sharp 2005; Beck 2004), Adaptive Software Development, or the Dynamic Systems Development Method (DSDM) in the 1990's. These approaches are summarised as ‘agile software development’ (Cockburn 2009). They emerged as an attempt to counter the poor success rates of novel software projects with high levels of unforeseen uncertainty where traditional PM did do not provide the means to handle their special requirements and could even paralyze them through too much bureaucracy, highly regulated processes and inflexibility. These agile software development methods have later been generalised to agile PM methods (Chin 2004; Augustine and Woodcok 2003; Alleman 2002).

Agile methods experimented with new forms of structuring projects which provide more flexibility, but thereby also rely more heavily on project members to handle uncertainty. Chin (2004) explains: "In the agile project, we spend more energy on information absorption and analysis, rather than constantly updating the plan" (Chin 2004, p.77). They also have a more outward looking information processing focus since project objectives are more volatile, and rather than pushing them through at any cost, they may be re-negotiated depending on the conditions in which the project is embedded (Chin 2004).
One of the earliest formal descriptions of agile methods outside the software context, namely Scrum, was made by Takeuchi and Nonaka as early as 1986. They described Scrum for product development as:

“... a holistic or ‘rugby’ approach where a team tries to go the distance as a unit, passing the ball back and forth ... Under the rugby approach, the ... process emerges from the constant interaction of a hand-picked, multidisciplinary team whose members work together from start to finish. Rather than moving in defined, highly structured stages, the process is born out of the team members' interplay” (Takeuchi and Nonaka 1986, p.3).

These methods provide increased flexibility through rolling planning and iterative and incremental project life-cycles (PLC’s). Takeuchi and Nonaka (1986) describe the success of this approach for companies, such as Fuji-Xerox, Honda, or Canon.

In terms of contribution to the development of PM theory agile methods are limited however. Their development was practitioner driven, and they are hence considered “empirical” (Fitsilis 2008, p.383). Fitsilis (2008, p.378) who compared Agile PM with the PM BoK argues that “agile project management methodologies cannot be considered complete, from the traditional project management point of view, since a number of processes either are missing or not described explicitly”. Turk et al. (2002) argue that success of these methods is merely anecdotal. They only provide selective solutions, which are more amenable to certain industries, such as the software industry, and to certain types of projects, such as internet applications for where there is significant time-to-market and cost pressure. Agile methods are less applicable for the development of large, complex, sustainable systems where the development process and the software have to be documented well to provide security and allow further development.

3.3.2 Decision Analysis (DA)

While the use of DA is well established for traditional PM and PRM in some of the key literatures (Kerzner 2009; PMI 2004; Chapman and Ward 2003), Virine and Trumper (2007, p.7) suggest that the principles are hardly known and applied in PM. They explain
that a structured decision analysis process can help project managers to “deal with uncertainties”.

In Decision Analysis (DA), uncertainty is defined as “things whose truth or falsity is not known to you” (Lindley 2006, p.i). To understand how much uncertainty is felt, a *degree of belief* specifies how much an event is believed to be true or false, the strength of which is measured by *probability* (ibid, p.12). Lindley (ibid, p.13) explains that uncertainty is measured by attaching a number to an event, which describes the degree of belief, and “the topic that deals with the use of felt uncertainty beliefs in action is called ‘decision analysis’”.

Virine and Trumper (2007), however, only briefly assess decision making under uncertainty, stating that “Before you start a project, you need to determine the potential uncertainties, identify the risk events that may affect the project...” (p.119). This is feasible for known unknowns, but is not applicable for unknown unknowns in soft projects, which cannot be identified in advance.

Virine and Trumper (2007) appear to relate to hard projects, basing their work on the traditional view of PM (see e.g. p 119). They reference the PMI BoK guide for project risk identification, which leads back to traditional PRM. This method is less applicable to address the uncertainty conditions of soft projects (cf. 3.1). Their approach appears to fall in line with a large body of PM literature, which discusses DA, such as the PMI BoK guide (PMI 2004), as well as standard handbooks, such as Kerzner (2009). These literatures also focus discussions of DA in the traditional context of PRM, which does not specifically address the management of soft project uncertainty conditions. Pich et al. (2002), who investigated the use of decision theory for the management of uncertainty in projects, state:

“In summary, ... decision theory literature has concentrated on complete probability spaces with (subjective) probabilities – that is, the project team knows the event is possible but they do not know whether it will happen. Existing work has implicitly viewed it as impossible to 'manage events that cannot be foreseen’”. (p.1010)
It is also argued in Loch et al. (2006), that:

“real options and contingent decision-making...turned out to be a dead end, as the powerful analytical methods from finance did not sufficiently carry over to project management, an environment where much less information is available than in financial markets. In project management, these methods were wonderful in theory but required too many assumptions to apply in practice.”

A well established DA tool in PM are decision trees. These can be designed in such a way that decision nodes indicate decision points (e.g. yes – continue with the project / no – do not continue with the project), with branches indicating time and cost for continuing the project. In PM these are followed by chance nodes which describe the major risks, with probabilities indicated for each branch. These project decision trees are very useful for identifying the value of contingent, preventive, and mitigating actions in response to risk, by identifying alternative options and assigning probabilities to these. Furthermore, such decision trees highlight the dependencies among risks, ordering them in time, and therefore providing an order of attention for the project manager. These qualities make decision trees very useful for the identification of risks, and supporting the subsequent PRM stages of risk prioritization and management. The drawback of this tool is the exponential growth of alternatives with the number of decisions and risks that have to be considered. Furthermore, decision and chance nodes may have more branches than only go/kill alternatives. Even if this can be managed with the support of appropriate technology, the information gathering efforts are likely to become unmanageable, and the results would not be useful as the resulting data will be too large to provide purposeful information. Due to this drawback, this tool was found to be less adequate for the application in soft projects, beyond use for a limited number of key risks. Similarly, Pearl (1988) explains that:

“...a decision tree is a convenient representation for a search for an optimal plan, it is totally inadequate for representing domain knowledge in the same way that knowledge about chess strategy cannot be represented by itemizing all possible moves: decision trees require an incredible amount of storage” (p.306)
Therefore, it would only be practical to generate parts of the decision tree. However, this requires diverse causal knowledge about the influence events have on each other, about feasible action sequences, and about desirable consequences. This is attempted to be addressed in influence diagrams, detailing decision, chance, and value nodes, however these still may require excessive storage for storing conditional probabilities using the node-elimination method for instance. (Pearl 1988)

Chapman and Ward (2002, p.24) discuss another concern regarding the application of DA for the management of uncertainty in projects, in that DA models focus on discrete events. Virine and Trumper (2007) suggest the use of DA for PM, also focusing on concrete and fundamental decisions in projects. However, one of the core qualities of projects is their continuous nature and variation of uncertainty over time, particularly in soft projects, which is more difficult to manage with analysis models that are focused on discrete events (Chapman and Ward 2002, p.24). While there are continuous approaches based on probabilities, such as posterior mean or mode, the key criticism of the application of DA relates to the exponential growth of options, and related to that the ability and capacity to gather data to help take the decision (Jaynes and Bretthorst 2003).

Projects require a lot of decisions to be made on different levels, from fundamental decisions, for example whether to buy a standardized software solution or engage in the development of a bespoke solution, to various smaller decisions by different project members and groups in dynamically developing project hierarchies. While it may be adequate to apply DA methods to some key decisions, applying them throughout may become time consuming, and managing the interactions between these decisions will become complex very quickly as the number of options and interactions which would need to be considered grow exponentially. In projects with fast changing environments or where different project parties proceed with a decision or have acquired further information, while other parties still work on decisions, co-ordination of decisions across teams and parties and over time, will be very difficult. As project structures change throughout a project due to natural staff fluctuation and the application of staffing curves, establishing clear decision structures to understand where DA must be applied and where decisions have to be made and then clearly communicated, will be a challenge.
In summary, DA may be very useful for fundamental key decisions, particularly where the information logistics support this approach. However, where the information logistics get flooded by too many unknowns, DA is less applicable. Furthermore, in order to use DA, experience is required to be able to assign useful probabilities. In soft novel projects, this experience is not available. Thus, while DA has a firm place in PM theory and practice, it appears not to provide a fully satisfactory solution to managing uncertainty dynamics in projects. Pearl's (1988) work highlights the mathematical difficulty of applying DA in a planning context, arguing it is myopic, as the evaluations required are too cumbersome for practical use (p.314). Therefore people make approximations to turn DA into a practical tool. In line with Pearl's (1988) argument, DA may be an adequate tool for specific, fundamental project decisions, however it is not considered an adequate approach for this study to address the optimization of information flow structures and information exchange processes of projects, which create uncertainty dynamics among project parties.

3.3.3 Uncertainty profiles

De Meyer et al. (2002) identify four different types of project uncertainty and argue that each requires a different PM approach. They propose uncertainty-based PM, where the planning, monitoring and management style is adapted to one of four uncertainty types: variation, foreseen uncertainty, unforeseen uncertainty, and chaos. These could be compared to four discrete points on Crawford and Pollack’s (2004) hard-soft scale. They distinguish:

1) Variation profile:

- A high number of variations or deviations that are small in their influence and within a predictable range.
- Well defined project objectives and scope, clear set and sequence of activities in a stable project plan.
- In the implementation, schedules and budgets diverge from the estimates. These influences are too minor to plan and monitor on an individual basis, but the resulting variations in the form of time and cost could be planned for, for example through building buffers into the critical path.
- Example: Weather influence in a construction project
2) **Foreseen uncertainty profile:**

- A few identifiable and understood influences which are not certain to occur.
- This requires risk analysis and the development of alternatives.
- Example: Side effects for the development of drugs

3) **Unforeseen uncertainty profile:**

- One or more factors that cannot be identified in the planning stage, as the project team is either not aware of the possibility or considers it to be unlikely, particularly in projects where new technologies are used.
- Example: Story of the Viagra drug development

4) **Chaos**

- No stable goals, project scope and project plan identifiable at the project start, for example in research.
- Example: The development of the Internet

De Meyer et al. (2002) suggest the creation of an uncertainty profile for each project where the mix and level of the different uncertainties which can occur in the project are identified. The first two categories relate to change management and PRM. For uncertainty in projects which have profiles with high unforeseen uncertainty and/or chaos, the contemporary methodologies (PMI 2004; PRINCE 2 1998; Pinto 2007; Kerzner 2003) do not provide concrete suggestions with which to manage these adequately. De Meyer et al. (2002) recommend iterative planning, increased flexibility and focus on learning, however, neither provide more details around practical management methods, nor a theoretical underpinning for these recommendations.

Winch (2004) similarly suggests adapting the PM approach to the level of uncertainty that prevails in a project. He classifies projects in terms of levels of mission uncertainty (cf.
2.6), and argues that different levels of uncertainty require different management approaches, detailed in Table 4, which he developed from De Meyer et al. (2002)⁴.

<table>
<thead>
<tr>
<th>Type of Uncertainty</th>
<th>Project Leadership Style</th>
<th>Risk Management Approach</th>
<th>Resource Base Mobilization</th>
</tr>
</thead>
<tbody>
<tr>
<td>Known knowns</td>
<td>Expediter and trouble shooter</td>
<td>Implement PMBOK Guide techniques</td>
<td>Fixed price contracts</td>
</tr>
<tr>
<td>Known unknowns</td>
<td>Contingency planner</td>
<td>Scenario planning and fast learning</td>
<td>Incentive contracts</td>
</tr>
<tr>
<td>Unknown unknowns</td>
<td>Flexible orchestrator</td>
<td>Stakeholder management</td>
<td>Joint venturing</td>
</tr>
</tbody>
</table>

Table 4: Project Mission Uncertainty and Project Management Approaches (from Winch 2004, p.50)

Winch (2004) suggests that the management of projects is essentially uncertainty management, and proposes to view projects as temporary organizations, where a coalition of project members negotiates the project mission with its stakeholders, and co-ordinates their execution through mobilizing capital and human resources. As De Meyer et al. (2002), neither does Winch (2004) expand on the recommendations for the management of each profile or uncertainty type. Furthermore, as Winch (2004) suggests, uncertainty in projects changes as the project evolves, or is even likely to vary among different parties within the project. Therefore, it may be difficult in practice to keep assessing and reacting to the current uncertainty profile over time and among different stakeholder groups.

### 3.3.4 Revised terminology to focus on uncertainty

Ward and Chapman (2003) and also Perminova et al. (2008) approach to the more recent debates on project uncertainty management from the argument that traditional PRM is inappropriately narrow and restricts the focus of managing the wide range of uncertainty occurring in projects. They both, furthermore, argue that the definitions and discussions on risk focus too strongly on threats, not allowing opportunity to arise from uncertainty.

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⁴ In this overview, Winch (2004) does not consider unknown knowns.
Ward and Chapman (2003) suggest a revision of terminology, away from a focus on events or circumstances, but rather directing attention on the ‘implications’ of threats and opportunities. Furthermore, they argue for addressing uncertainties in estimates by switching from explicit probabilities to expected ranges, similar to Zadeh’s (2005) approach in mathematics, and by exploring the root causes of variability in organizations and how to manage these, for example through studies of operations. They propose to clarify uncertainty regarding the basis of estimates by “establishing the quality, reliability and integrity of the underlying data” (p.103), recording key assumptions, and delineating responsibilities for different uncertainties. Ward and Chapman (2003) address uncertainty about relationships, design and logistics by directing attention to identifying root uncertainties with regard to who the parties involved are, what they want to achieve, what their underlying motivations are, which resources they require, and when they have to complete their work. With regard to uncertainty about objectives and priorities, Ward and Chapman (2003) propose that it must be achieved that all parties understand their responsibilities and expectations of other parties. However, this reflects thinking in the traditional paradigm. Nevertheless, they recognize that objectives and priorities cannot always be determined at the start, but remain vague on optimizing the management of related uncertainty.

In summary, Ward and Chapman (2003) propose a constructive approach towards expanding the mind-sets of project managers by changing terminology. They, furthermore, present a number of practical suggestions for managing uncertainty better. Their suggestions, however, merely state a number of issues to be aware of, rather than comprehensive, consistent, and theoretically founded proposals for managing uncertainty.

3.3.5 Learning

Perminova et al. (2008) build on the argument of Ward and Chapman (2003) that uncertainty is insufficiently commonly defined and too negatively focused on threats. They discuss the shortcomings of current approaches to uncertainty management and argue that uncertainties should not be managed as risks, but rather reduced through sense-making and reflective learning to increase flexibility, which Crawford and Pollack (2004) similarly suggest for the management of soft projects. In line with this approach, De Meyer et al.
(2002) and Winch (2004) also mention learning for their unforeseeable and chaos project profiles.

Cleden (2009) suggests learning cycles as a strategy to manage project uncertainty, which start with being receptive to learning, leading to observations, lessons, and the validation of such lessons. He recommends these cycles to run continuously. This strategy appears to extend the “lessons learned” approach, where project members discuss their observations and drawing lessons from these on what to do better in future projects. Cleden (2009) does not provide further detail as to how this would work under unforeseen uncertainty and how it would contribute to anticipating and managing uncertainty better, other than learning for the next time, which would only be useful if similar situations appear. This would be less applicable for soft projects that are inherently nonstandard.

Loch et al. (2006) discuss learning for project uncertainty management in more detail. They focus on learning in the sense of adjustment as a response to emerging unforeseen uncertainty in a project:

“Learning in projects is the flexible adjustment of the project approach to the changing environment as it occurs; these adjustments are based on new information obtained during the project and on developing new – that is, not previously planned – solutions during the course of the project” (p.103)

They refer back to classic organizational learning typologies (Argyris and Schön 1978), who distinguish three levels of learning:

1. **single loop learning** - where an organisation which finds errors, makes corrections based on existing plans and policies.
2. **double loop learning** – where an organization detecting errors corrects these by modifying existing plans and policies.
3. **deutero learning** – where the learning system by which organizations detect errors and act on these is being adapted to reduce these.
Loch et al. (2006) characterise traditional PRM as single loop learning, explaining that projects create policies consisting of contingent actions for an event, which are implemented if the event does occur. In this type of learning the policies and plans do not change. Under conditions of increased unforeseen uncertainty in projects, Loch et al. (2006, p.113) suggest double loop and deutero learning. They describe double loop learning under uncertainty in projects where the project plan is modified “in response to acquiring new information” and also creating and implementing new policies as the project proceeds, either through improvisation or experimentation. “Thus, actions, and the policies and plans that generate these actions, are changing over time”. They explain that in improvisational learning, real-time experiences determine new actions, with both, planning and execution happening at the same time, typically as a response to problems or opportunities arising from unforeseen uncertainty. Loch et al. (2006) state that the ability to improvise becomes vital to be able to respond to unknown unknowns, in particular to produce rapid responses. The more uncertainty is present in the project, the more widely improvisation must vary with regard to creativity and spontaneity.

Experimentational learning refers in a basic way to the Plan-Do-Check-Act (PDCA) cycle. Loch et al. (2006) describe the key success factor for this to keep the PDCA cycles small and fast, so that failures appear early and often before they escalate to catastrophic dimensions, as failures in projects later on can be more costly than early errors. This approach shows similarities to iterative approaches in Agile PM, and contradicts the traditional PM approach of upfront definition and planning. Loch et al. (2006) also acknowledge that experimentation may be seen as an obstacle to progress. However, if soft projects are based on traditional upfront projects plans which cannot acknowledge fundamental uncertainty, these plans become illusions of certainty. Managing along these plans will sooner or later cause the project to be fundamentally troubled, and may take more time and resource than early experimentation and learning where actions are still cheap (cf. 3.1.2). They state that “information is most valuable if it is gained early” (p.119). This experimentation requires acceptance of failure as a source of learning, anticipating and exploiting early information. The project team requires to be organized for rapid organization, and they suggest combining multiple technologies in order to maximize the opportunities for varied learning.
Finally, Loch et al. (2006) argue that deutero learning helps managing unknown unknowns in projects by “shifting from a project mind-set, infrastructure, and governance geared toward contingency planning to one geared toward active project learning” (p.113). They suggest achieving that through project partner relationship management, stakeholder management, and senior stakeholder management. For project partner relationships they recommend competency based project partner choice, risk and reward sharing, relationship and trust building. For project stakeholder management, they suggest mapping the selling points and points of resistance the project is facing. These should be related to the business strategy (i.e. priorities) and politics (key players, interests, influence) and the strategy to selling a less traditional project approach by understanding the organisation’s culture, including its communication and authority structures, and emotional “hot buttons” of the stakeholders. This would allow to “navigate the jungle of influence” (ibid, pp.257-258) in an organization. With regard to senior stakeholder management they discuss that soft projects require more involvement of the senior stakeholders, as less can be delegated and more engagement is required to question assumptions and allow changes to agreed plans.

Loch et al. (2006) also suggest developing team members who have experience with unknown unknowns and do not fall back to traditional PRM in the face of these, who will be flexible and who are mindful in their ability to detect and respond to unexpected events. This involves seeking failure, acknowledging the complex and unpredictable nature of a project, learning from operations, accepting that unexpected things will happen, and deference to experience allowing decisions to be made where the knowledge lies and variety in approaches increase the chance of finding good solutions.

In summary, many authors discuss or mention learning as a strategy to manage uncertainty in projects. However, much of the literature refers to learning which can be applied for the next uncertainty project, rather than supporting uncertainty management then and there. Loch et al. (2006) provide more empirical detail, in the form of recommendations aimed at practitioners. These recommendations are presented as derivations from case studies supported by organizational learning theory. Further research may be able to validate the effectiveness of the proposed methods.
3.3.6 The information processing approach to project uncertainty management

Uncertainty is almost universally linked in various disciplines to information, as it is described as lack of information (Lindley 2006; Garner 1962; Zadeh 2005; Galbraith 1977; Winch 2002; Simon 1976). Daft and Lengel (1986) and Tatikonda and Rosenthal (2000) state that uncertainty is a force which influences information processing, and vice versa information is processed, in order to reduce uncertainty. Based on this thinking, the information processing perspective has been well established in Organisational Science for the management of uncertainty (Galbraith 1973; Galbraith 1977; Simon 1976; Cyert and March 1963), and has then found its way into PM.

Burns and Stalker (1961) view organisations (and by extension project organisations) as an interpretive system where people work

“... in response to information received; each involves altering, rearranging, or recomposing information or things; each ends with the transmission of the altered information or thing to somebody else. ... ‘Acting on this information’ means the application to it of technical or manual skill, or knowledge or understanding, in conformity with the expectations of the other members of the organization.” (p.78)

This process is only complete when the information is passed on to all the targets that require it to base their subsequent actions on. This process can only work if the structures of the organisation or project facilitate the receiving, processing, and re-distribution of information. (Duncan 1973) also defines an organization (and hence by extension a project organisation) by its information and communication links. He sees such a social system as

“a set of elements linked almost entirely by way of the intercommunication of information. The essential point is that, while the relations among components of mechanical systems are a function primarily of spatial and temporal considerations and the transmission of energy from one component to another, the interrelations among components in complex organizations come to depend more and more on the transmission of information. All social systems are networks held together by information” (p.276).
In order to optimise these social systems, (Duncan 1973) argues that emphasis must be placed on developing the internal capabilities of an organisation to prepare it to recognise and handle uncertainty. This can be achieved by enabling the organisation to better process information about existing uncertainty by finding optimal structures for decision making under uncertainty\(^5\).

Galbraith identifies three concepts pertaining to organisational information processing: 1) information processing needs, 2) information processing capability, and 3) the fit between these to achieve optimal performance. The theory argues that organizations require quality information to cope with uncertainty which stems from complexity and frequency of changes of different environment variables. Organizations can use two strategies to deal with uncertainty and the resulting increased information needs: 1) to develop buffers to reduce the effect of uncertainty, such as contingencies and 2) to implement structural mechanisms and information processing capability that enhance the information flow and hence reduce uncertainty such as redesigning the business processes to improve information flow and subsequently reduce uncertainty within the organizational workstreams. (Premkumar et al. 2005)

Winch (2002; 2004) opened the information processing paradigm to the discipline of PM, and to the management of uncertainty in projects. He proposes that a project is “…an information process through time – an information flow that stimulates and controls a material flow” (p.211). He argues along the lines of Galbraith (1973; Galbraith 1977), that uncertainty is the greatest challenge in the management of information flows, and that “…the reduction of uncertainty [is] at the heart of the project management process” (p.12). He describes information flows to be at the centre of projects and uses the analogy of water in a river to explain that, just as the flow of water in a river cannot be influenced directly, the actual information flows cannot be immediately influenced. However, these flows can be managed indirectly through the structure of the project, which shape the information flows, just as the river banks direct the water. Winch (2010) describes four generic types of information processing (see Figure 3).

\(^5\) Here decision making is understood in a wider sense as the group activity of gathering of information, processing it, and consequently making a choice.
Figure 3: Four generic types of information processing, taken from Winch (2010, p.209)

- **Pooled** information processing takes place where project tasks are not interrelated and are not dependent on information from each other. Information does not have to be passed on from one task to another. Such tasks exist independently in the same project.

- **Sequential** information processing is one-directional. It occurs where information is passed forward from one task to another, and there is no requirement for feeding information back.

- **Reciprocal** information processing occurs along clearly defined feedback loops between tasks. The main flow of information is downstream in the PLC, but information from downstream tasks is required to complete earlier tasks in the project.

- **Iterative** information processing takes place where there is insufficient information available to define the order of tasks (and even the tasks themselves), so that there is the need for intensive and unstructured feedback between them.

Winch (2010, p.210) argues that “… the more intensive and unstructured types of information processing are more common under greater levels of uncertainty, while the more sequential information processing is found when task definitions are more clearly defined and sequenced”. As discussed in 2.6, Winch (2004) distinguishes between mission uncertainty, which relates to insufficient amounts of information available at the project start and decreases throughout the PLC, and dynamic uncertainty, which exists at particular points in the PLC, relative to previous or later PLC stages.
Winch (2004), who presents the most comprehensive information processing body of work within PM, focuses on construction projects, which tend to be on the hard side of the spectrum, and have a long tradition in PM around the development of knowledge, methods and tools, and experience, as well as their inherent uncertainties. Therefore, further research would be required to understand whether this approach would be useful for soft projects.

Winch (2010; 2004) also resorts to various management theories, such as systems analysis, the resource based view, and transaction cost economics, coupled with traditional PM tools and methods to handle the information and uncertainty requirements of projects, (Winch 2004, p.47). This approach could be criticised along the lines of the discussion in section 3.2 with regard to imposing theories, as opposed to scholars’ challenge to explore and understand what is going on in projects and to develop theory out of that understanding. Overall, the information paradigm so far is dominated by a functional prescriptive tendency, with theory development and imposition. This study is aiming to take this paradigm into a new social interpretive direction (cf. 3.2).

Galbraith (1973; 1977) was criticized for not defining the information and information processing aspects of his views, and Winch (2010) may be criticized similarly. In order to cater to this criticism, chapter 4 reviews the literature about information and aims to define the concept for the purpose of this study.

3.4 Conclusion

Following the introduction of the traditional PM concepts in chapter 2, this chapter critiqued these on their ability to manage uncertainty in projects, and soft projects in particular. This review was started with the classic normative PRM approach, which was shown to be less applicable for increased uncertainty levels, as it relies on a project plan as a baseline, against which project threats are managed. Due to this integration of PRM into the traditional PM approach, the traditional views around project planning, project goals, and project structures were also critiqued.
Following the establishment of the shortcomings of the traditional PM paradigm for the management of uncertainty in soft projects, the theoretical foundation of the PM discipline was examined and the variety of paradigms prevailing in the discipline were reviewed, including the information paradigm. It was established that the traditional functionalist deconstructive paradigm is increasingly challenged with regard to its ability to facilitate the theoretical integration of new soft projects and support research into new ways of managing these.

In the last part of this chapter, alternative approaches to managing project uncertainty were reviewed. It was shown that these are largely theoretically isolated, or based on empirical insights without sound theoretical foundation, limited to specific circumstances, or building on theory from other areas, where the utility still needs to be established by further research.

It was established that while traditional PM models, such as PRM have been normative, there is a new tendency to adopt interpretive models and engage in explanatory research, rather than imposing theory imposing approaches. However, this is merely a starting point among the PM research community, and hard to reconcile with the traditional theoretical foundation of the discipline. At the end of this chapter a new social scientific interpretive perspective to the investigation of uncertainty management in projects is hence proposed, based on information. The following chapter provides a justification for the adoption of this information paradigm to investigate the uncertainty dynamics in projects, and defines the employed concepts in more detail, for their application in the empirical chapters 6 and 7.
Chapter 4 - Information Model for the Study of Project Uncertainty

4.0 Introduction

It has been shown that this information processing perspective has been widely established in organisational science, and was more recently introduced to the PM discipline as one of the novel approaches to the understanding and management of project uncertainty. This chapter provides a justification for the choice of this paradigm for the purpose of this study. It, furthermore, develops the theoretical background required to build this research on a solid theoretical foundation, by reviewing the literature on the concept of information, and providing precise definitions. Based on different understandings of information, a stratified information model is then constructed to incorporate these different perspectives on information, and related uncertainties are established. This model is applied as a paradigmatic lens to observe and understand the uncertainty dynamics in projects in the empirical part of this study.

4.1 Justification for the Application of the Information Paradigm for this Study

The benefits with regard to the adoption of an information paradigm for the management of uncertainty in an organizational design context are well established (Galbraith 1973, 1977). Galbraith (1973; 1977) for instance, took an information processing view on the design of organizational structures, suggesting that each organization should build an
organizational structure that can handle and process the different uncertainties the organization is facing. In this context Galbraith (1977, p.36) described uncertainty as “... the difference between the amount of information required to perform the task and the amount of information already possessed by the organization”.

While Winch (2002; 2004) recently introduced the information perspective to the discipline of PM, and it is recognised as one of the paradigms that inform and shape the discipline (cf. 3.2.1), the literature relating to this perspective is limited. This novel view on projects and their uncertainty conditions is currently not developed in much detail. Therefore, it is helpful to critically question this perspective with regard to the solidity of its theoretical foundation, and with regard to its value for the study of project uncertainty.

Winch (2002, 2004) attempts to construct a purely theoretical framework based on the information paradigm, but within this theoretical approach he employs other management theories, such as the resource based view of the firm, to prescribe how to handle the information and uncertainty conditions of projects in corporation with traditional PM methods and tools. Such a theory imposing approach is lacking empirical grounding, and has recently been questioned by the academic community (cf. 3.2). In search of a more profound understanding of what is actually happening in projects, scholars are suggesting to take a bottom-up research perspective that studies individuals’ actions and interactions in projects to generalise theoretical models and concepts from those (Blomquist et al. 2010; Cimil et al. 2006), rather than imposing theories which may not be purposeful or even distorting. The information paradigm is expected to facilitate such an interpretive study, by observing information flows and hence project uncertainty dynamics through this particular paradigmatic lens, rather than imposing theory. It is not so much a method, but a paradigm (cf. 3.2.1) which grants a particular view on the discipline, and thereby also shapes the view on the actualities of projects, and the PM tools and methods used. While the information paradigm may in its pure form still be normative and following a traditional PM understanding, this research employs this paradigm taking a social interpretive view on understanding and explaining the uncertainty conditions and dynamics.

Uncertainty can be described as a lack of information (c.f. 4.2). Due to this direct link between uncertainty and information, the adoption of an information lens to study
uncertainty in projects is expected provide more insights than other paradigms have done so far, such as the traditional functional one. It enables establishing how information flows through a project, how much information actually exists in projects, and how the information travels through the interaction of project members, and how it is shaped and represented with different PM methods and tools. The study of uncertainty under the information lens, furthermore, allows establishing under what conditions and in what situations the existence of uncertainty becomes evident, and how project members then deal with it, how their interactions and the project structures and methods affect it, and how it develops through the project organisation over time. In this way, not only aware uncertainty management can be studied, but also the unaware handling of uncertainty, by looking at how information is managed. Such observation of information levels and changes in the quality and quantity of information always focuses on uncertainty management, as uncertainty arises as information quality and quantity reduces. Hence, the application of an information processing perspective allows identifying uncertainty in such a way and studying its development, which may not be possible when adopting other paradigmatic lenses for the study of project uncertainty.

The standard organisational information literature mainly adopts the term “information processing”. However, this term may be misleading, as information processing also has a psychological connotation about individuals’ cognitive processes. In order to understand uncertainty in projects, the information dynamics among project members are observed. Specifically this allows studying the information behaviour of people in projects, how artefacts and communication structures support or hinder information logistics, and how the absence of sufficient information is dealt with. The information perspective is hence expected facilitate insights into uncertainty dynamics which may not be possible by employing other paradigms.

While the above points provide a theoretical justification for the use of this paradigm, relating to its potential value for an interpretive approach to the topic, and its adequacy due to an implicit incorporation of uncertainty by studying information, its actual value will need to be proven through its application. In the proprietary interview research the utility of this paradigm for the study of project uncertainty dynamics are confirmed, and this lens and the information layer model are then applied in the main case study.
In order to use an information based paradigm for this study, the concept of information must be defined. The following section reviews the literature on the ubiquitous use of the term “information” and distinguishes and defines the concept precisely, depending on the area of application and epistemological perspective. This discussion is followed by the construction of an information model using the information types distinguished in the literature.

4.2 Defining “Information”

Information is a word used with the same imprecision as uncertainty in everyday language, and it has a similar versatile and interdisciplinary concept behind it. This vast use of the concept of information offers various context-dependent definitions. It is viewed as a resource in library studies (Kaye 1995), as an asset in organization theory (Galbraith 1973), as measure of physical organization (Shannon 1948), as a form of control and feedback in communication theory (Griffin 2000), as the content of a cognitive state in psychology (Dervin 2003), as explicit knowledge in the field of knowledge management and information science (Al-Hawamdeh 2002), as “data of value” in decision making theory (Yovits and Abilock 1974) and many more.

The controversy about information has de-humanized and abstracted the concept in cybernetics, naturalised it in biology and then again re-humanised it in linguistics by placing it in a cultural context (Capurro and Hjørland 2003). A number of authors have attempted to give an overview of the various approaches to and dimensions of the concept of information, such as Machlup (1983), Qvortrup (1993), Kaye (1995), Rowley (1998), and Capurro and Hjørland (2003) ⁶.

Broadly, two tendencies in the understanding of the concept of information in the natural sciences and the social sciences can be identified (Machlup 1983; Qvortrup 1993; Capurro and Hjørland 2003):

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⁶ For a lexical definition and the etymological roots of the word information, please refer to Machlup (1983) and Capurro and Hjørland (2003).
- In the natural sciences, information is applied in the form of an object, a contextual concept which can be quantified and is a property of material entities, such as the DNA encoding the information of life forms. It is used as a theoretical construct, since it has to be defined within a scenario and is not just observable, which implies that it exists independently of a human observer. In this context, much research has gone into measuring and managing information.

- In the social sciences information is seen as a psychic construct which relates to human beings and is therefore more concerned with value. In this context, information only is information when it is information to somebody. Here, the process is of importance, as information depends on a choice made by a sender and a receiver. It is context or constraint dependent, rather than the property of facts, implying that two different receivers might obtain different information from one signal. In this standpoint, information is no longer an objective Ding an sich (Kant 1787), as it involves meaning, requires an interpretive process and is relative to the receiver’s knowledge. Information is understood more as a process, rather than an object.

These two viewpoints are reflected in Zadeh’s (2005) generalized theory of uncertainty (GTU), where he distinguishes between measurement-based, numerical information, which reflects the former viewpoint (e.g. “It is 35°C.”), and perception-based, linguistic, and therefore human-centred information (e.g. “It is very warm.”).

These two extremes have been detailed into a number of intermediary viewpoints (Buckland 1991; Qvortrup 1993). Qvortrup (1993) discusses two intermediary views on the concept of information to these two farthest notions. He summarizes the debate over the concept of information into four perspectives:

1) “Information as a difference in reality”
2) “Information as a difference which makes a difference”
3) “Information as a difference which finds a difference”
4) “Information as a cognitive difference which brings forth (an idea about) an external world”
These perspectives provide an overview of the concept of information which reflects the debate about uncertainty and are, therefore, discussed in the following:

1) “A difference in reality”

Here, information is understood as something which exists independently of an observer, a difference in physical reality. It is identifiable and measurable in the material world. This point of view is supported by a number of scientists and theories:

The biologist and philosopher Stonier (1990) states: “Information exists. It does not need to be perceived to exist. It does not need to be understood to exist. It requires no intelligence to interpret it. It does not have to have meaning to exist. It exists.” (p.21). Stonier (1990) parallels the development of our understanding of information with two examples. He argues that the invention of clocks dissociated time from humanly experienced events, for example in daily cycles, thereby building awareness for its linearness. Similarly, the abstraction of the concept of energy happened when humanly-created energy devices were first developed. He derives that similarly to those two examples, the development of information technology externalized information processing “... a process which previously could be accomplished only inside our heads” (p.6). He provides a variety of indications that information is an external “thing”, such as telecommunication appliances which manipulate “... the transmission of information in a physical form” (Stonier 1990, p.6), or art galleries which store information that was created by human beings outside their minds. Stonier (1990) supports his view by arguing that the information from the sound of a falling tree could also be negated if no one is present to receive the airwaves which cause the eardrums to vibrate and the consequent experience of the sound.

Shannon (1948) describes information as a physical quantity, similar to mass or energy which allows measuring and comparing the rate at which information is produced (R) by a source and at which it is transmitted through a channel (C). However, despite Shannon’s view on information as an external object, his transmission viewpoint on information entails information as choice, since the transmitter decides what specific message out of a range of known possibilities is transmitted. This act of choice counteracts the concept of
information as an objective autonomous entity, as it involves the question of meaning of information to someone.

Qvortrup (1993) connects this view of information with probability and consequently with expectation, stating that “information is ‘something’ in the outer world only so far as it is related to an expectation, i.e. something in the human mind.” (p.7). If the receiver has a certain expectation, but receives something different from this expectation, the amount of information appears to be great. He derives this viewpoint from Wiener’s (1968) cybernetic approach who states “… the more probable the message, the less information it gives” (p.31). Wiener (1968) and Stonier (1990) believe that information is equivalent to order. Stonier (1990) says that “The addition of information to a system manifests itself by causing a system to become more organized, or reorganized.” (p.26). This is directly opposed to Shannon (1948) who argues that information is inversely proportional to order. Independent of their viewpoints, all three scientists are criticized by Qvortrup (1993) regarding the fact that their concept of information is not actually as objective and independent as it is presented, since it does depend on “… an observer’s idea of order, organization, etc.” (p.8). Wiener (1968) seems to recognize that by stating that “Information is a name for the content of what is exchanged with the outer world as we adjust to it, and make our adjustment felt upon it” (p.26). Furthermore, this object-approach to the concept of information was indirectly discarded for the social sciences, for example by Luhmann (1995) who argues that such a view implies that the sender is giving up something which the receiver acquires. However, the sender does not lose anything by sending information. Luhmann (1995) also states that the information from the sender does not have to be the same for the receiver, since this depends on the meaning it has for the sender and the receiver. This meaning can be different for both of them.

2) “A difference which makes a difference”

This second definition regards information as a change in the psychic system which is caused by something in the external world (Qvortrup 1993). This notion was developed by Bateson in a number of lectures and papers from 1969 onwards. Bateson (1972) argues that with regard to the problem of objectification, human beings do not have concrete objects in their heads, but rather transformations and images of these, together with a set of rules according to which these objectives are transformed into images. Hence, a human
being develops an idea of an object from the object itself. In the world of objects, forces and influences exist, whereas in the cognitive world, forces, objects and influences are not applicable, but rather differences and ideas. Bateson (1972) therefore, argues that “A difference which makes a difference is an idea. It is a ‘bit’, a unit of information” (pp.271-272), or alternatively he formulates “what we mean by information – the elementary unit of information – is a difference which makes a difference ...” (p.459). For Bateson differences are something abstract. The mind does not contain objects but perceptions, images and rules for developing these, which lead him to differentiate between the physical and the psychic world. He concludes that from the infinite number of differences existing in the physical world, a human being filters a small quantity which then becomes information. Here, information is the product of the mind, not an objective fact which exists independently of the observer. Bateson (1996, p.582) relates this view to Kant (1787), who argues that a “Ding an sich”, does not enter the cognitive process. Instead, human beings create a mental representation by taking in a limited number of cues from the physical world which in Bateson’s terms form “differences” in the mental representation from the noise of the environment, and thereby become information within the human mind.

Machlup (1983) also disagrees with the application of the concept of information in the context of signal transmission and relates information closer to Batesons’s (1972) view, as he comes to the conclusion that “Information is addressed to human minds and is received by human minds...” (p.660). All other senses, including its use with regard to non-human organisms as well to society as a whole, are according to Machlup (1983), metaphoric.

3) “A difference which finds a difference”

This definition describes information as a difference in the psychic system. The psychic system stimulates, directs and filters the input from the real world from an existing frame of reference. Here the logical order of the external physical world and the cognitive system is reversed compared to the previous definition.

Luhmann (1995) introduced the concept that social and psychic systems are constituted by “Sinn” (translated as “meaning”) which differentiates them from other systems (p.59). Meaning in this context is understood as structure, i.e. the set of relations between events, in the psychological sense, for example a number of dots, which, arranged in a certain way,
allow the observer to construe an image (Augustine and Woodcok 2003) and hence turn into information for the human observer. The construction of this image takes place through the interpretation of the observer’s cognitive system. It is guided by his understanding of the world, i.e. his reference system.

Qvortrup (1993) bases his argument for this third definition of information on Luhmann, inferring that “We ‘see’ the world through our concepts, through our system of meaning” (p.14). This understanding of the world, or respectively not understanding something, guides and directs our search for information to ‘find’ external differences. Here, information is a process of selection (Luhmann 1995, p.194), sense-making, and accepting which is directed by and based on the cognitive system in that information is an internal change of its state by adding something and accepting it.

4) “A cognitive difference which brings forth (an idea about) an external world”

This fourth definition understands information as a concept or idea existing purely in the human mind. It constitutes a mental construction of epistemological and ontological principles about the world, detached from the immediate experiential world (as in definition 2), and also detached from the applications of these principles (as in definition 3). When these reference systems are challenged, contrasted, interlinked, and amended new information is created, bringing forth a cognitive difference and hence a new idea about the external world.

Qvortrup (1993) in this definition describes information as a mental construction: “The human being constructs a mental difference, and through this the world is brought forth” (p.12). However, he criticizes that understanding the concept of information as an observer’s construction does not mean that the difference in reality which triggered the mental difference as in definition 3, is also a psychological construction, but actually is information, too.

This approach to information goes in line with sense-making theory. Sense making theory comprises “... a set of metatheoretic assumptions and propositions about the nature of information, the nature of human use of information, and the nature of human communicating” (Dervin 2003, p.270). The theory is based on the viewpoint that
discontinuity is ubiquitous in our world. Information as an objective reality is, therefore, discarded as it implies continuity. Rather, it is linked to human action. “… information is conceptualized as that sense created at a specific moment in time-space by one or more humans.” (Dervin 2003, pp.271–272). This is linked back to knowledge, as introduced in the two extreme views of information outlined above. In sense-making, information is used to fill a perceived gap or discontinuity in information in the cognitive system. “Information is therefore not seen as an object to be transmitted, but as a construction created by the perceiver.” (Kaye 1995).

The concept of information is complex and widely discussed. This literature review does not seek to capture a discussion related to all scientific fields and arguments; however, the four above viewpoints outlined above provide an overview of the different understandings and uses of the concept of information throughout various disciplines. Information is understood and defined in very different ways across various disciplines. Therefore it is questionable, how a definition of uncertainty can be related to information as a universal concept. The four definitions outlined above will be further built upon in the following section to provide more precise uncertainty definitions, depending on what type of information is lacking.

### 4.3 Information layer model and corresponding uncertainty

In line with the information paradigm adopted for this study, the following sections describe the theoretical construct of an information layer model. As established in 4.2, information can be interpreted using the following four perspectives (Qvortrup 1993):

1) “Information as a difference in physical reality”
2) “Information as a difference which makes a difference in the mind”
3) “Information as a difference which finds a difference”
4) “Information as a cognitive difference which brings forth (an idea about) an external world”
The literature gives no indication that these are related. Because of their epistemological differences, Qvortrup (1993) suggests they have nothing to do with each other. This research develops Qvortrup’s (1993) thinking by integrating the four definitions into one single spherical model. The substantial meaning of the definitions is retained.

The four information perspectives can be considered as four layers which build on each other. In the following these will be referred to as information layers 1 to 4 (L1 to L4). Looking at how information is represented on these layers and how it must be transformed in the crossing over between these layers allows the transformation of information into different qualities and degrees of abstractness to be grasped and described - from physical reality on L1, to a human representation of physical reality in the cognitive system on L2, further abstracted to be embedded in a system of meanings or concepts, determining which new cues from the physical world are taken in on L3, to an entirely internal process of developing and reflecting on a set of ontological and epistemological principles as reference systems on L4. Here, L2 and 3 can almost be described as two sides of the same coin. L2 is focusing on the external-to-internal information, describing the representation of physical information from the physical world into the observer’s system of meaning. L3 reverses the focus to internal-to-external, where the system of meaning determines which L1 physical world information is taken in to L2.

The representational changes of information across the four layers imply the emergence of different kinds of uncertainty due to loss of information, artificial closing of information gaps, and reduction of information leading to incomplete or incorrect mapping or misrepresentation upon transition from one layer to the next. The following sections will detail these layers and, their interactions, and uncertainty implications, and validate this model, using PM related examples. In order to demonstrate the context independence and consistency qualities of the model, Appendix A applies the model to the discovery of DNA and explains the related uncertainty resolution during this process. It explains the interaction between the different layers in the information model in more detail, as well as

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7 Some of these layers may be termed data, information or knowledge. However, it is not the objective of this thesis to contribute to research investigating the relation between data, information and knowledge. Such matters of terminology are irrelevant in this context, as the model put forward here is based on a set of four scientific definitions which describe their qualities independent of terminology. For the purpose of this research, these definitions are referred to as information L1,2,3 and 4.
the social influences which may stimulate a transfer of information to a different level and subsequently reduce or create uncertainty in a collaborative context.

4.3.1 Information L1 and 2 interaction and related uncertainty

Information on L1 is physical reality. It is information existing in the physical world, independent of the observer. In a construction project for instance, this could be the land used as the future construction site. In a logistics project this L1 information may be the physical existence of a letter processing facility, or the letters which need to be transported. In an acquisition project, L1 may be the physical assets and employees from the acquired company who need to be integrated into the organization.

Uncertainty in this context is fully observer independent and objective. One of the few examples of such observer-independent uncertainty relates to whether a radioactive atom will decay within a certain time period. Finkelnburg (1967, p.206) describes that this decay is purely statistical. In this example, uncertainty about the point of time of decay is not based on insufficient information. The atoms do not age, so it is impossible to determine the moment of decay.

L1 information maps onto information L2 as cognitive images or representations. This is achieved by transforming L1 information into mental artefacts. In the transition from L1 to L2, information is lost. The mapping cannot represent physical reality in a 1:1 fashion because there is an abstraction process taking place. Referring back to the example of the construction project, the mapping of a landscape into the cognitive L2 representation of the project’s Architect may comprise the shape of the landscape and the position of trees or a river. In the logistics project, the physical information about the parcel processing facility that may be transformed into L2 information could relate to a mental representation of the shortest path through the parcel processing facility.

In this transformation process from L1 to L2, information may also be distorted or lost because of misrepresentation or oversimplification. Such misrepresentation or oversimplification produces uncertainty due to lack of information or, indeed bias and misleading information in the L2 representation of real world information. This uncertainty
may result in flaws in subsequent information processing where such faulty representations are resorted to. In the example, this could mean that whereas the Architect may hold L2 representations about the views in each direction on the construction site and about the service connections to and from the site for example, a Geotechnical Engineer may store less detailed or no information about the views on that site, but instead holds representations of the type of stone or soil at that same site. These perceptional differences highlight that information L2 determines how the physical world is perceived.

An incremental development of a more correct L2 representation can take place over time. The Architect may develop more detailed L2 information with regard to the shape of the landscape, its access paths, and exposure to the elements. The Geotechnical Engineer might develop more detailed L2 information about the consistency of the ground. This process demonstrates the incremental development of a more detailed representation of information on L2. The initial representations of the landscape for the Architect may have been an insufficient representation of reality and hence carried too much uncertainty to be valuable for further work, i.e. to plan a building. This type of uncertainty will be termed L2 uncertainty.

In order to reduce L2 uncertainty, the accuracy of a L2 representation can be checked by looking for more evidence in the physical reality on information L1 which supports or contradicts the representation. However, this process is initiated on L3, as discussed in the following, because L2 does not challenge the accuracy and adequacy of mental representations.

### 4.3.2 Information L1, 2 and 3 interaction and related uncertainty

On L3, an individual's system of meanings directs an active search for information and determines which new cues from the physical world will be taken in. This layer with its system of meanings can challenge the correctness of L2 representations. It allows identifying what is missing, and can challenge the representation constructed on L2. Such challenge would not take place on L2. Referring back to the examples, the Architect’s system of meaning around functionality and aesthetics of a building will direct their search for information in relation to these concepts, taking in information about the views from
the construction site, or the surrounding architecture and landscape the future building will have to blend into. A person trained to hold a Geologist’s system of meanings will be more likely to direct his search for information to information on the surface of the site which gives cues about the consistency of the ground beneath and its stability to carry a building. In this context, L3 allows identifying inconsistencies with regard to the stability of the ground, whereas L2 would just store the representation of the ground. The Geotechnical Engineer might use different techniques to explore the L1 information, the physical ground, further to extend their L2 information, such as mineral analyses of soil samples, or compression tests with a cylinder of soil taken from the site.

As the L3 system of meanings directs the search for more information on L2, it equally limits the possibility of building information which lies outside these systems of meaning. This makes it inconceivable for the person to look for new information in the real world outside their system of meaning. For example, the Geotechnical Engineer may not register the surrounding developments, as the Architect or the Property Developer would, to determine for instance whether there are enough houses to justify a supermarket and whether there are any other supermarkets within a certain range.

Uncertainty can appear in the interaction between L1, 2, and 3 where an incomplete, faulty, or wrong concept is applied to direct the search for L1 information, or where there is no concept to anchor any of the information at all. A good example for this is the black swan (Taleb 2008). As people assume that all swans must be white, there is no concept for a black swan, so when the bird was spotted, it was not recognized as a swan.

In the interaction between L1, 2 and 3, uncertainty can be reduced by consciously and critically questioning which concepts and representations of reality are applied, whether they provide the right information filters to anchor L1 into L2 information. This works especially well in an information-sharing, interdisciplinary environment, as people with different backgrounds will use different concepts to build L2 information. Checking each other’s representations by discussing them within an interdisciplinary project, for example, can help to discover misrepresentations and, hence, uncertainty.
Checking reality from different systems of meanings is more likely to produce a sounder approach to reducing uncertainty. Having said this, such a process of applying concepts from different systems of meanings could also create more uncertainty in the form of false certainties if some or all involved apply inappropriate concepts that do not allow searching for confirming information on L1 adequately or at all. This type of uncertainty is referred to as L3 uncertainty. Systems of meanings only allow for the collection of more L1 information within those systems of meanings. Hence, uncertainty can only be checked within these, too. Therefore, uncertainty that lies outside these systems of meanings cannot be acknowledged. Such uncertainty could only be acknowledged if new systems of meanings are produced or if a switch takes place to a different system of meaning which then guides the search for different and new L1 information. This L4 process is added to this model in the following section.

4.3.3 Information L1, 2, 3 and 4 interaction and related uncertainty

On L4, information purely relating to systems of meanings, in other words concepts, is represented. Whereas on information L3 a search for information takes place from within a given reference system, on L4 the reference systems or concepts themselves can be challenged, contrasted, interlinked, and amended. Thereby new L4 information is created, bringing forth a cognitive “difference” and hence a new idea about the external world.

In the context of construction projects, an example for challenging and developing the L4 concepts relates to the convergence of economical awareness and environmental awareness in recent years, interlinking these two concepts into the new concept of “sustainability” within construction. This was triggered by insights around the limited availability of energy resources and debates about environmental change. These caused societal changes, such as consumer awareness of environmental issues, shareholders preferring environmentally friendly companies, tax breaks and government driven financial incentives for organizations which use sustainable building techniques, such as photovoltaics. Such construction of new concepts, or a connection of previously unrelated concepts, or a relation of L2 and L3 information to concepts it had not been related to before, directs the search for more real world information which is initiated on L3 and executed on L2 to anchor new L1 information. In the example of photovoltaics, this leads Architects to take
in a new view on a potential construction site, with regard to site orientation to optimize sun path. Without the concept of sustainability and the subsequent directed search for information about photovoltaics, the Architect may not have looked for this L1 information about the sun path.

Incorrect concepts on L4 can introduce errors in the transition from information L2 to L3 so that information may be misinterpreted or may get lost by resorting to incorrect concepts, or to incomplete or faulty concepts which then provide inappropriate cognitive filters. Such insufficient or wrong filters may not allow relevant information to enter the cognitive system. The basic technology of photovoltaics existed long before it started to be used in construction. As the L4 concept of sustainability to combine economical and environmental considerations for construction had not been developed, the link to develop this technology and use it in construction was not made. Only once this link was established, the development of this technology experienced a huge push.

L4 information processing may challenge the way uncertainty is handled by placing it in a different or wider context. If people are not able to represent concepts on L4, or if they use faulty, incomplete, or incorrect concepts, and are not able to reflect on this to change it, uncertainty will arise due to the lack of ability to process information within a sound conceptual framework. This is referred to as L4 uncertainty.

Uncertainty may be reduced by linking concepts which are potentially represented incorrectly on L4 to their L3 information and questioning the nature of the mapping. Similarly, further down in the model, L2 representations can lead to exploring actual evidence from the physical reality, i.e. L1. Such an iterative process of evidence gathering and repeated abstraction is likely to produce more precise concepts, and more purposeful concepts.

Figure 4 provides an overview of the above discussion. It depicts the information layers with their different types of information, and shows where uncertainty can arise, and how it is reduced.
In the above discussed information model, information may be processed on each layer separately, such as the abstract construction of concepts which purely takes place on L4, or it may travel from L1 upwards and/or back down, while being transformed and processed. Information can be exchanged between individuals on L1 and L2. L3 and L4, on the other hand, are abstract cognitive information constructs. Nevertheless, information about L3 and 4 can be exchanged through L1 and 2 by talking about concepts and how concepts relate to representations or physical reality. However, the actual physical exchange takes place orally, textually or in any other form which L1 and 2 provide for.

4.4 Conclusion

The discussion in the foregoing chapter highlighted the inadequacy of traditional PM methods to address all types of uncertainty in projects, and identified potentials and shortcomings for the development of new approaches. Challenges around the theoretical foundation of the discipline were highlighted, which led scholars to demand to truly understand what is going on in projects. In order to address this challenge, the adoption of an information based paradigm was suggested for the purpose of this research, due to the close link between uncertainty and information. The value and the theoretical foundation of this paradigm have been examined in this chapter. In order to build this research on a
solid theoretical foundation, the literature on information was discussed, highlighting
different understandings of the concept of information, dependent on the discipline and
epistemological views adopted. From these different definitions, an information layer
model was constructed, in order to obtain a more precise tailored information lens for
studying uncertainty in projects than previous research which adopted the information
paradigm has done. Different uncertainty types have been specified, relating to the
different information layers, and their occurrence could be indicated based on the
information processes within and across the information layers.
Chapter 5 - Research Methodology

5.0 Introduction

The following chapter discusses the ontological and epistemological position adopted for this research and demonstrates how this relates to the chosen methods for data collection and analysis. It is structured as follows: Initially different philosophical stand points are discussed and contrasted. A great part of this discussion focuses on the qualities and applicability of positivism in the context of this research, as the positivist philosophy is traditionally adopted for Management research, and PM research in particular. Critical realism is introduced and it is illustrated how this position adds value for the chosen research topic, allowing an investigation of dimensions that may contribute to uncertainty management which cannot be captured in a positivist approach. Following the argument for critical realism, the case study approach and its application under the critical realist paradigm are critically discussed.

The second half of this chapter details the choice of research design. The interview technique is discussed and critiqued within the critical realist perspective, and its application detailed with regard to purpose, scope and sample. Subsequently the case study is introduced. The observation method is discussed, the case context and the key stakeholders are introduced, and the data collection process is described. Analysis methods for both, the interviews and the observation data, are detailed, and finally ethical aspects of this research are critically discussed.
5.1 Ontological and Epistemological Position

Positivism in project management

Positivism is historically dominant in PM research (Smyth and Morris 2007) in line with a general historical positivist tradition in management research (Johnson and Duberley 2000, pp.38, p.44). It forms the foundation of the classical process and competence based PM BoKs (Ohara and Asada 2009). Thus, many approaches to uncertainty management in PM are also of a positivist and deterministic nature. This methodological consistency may advocate the use of the positivist paradigm for this thesis as well.

While there are various versions of positivism, the current discussion refers to the following core claims of this philosophical tendency:

- It is assumed that one single social reality exists which is objective and constant.
- The properties of this reality can be measured by objective methods and captured as objective knowledge.
- The creation of such knowledge must be based on observations of this external reality (Easterby-Smith et al. 2002), where the observer is independent of the observed.
- The foundation for knowledge must be derived from empirical data.
- Anything unobservable has to be rejected.

Positivist research is hypothetico-deductive: It is approached by developing a hypothesis of fundamental laws and subsequently deducing what observations prove or falsify the hypothesis. The knowledge gained in this scientific process is understood to be systematic and general (Ackroyd and Fleetwood 2000). Positivism assumes that reality can be modelled by ‘definite laws’ (Saunders 2003) that define cause-effect-relationships which apply at all times (Welman 2002; Ackroyd and Fleetwood 2000). Furthermore the positivist tradition assumes that a research problem as a whole can be better investigated and understood when reduced into its simplest elements. Positivist research aims at prediction, achieved through the establishment of models, principles and laws. This
approach drives generalizations. In the traditional view of PM which describes standardized methods and techniques to manage all aspects of projects, positivism might hence appear to provide an ideally match for a philosophical underpinning. However, Ohara and Asada (2009) criticise this approach for PM: “Positivism has led in some cases to oversimplification, and in many cases, has obviated against recognition of the complexity and of the relativity of the world” (p.318).

In section 3.1 the shortcomings of this traditional positivism-based PM approach for managing projects and project uncertainty have been described. It outlined how such positivist tendencies can led to an increasingly questioned functional view of projects (Smyth and Morris 2007; Cimil et al. 2006), promoting the application of reductionist methods, and relying on quantification for planning and implementation control. This is seen, for example, in the theoretical underpinning of the PMI BoK (PMI 2004), which adopts a very limited and traditional approach to the management of uncertainty in projects. It is also reflected in the currently limited traditional approach to uncertainty through PRM (PMI 2004). The construction of models, principles and laws for general application in project practice are limited and conditional, as positivist research tends to be undertaken in closed systems. Hence, the number of influential factors is reduced, and assumptions are made about the excluded ones. This leads to the conclusion that models, principles and laws derived under such artificial conditions, may have a limited predictory capability in practice. This may be one of the reasons for the limited usefulness and understanding of academic research in PM, and its approach to uncertainty management (Smyth and Morris 2007). Applying such a philosophy to a discipline that lives and grows in tensions between the search for generalisations on the one hand, and managing the unique on the other, poses a number of challenges. Pursuing a positivist philosophy through verification by induction means that generalisations induced from research have to be challenged as contradicting evidence is found. The falsification approach which Popper developed as a deductive alternative (Popper 1934) was found not to work well in project research either, as often a normative agenda is pursued of what ‘should’ happen in projects (Smyth and Morris 2007). A deductive positivist view, thus is limited insofar as management models in reality tend to be practitioner driven and developed through experiential learning, and as this denotes an inductive normative approach it is unacceptable in positivism as it compromises objectivity.
A further criticism of the application of positivism in social science and business contexts generally is that it determines that knowledge simply reflects the world. This leads to an uncritical understanding of reality. “... as a result, it encourages us to experience the world as rational and necessary, thus severely impeding attempts to change it. ... [leading to] ... an ideology of adjustment, undermining our power to imagine a radically better world.” (Adler et al. 2007). This criticism suggests that positivism is not the most appropriate methodology for a practitioner-driven discipline, as project practice requires more than an uncritical descriptive understanding of reality. It must go beyond explanation, providing realistic and creative approaches to developing functional ways of managing challenges, especially in project environments where actors and circumstances are not constant or stable.

A final criticism of the positivist philosophy relates to the multidisciplinary nature of PM. PM research frequently applies concepts from other disciplines. Under the positivist tradition these concepts are often investigated and applied without acknowledging the contextual nature of projects, as a positivist methodology is not able to address such contextual conditions. Ignoring context may lead to the wrong application of such concepts, or at least to an inappropriate adoption of such concepts, leading to a false sense of project control by focusing attention on measures that are unsuitable or unpurposeful for a particular project. An example for this is addressing the entire spectrum of project uncertainty with risk control concepts adopted from mathematics.

Positivist domination has limited the PM research discipline, according to several scholars, who question the nature and theoretical base of PM (Turner 2006, Smyth and Morris 2007, Winter et al. 2007, Koskela and Howell 2002, Jugdev 2008), and seek a new theoretical perspective with a more appropriate methodological underpinning (Turner 2006; Geraldi et al. 2008; Winch 2004; Cimil et al. 2006; Morris 2010; Koskela and Howell 2002; Maylor 2001; Morris et al. 2000; Morris 2004).

Positivism in Uncertainty and Information research

Research on uncertainty is mainly rooted in the natural sciences, therefore a strong positivist tendency is prevalent. However, the discussion on the different dimensions of uncertainty in 2.5 relies on sense-making and creating meaning of the project and its
environment in order to be able to manage uncertainty. This highlights the need for an approach which is not limited by the positivist paradigm. Information is researched from different perspectives, including positivist or interpretive tendencies. Positivist methodologies objectify information and assume its existence independent of an observer, while interpretive traditions understand information as a psychic construct.

*Interpretivism*

Hermeneutics and interpretive methodologies rest upon idealism. The world is interpreted through the researcher’s mind and the study of the social world entails the investigation of how people use language and symbols to construct social practices; i.e., understand their experience. In this philosophy the social world becomes the creation of the purposeful actions of conscious agents; and social explanation requires adequately describing the role of meanings in human actions. Actions are not governed by discrete patterns of cause and effect (as in positivism), but by rules that social actors use to interpret the world. In contrast to positivism, there appears to be no objective, observer-independent knowledge.

*Constructivism*

Constructivism portrays "local and specific constructed realities" (Lincoln and Guba 2000, p.165) where social phenomena are the product of "meaning-making activities of groups and individuals" (Lincoln and Guba 2000 p.167). Whereas positivism essentially implies that the observer is separate from the observed and that findings are "true," constructivism is transactionally oriented with its findings subjectively tinged and "created" (Lincoln and Guba 2000). Constructivists would argue that the notion of “truth” is relative to individuals and groups / societies. While the precise operational definitions in the positivist tradition can take away the richness and texture of a phenomenon, so that it is reduced to a technical prediction, constructivists may study and present a phenomenon with a particular interpretive context, so that it runs the risk of being “isolated within collective solipsism” (Cupchik 2001). Both traditions, hence, have different epistemological problems to face: Under the positivist lens measurement may “transform meaning into nothingness” (Cupchik 2001), for constructivists on the other hand, the religious use of dense language is able to generate meaning, but only for those familiar with that language.
An analysis of PM research conducted by Smyth and Morris (2007) yielded that less than 10% of papers had a constructivist or interpretivist methodological basis. Thus, neither of these methodologies have strong application in PM research to date.

While generalisations are useful for an overarching PM discipline in order to be able to document, teach, manage, and develop a coherent core of the discipline (and to constantly question and advance best practices), the particular must not be lost sight of. It is the particular which provides richness, texture and context which is valuable for learning and improvement in a discipline that deals with highly complex and unique undertakings that are subject to a lot of factors which not all will be coverable in a generalised core framework. The diverging and seemingly irreconcilable foci between these different philosophical tendencies have led to an exploration for a more balanced methodology which is able to accommodate both, the general and the particular.

**Critical Realism**

Critical realism was offered as a new approach to managing the challenges that the social sciences are facing as positivism is losing its plausibility (Archer et al. 1998; Ackroyd and Fleetwood 2004; Sayer 1992). As Easton (2000, p.207) puts it: “The fundamental assumption of the realist position is that there is a reality ‘out there’ waiting to be discovered”. Constructivists would argue that this reality is merely socially constructed, or that there is no reality and that all knowledge claims are relative to the system which produced them. In contrast, the problem with naïve realism is the idea that reality is obvious and easy to discover and describe. However, critical realism admits that the real world is “fallible and theory laden … [but] Nevertheless it is not immune to empirical check and its effectiveness in informing and explaining successful material practice is not mere accident.” (Sayer 1992, p.5)

The meta-philosophy of critical realism is most commonly associated with the body of work produced by Bhaskar (1978). In arguing that reality is layered, Bhaskar (1978) distinguishes between the real, the actual and the empirical domains (see table 1 below). The real domain contains mechanisms, independent from the observer. These mechanisms have the causal powers from which observable events may emerge. In the actual domain the events created by the interaction of the mechanisms appear. Such events
may or may not be actualized, and may occur without them being observed. In the empirical domain events are observable by human beings. The events and the experiences that stem from them may not be in sync, creating the complexity which the researcher must deconstruct. Further complexity is added by the fact that events may be one-off, or following particular patterns.

Bhaskar (1978) presents the following chart to distinguish the different domains of reality:

<table>
<thead>
<tr>
<th></th>
<th>Domain of Real</th>
<th>Domain of Actual</th>
<th>Domain of Empirical</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mechanisms</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Events</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Experiences</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>

Table 5: Domains of Reality, taken from Bhaskar (1978, 13)

He argues that what differentiates the practice of scientific investigation is the assumption that the object of study physically exists, independent of the observer, and that this existence can be directly accessed and represented in the form of objective knowledge. While positivism approaches science as finding patterns in observable facts directly, critical realism aims to identify the real structures which generate these facts and patterns. These structures are typically not directly visible. The mechanisms which scientists are trying to test in experiments in order to prove or disprove their hypotheses are the result of the work of the underlying structures. Bhaskar (1978) argues that mechanisms are ‘nothing other than the ways of acting of things’ (p.14). The central concept in critical realism is causality, inherent in the nature of things, and to discover which causal powers act, and in which ways. A key aspect of the critical realist view on causal powers is that these are contingent:

“Events may occur as the result of causal powers of an object acting in certain contexts and under certain conditions. … Thus, valid explanatory knowledge in this realist perspective requires the researcher to identify the contingent causal powers that are operating in the particular situations under research and the ways in which they combine and interact in order to create the particular events observed in the empirical domain.” (Easton 2000, p.210)
For the PM discipline, such a layered ontology explains why the observed processes and
behaviours in projects hide as much as they reveal about the underlying information flow
and information management causes of uncertainty. Thus, critical realism provides a basis
for challenging the scientific presentation of positivist findings that describe the social
world with natural scientific descriptions by presenting its manifestations as ultimate
knowledge, without regard for the underlying structures. Easton (2000) argues that “much
of the operationalisation of the positivists is an attempt to bridge the gap between the
actual and the experienced. The crucial link is, however, between the real and the actual.
How these two domains are linked provides the basic raison d’etre of realism.” (p.208).
Critics of critical realism dispute the claim that there are indeed real mechanisms which
science could detect (rather than construct; e.g. Willmott 1996). They argue that the critical
realism philosophy has an authoritarian view of science providing the basis of objective
knowledge. Critical realists respond with the argument that science does not claim to
develop objective knowledge, but that it has developed procedures that allow for a
reasonable expectation of progressing toward such objective knowledge. The realist
tradition looks for valid explanatory knowledge (Easton 2000, p.207) and the critical realist
invitation to open science to rational debate reduces the risk of authoritarian and misguided
knowledge creation (Willmott 1996; Mutch 2005).

Easton (2000) contends that “…the death of positivism seen in the basic social sciences
should and is beginning to have an impact on more applied disciplines” (p.206), such as is
the case for PM. Thus, the crisis of positivism has led PM scholars to demand critical
realism to be employed more regularly (Smyth and Morris 2007).

Critical realism is a philosophy which harmonizes with the nature of projects, and allows
considering and optimising the general structures and objective knowledge for managing
projects and addressing critical factors by incorporating a normative perspective. At the
same time it acknowledges the value-based and interpretive nature of scientific work. It
provides the intellectual space to explore the particular and acknowledge contextual
conditions at the same time by recognising that the application of the general laws,
principles and methods cannot guarantee precise and predictable effects “...because
projects typically carry uniqueness, asset specificity, and high levels of uncertainty.” (Smyth
and Morris 2007). This balance may provide a new understanding around the difficulty
between PM BoKs which aim to outline the essential and generalised knowledge required
for managing projects and project practice on the one hand, and the misunderstanding that following these guides may not always be possible, or may be insufficient due to the unique, complex, and highly contextual and uncertain conditions of individual projects.

5.1.1 Epistemological and ontological integration of the information model

The stratified information model corresponds with the critical-realist positioning of this research, which argues that “…reality is arranged in levels” (Denzin and Lincoln 2000, p.13). The critical realist philosophy assumes that a world exists independent of the cognitive system, paralleled in Qvortrup’s (1993) information definition of “a difference in reality” (cf. 4.2). It, furthermore, argues that this world is accessed by human beings through their cognitive system, creating an abstractly constructed representation of it (Bhaskar 1978; Margolis 1986), paralleled from an information point of view by Bateson’s “difference which makes a difference” (1972, pp.271–272) and Qvortrup’s (1993) “difference which finds a difference”. While this model shares the basic epistemological assumption that humans deconstruct reality with Bhaskar (1978), his critical-realist philosophical ontology is divided into the real world of mechanisms, the actual level of events, and the empirical level of observed events. The model introduced here, however, resorts to Qvortrup’s (1993) four information definitions as levels of human representation of physical reality, as these are specialised in information and, therefore, provide a more precise separation and definition for the purpose of this research, which allows a more precise distinguishing of different types of uncertainty and their sources than the current literature does. As it is expected that such a more differentiated view on projects will provide further insights on uncertainty in projects, this model was applied for the data collection and analysis.

The reason for working with these specific four definitions of information, while a vast variety of other definitions exist in different disciplines is because, since PM comes from such a multi-faceted background, Qvortrup’s (1993) definitions provide a lowest common denominator of the discipline-specific definitions of the concept of information. What makes the information model useful in the context of PM is the more comprehensive, precise and abstract view on uncertainty that it provides than is typical in the current
thinking within of PM. Furthermore, the insights that the model provides into the interactions between the four layers of information allow for a more precise distinction of where uncertainty emerges and how it can consequently be reduced. In the following 2 chapters, this information layer model will be used to describe the findings of the interviews and the observation.

5.2 Critical Realist Case Study

The term case research is often used rather loosely in research studies (Easton 2000, p.210). Specific definitions for case research have been discussed by various authors who emphasize different qualities of this method. Goode and Hatt (1969) stress its holistic nature: “It is a way of organizing social data so as to preserve the unitary character of the social object being studied.” (p.331). Hakim (2000) points out another defining quality of case studies, that they: “... take as their subject one or more selected examples of a social entity” (p.61). Though more than one case may be investigated, case study research can generally not base its epistemological justification on numbers. While case studies are not restricted to qualitative data, it is more likely to be sought in case study research as it is more suited to understanding complex and rich contexts. Yin (1989) describes another quality of case studies:

“A case study is an empirical enquiry that: investigates a contemporary phenomenon within its real life context; when the boundaries between the phenomenon and context are not clearly evident, and in which multiple sources of evidence are used” (p.23)

This is particularly useful in a PM context, where information dynamics are strongly context dependent. Thus, they are best studied by using multiple sources of evidence, as the use of different data sources when looking at an information flow, provides a more reliable account of how information is transformed and why, where information is missing and how such gaps are dealt with.
Yin (1989) discusses another important criterion when describing the application of case studies for explanatory purposes, though his use of the concept ‘explanatory’ diverges from a critical realist view:

“How and why questions are more explanatory and likely to lead to the use of case studies, histories and experiments as the preferred research strategies. This is because such questions deal with operational links needing to be traced over time, rather than mere frequencies or incidence.” (p.18)

In Yin’s description and in a realist sense, case studies must explore the dynamics of time if they want to be explanatory. A critical realist can only identify causal mechanisms if these operate to cause events to happen, which is a time-based phenomenon. This explains the use of the word ‘contemporary’ in the previous definition, as case studies are different from histories where data cannot be created nor events followed. They are also different from positivist experiments where if-then effects are observed in a closed system. Realists start from the position that the world is made up of 1) physical objects; 2) their relations which can have structures that may not be obvious; and 3) causal powers that combine in complex ways and thereby create events which occur in the physical world and are empirically researchable. The use of multiple data sources allows tracing these links over time, and driving down to the real objects. Thus, case study research under the critical realist prism follows an iterative and reactive process. Each stage of research depends on what has been found in the previous phase. It may become necessary to go back over the same ground, but with a different approach, as simply drilling down to the real domain may not reveal the physical reality. Sayer (1992, p.107) argues that acts of creation and retroduction must be carried out. This is complicated by the critical realist view that causality interferes with a clear view on reality. If an event is not occurring, this does not necessarily imply that a certain causal power is not at work, it may just mean that the constellation of other objects with their causal powers are interfering in such a way that these causal powers stay unrealized. For example, the introduction of a new template for weekly project reporting may have the potential to increase the realistic representation of uncertainty conditions, but the weekly status meetings are set too short to be able to communicate these, or the project time pressures are so great that individuals do not have enough time to reflect and complete the templates and hence the potential of improving uncertainty management cannot be utilised.
In contrast to other methodologies, particular demands are placed on case research under the critical realist philosophy. Easton (2000) argues that:

“Case research which would wish to lay claim to a realist philosophy should be ... inquisitive, to look for the roots of things, to disentangle complexities and to conceptualise and reconceptualise, test and retest, to be both rigorous and creative and above all to seek for the underlying reality through the thick veil in which hides it.” (p.212)

A centrally different characteristic of positivism is that the foundation for knowledge must be derived from empirical data. In contrast to the critical realist approach, this lead to the view that anything unobservable has to be rejected. An even stronger differentiation between the two philosophies is the positivist tendency to look for regularity and concurrence. Law-like relationships are being hypothesized between empirically measurable elements, tested - mostly in closed systems - , and confirmed or refuted. Positivists look for regularity and conjunction. If elements appear to be correlated, it is investigated whether these correlations are significant enough to confirm or reject the hypothesis and further tests of the same theory lead to a view of increased confirmation. If they are of insufficient significance, the hypothesis is rejected. In contrast, Tsoukas (1989) argues:

“If positivistic claims about the natural and social sciences were true, scientific activity would not have been possible because most events in the natural world take place in open systems, in which events do not invariably follow a determined and recurrent pattern.” (p.552)

Because the positivist view does not allow for incorporating the unobservable, there is no possibility for providing explanations. Results based on a positivist philosophy can take the form of descriptions and summaries of relationships and patterns. However, why-questions cannot be answered. While this is a strong simplification, it broadly characterizes the main issues between the two philosophical views.

For case study research that seeks to examine the qualitative, and especially the ‘why’ questions positivism has obvious limitations. The use of single cases in positivism is not purposeful for identifying statistically solid correlations and hence for concluding
causations. Cases facilitate exploratory research as they allow identifying likely factors and the relationships among these. For positivists, this comes at the cost of generalisability. Positivists would generalize from a sample to a greater population. From a critical realist view, one case can afford generalisability to reality, but not to a greater population. Yin (1998) refers to this as analytical generalization:

“The short answer is that case studies, like experiments, are generalisable to theoretical propositions and not to populations or universes. In this sense, the case study, like the experiment, does not represent a sample and the investigator’s goal is to expand and generalize theories (analytical generalization) and not to enumerate frequencies (statistical generalization)” (p.21).

This concept of analytical generalization matches the realist notion discussed earlier, aimed at understanding and explaining the objective reality that is underlying an event or set of events (i.e. a case) by drilling down and describing the causal powers of the objects which produce them. Easton (2000) argues similarly “One case can create and / or test a theory to the extent that it uncovers reality. “ (p.214)

Constructivism on the other hand is based on the belief that no physical reality exists and that ontological insights are (socially) constructed (cf. 5.1). Therefore, data collection is guided by the perceptions of the world and only those perceptions can be recognized which can be anchored in conceptions the researcher holds. Analysis and interpretation of data is channelled through language. In this view, it would be argued that a case study is shaped by the person who has written it. There is no measurability of whether it is a true account, as an objective reality which it could be related to and modified by, is assumed to be non-existent.

Interpretivism equally may reject case studies on the basis that since humans construct multiple realities, researcher and research topic are mutually dependent. Cause and effect relationships cannot be separated, and research cannot be value-free. The depth that case studies offer to critical realists would be an illusion for interpretivists. Nevertheless, the point to learn from the interpretivist view is the social and constructed perspective which forms a part of a critical realist case study research. Sayer (1992) for example argues: “Social phenomena such as actions, texts and institutions are concept dependent. We
therefore have not only to explain their production and material effects but to understand, read or interpret what they mean.”

The above discussion has shown that case studies are a well suited research method under the critical realist philosophy, and purposeful for the research aim of the current study on PM. They support exploratory research, which this thesis is aiming for. They allow identifying likely factors that contribute to or hinder uncertainty acknowledgement and management in projects, and provide an ideal environment for studying the relationships among these. Constructivist and interpretivist criticisms are valid however, and as such it is imperative to account for bias and mitigate as far as possible for it in the research design and operational methodology employed under critical realist paradigm.

5.3 Interviews under the Critical Realist Philosophy

In critical realist research, the objective is to uncover the mechanisms in the real domain and their causal powers, which may or may not be exercised. While these mechanisms cannot be directly perceived, they can be derived by examining their effects (Bhashkar 1989). Similar to the discussion in 5.2 relating to the case study, these effects can be explored using the interview technique (Pawson 1989). This technique, and the ontological and epistemological consequences of its application, can be reflected on more holistically under the critical realist lens, than in the positivist or interpretivist traditions.

The positivist approach to the creation of objective knowledge links well to the highly structured interview technique, which allows for the collection of standardised response data from a large sample which can be quantified. In such highly structured surveys, the framework of concepts of the researcher are imposed on the interviewee as the questions and range of answers are designed by the researcher and the interviewee is not necessarily informed about the purpose of the questions. Interviewees are asked to commit in their response unconditionally in pre-formed categories. Subsequently, the obtained data is structured according to the researcher’s pre-defined agenda and only a section of the subject’s ideas may be represented. This provides an insufficiently realistic representation
of respondents’ reality due to the pre-coded limited response options. Interpretivists criticise this form of the interview technique as it insufficiently explores the context and meaning that people attribute to their actions. For example Marshall et al. (1988), who conducted research on class and mobility, used questions which focused on class. The study was limited as a result because class was imposed as the shaper of respondents’ experiences.

Interpretive research responded to these drawbacks of highly structured interviews with the concept of unstructured conversational interviews. These allow interviewees to express a topic using their own words within their own systems of meaning. While it can be argued that this interview style presents a more naturalistic idea of the subject’s reality, interpretivists seem not to consider that this approach also imposes the researcher’s framework of concepts. Since the researchers ‘steer’ the conversation this happens during the interview as with the positivist approach, but also afterward, when selection takes place in the analysis, interpreting, and documentation stages. These criticisms of different methodological approaches to interviews highlight the difficulty of accessing the real world through the interview technique, as an imposition of the researcher’s concepts and view on data always appears to take place one way or another.

Despite these differences in the approach to interviews, both, the positivist and the interpretivist traditions share the focus on the interviewees and their accounts. The realist tradition adds to this a more comprehensive consideration for the circumstances in which the data are collected and interpreted. The interview technique in critical realism acknowledges that the interviewee’s views are contaminated by the views of the researcher as the data emerges in the interaction between the interviewer and the interviewee (Pawson 1989). Pawson (1989) distinguishes two types of problems with data collection in social research: The ‘control’ problems and the ‘imposition’ problems. The former relates to the limited amount of control that can be exerted by the researcher during data collection, compared to positivist experimental research settings. For example, a slight change in language may change the course of the entire interview. Furthermore, the social situation of the interview influences the data collection (status, appearance, manner, etc.), which is very difficult to keep constant across a series of interviews. The latter type of data collection problem relates to the fact that the questions determine the conceptual
framework that the correspondent may, or worse, may not think about in the interview topic. Pawson (1989) describes this as follows:

“Essentially, we are looking for measures (questionnaire items), to capture the concept under consideration as precisely as possible, and this means that our theoretical assumptions about the concept are carried more or less directly into the data… the concepts and ideas in the questionnaire items potentially impose a frame of reference onto the respondent’s answers regardless of whether the respondent sees the issue in this way.” (p.289)

Pawson (1989) suggests the realist interview should follow a different, novel pattern by reallocating tasks and responsibilities between the interviewee and the respondent. His reasoning behind this is that he considers the focus on the respondent as the subject of enquiry as dysfunctional. He suggests placing the focus on the researcher’s theory to inform the interview instead. His solution to the imposition problem is to work with a more “open-ended exchange of language” (p.301) that utilizes mutual knowledge without making assumptions about how the subject may regard or value the concepts referred to and without imposing meaning. The idea is for the interviewer to “take advantage of respondents’ typical willingness to try and provide responses that are orientated to the researcher’s interests” (Taylor and Tilley 1998, p.46). Taylor and Tilley (1998) suggest that a learning process can take place where the interviewee can understand the research interest of the interviewer. Concretely, Pawson (1989) suggests informing the interviewee about the researcher’s topic, short of stating the actual hypothesis. This approach, furthermore, entails that the interviewee makes the purpose of a question clear, so that the subject can develop a response that meets the researcher’s investigation needs. While interviewees may not be experts in the researcher’s topic, they are experts regarding their actions, views, options, and decisions in which the interviewer is interested. Taylor and Tilley (1998) suggest that the interviewer should design the interview in such a way that they can tap into the subject’s expertise: “The researcher uses that expertise in relation to those parts of the theory to which it is relevant and the interview is thus openly driven by the theory.” (p.46). In this form, Pawson (1989) regards an interview as “... data construction rather than data collection” (p.307).
5.4 The Interviews

Scope and purpose

Following consideration of an appropriate research philosophy in the PM context a methodology for the current study was developed. This consisted of a series of 11 scoping interviews in 9 organisations in which projects are common developmental or strategic instruments. This was followed by observation research in the form of a multi case study in one organisation.

An exploratory set of interviews was conducted as a scoping exercise to investigate the parameters of thinking around uncertainty in PM. The purpose of applying this method was to gain a topical overview and identify problem areas in the management of uncertainty in projects. These exploratory interviews investigated practitioner-perceived issues and challenges associated with uncertainty management in projects. As Bresnen (1988) argues in his research on construction projects, the start of data collection must provide the possibility to get a feel for the topic and its characteristics. For this study the interviews permitted the exploration of PM practitioners’ experiences of uncertainty dynamics, and of managing the uncertainty inherent in their projects. The semi-structured nature of the interviews facilitated the exploration of the topics found in the literature while maintaining the flexibility to uncover factors which practitioners may consider relevant, thus allowing for exploration of critical issues and potential gaps between theory and everyday practice, or providing new views on the literature. The interviews, furthermore, provided support for the justification of this research by helping to establish whether this study indeed addressed a critical topic which requires further research. They helped focusing the research objective and detailing the research questions (cf. 6.7.3).

A further purpose of this preliminary study was to assess the utility of the information paradigm to achieve the research aims of this study. Therefore, the interviews were analysed from a traditional point of view and through the information paradigm lens, to establish if this lens provides additional insights into the causal mechanisms of uncertainty dynamics in projects. Only if that was the case, this approach would be taken forward into the main observational research.
Finally, the overview gained from the interviews allowed ensuring that a “typical” project was chosen for the observation research and helped preparing the observation research that followed the preliminary interviews. Results are presented and discussed in chapter 6.

The sample - interview details

Based on information obtained via the literature and supported and supplemented by information obtained in the pre study various issues to be explored were identified. These were developed as the foci of 11 semi-structured exploratory interviews. These explored 11 different projects across nine industry sectors in six countries. This breadth was sought in order to explore the extent to which uncertainty management is an issue in projects in different industries and organisations. It also afforded the opportunity to study whether PM’s uncertainty management methods, techniques and tools are applied broadly throughout different types of projects in organisations and whether the consequences of this were similar. The interviews were undertaken in primarily large international organizations. These organisations include SIEMENS – Europe’s largest engineering conglomerate, Deutsche Post DHL – the world’s largest logistics group, SAP - the largest European software enterprise and fourth largest in the world, and Deutsche Telekom - the largest telecommunications company in the European Union. On the other end of the scale, they also included smaller local organizations, such as a Construction company in Dubai, UAE, and a start-up in the German food industry.

Respondents included senior project practitioners, senior management of the project organisation or project managers of medium to large sized projects. Staffing of the projects varied due to the application of staffing curves, but all were large involving between 10 and 120 employees at their peak. The length of projects discussed ranged from approximately 6 month to 4 years. Due to confidentiality issues, interviewees would often not provide more concrete numbers. An overview of the interview settings is provided in Table 6. The names of the interviewees are abbreviated for reasons of confidentiality.

<table>
<thead>
<tr>
<th>Interviewee</th>
<th>Organisation</th>
<th>Position</th>
<th>Sector</th>
<th>Project Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>AR</td>
<td>Siemens</td>
<td>Project and Program manager</td>
<td>IT Infrastructure – Fiberoptics</td>
<td>Hardware development, B2B</td>
</tr>
<tr>
<td>ML</td>
<td>t-systems</td>
<td>PMO, Project Manager</td>
<td>Telecommunications</td>
<td>HR, Merger and Acquisition project</td>
</tr>
<tr>
<td>TA</td>
<td>t-systems</td>
<td>Sub-Project Manager</td>
<td>Telecommunications</td>
<td>Change Management</td>
</tr>
</tbody>
</table>
Table 6: Anonymous overview of interview contexts

<table>
<thead>
<tr>
<th>Sub-Project</th>
<th>Project Manager</th>
<th>Education</th>
<th>International development project</th>
</tr>
</thead>
<tbody>
<tr>
<td>BS Heriot-Watt University</td>
<td>Project Manager</td>
<td>Education</td>
<td>International development project</td>
</tr>
<tr>
<td>HM SEWAG Energy</td>
<td>Project Manager</td>
<td>Energy</td>
<td>IT Infrastructure development project</td>
</tr>
<tr>
<td>DM SAP</td>
<td>Project Manager</td>
<td>IT</td>
<td>Consulting and software development, B2B</td>
</tr>
<tr>
<td>RP DHL</td>
<td>Project and Program Manager</td>
<td>Logistics</td>
<td>Internal Business Process Reengineering</td>
</tr>
<tr>
<td>PN Deutsche Post</td>
<td>Contractor Sub-Project Manager</td>
<td>IT</td>
<td>Software project</td>
</tr>
<tr>
<td>TC GEC Ferranti Defence Systems Ltd., now SELEX Sensors and Airborne Systems</td>
<td>Project Manager</td>
<td>Transport</td>
<td>Research and Development</td>
</tr>
<tr>
<td>JG Frischback GmbH</td>
<td>CEO and Project Manager</td>
<td>Food industry</td>
<td>Mergers and Acquisition</td>
</tr>
<tr>
<td>MM Consolidated Contractors Intl. Co.</td>
<td>Sub-Project Manager</td>
<td>Construction</td>
<td>Construction project</td>
</tr>
</tbody>
</table>

The interviews were of a semi-structured nature and lasted between 40 min and 3.5 hours. In total 27 hours were recorded.

The interviews followed a set of topics which were considered relevant for this research, (cf. Appendix A). Each interview started with an explanation of the purpose of the study and a brief contextual introduction, then questions were derived from the set of prepared topics, depending on the flow of each individual conversation, and further context was provided in line with a critical realist approach to the interviews. Interviewees were also encouraged to address topics which they found relevant in relation to uncertainty dynamics, beyond those introduced by the researcher, in order to allow for other relevant or critical topics which had not been foreseen by the researcher, to be identified (Bresnen 1988; Robson 2002). The interviews were audio-recorded and transcribed verbatim, and where necessary translated. The transcripts were shown to the interviewees for their approval, ensuring correctness of the data captured. The interview guide is provided in the appendix.
Purposive sampling

The sample of interviewees in this research was purposive, not seeking a representative sample at any cost, but rather sampling in such a way that additional information could be obtained (Robson 2002, p.193). The sample size for the interviews was not pre-defined, but rather data collection was continued until reaching saturation, ensuring that various perspectives could be uncovered. As the majority of interviews exceeded 1 hour, the depth of quality of data obtained in such extensive interviews justifies smaller numbers of interviews (Robson 2002), particularly for a scoping study.

For the interviews individuals who had experience in a senior project management position were targeted. This ensured that these individuals could draw on their individual knowledge to provide high quality primary data rather than reproducing established PM knowledge. It was hoped also that senior individuals would be, due to their professional experience and position, less likely to be intimidated by the interviewing process.

As the interviews were undertaken in different organizations and for different types of projects, they allowed establishing the scope of the problem addressed in this study, determining if inadequate uncertainty management was a general issue in PM. They also showed tendencies around whether PMs across different projects apply the discipline’s core uncertainty management methods, techniques and tools and whether the consequences were similar, highlighting that this is indeed a problem. They, hence, confirmed the relevance of the study and the value this research could add for the discipline.

Critique of the interview technique

Potential difficulties and problems of the interview technique include the artificiality of the situation, lack of trust, time, elite bias, ambiguity of language, and the pitfall of interviewees wanting to appear knowledgeable which may lead to the construction of a story in order to appear logical and consistent (Myers 2009, p.127). This was countered as far as possible by:
- Setting clear expectations, explaining the research interest and the researched topic, so as to optimally utilise the interviewee’s knowledge and experience.
- Explaining the purpose of the questions.
- Discussing matters of confidentiality to establish trust.
- Choosing social situations which would not influence the interviewees’ replies.
- Conducting the interview in an appropriate manner and getting informed about the context and organization in advance.
- Listening carefully and asking clarifying questions where necessary.
- Performing trials in advance in order to get used to the technique and how to interview about the chosen topic area.
- Using mirroring in order to use the interviewees’ language and context.
- Taping interviews in order to increase credibility being able to reproduce the exact words.

Bowman and Ambrosini (1997) argue against the use of single respondent interviews in the context of strategy research studies. They discuss that “if there is a lack of consensus in a firm about [..] strategic dimensions, then relying on a single respondent for anything other than factual, objective information may be misleading. “ (p.119) which apparently renders the research unreliable. While this may be a valid criticism for research that focuses on researching disagreement among managers on organizational strategy, this disadvantage of single respondent interviews is less critical in the context of this study. The interviews served as preliminary orientation. While it may not have been possible to gather different views on one single project’s uncertainty management approach through single respondent interviews, they allowed researching the facts around what uncertainty management processes and tools are used. Furthermore, different views on the effectiveness of uncertainty acknowledgment and management could be gathered by conducting interviews across various projects with executives on different levels and with different views on the project information (program managers, senior and junior project managers). Bowman and Ambrosini’s (1997) conclusions are based on survey research conducted in 76 organisations with 371 respondents. The soundness of this study may be questioned for the use of a survey tool and, hence, its positivist over reliance on quantification. A critical realist
interview would not have to question validity based on the fact that a single interview is conducted. Findings are not validated in greater numbers which come at the cost of less precise and comprehensive data. Henderson (2002) also argues that Bowman and Ambrosini’s (1997) criticism is “far from conclusive”. Bowman and Ambrosini (1997) argue that where none of the responses of managers of an organization match, the study should be discarded, as none of their views may match reality. This recommendation could be concluded into the argument that it may be futile to do many interviews around the same project, as none of the views may match reality either. This argument highlights the limitations of their positivist approach to this problem. Approaching this study from a critical realist perspective instead entails a different ontological approach, as it may be argued that it is possible to uncover mechanisms in the real domain by examining their effects together with a respondent who is informed about the purpose of the research before and during the interview.

Practical limitations, furthermore, dictated the single-respondent approach, due to the difficulties of negotiating access and time with more than one respondent. The advantage of single respondent interviews in a critical realist context is the opportunity to maximize the benefits of getting to know a single respondent, taking the time to explain the context and research background, and explore a variety of thought-streams. It provided the time to offer more context, as well as different question queues to help critically reflect on the descriptions and circumstances around uncertainty acknowledgment and management, allowing the respondent to become aware of beliefs and perceptions that go unnoticed in order to illuminate the underlying causes.

As demonstrated in the results section, the fact that the majority of interviewees from different projects discussed the same problems, PM tricks, and insights, demonstrates a coherence which reduces the concerns around the single respondent approach. The responses converge in a tendency which confirms that not just one particular view is represented. It may even be argued that interviewing many project managers on the same project problems and mechanisms is similar to a multi-respondent interview strategy for one project.
5.5 The Case Study

As discussed in 5.2 and 5.3, a positivist approach is not suited for the current research. Instead, a case study approach was considered to be the appropriate method for facilitating this investigation. This method allowed gaining an understanding of an entire project setting. Furthermore, because information dynamics and their uncertainty effects are strongly context dependent, they are best studied in a natural and holistic project context (top-down, bottom-up, horizontal disseminations and consolidations) in order to understand how and where they start and develop, what they influence, and how different information flows interrelate. As “Case studies need to be concerned with dynamics and time if they are to be explanatory…” (Easton 2000, p.211), they allow for such multidimensional exploration of collective information processing. Furthermore, information dynamics are best studied by using multiple sources of evidence, as the use of different data sources provides a more reliable account of how the information was transformed between different media (e.g. oral and textual) and how that changed the uncertainty perception.

Observation

One way of implementing the case study method is by observation. Non-participant overt observation was found to be the most valuable method for this study as it should yield rich qualitative data because:

“… qualitative research entails much more sustained contact [with the people being studied], especially when participant observation is the central method. … The need for the fostering of such relationships is a product of the qualitative researcher’s need to see the world through his or her subject’s eyes, since the researcher would be unable to gain any leverage on this level of analysis from a distance.” (Bryman 1999, pp.37–38)

Observational research allowed the researcher to look at all previously collected insights and links with theory in a natural setting, and to collect richer data. In comparison to other qualitative and quantitative methods, participant observation is ‘naturalistic’ and should create an account rooted in the natural setting (O’Neill 1990). Scholars in the field of PM are requesting research which can uncover an “… understanding of the lived experience …
Their actions, decisions and behaviours ...” (Cimil et al. 2006, p.676). Participant observation is about: “... observing things that happen, listening to what is said and questioning people over some length of time” (Becker and Geer 1969, p.322). This is particularly important for a study in the field of projects, as PM is an applied discipline which is strongly practitioner driven. Therefore, observing firsthand experience was vital for making this research successful. Observation does not rely on people recounting situations, potentially missing vital information or adding nostalgic colouring. Other methods cannot bring these types of insights to light as they are all of a more indirect nature. Furthermore, observation provides meaning as advocated by the people experiencing it. It allows the researcher to witness firsthand accounts, providing the researcher with the opportunity to learn about a topic from those who are closest to it – in this case the various project parties and stakeholders involved. This provides a view of the problems being studied from the inside and gives a more holistic account by allowing for the collection of more variables and influencing factors. Thus, it provides more opportunities to drill down to the domain of the real. Only by recording such a comprehensive picture of how information flows and is processed cooperatively in a project, and which factors influence this information flow, can a comprehensive understanding of the management of uncertainty be gained. Finally, it can be argued that participant observation has a long pedigree, providing another justification for its use. For example there have been notable studies of informal groups in large enterprises (Dalton 1959) and of group developments in teams (Gersick 1988).

While observation is typically associated with ethnography, this study is not just ethnography as such, as it is not primarily looking at cultural interactions. Observation was used in the context of this research as a general method of data collection in the context of a multiple-case study.

The case context

The observation was conducted within the NX program at Deutsche Post AG - DHL in Atlanta, USA. Deutsche Post AG – DHL is the largest logistics group in the world. The NX program is one of their four key strategic change programs currently undertaken within

8 For reasons of confidentiality, the name of the program was abbreviated
the organisation, making it a high visibility and high priority program. The NX program consists of a set of five interdependent software projects for the logistics sector⁹, which rendered this research a multi-case study as all five projects were observed.

The company has extensive experience in the management of projects and uses a customized PM model based on the V-Model 97 (Dröschel and Wiemers 1999)¹⁰. The nature of NX matched the requirements, in that it was large enough to investigate information dynamics. Access was granted to a set of interrelated projects, so that the research could be extended to a multi-case study, increasing validity of the study and sample representativeness. The use of novel technologies positioned the project more on the soft side of the spectrum. Much freedom was provided to the researcher for collecting data and access was granted to approach important individuals, sources and situations for the data collection.

The goal of NX is to develop a globally unified IT-platform which supports the operating processes of DHL/Deutsche Post Global Mail’s value chain and local production facilities. NX is intended to provide functionality for gathering and processing billing information of customers, service providers and other Deutsche Post subsidiaries; it should support the oversight and control of internal business processes; facilitate global networking of the production facilities allowing for greater transparency and division of labour; and provide interfaces to customers’ IT systems, service providers and internal finance and controlling software. Current systems are not unified due to a number of international acquisitions over recent years. They are deemed outdated, unstable, provide insufficient interfaces to other systems, and are not sufficient for the new business dimensions, and therefore present a business risk.

The new IT-platform is planned to be developed and rolled-out in four stages, initially tested in the US, subsequently rolled out in Asia and Australia, and finally in Europe. The program is scheduled to take 4 years, from the 1st quarter 2005 to the 4th quarter 2009. An

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⁹ Several months earlier, one of the interviews had been conducted with a sub-contracted project manager who is leading one of the 5 projects in the NX program. Another interview was recorded with the program manager of NX. However, this interview covered a different project which this program manager had managed previously.

¹⁰ The V-Model 97 is an abstract PM method, originating in the IT sector (Dröschel and Wiemers 1999).
overview project plan is depicted in Figure 5. The budget for the entire program is set at approx. 28 Mio Euro. The team size fluctuates around approximately 60 core staff and a large number of stakeholders who are required to participate actively by providing their expertise during specification, design, testing and roll-out. NX is roughly divided into several main projects, covering different aspects of the application, such as the preparation of the data which is fed into the software, a SAP business module for customer management and billing, a core module which handles the main logistics processes, an address management module, and a number of smaller projects. The observation for this thesis comprised the projects in the following referred to as TMS, DW, and NX Core Releases 1, 1.5 and parts of 2.0. The real names of the program and its projects are concealed for confidentiality reasons.

![Figure 5: Original project plan for the NX program](image)

The observation was conducted at the DHL facility Atlanta, in Forest Park, GA, which was strategically chosen as main development location for the NX Program. The facility is one of DHL Global Mail’s major logistic hubs in the US for sorting and redistributing mail. DHL/Deutsche Post has chosen to locate the development team at a facility, in order to ensure close contact with an actual facility, to allow for direct knowledge transfer and short communication paths.
Stakeholders of the NX program

Various parties can be identified in the NX program and its projects. What was colloquially referred to as “The Business” represents the business owners who are the future users of the application. Their task is to pose business requests for certain functionalities which the IT-platform should provide in order to support the business processes. “The Business” must answer any questions the Specification Team may have, must prioritize functionality and must make decisions about the functional aspects of the software.

The Specification Team, referred to as “Spec Team”, must detail and document the request the business makes into requirements, must put them into a textual, diagram and image form (Use-Case Diagrams, Business Object Model, Graphical User Interface mock-ups), and must answer questions the IT team may pose during the software design and implementation of these functionalities.

The “IT Team” must detail the specification, analyze the legacy systems, establish gap analyses in collaboration with the Spec Team, and must develop the IT design and implement the system.

The “Test Team” must then test the functionality, performance, integration with the other modules, and must support the business acceptance test where business approval is obtained.

These teams are assembled from different backgrounds. The Business represents the corporate group. The spec team and the test team are contracted from specialized companies. The IT team is partly composed of people from the IT-Subsidiary of Deutsche Post and partly staffed with contractors who were contracted by the IT-Subsidiary.

Data collection procedures

The observation was carried out as non-participant overt observation, meaning that the researcher did not take part in the activities, however, her status was known to the observed subjects (Gold 1969).
Qualitative data was gathered through traditional observation and note-taking, video- and audio recording, ad-hoc interviews during the observation, and the collection of documentary evidence and image artefacts. During observation periods, hand-written notes were taken. These were divided into a description of observed situations, events and their context, and possible quotes which were considered important, adding meta-comments on the side of the note block. These notes were transcribed immediately after each observation period to ensure that the facts were still fresh and so that information which might have been left unrecorded due to time pressure during the observation, could be added. An example of an observation protocol is attached in Appendix.

Meetings were mostly video-recorded or, where not appropriate, audio taped. These were labelled, backed-up and secured through encryption on a daily basis. At times, photos were taken of sketches people had drawn on paper or on the various blackboards.

**Observational techniques**

In comparison with experiments, survey research, and interviews, observational techniques provide the opportunity to consider the flow of information and related development and reduction of uncertainty, by being able to witness the dynamics of behaviour in natural environments. Some literatures advocate that observation should consider social interaction solely from externally observable behaviour, and refrain from implicating intrinsic meaning of actions, beyond stimuli which may have occasioned certain responses. For instance, Morris (1978) argues that all observable behaviour can be attributed to underlying drives and patterns which are biologically or socially inherited as a product of evolutionary pressures. In contrast, interpretive approaches to observation, such as symbolic interactionism, phenomenology, and ethnomethodology, assume that social action results from intended and meaningful behaviour which makes reference to understandings of a shared social world (Miles and Huberman, 1994). This stream is often combined with semi-structured interviews (Glaser and Strauss, 1967), which are also used in this study.

Depending on the nature of the field work, observations may start with a phase of familiarisation, followed by generating codes and categories to order the initial unstructured observations. Alternatively, observation may start immediately with the application of structured research instruments (e.g. Flanders 1970, Galton et al, 1999). The former...
approach is deemed more appropriate for exploratory case studies (Robson 2011), while the latter is suitable for large-scale surveys, or to establish wider reference points for more qualitative small-scale enquiry. (Woods 1986) The observation conducted in this research followed the former approach, recording what occurred, supported by a combination of video and audio recording, and verbatim and selective field notes. Field notes included direct observations, together with considerations and reflections on significant observed episodes and decisions made by the observer on insights generated, tested, confirmed or disproved. This exploration allowed for topics to emerge, and to then decide on an appropriate coding scheme which would facilitate the clarification and focus on the research questions.

Using recording technology richer data is created, which can more adequately represent the interactions, however it also increases the amount of data which needs to be analysed. There is a risk that content analysis in this context may not always be able to consider the extensive observations, and identify the underlying mechanisms of multi-layered interactions and influences. The research aims should guide the observational focus, to concentrate on essential information. In ethnographic observation the researcher functions as the research instrument and must make decisions on sample and where to direct attention. Such inductive methods generate emerging insights, hypotheses, and theories from the data which are then explored further in different contexts (Glaser and Strauss, 1967). This forms a process of progressive focusing where the observer begins to distinguish the peripheral from the central factors and directs attention at key contexts for the vital evidence.

Delamont (2002) suggests that following an initial period of relatively unfocused watching, it is essential to start paying close attention to a selective set of phenomena (pp. 130-1). In an ethnographic study for instance, it may be appropriate to pay close attention to clothing worn by participants, furniture arrangement, items employed and used. This was less purposeful for this particular study where an abstract commodity (information) is researched. Therefore, furniture arrangement was merely noted in the field notes to jog memory of certain situations, for instance where unfamiliar observees sat in a large meeting room in order to remember them and jog the researcher’s memory. Over the period of observation some indication about time spent, physical movement of players, handling of equipment/resources and recording verbatim speech (as far as possible) may be desirable where there is some focus on physical activity and artefacts used. This is less feasible and
less useful in research focusing on more abstract intellectual contexts such as this study. Delamont (2002) argues that it does not matter what the observer looks at, as long as the gaze is focused on some person, object or location in a thoughtful way (p. 132).

In terms of how to observe, Wolcott (1981) proposes different strategies for choosing what to look at and how:

- Observations by broad sweep
  The broad sweep approach tends to make the researcher aware of the need for selectivity. It also creates an awareness of important points.

- Observations of nothing in particular
  This anticipatory approach can identify unusual activity by not focusing on a particular detail, but merely seeing if anything unusual arises. It is compared to watching for a blip on a radar screen, indicating unusual activity

- Searching for paradoxes and for problems facing the observed groups
  This is considered a useful approach to countering familiarity

All of these were applied in this study, the first two more at the start of the observation period, whereas the latter could be used as more focus was placed on certain emerging patterns in order to gain additional or novel insights.

Wolcott (1981) mentions a further observation method where the researcher is learned in the activities of the participants, to increase understanding of events and hence being clearer how to observe and what to focus on. It was possible to use this approach in this study due to the observer’s shared professional background with the observees.

On considering how to observe, Delamont (2002) explains that selecting where and when to look is also a matter of systematic and reflexive choice (p. 134). This was applied in the study by choosing different areas in and outside the workplace where observes would gather, considering more or less formal settings, and larger or smaller groups to be observed (e.g. kitchen, meeting rooms, by desks or blackboards).
The observation focus included:

- Tracing particularly contentious topics through the project both, across different people and groups, and over time, observing how these transformed through these journeys
- Identifying clues, such as questions, facial and gesture changes, certain wording clues, which were symptoms of information transforming to different layers, and focusing observation on these
- Facial expressions, body language and noises or statements indicating an insight, or gaining clarity or being confused, indicating transformation across the information layers
- Frustrations and irritations, indicating informational inconsistencies
- Physical gatherings and dispersions and their impact on information flows

In terms of observation recording, Delamont (2002) suggests this to be done as unobtrusively as possible, noting verbatim speech or key words/phrases where possible (p. 138). She reiterates that it is essential to keep analysing and interpreting data throughout, in order to manage the complexity, and ensure the observations continue to be purposeful. Faster noting styles were developed with certain abbreviations to note as much verbatim valuable information as possible. Cameras were set up in unobstrusive places, so that at times the filming angle was deliberately compromised to reduce intrusion.

Adler and Adler (1987) explain that the degree of involvement in field enquiry influences the detail and structure of field notes and coding (participant, non-participant, overt, or covert). Due to the non-participant and overt approach adopted for this field research, large amounts of data could be gathered openly.

**Coding**

Coding forms part of the qualitative data analytic process. Saldana (2009) confirms that there is no best way to code. Along with Patton (2002) and Miles and Huberman (1994) he promotes the pragmatist paradigm, choosing context specific coding, determined by the research questions, methodologies, conceptual frameworks, and fieldwork. This approach was applied in this study.
Merriam (1998) argues that “our analysis and interpretation – our study’s findings – will reflect the constructs, concepts, language, models, and theories that structured the study in the first place” (p. 48), and it is not only your approach to qualitative enquiry (e.g. case study, ethnographic, phenomenological), as well as ontological, epistemological, and methodological orientations that influence and affect coding decisions (Creswell, 2007). Sipe and Ghiso (2004) argue that “all coding is a judgment call” as it is influenced by “our subjectivities, our personalities, our predispositions, [and] our quirks” (pp. 482–3).

Coding will reduce data, in view of identifying pattern symptoms, themes and ultimately underlying mechanisms. From codes categories are established. In qualitative research, these are unlikely to be precise and discrete, but rather bounded in fuzzy intervals (Tesch, 1990, pp. 135–8). Hatch (2002) proposes to consider patterns not so much as constant regularities, but as varying forms, which can be characterised by:

- similarity (things happen the same way)
- difference (they happen in predictably different ways)
- frequency (they happen often or seldom)
- sequence (they happen in a certain order)
- correspondence (they happen in relation to other activities or events)
- causation (one appears to cause another) (p. 155)

The above were used to guide coding and to guide and focus observations, through the identification of similar types of information inconsistencies and information exchange patterns to establish the cause of these, or breakages in information flows for instance. Differences were observed and coded, for instance, around informal and formal information flows. Frequency and sequence of certain occurrences were tagged relating to different project structures, approaches to topics, and project phases, cycles, or processes. In order to establish such sequences, as well as correspondence and causation patterns, observations followed topical trails (and were coded along these trails) to group the data and highlight the information journeys. In some cases gaps of observation were followed up with informal interviews and conversations to complete such trails.

The majority of qualitative researchers code data, both during and after the field work (Miles and Huberman, 1994, p. 56). Field notes were coded during observation by
structuring the note taking into written observations, quotes, and a column for marginal remarks next to these, as per suggestion in Miles and Huberman (1994). The majority of these notes were transferred into digital versions at the end of each observation day and at times reflective remarks were added (Miles and Huberman 1994). This initial coding during field work, allowed the researcher to identify further patterns which could be pursued further.

Several coding schemes were used, in order to capture different observations. For the majority of data, open coding was used (Strauss 1987, Corbin 2008). For this process, observation notes, videos, and audio recordings were reviewed and initially some categories and subcategories were noted and labeled. Also, some connections between these categories were identified and comparisons considered, for instance between meeting observations in different sub-teams, and some cause effect relationships hypothesized for instance between type of information provided and observers reactions. Some event coding was applied (Robson 2011) later into the observations, for example to capture questions asked in meetings. State coding (Robson 2011) was applied to capture how information seemed to transform through the information layers during a meeting. Further details on data analysis following completion of the field work are discussed in section 5.6.

Amount of data collected

In total 221,4 hours of video data were obtained, 17,5 hours of audio recordings, 21 photos of sketches and situations and 29 observation protocols were completed. 60 GB of documents, or 83,873 files were collected. These include project documentation, such as status reports, project plans, MS PowerPoint presentations, budgets, organisational charts, risk management spreadsheets, as well as system documentation in the form of design documents, business requirements documents, documentation, protocols, release notes, change requests, reports, system architecture diagrams, and delivery protocols.

In the field

The observation time frame was from June 25th to August 3rd 2007. The observation time was from mornings to evenings, including discussions about work issues in shared car rides to the facility in the mornings, to regular social events or gatherings after work and on week-ends.
The observation of the NX program was preceded by working through a number of high-level documents, such as the project manual, Gantt charts, and OBS', which provided a basic understanding of the program, its structure and some of the internal jargon, which allowed the observations to become productive more quickly. Furthermore, phone calls with the project manager and members of the Project Management Office (PMO) provided the opportunity for the researcher to ask clarifying questions.

The observation involved attending meetings as they are the main settings where information is verbalized and transformed in a collective setting. Since IT projects require a great deal of intellectual work which is hard to observe, meetings were the key information sources where people would interact, exchange thoughts and ideas, develop solutions together, plan the next activities and raise issues. In between attending meetings, the researcher took the opportunity to conduct informal interviews, for example by spending time in the kitchen to come across people not already encountered, hear news, meet up with the office secretary, see if any other meetings or less formal gatherings were planned. While sitting at a desk in the open plan office which was assigned to the researcher for note taking, it was possible to observe almost in a covert way, getting a sense of overview for what was going on in the large room where the majority of the project team was working. Often, critical activities or issues could be identified by realizing who was rushing through the room, who went to see someone else at their desk, where small groups gathered on an ad-hoc basis around someone’s desk, or in front of a printout or a black board to discuss something, or where a group of people would rush into a meeting room.

In the first week, the researcher was introduced to the higher management of NX. A short presentation was given about the research, as well as the purpose and conduct of the observation. Each manager passed this information onto their team and during the first week the researcher attended all weekly team-status-meetings and was introduced to the teams. In each of these status meetings the researcher said a few words about herself, how the research would be conducted, assured the team that all information was kept confidential and that people should feel free to ask questions or express any concerns about the researcher’s presence.
Into the second week the researcher was familiar enough with the jargon and the program structure, that she could direct more attention to observing information dynamics; as well as uncertainty discovery, representation, dissemination, and resolution strategies.

Permission was sought every time the researcher intended to audio- or video tape. Only on very few occasions was permission denied. People soon grew accustomed to the researcher’s presence as ‘the PhD student from the UK’. This slightly detached image was encouraged through behaviour and dress code, in order to counter initial suspicions that the researcher may be an auditor sent from the headquarters in Germany.

While some project members initially joked about the presence of a camera or would sit at an angle where they would be further away from it, people soon stopped taking notice of the researcher and continued their daily business. It is difficult to judge whether the researcher’s presence had an effect on the course of events. However, evidence against this is the fact that after a week into the project, people discussed sensitive issues while the researcher was present. Further into the research, people even actively volunteered that they would be having a meeting that day and invited the researcher to attend. At that point, individuals also started to approach the researcher to provide unsolicited information about the project – about their role in it, their concerns and even internal conflicts. During the individual informal interviews, it appeared that people felt relieved that they could share the pressures of their job, their concerns and also the achievements they were proud of.

Sample representativeness

Sample representativeness in observation involves the question whether the individuals and settings studied are marginal or core to the situation (Bryman 1999). Once the project structures, responsibilities and decision horizons of various groups, and their interactions became clear in this program, representativeness could quite easily be established. A purposeful sampling was derived from the team structure within the projects, allowing the researcher to collect data in different sub teams, from different stakeholders, observing key people, or following the development of issues, ensuring top-down as well as bottom-up reviews of information dynamics.
Glaser and Strauss (1967) argue that qualitative research should be less concerned with meeting statistical sampling criteria, but rather the adequacy of a sample, collecting enough data to ensure a saturation of the categories which are emerging during the research. This was ensured by choosing a time frame which allowed the observation of all critical phases of a project. The projects observed were typically split into 3 phases: specification, design, implementation and testing. The completion of a cycle of one release (i.e. version) of the software was observed. This was achieved in the relatively short time available since the project used fast-tracking to overlap project phases in order to speed up development. Unfortunately, the observation started too late to cover the whole specification phase. However, specification was continued throughout the design and implementation process and this continuous process allowed the researcher to observe the work of the specification team. Over time, saturation was reached, as patterns started to repeat, which indicates representativeness of the sample. Glaser and Strauss (1967) advocate that the adequacy of a sample (length and size) is determined by the degree to which it allows the researcher to establish a theoretical point. They explain that the researcher only observes as many subjects and situations as required to develop a category and then moves on to the next. Over time a theoretical saturation point was achieved. Furthermore, Myers (2009, pp.144–145) argues that compared to Anthropology, the periods of field work in business and management tend to be much shorter as no new culture and language have to be learned, in particular if the subject matter is familiar to the researcher, which was this case as an interview had previously been conducted with a member of the observed program and the researcher worked in IT projects and IT PM.

5.6 Analysis Methods

The data analysis followed an iterative process, allowing new data to inform the ongoing analysis, revising analytical categories as required, and pursuing new questions which emerged during the writing up of the findings. At the same time, theory from the literature review was applied to abstract and confirm findings. The analysis aimed at preparing the development of a new understanding of uncertainty in projects and how to better manage it. Therefore the analysis was aimed at preserving holism and complexity of the data.
5.6.1 Observation analysis under the critical realist paradigm

Pawson and Tilley’s (1997) realism based Context Mechanisms Outcomes (CMO) approach was considered to assist in the analysis of the findings. Their realistic evaluation approach aims at identifying the underlying causal mechanisms, how these work, and under which conditions (Pawson and Tilley 1997). Because causal mechanisms are embedded in particular social contexts, Pawson and Tilley (1997) argue along the lines of a realist tradition that it is necessary to understand the relationship between these mechanisms and the effect of that context on them working and on their outcomes. They sum this up as: Context (C) + Mechanism (M) = Outcome (O). Because these relationships are context dependent, they are not constant and repeatable. A process may work differently in different circumstances. So, rather than identifying simple positivist type cause-effect relationships, Pawson and Tilley (1997) try to identify which mechanisms work, under what conditions, and what outcomes are produced. They describe the purpose of a realistic evaluation as establishing whether there is a causal relationship between a program and its outcome, aiming at measuring change following the implementation of that particular programme.

Pawson and Tilley’s (1997) approach is based on developing a hypothesis, implementing a changed based on this hypothesis, and measuring its effectiveness. It thus focuses on the operationalisation of methods in order to improve a social situation or context. This is applied in action research contexts (e.g. Eijnatten and Dijkstra 2005), but stands in contrast to the principles of a non-participant observation method which aims at being non-obtrusive. Harrison and Easton (2004) argue that the term “context” carries some ambiguity, as it is used to describe both, necessary and contingent conditions (Sayer 1984). They criticise that Pawson and Tilley (1997) provide no clear definition to explain the nature of contexts and mechanisms. The “outcome” may be one aspect of a response process for a particular case at a particular point in time. Pawson and Tilley (1997) leave it to the researcher to explain how the contexts, mechanisms and outcomes come together. Harrison and Easton (2004) criticise in the context of applying Pawson and Tilley’s work for the analysis of organisation and management research studies:

“Pawson and Tilley offer little advice for the situation where it is necessary to combine multiple configurations when building an explanation for a particular outcome within a case. This issue is
exacerbated when multiple cases are incorporated within the same research study. The authors do not fully discuss how a set of combined contingencies and mechanisms from several cases are combined into a broader more generalisable mid-range theory. Nor do they state that what is needed is theoretical comparability rather than attempting to replicate empirical situations” (p.202)

Pawson and Tilley (1997) are concerned with evaluating the effectiveness of a particular intervention in a particular social field and situation / context, focusing on delivering change programmes and policy interventions for areas such as health care or criminological research (Jupp et al. 2000). Their approach was developed in a social scientific context and is mostly applied in such contexts (see e.g. Rycroft-Malone et al. 2010). It has rarely been adopted in management research, and has not found its way into PM research at this point. PM has different issues and different ways to address compared to the social scientifically oriented research Pawson and Tilley (1997) focus on. There has to be more clearing done in the context of PM to be able to utilise this approach, as not everything drawn from the sociological tradition is automatically usable for Management, and PM studies. This approach was, hence, relegated in favour for a more commonly applied data reduction approach for the analysis of observation research.

The data analysis for this research was conducted using the suggestions of the realist authors Miles and Huberman (1994), while following the logic of critical realism. Miles and Huberman (1994) describe their realist approach to qualitative analysis as follows:

“*We agree with interpretivists who point out that knowledge is a social and historical product and that “facts” come to us laden with theory. We affirm the existence and importance of the subjective, the phenomenological, the meaning-making at the centre of social life. Our aim is to register and “transcend” these processes by building theories to account for a real world that is both bounded and perceptually laden, and to test these theories in our various disciplines.”* (p.4)

They outline their approach to qualitative analysis following Bhaskar’s views (Bhaskar 1998; Bhaskar 2008; Archer et al. 1998) which understands social phenomena to have a real objective and a subjective existence. It was decided to adopt Miles and Huberman’s (1994) methods, as they offer the most appropriate approach, and provide useful tools and techniques that can be applied to PM research. The application of these tools and
techniques is detailed in section 5.6. The discussion of the findings, based on the insights of the data analysis, are presented in chapter 7.

5.6.2 Interview analysis

Initially the data was organized and prepared for analysis. The interviews were transcribed and translated into English where necessary. In the first interview analysis stage, all interview transcripts were read in order to “... obtain a general sense of the information and to reflect on its overall meaning” (Creswell 2003, p.191), while taking notes of thoughts and notions that came to mind while reading. This initial screening helped to gain an understanding of what general ideas were expressed by the participants and in what tenor these were presented. After reading all interviews, similar topics were clustered with the help of the NVivo 7 software, and broad thoughts were noted applying the Memo Technique suggested by Miles and Huberman (1994). These are "Written records of analysis related to the formulation of theory" (Strauss and Corbin 1990, p.197). Memos are a way of recording ideas to facilitate reflection on the data and coding, and help producing analytical insights (Maxwell 1996, pp.11–12). Strauss describes theoretical memos as "writing in which the researcher puts down theoretical questions, hypothesis, summary of codes etc. - a method of keeping track of coding results and stimulating further coding, and also as a major means of integrating theory” (Strauss 1987, p.22).

An ontology was developed, identifying crucial themes related to uncertainty and information management in projects. This preliminary analysis took place in the early stages of the research, in order to identify critical themes which would help to shape the research, set the scope for the research and identify the key areas which needed to be attended to. In a second round of analysis the interviews were reviewed again, using an MS Excel spreadsheet to cluster topics and themes as the NVivo7 software did not provide the desired visibility for the abstraction processes. The findings were then reviewed under the information paradigm, with the use of the information layer model, to contrast the analysis under the traditional paradigm, and establish if additional insights into the causal mechanisms could be gained which could not have been accessed under the task based normative paradigm. This second stage provided the basis for writing up the interview findings and discussion, presented in chapter 6.
5.6.3 Analysis of the case observations

The nature of the observational method produces large amounts of data. In the following the indicators that were used to identify uncertainty-related patterns in the data are discussed. Furthermore, the process of reducing and analyzing the data will be described. Finally, the use of the different types of recorded data, that is field notes, documents, images, audio and video recordings, to increase the quality and validity of the analysis are discussed.

Analysis indicators

During the analysis of the observation data particular focus was placed on a number of topics and indicators which, based on the literature study and interview experience, are linked to the successful or unsuccessful detection and handling of uncertainty.

In the analysis of the data, attention was focused on settings and situations where traditional PM methods did not appear to work as expected, for example with regard to scheduling and forecasting, or controlling, or with regard to the management of interaction of different project parties, or in the use of standard processes such as Change Management, as these could be linked to inadequate uncertainty management. The occurrence of such problems and errors could be a consequence of uncertainty either not being detected or not adequately managed. Also approaches which consciously or unconsciously deviated from traditional PM were particularly focused on in the analysis in order to see whether and how these would facilitate or hinder uncertainty management. Furthermore, specific topics were followed through different meeting forums, across different project members, and over time, to see how the uncertainty dynamics in these changed and which processes or methods impacted the information availability and exchange in what way. Additionally, particular incidences, such as conflicts or problems which disrupted the project were particularly analyzed, as these may have arisen out of some form of uncertainty.

Further into the data analysis, various factors which would impact information dynamics and availability were looked for. It was focused on indicators of manifestations of
information dynamics and structures, as well as complications and facilitators, to determine crucial uncertainty situations and processes.

Data reduction and analysis process

As Myers (2009, p.165) argues, differentiating data collection and analysis in qualitative research, and particularly in observation, is problematic and overly simplistic. While the bulk of data analysis was performed after the observation had been conducted, a number of insights had already occurred to the researcher while in the field, which influenced further data collection. The analysis can be roughly divided into the following phases:

During observation stage:

- Initial analysis during the daily observation periods
- Initial reflection during the daily writing and cleaning up of the observation notes, shaping which further contexts and settings to observe

After completion of the observation stage:

- Logical and sequential ordering of the observation materials
- First reduction of data in a pre-analysis screening of materials and identification of crucial fragments
- Second reduction and abstraction of data with a coding process
- Writing-up of the findings in several iterations

The observation field notes were typed up every evening during the observation, in order to stay familiar with the data and add insights which may have occurred during the day but where there was not enough time to write them down immediately.

After the completion of the observation, the audio and video files, as well as the photos were put in a timely order and matched to the observation notes in preparation for further data analysis and to gain an overview again.
In an initial post-observation analysis stage, looking at the photos, listening to parts of the audio recordings and scanning the videos allowed to identify crucial video and audio recordings and helped to focus on the most important aspects of the data (Myers 2009, p.166). This was also because the amounts of data collected were rather huge, as is normally the case in observational research.

In the following, the data was further reduced in size as a detailed analysis was undertaken with a coding process. Miles and Huberman (1994) state that “Codes are tags or labels for assigning units of meaning to the descriptive or inferential information complied during a study. Codes are attached to “chunks” of varying size – words, phrases, sentences, or whole paragraphs, connected or unconnected to a specific setting” (p.56). This process was initially supported by the NVivo7 software. The material was organized into segments in order to put them into categories in sections, paragraphs or single statements, labelling them in the NVivo7 software. However, again due to the instability and inadequacy of the software, the data was further analyzed manually, conducting different analyses and producing different representations, mainly following the suggestions of Miles and Huberman (1994), also applying the memo technique as mentioned above for the interviews, writing analytic memos for hunches and ideas regarding the meaning of the data and emerging concepts and themes.

An ontology was developed based on the literature review, problems and concepts were defined, and codecs were applied which allowed an index to be created and allowed observed phenomena to be categorised and their frequency and distribution to be identified. This was not done in order to quantitatively analyze the data, but rather to identify relations between events or cause-effect relationships explaining their occurrence. The findings were then abstracted into a number of concepts and themes and their interrelations and these were tested on further data.

A final step of analysis was the writing and repeated re-writing of the observational setting and findings. The process of structuring the textual representation of the observation findings, the numerous iterations of summarizing the extensive data into a comparably short presentation of the quintessence of the findings, and the decisions on terminology to be used, in order to present the data in an accessible way, required further abstraction and constituted the last phase of the data analysis.
In parallel to these steps, continual reflection about the data during the entire analysis phase was taken by having continued conversations with supervisors, practitioners, NX staff, and peers, facilitating the abstraction and interpretation process of the wider meaning of the data, as well as asking and answering analytic questions to further develop an understanding while working on the development of new concepts. As with the interviews, this interaction of data analysis and theory building helped to process the data, as well as to develop new concepts.

Cross-examination of traditional and multimedia supported analysis

The analysis of the observational data took a twofold approach. The gathering of large amounts of audio and video data on the one hand, and the more traditional field notes, hand written interview summaries and documentary evidence on the other, provided enough quality and richness of data for an analysis on two magnifying levels, a comprehensive ethnographic-inspired one, and a detailed video and audio analysis of micro-processes for selected sequences.

Beyond employing the traditional holistic methods for the analysis of the traditional observational data, the video and audio recordings could be used to remind the researcher of particular situations being able to return to the scenes as often as required. This allowed for reviewing situations from different viewpoints which for reasons of constraint of time or lack of additional information in the original setting may have not been possible in the original setting. It, furthermore allowed using overview knowledge from the entire observation under which to judge the data. However, they were not used for particular detailed analysis, such as Hermeneutics or Discourse Analysis as the naturalistic setting where the researcher was trying to stay in the background did not allow the set-up of controlled environments for such studies. For example, the camera often had to be set up with time constraints and had to be positioned in such a way that it would not disturb proceedings. This often meant that the angle of the filming was not ideal or that in some instances parts of the audio sequences were unusable.

Complementary use of documentary data

Throughout the analysis of the observation data, the document analysis of the NX program repository complemented the analysis of the direct observation data, often adding more
factual data, in the form of project plans or specification or documentation of parts of the software, providing the context for observed situations. Myers (2009) states that “It is much easier to obtain data from documents than from interviews or fieldwork” (p.161).

Using documentation, it must be kept in mind that it is an “unobstrusive measure (...) which is nonreactive” (Robson 2002, p.349), as it is not affected by being employed for the research. It must further be kept in mind that these documents were produced for a purpose other than the research that is using them, influencing their analysis, by critically checking the purpose they were written for, and what level of completeness and accuracy they exhibit. “The material to be analysed is not only unstructured, or at least not structured with the needs of the observer in mind; it will in general be a document with a purpose. And that purpose is important in understanding and interpreting the results of the analysis.” (Robson 2002, p.351). Various project documents, written with the purpose of organizing its management and documenting the project’s progress helped to make sense of project developments over time by comparing various versions of documents, such as project plans, descriptions of the projects and project goals, or specification documents. Here, for example the alterations and changes in the project plans helped the researcher to understand where progress was misjudged, where plans had to be altered, and hence uncertainty had previously occurred or information conditions were judged wrongly to have led to incorrect estimates. This condition is supported by Prior (2003) who argues that documents make things visible and are traceable.

Furthermore, resorting to the document repository allowed for a comparison of the oral and informal information flows and information statuses between individuals and subgroups in a project, compared to the target group and contents of the official documents. Here, discrepancies could be identified to discover sources of uncertainty.

5.7 Ethical Considerations

The nature of qualitative research entails a high degree of involvement in an intensive experience with the subjects of the research. This fact entails a number of strategic and
ethical matters which should be reflected on in order to identify potential biases, as well as personal interests and values related to the research area and research procedure (Creswell 2003).

As a general rule with regard to ethical conduct, Myers (2009) proposes to follow the principle of “you should do unto others as you would have them do unto you” (p.46). Maylor and Blackmon (2005) extend this rule to the field of business and management as follows: “Treat others as you yourself want to be treated and provide benefit to the organization and individuals involved in your work.” (p.281). This golden rule provided ethical guidance during the conduct and analysis of the interviews and observation, approaching the research and its participants with honesty and protecting their privacy.

Creswell (2003, p.64) point out that: “researchers ... need to respect the participants and the site for research”. Site access was negotiated with management in a number of preliminary meetings and telephone interviews. An overview of the aims and how the observation would be conducted was presented. It was agreed that concrete facts, such as the name of the program and program staff should be kept confidential. Myers (2009) state that informed consent is an important part of ethical conduct in qualitative research. Informed consent to participate and the advice that involvement may be terminated at any point for any reason (Myers 2009, p.48), was obtained by interviewees and the majority of staff in the NX program, particularly all of those who were audio- or video recorded.

Documentary data, as well as audio and video data, has been kept concealed. Participants were protected in that data was kept confidential, stored video and audio data was encrypted and only kept by the researcher, and access in the observation was negotiated. Privacy of the participants was protected - no individual information was divulged to other individuals, participation was voluntary in interviews, and, for the observation video and audio taping, permission was negotiated in every single instance and refrained from when requested; the research was explained to the participants, they were offered the opportunity to ask questions and to obtain a copy of the results.

When conducting observation “Researchers need to respect research sites so that the sites are left undisturbed after a research study. This requires that inquirers, especially in
qualitative studies involving prolonged observation or interviewing at a site, be cognizant of their impact and minimize their disruption of the physical setting.” (Creswell 2003, p.65). The researcher withdrew gradually from the site. Disturbance of the activities was minimized by ensuring that her presence was hardly recognized and ad-hoc interviews would take place in the breaks, in the kitchen, in the evenings on the way home or during social activities. This minimized intrusion on the flow of subjects’ activities.

“In the interpretation of data, researchers need to provide an accurate account of the information” (Creswell 2003, p.66). This was achieved through debriefing with the observed project team. It was also agreed that potential research papers following the investigation would be checked by members of the observed PM team prior to publication. Anonymity of individuals, roles and incidents is protected by using aliases or pseudonyms to protect identity. Data gathered during the observation is stored encrypted, so that the chances of it falling into the hands of people who could use it for inappropriate purposes are minimized.

It was agreed with the interviewees that their names and those mentioned in the interviews will be kept confidential. In order to protect Deutsche Post, it was agreed with the NX management that the PhD thesis would be kept confidential for several years and that publications resulting from the research would be checked with the NX management prior to publication in order to ensure that confidentiality is preserved.

5.8 Conclusions

The goal of this chapter was to identify appropriate research methods to study the chosen topic. The philosophical foundation, methodology and the methods for this research were examined. Critical realism has been identified as the central philosophical underpinning for this research as it accepts an independent objective reality while recognizing the value of abstraction of meaning. A research design consisting of preliminary semi-structured interviews and overt non-participant observation for this research has been critically discussed. These methods were chosen as they capture the complexity of the topic while
providing different qualities and quantities of data. The following two chapters are testament to the value of both methods.

It was ensured that the research design was of high quality by employing various approaches, procedures and concepts which throughout the planning, data collection, analysis and presentation phases would ensure that the results are internally consistent, valid and reliable, minimizing errors and biases of the study.
Chapter 6 - Interview Findings

6.0 Introductory Remarks

The following chapter presents the findings of the analysis of the primary data collected in a series of 11 early exploratory interviews. These were conducted as a scoping exercise to investigate the parameters of thinking around uncertainty in PM and to assess the utility of an information based research approach (cf. 5.4). The interviews provided a practitioner-perceived overview of issues and challenges associated with this topic, and permitted the exploration of their experiences with the uncertainty inherent in their projects. The interviewees’ backgrounds have been detailed in Table 6.

The findings from these exploratory interviews are discussed in the context of the literature previously examined in this thesis. The presentation of the findings is structured according to the defining elements of projects discussed in the literature review in chapter 2, i.e. the project goals, project planning, PLC, project structure, etc. Interview data is presented pertaining to the value of these for the management of uncertainty dynamics in projects. In particular, the discussion will be three-fold for each element: 1) The traditional task-based view of projects will be summarised, which will be 2) contrasted with deviations from this approach that could be identified in the interviewees’ descriptions. 3) These deviations are then discussed from an information perspective using the information layer model defined in chapter 4. In that manner, the analysis contrasts the task based utility for the recognition and management of uncertainty with the application of the information perspective. It can thereby be established whether the information perspective offers any insights towards the objectives of this study, beyond those currently established in the literature, mostly built on the traditional paradigm. This approach will reveal if there are benefits to the adoption of a new paradigmatic lens over the traditional task paradigm with regard to understanding and managing project uncertainty dynamics.
6.1 Project Goals

The literature review (cf. 2.3.2) established that goals shape and direct projects. Under the traditional task-based paradigm it is a prerequisite that goals are pre-determined, clear, well defined, and stable from the start of the project, as they form the basis for upfront planning. The plan, which is based on the goals, is baselined, and implemented. Therefore, the literature established the link between goal clarity and project success, as well as various issues related to changing goals (cf. 2.3.2). The following sections discuss the findings around the traditional goal qualities: definition, clarity, pre-determination, and goal stability.

6.1.1 Goal definition (vagueness)

The traditional paradigm assumes that the project goals need to be well defined, so they can be used for upfront planning (cf. 2.3.2). When describing the process from receiving the goals to doing the planning work, TC states in the context of a research and development transport project:

“Our project customer, the sponsor, Mr XX tells us what he is looking for, what he wants to achieve. Then we go through a period of definition and negotiation, until we are clear on what we need to do.”

This statement offers an example for how PM practice deviates from the theory. All 11 interviews yielded that the goals in reality are not fully defined at the project start. They cannot immediately be used for project planning, as theoretically assumed by the traditional paradigm. TA’s statement in the context of a Change Management project, exemplifies this problem:

“When we wanted to start planning, we realized that we had more and more questions we had to work through before the goals were really sharp enough.”
It becomes evident from various statements that project goals are initially not able to shape and direct projects. The goals appear to be too high level initially to allow deconstruction into tasks, task interdependencies, and timelines for a detailed plan. It appears there is too much L1 uncertainty, i.e. information lacking on information L1, (cf. 4.3.1) to consider the goals well defined. They are too vague. Therefore, various interviewees describe that the goals get detailed in a phase of further goal definition, such as TC discussed in relation to his transport design project:

“We first get the project goals. Then follows a phase of exploration, getting down to the details. And yes, sometimes you can’t get the goals clear when you do your planning. Sometimes it takes a while…”

From an information perspective this points to the finding that the goals initially do not provide sufficient information to guide the planning process. In particular, they do not allow identifying which information is relevant for the project and which is not. So it is not clear which information must inform the plan. Therefore, an intermediate stage of information detailing or refinement is added by PMs prior to the planning stages, with the aim of reducing goal uncertainty by detailing the goal understanding, so that it can then guide and direct which information is relevant for subsequent project phases. This intermediate stage appears not to be a systematic approach. Instead, this step of refinement of the goal information is driven by the fact that the planning cannot be done. So the requirement to do the planning work drives the project managers to try and understand the goals better, i.e. to gain more information.

From an information perspective this means that the existence of uncertainty (lack of goal information) is not explicitly acknowledged, and therefore it can also not be addressed in a structured manner. The traditional paradigm does not discuss the possibility of uncertainty at this point, and provides no methods to address it. Instead the project team implicitly manages this vagueness and searches for further information. However, the extent of that search can vary significantly. Four of the most senior and experienced interviewees described a strong focus and the importance of these goal definition activities, whereas others mostly just mentioned that further information was required for the planning work. For example TA explains, describing the start of his change project in the telecommunications sector, that:
"There was pressure to present a project plan. We didn’t really know yet what we were doing, but we pulled one together. We just added contingencies, but then of course we had to change it a lot over the following period."

This statement highlights that project activities progress immediately with the planning work, as proposed by the traditional body of knowledge. An information-based interpretation of that statement concludes that while not all required information was available to produce a project plan, these information gaps were filled with assumptions, creating false certainties, to be able to produce a plan.

A second challenge around goal definition is described by PN in their software project:

“We had a problem with our goals for the data warehouse, but we only realized too late. The goal we had agreed on, to use the existing data warehouse and restructure it to fit the new systems, didn’t really work. But we didn’t really question that. We just went ahead and tried to achieve this. So a lot of time passed, with a lot of work happening all over the place, and then we realized far too late that this approach didn’t work. We should have taken a step back and thought about if this is the right way. Instead we just marched forward. In the end we had to scrap the whole thing, and start from scratch. Then we put some more thoughts into what would be the smartest way to do it. So we ended up with better goals.”

The above statement describes an example where the project goals were not adequate. From an information paradigmatic perspective such an inadequate goal guides the wrong kind of information search. The goal was too restrictive. The project team relied too quickly on this restrictive goal without questioning its adequacy, and progressed into the implementation phase. A challenge of the project goals should take place during the initial definition phase, and regularly throughout, to review the goals with regard to their quality to guide the information search. This is not part of the traditional PM paradigm, and has not been discussed in any literature challenging the traditional goal setting views.

In summary, project goals are traditionally expected to be clearly defined, to be able to use them for planning purposes. While these goals may be clear to the key stakeholders, they can be too high level to use them for planning work, as they are too vague. Therefore, a
detailing of the goals phase often has to precede the planning activities. This is driven by
the need to get more information about the goals to increase their utility. As this goal
definition phase does not form part of the traditional methodology, it is often rushed, as
stakeholders expect to see a project plan immediately. This was particularly found to be
the case for less experienced project managers. This insufficient establishment of L1
information can lead to the creation of false certainties (assumptions) about the project
plans on L2 and L3. A further finding relates to the adequacy of project goals to guide
information search. There are no mechanisms in the traditional PM body of knowledge or
other PM literature that discuss reviewing the adequacy of goals.

6.1.2 Goal clarity – understanding the goals

The following quotes detail two interviewees’ views on project goals at the start of their IT
infrastructure, and transport research and development projects respectively:

HM: “The difficulty is fully understanding the goals. Our sponsor, Mr XX, initiated the project
and got me on board as the PM. I get told what the goals are, because they have been developed
before I started. We talk about why the project was initiated. And I then formalize them in the
project brief. But that doesn’t really give you the detail you need. So when we have most of the
core project team together, and the project has officially started, we spend a lot of time really
understanding what we are doing, and to get everyone who needs to understand it and to internalize
it. So we really shape them for the first few weeks.”

TC: “The problem is, they need to grasp what we’re doing, what the really important bits are. We
had to go through it a few times in kick-off sessions and planning sessions until it [the goals] sinks
in.”

The goals initially appear not to be clear enough to the project members to guide progress.
This finding aligns with the insights from the literature review (cf. 3.1.3) where Halman and
Burger (2002) found that after project kick-off more than 50% of project managers did not
yet have a clear understanding of their project’s goals. The interview findings established
that even if goals appear clear to the project sponsors, the quotes show that the same
cannot be said for the project teams. Therefore, a phase of goal exploration takes place
within the project team, which does not form part of the traditional PM methodology. During this phase, the project members try to familiarise, and internalise the goals, in order to achieve a better understanding that allows applying or building on these goals for the subsequent project stages.

From an information perspective, the above statements demonstrate that the project members initially lack information around the goals. However, this uncertainty does not relate to lacking L1 facts about the goals, as described in the previous section 6.1.1. This phase of understanding the goals is in fact a replication of these goals in their understanding, on information L2 and L3. It is a transfer of the goal information from the sponsors’ information L2 and L3 to the project members’ mental representations. It is also about anchoring this information to either new, or adequate L4 concepts. The representation of the project goals is initially not established on sufficient information layers and particularly L3, to be able to use this understanding to guide information search in subsequent project stages. Therefore, a period of information search and amendment of the L2 and 3 goal representations is required. It appears this is not a conscious process, as the above statements highlighted this search for more information only took place when attempts were made to use the information, i.e. to apply the understanding of the project goals. This shows that there is no awareness about the information density of a project, i.e. that information about the goals is lacking.

In line with that finding, the above statements highlight that while uncertainty at the point of initial project goal definition is present, it is not explicitly acknowledged or formalized, as the traditional paradigm provides no formal structures or language to represent uncertainty of project members about the project goals. Instead, it demands clear goals and immediate application for further planning. However, in line with the above statements, the analysis yielded that most project members feel uncertain at this point, in the form of project members not holding sufficient information about the goals to be able to use these productively. This is addressed in a phase of goal information replication. This process is described by interviewees through the use of terms, such as “must be clear”, “sinks in”, “internalize”, or “get it”.
Shared goal clarity

The above statements, and the following ones in particular, highlight that the process of developing more L2 and 3 information is a co-operative and interactive process, involving the entire project team. For example in their capacity as PM in a major acquisition project, ML states:

“But initially, it is important to me that these teams that come together there, have understood what they are supposed to and want to achieve. And that sometimes is really hard work, to get them to the point where they understand what they are supposed to do.”

When asked how this might be done ML replies:

“For the XYZ project we ran a series of workshops at the start. That helped the guys to internalize the goals.”

Similarly, in the context of his change project, HM states:

“See at this point [points at goal specification phase], it’s really important we get people in a room together, so they understand what everybody is supposed to be doing.”

These quotes point at the importance of interaction of the project members to increase the quality of their L2 and L3 representations. Such an interactive approach ensures that all project members internalize the goals, and develop converging representations of these on L3, and apply shared concepts as much as possible on L4. This ensures that goals are understood in the same way, so that planning and implementation work proceeds in a common direction.

The above quotes also highlight that there is an expectation of achieving full goal clarity. Similarly AR states in the context of a large IT Infrastructure development project:

“Well, where do I want to go, the goal must be clear. I need to have a realistic image in my head as to whether I can achieve that goal or not”
This goes in line with the traditional literature, suggesting that early goal clarity is linked to project success (see 2.3.2). There also appears to be an urgency to complete the project planning, so there is time pressure regarding the goal clarification required for the planning work. The following quote describes an example from a software project where this time was not taken:

PN: ‘We made the mistake to try and move forward too quickly. It is always a pressure to report progress quickly. So we jumped right in with the requirements gathering. So I didn’t want to put that on halt, but I made clear that we need to go back to the goals, and clarify. “

Similar to the previous section 6.1.1, the tendency of replacing lack of information on L2 and L3 with assumptions, rather than acknowledging and holding these information gaps, is becoming evident. Again, this introduces false certainties into the project. This may be due to not providing the room to acknowledge that there are uncertainties, or not having time to explore the identified uncertainties. Nevertheless, the above quotes demonstrate that some of the project managers appear to have more of an ability to consider such uncertainty from lack of L2 and L3 clarity than others and to give the goal representations time to develop.

In summary, the findings of this section show that the project goals need to be understood by the individuals in the form of taking in L2 and L3 information that build representations of the goals which are detailed enough to proceed with the project activities. Secondly, it was found that this understanding and clarifying of the goals is also a social process. Project members need to understand the goals in a similar way, i.e. develop similar L2 and L3 representations, in order to develop the project in the same direction. They need to develop a shared understanding of the goals. If these L2 and L3 do not hold sufficient information, information gaps are unacknowledged or replaced by assumptions, in order to proceed with the project activities. This is due to the fact that the traditional PM thinking and paradigm does not acknowledge the need for shared goal understanding. This lack of acknowledgement and lack of time and processes to develop this understanding leads to the suppression of project members’ uncertainty, progressing despite significant lack of goal information, and subsequent introduction of false certainty.
6.1.3 Goal stability

As discussed in section 2.3.2, one of the key assumptions in PM is that goals will only be reviewed if a significant external factor, such as a changed customer requirement, or policy change, requires a re-direction of the project. It is assumed that project members do not initiate changes (Thomas and Tjader 2000, p.5) and that changes are rare and have to be averted.

The interview findings reveal that this appears to be unrealistic in modern projects experiencing conditions of rapid change and competition, for example when asked about this, TA stated:

TA: “Sometimes some aspects of the goals seem not to be quite right as you are further down the line and the team have done some more detailed thinking about how to approach things.”

The above quote shows that, counter to the traditional PM view, aspects of the goals do need to be revisited. Building on the information-based insights from the previous sections, this quote confirms that false certainties within the goals either due to insufficient L1 information or due to L2 or L3 misrepresentations were accepted, and hence carried forward into the project execution phase. During the execution phase, these false certainties are being challenged by contradicting L1 information, forcing the project team to review their understanding of the goals.

Similar to the above quote, HM describes that as the project progresses more points are questioned and the direction of the project develops. This contrasts the traditional paradigm, which assumes that the project goals set the direction of the project at the outset. When asked whether he ever goes back to adjust the project goals, HM responds:

“Nah, not really, at least not formally with the documentation. But we’d adjust our plans and our detailed requirements to reflect these changes. I mean, this is a natural process. As you dive more into the detail, you find more and more questions. Then you need to make choices, to decide which way to go. But that’s normal. The more you dive into the details, the more questions...
appear. We just work through these to become clearer on what we are doing. You don’t know all these details yet when you get the goals. So it’s normal that things develop.”

This statement provides testament that goals are pre-determined and assumed to be stable, because this is expected as part of the traditional PM approach. The project is then progressed based on these goals, as per traditional methodology. However, once the project progresses, the quote above demonstrates that the original goals are not of value anymore to guide the project work. The literature also challenged the traditional view on project goals and confirmed that a constant process of goal reconciliation and management is required (Boehm 1981). However, the above statement demonstrates that instead of reconciling the project goals, an adaptation of the project direction takes place at task level. The goals are not re-visited. This is a deviation from the traditional paradigm, where it is assumed that the goals stay stable throughout the project or are reconciled regularly. This example shows that the goals become inadequate as the project progresses.

Considering this finding through the information lens shows that in some case the goals may not be useful to guide the information search, because they carry false certainties that come to light as the project progresses. Rather than revisiting the goals to review and correct initially falsely assumed certainties, the project plan becomes the guiding tool for further information management and the project tasks are adapted instead.

The two following accounts from a Change and a Software Project respectively, further challenge the traditional notion of stable project goals:

HM: “I mean, there may be a radical change, then we need to go back and re-think our goals. For example, we had a customer who suddenly wanted to change the technology we were using to achieve more efficiency. So we had to go back with the project brief that said what we wanted to achieve. And the technology we decided to go for was right for that. So when the customer changed their mind, to be more future proof and go with the market, we had to say ‘ok, let’s stop everything, and talk this through’ And we explained the implications of such a change. Switching to a different technology so late in the project has enormous cost implications, and it means we would have to re-plan the whole project, get new experts on board as well...”
PN: “When we were already developing the system, the stakeholders suddenly wanted more and more functionality to be added. This had not been agreed in the requirements phase. This made it very difficult for us, a lot of change requests, and there were also a lot of arguments and conflict. The stakeholders really wanted these changes. But we had agreed what the system was going to deliver, and it became increasingly difficult to accommodate all these changes. It became chaotic. And the costs exploded. The stakeholders were unhappy and the IT team became quite frustrated.”

The literature review (section 3.1.3) challenged the traditional project goal understanding established that objectives may be poorly defined, intangible, or even conflicting among stakeholders (Abdel-Hamid et al. 1999). The above quote provides an example for this. As a stakeholder’s grasp of the project develops, their ideas of the requirements may develop as well. Building on sections 6.1.1 and 6.1.2, an information based view on these findings suggests that for the projects included in this study, a replication of the goal information to different parts of the organisation, and different stakeholders may not have taken place properly. The stakeholders may not share the false L2 and L3 assumptions the project team have developed at the project start to close the information gaps and proceed. Therefore, these stakeholders are able to question the false assumptions, i.e. the artificially developed information that guides the views of using a particular technology, or of particular project deliveries. This process uncovers and reduces false certainty.

Furthermore different stakeholders may link goals to different L4 concepts, due to different backgrounds, and consequently many use different language. Such different backgrounds, perspectives, and language may complicate understanding and pursuit of goals in a converging way. Butterfield and Pendegraft (1996) argue that such differences in perception among stakeholders can hamper project progress. When reviewing these facts from an information perspective, it becomes clear that the mental representations of the project goals may slowly shift, as more information is added to the representations of the initially uncertain goals. Different stakeholders may add different information to their goal representations if this process is not co-ordinated among the stakeholders to get a uniform representation, and if there is no formal process of re-visiting these with all project stakeholders, as they are assumed to be stable. So the project focus may slowly or partially shift, but this is not consolidated again in formal re-visiting of the goals.
Once project goals have been established, and the project is in the delivery phase, it is difficult to establish and communicate changes to project goals to a team that has been geared to move into a certain direction from the start of the project. This is exemplified by HMs continued quote from above where a change of technology was required:

HM: “… So eventually we agreed, though we tried to limit the changes as much as possible. But it was a lot of chaos and hard work, a lot of re-planning, and we had to get everyone on board. Not everybody agreed with the change, and people had worked hard on the original plan. So it took some time and lots of communication to explain, set the new direction, and reorganise ourselves, and move forward. Some were faster on board than others, probably because they had more of the context and understood where this was coming from. But eventually we got everybody there, and the implementation picked up speed again.“

As the traditional paradigm entails a culture where the approach adopted and initial understanding is meant to be pre-determined and stable, and forms a strong foundation for the project, a change of goals is likely to be harder to communicate and implement, than for a project team that may be aware of the fragility and temporary nature of the project. This example demonstrates the deterministic culture in traditional PM, which does not accept new information, and trains project members to work with certainties. If the concept of uncertainty is excluded or not assumed in goal setting, people are less able to switch their information base, i.e. the information they built up on information L3. If acknowledging uncertainty and questioning information were more common, a project team may be more receptive to the temporary nature of the information foundation, and may hence be more receptive to questioning that information foundation and to changes.

To conclude, the statements discussed in this section highlight that goals are often imposed from outside the project. They can initially appear not to be well enough defined for project planning. Therefore, intermediate steps of goal detailing and goal clarification are sometimes added by project managers for further planning purposes. The accounts given suggest that sometimes goals are also not clear enough, i.e. not sufficient information is available on the higher information layers, and the process of goal assimilation facilitates exploring and closing the information gaps (L2- and L3-uncertainties), allowing more project members to build information on more layers to develop a more solid goal representation and become clear on what information is missing and where goals, hence,
may be instable. However, there is pressure to progress the planning work to the production of a project plan, which carries the risk of considering the goals as certain too soon. This means that the quality and quantity of goal related information may be too low, and too little information can be presented on the higher information layers, or the information is not linked to fully formed or wrong concepts, which provides an insufficient informational base for further planning and shared implementation work. Therefore, under the information-paradigm it can be explained why goals are not as stable as the traditional paradigm presumes, and that they may have to be re-visited.

6.2 Project Scope

As discussed in the literature review (cf. 2.1), the project scope is derived from the project’s goals. It encompasses the requirements or specifications of “The work that needs to be accomplished to deliver a product, service, or result with the specified features and functions” (PMI 2004). This means that scoping forms a prerequisite to the planning work, because in order to develop a project plan, the work packages which are ordered into an execution sequence in a project plan need to be established. Scoping follows the goal setting phase, and determines these work packages. The following three sections discuss various findings concerning the value and challenges of scoping in the context of project uncertainty.

6.2.1 Scoping to challenge goal definition and clarity - information feedback loops

The following quote provides an example of scoping, in the form of requirements gathering, which is a traditional scoping exercise, particularly in technology projects:

TC: “We then went into the requirements gathering phase to develop the details of what we are planning to do, what functionality is needed, and so on. This is documented in a number of specs, the requirements catalogues. These give us the more detailed understanding of what we are doing, and we use them to develop our designs and the final solution from them.”
JW: ‘What challenges did you face during that phase?’

TC: ‘We do this to understand how we design the system. But while we do it, a lot of questions come up, that force us to consider what’s in scope and what isn’t. For example there was a bit of functionality that should be out of scope, but the business really wanted it. So they had to get agreement from the board. In case of doubt and significant financial or time impact, they would decide if something that we were unclear about would be in scope or not.’

The above statement demonstrates a case where the progress of the scoping work was hampered, as it could not be decided whether a piece of functionality was in scope according to the goals. Traditionally, the project goals should provide a guide to determine what deliverables are in scope. The above statement, therefore, offers an example where the goals did not support the scoping work sufficiently.

Reviewing this statement through the information lens highlights that lacking information in the project goals is unearthed. Scoping can challenge two different goal qualities: Goal clarity (6.1.2) and goal definition (6.1.1). Scope discussions challenge the completeness, correctness, and hence the clarity of the L3 goal representations as guiding principles for that discussion. In detail, this means where these representations are not sharp enough defined, i.e. goal information is lacking on L3, they are not strong enough to guide the determination of project scope when challenged with new information items. Hence, it cannot be clearly enough distinguished which information is in scope, and which is not in scope, as the mental representations are not mature enough to provide sharp enough decision criteria. Scoping may also challenge the goal definition (L1 information) in a similar way. Instead of the mental representations not being clear enough, there is not enough L1 information about the project goals to understand and apply these sufficiently to assess in scope and out of scope items. Therefore, it would be sensible for the scoping work to feed back into goal refinement, either for further definition of the goals (L1 goal information – cf. 6.1.1), or to achieve more goal clarity of the representations held by the project members (L2 - L3 goal information – cf. 6.1.2), or both. However, such information feed-back loops from subsequent project phases into earlier ones, i.e. from scoping back into goal definition, do not form part of the traditional PM view. Therefore, uncertainty due to lacking completeness or clarity is carried forward through the project phases, and increases. This increase comes from building on uncertainty as false certainty,
which create further false certainties, requiring even more information to reveal these. Informational feed-back mechanisms do form part of criticisms of the traditional paradigm (3.1.3) and alternative approaches to PM, such as agile project management (3.3.1). However, in the agile approach these feed-back loops are not goal driven, i.e. not directed. They cover all learning from previous iterations, even if not purposeful going forward. The information paradigm can add value here by driving more precise and directed feedback loops, for example by guiding these based on the goals.

AR’s statement describes the consequences of lacking goal feed-back loops:

AR: “For the other one, yes, but in that case our customer then changed their mind, as they saw how the details unfolded. Somehow they hadn’t thought it through properly at the start, or at least earlier on. So that resulted in a lot of negotiation, and changes, frustration on both sides, and in the end we had to move some of the systems the customer wanted into a follow-up project, so we could get the project across the finish line.”

This account describes how goals are not sufficiently anchored in some stakeholders’ information representations, so they cannot guide the thinking around the scoping. They remain unchallenged, and carry the uncertainty forward into the scoping phase and into subsequent project phases. This leads to increased information exchange efforts, changes, and delays, to manage the uncertainties, and results in frustration for the project team.

6.2.2 Scoping to establish and link new information sources

All respondents’ statements showed that scoping is part of the early project activities, following or overlapping with the goal clarification period. TC provides a traditional example of scoping work, where the project scope is developed from the project goals:

JW: “Did you do any scoping work?”

TC: “Yes, of course.”
JW: “And what exactly did you do?”

TC: “We had a series of workshops with the stakeholders. We started off talking through the goals, to try and identify the key elements for the project, such as the workstreams that needed to be involved, the rough areas that we would need to work through, high level parts of the solution, etc. That kind of helped us to get an overview.”

JW: ”And what was the output of these sessions?”

TC: “We produced a high level scoping document, and a number of key scenarios that showed more tangibly from an end-user perspective what was in scope”

RP made a similar statement around identifying stakeholders during the scoping workshops:

“We also didn’t have all stakeholders there from the start. During the workshops we realized who else we needed to get involved.”

The above statements highlight that scoping also serves to gain an initial understanding of who the involved stakeholders are. This does not form part of the traditional PM methodology, which understands scoping in relation to project deliverables. From an information perspective, such a creation of an overview with regard to involved parties establishes who forms part of the project information dynamics.

The following quote illustrates the challenge to manage information exchange among these different stakeholders:

TC: “At times you would have the investors on one side of the table – considering the market needs, funding, and how to market the product and so on… and the engineers being in their own world around technologies, and … well… how to solve technical problems really. It was a challenge at times to get them to talk to each other, or well to get somewhere that makes sense and helps both sides to feel comfortable and get on with their stuff. I mostly tried to keep them apart to be honest,”

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but that is risky, too, as you can’t really be the messenger all the time, or, well… let’s put it that way, that approach can be risky because you might miss something vital where it would have been better if they talked directly.”

This quote describes how stakeholders use different language, depending on their background, which can cause challenges for the information exchange, resulting in difficulties agreeing scope. An information analysis of this example points at the fact that along with the language, the different stakeholder backgrounds may entail the use of different L4 concepts to anchor the project information. However, the discussions are triggered on L3, because the stakeholders are not aware of their difference in underlying concepts. In this example, the scoping could not proceed successfully, as the information exchange between the different stakeholder groups was hindered. They were not able to grasp each other’s different L4 systems of meaning, and related language, and could therefore not communicate. In order for such an information exchange to work, a bridging role would be required, whereupon the different L4 concepts can be “translated” between the stakeholder groups, using both concepts, to improve information exchange. Neither traditional PM, nor challenges to the traditional paradigm (cf. 3.1), acknowledges such a problem.

6.2.3 Scope creep reconsidered from an information perspective

Similar to the project goals, the traditional PM approach requires the scope to remain stable in order to be able to plan and budget for that scope, and implement against that plan. The following quote provides an example for the difficulties faced around scope creep RP describes that the project scope extended significantly as the team worked through the scoping phase:

“We also realized that as we dove into the details, more and more questions appeared and it seemed like we had to add more and more things to our to-do list. So we got quite worried as the whole thing seemed to grow arms and legs.”
Six further interviews described concerns around scope creep, despite the fact that this is not expected under the traditional paradigm. From an information perspective this can be interpreted in three different ways:

1) What is being experienced as additional scope items, is actually not scope creep, but instead are just information items which have been overlooked or unacknowledged previously, and now become apparent. Therefore the scope initially appeared smaller. Therefore, the scoping phase is fulfilling its purpose of driving these points out into the open and reducing uncertainty in the form of known unknowns.

This identification of previously unacknowledged scope items may be amplified if not all stakeholders were engaged in the scoping work from the start, because scope relating to their areas may not have been elicited (see previous section 6.2.2). This is what is referred to as unknown knowns in 2.5. As the traditional paradigm has no view on these information dynamics, this is considered scope creep, even though this information should form part of the full scope, as the stakeholders and their requirements form part of the project. It means that L2 and L3 representations need to be levelled among those project members that require the same information.

2) A second explanation for scope creep from an information perspective is that the experienced scope creep items are actually refinements of the scope. In other words, what is experienced as additional scope is actually further information that clarifies and details the scope items, so that they become more defined and certain in view of the implementation phase. This process may make the initially identified scope items appear larger or more extensive, even though they only appeared more concise initially as not all pertaining information had been elicited – either on L1 due to lacking definition, or on L2 and L3 due to lacking clarity, i.e. acknowledgement of an incomplete representation of the scope items.

3) A third interpretation is actual scope creep In this case, the original scope is extended by additional, genuinely new items, which come to light during stakeholder discussions. The following quote provides an example of this:
JW: “What difficulties did you face in these scoping sessions?”

RP: “Well, there was a bit of chaos at the beginning, everybody having different ideas. So for example the IT guys were looking at some technical nice to haves, the end users wanted to add more functionality that would help them dealing with their customer’s needs better, the marketing team wanted to add tools that helps containing customers and identifying different target groups and tracking behaviours, etc. So basically everybody was diving into their details, and felt quite strongly about it.”

This quote shows that as stakeholders discuss scope, they are likely to feel strongly about their needs. From an information paradigmatic point of view, it can be argued that sharper goals on L3 or L4 would provide guidance and clarification, which information (i.e. scope items) should be in scope. New scope items suggested by stakeholders could be checked and validated against the project goals, rather than following artificial budget or time limitations, which are not able to distinguish relevance of the scope items. This quote, hence, provides an example of the implications of lacking goal benchmarks to evaluate discussions around scope against.

The following quote supports and confirms several of the above conclusions:

RP: “We had a lot of change requests. In other projects I would usually manage to have less, but in this case we had quite a lot, unfortunately. That’s never good. It drives the cost through the roof, pushes the dates out, and makes things more difficult altogether. You need to agree the changes, make sure you can fit them in even though it disturbs the plan and the neatly defined initial solution, and you need to keep everyone on board and updated about the changes. It’s quite a hassle, but that’s part of the job.”

JW: “And why do you think you had so many changes?”

RP: “Hmmm, I think we had a lot of parties involved, and some were not fully engaged, also, as things unfolded what we did became clearer to them and then they started to give their opinions and ask for changes. For us that was quite late in the process. ... It was a complex project, even we were not fully aware of the implications ourselves at the start.”
In this example the project goals were not fully established to provide benchmarks and guide the scope. Information sources not fully established (cf. 6.2.2), and those established may not have had clear or well defined scope representations. The result were increased information exchange and Change Requests (CRs).

To conclude the project scope findings, the traditional PM approach requires the project scope to be stable, just as the goals, in order to be able to plan and budget for that scope. The findings discussed above have shown that the project scope develops. As the understanding of the project develops during scoping, lacking goal definition and/or clarity impacts scoping through lack of benchmarks. This should be improved through feed-back loops to clarify the project goals. However, such feed-back is not acknowledged in the traditional PM paradigm, which bases each phase on fully determined outputs of the previous PLC phase, such as fully defined, clear and stable upfront goal definition and the scoping. Furthermore, during scoping, project parties that can provide or require information are established. If these have not been involved in the goal setting process or are not involved in the scoping process, further uncertainty is introduced. Scope creep can either be falsely experienced due to previously unacknowledged information items, due to lack of clarity and definition of scope items, or due to addition of scope items due to lacking goal benchmarks. Where scope is forcefully fixed, in cases where lacking information or lacking representation in stakeholders’ information layers remains unacknowledged to create false certainty for further planning steps, increased information exchange and changes become evident later in the PLC. Therefore, scoping challenges relate to reducing uncertainty prevailing in the early stages of the project by bringing stakeholders together, initiating information exchange and facilitating the development of more detailed L2-4 representations.

6.3 Project Planning

A number of issues around project planning could be identified from the interview analysis. These relate to the creation of false certainty with an upfront plan, to carrying this false certainty forward into the implementation work, to lacking acknowledgement of
fundamental uncertainties beyond the boundaries of the project plan, and to the degree of planning detail. These are discussed in the following four sections, which offer insight into the restrictions these traditional patterns form from an information perspective for uncertainty management.

6.3.1 Planning to create certainty

The following two quotes exemplify descriptions interviewees made of the planning process. MLs statement describes how all available information from the goal and scoping phases is assembled over time to produce an initial high-level plan. This plan is reviewed to identify relationships between teams and work packages.

ML: “We pull together the items we know we need to do and start with a high level kind of straw man plan, dropping all the workstreams into a roadmap. And then there are a number of reviews and discussions, to go into more detail on who will do what, how do these activities depend on each other, so for example what a team needs from another team to be able to start working, etc. For example the communication team needs to understand when what agreements are made and when people come over, so they can plan their communication schedules, and they need input from the legal team and the business to agree what is communicated when to whom. So we describe all of this high level, and then the dependencies are identified, so the work packages are ordered into a timeline to reflect dependencies. At the same time all the teams estimate the work so that the timelines become more realistic, and add their resource and budget forecasts. That usually takes a few weeks, and we go through a number of reviews to make the plan more and more precise, and also make sure everybody understands what they are doing and who they depend on, so that these teams co-ordinate this amongst themselves. And of course that helps the project manager to know what he needs to focus on.”

In the following example, AR describes a similar approach, explaining that an initial plan was produced, which was subsequently challenged and refined:

AR: “Once it became a bit clearer which activities were on the critical path, we took those workstream leads together and drilled down in more detail. We challenged the activities to see how we could reduce the critical path. We tried to break some of the dependencies, so basically we worked through it in more and more detail, and it takes a few rounds – we’d have a session, then
they take it away, think about it further, talk to each other, and to the vendors, and then they adapt their views, and we come back together to review the updated estimates, and that goes on a few times. That way we get clear bit by bit who needs to do what, who depends on what or whom, how long do we expect things to take, where are the critical bits that need to be co-ordinated really well, and so on...”

The above quotes, in addition to similar statements from four further interviewees, highlight that in line with the traditional paradigm, a project plan is produced. This plan identifies the activities that have to be undertaken to complete the project, with estimates of durations and interdependencies. The project plan is based on the goal and scope items. Tasks required implementing the scope items are ordered and put into relation with each other. These relations establish dependencies and structure the activities over time. The above quotes show that after the goal detailing and the scoping phases, the planning stage forms a third iteration of detailing information, as it explores the relationships between the information items, their size, the expected inputs and outputs and durations of working through these. However, these items are reviewed from a different angle than in the previous stages that is from the point of view how to realise or implement them. Thus, in the planning phase there is much less focus on considering whether all required information items are available. Instead, there is a focus of how the project information gathered to this point fits together. This internal focus on organising the available information creates the risk of false certainty. Only where there are inconsistencies to complete the plan, so that the uncertainty hinders the planning work, further information is sought. In essence, this planning activity creates certainties. These may be due to information being genuinely evaluated and accepted, but also due to information gaps being filled with false certainties, in order to produce a complete plan. This activity creates information filters. It filters information, in that only information that is functional for assembling the project plan will be added to the project information landscape. The L4 concepts of project planning create these filters on L3.

The following quotes discuss the consequences of incomplete or inconsistent information from the planning stage for the project implementation phase. Interviewees describe how projects got into problems, due to two information issues. Both of these issues could be identified under the information paradigm as forcefully creating planning certainty:
1. The information that informed the plan was too little, i.e. too much uncertainty was present, so that initial assumptions which were used to replace the lack of information, turned out to be wrong. These couldn’t support the plan and the initial estimates anymore, as additional information came to light during implementation:

   HM: “We ran into trouble when we slowly realised that the budget and remaining time weren’t enough. There was so much more work involved than we had expected. We hadn’t anticipated this.”

2. The information used as a basis for the planning work was not checked with regard to its stability and soundness, so that conflicting or changing information was encountered during execution, which then challenged the original plan.

   TA: “We thought we were clear on the strategy. Then, after further negotiations, and consulting the legal team, especially around the people transfer, there were some concerns, and it became clear we couldn’t do it like that. So we had to revise some of the original assumptions. So then we adapted the approach. That impacted our plan, of course, because it meant rework. When we decided on the strategy we thought we had the way forward. But well, that happens.”

Considering these dynamics from an information perspective, it can be concluded that the plans did not hold up to the actual information state of the project during implementation, due to the two reasons identified above. These information issues arising from the separation of planning and implementation are discussed in the following section.

6.3.2 Separation of information exploration and implementation

As discussed above, the purpose of the planning process is to structure all required project information for implementation because traditionally PM assumes that an upfront plan needs to be in place to create certainty for implementation. Once the project plan is prescribed, the traditional mind set then moves to implementation, as described by TC who
explains that the system design and development phases commenced as soon as the project plans were complete:

TC: “Once the project plan was as good as baselined, we went full steam ahead with the design.”

This approach creates a separation between the exploratory activities at the start of the project which serve to understand what and how the project should be delivered, and the actual implementation of that plan. In information terms this separation also separates the exploration of project information during the initial phases, from working through a set array of information during the delivery phases.

Various interview statements indicate that the theoretical completion of upfront planning prior to implementation is often not possible in practice, due to lack of information. Often new information is available after the completion of the planning phase, or false certainties that were used to close information gaps for planning become increasingly challenged by realities of the implementation, so that they need to be reviewed and amended with that new information. In order to manage the separation of the exploratory and the delivery phases, it was found that project managers use a number of practical workarounds to be able to create further opportunities for considering new information or challenge information items during the implementation phase. HM for instance highlights the assumptions underlying the presented plan which allow for a change of plan once these change, as well as contingencies to allow for limited change to the plan:

HM: “When I hand in my plan, I’d also list all the assumptions I made to get to that plan. So then at least it’s clear what my plan is based on. And then if any of these assumptions change, that gives me an argument for why the plan needs to be reviewed. I also add contingencies to the plan, mainly for the more complex pieces, I mostly add around 20% to the timelines, but often for the most important pieces that is not possible because they tend to be on the critical path, so they’d delay the completion date. So that doesn’t really work. Sometimes I add additional resource to the budget, but that is more difficult because it drives the cost up.”

TA calls out risks and issues related to the project plan:
TA: "Apart from starting the planning, one of the first things I set up is a RAID log, a risk and issues log. So I can document concerns around the plan for example. When I don’t know enough about something, I would raise an issue. So for example, we needed guidelines from the Legal team on some aspect of the Merger. That issue then gets reported in the formal reporting, and so the stakeholders become aware of it, it gets some visibility. And then there’s a better chance that it gets addressed."

Some project managers reported to add float or contingencies to the project plan to manage changes to the project information after the completion of the planning phase through change requests and contingencies.

PN: “I usually add contingencies to the plan and the budget, as far as that is possible, though that is difficult for the activities on the critical path, as you’re usually get told an end-date. But in this project, we learned a lot more about how things are done, that needed to be reflected in the systems, as we worked through the requirements sessions, and then in the design phase where we reviewed prototypes with our end-users, the business, who are our customers. It turned out that certain things were really important to them to manage their customers, which we didn’t know about. So the scope exploded, and that couldn’t really be absorbed by the contingencies.”

An interviewee explained how scope and budget, or respectively resource adaptations, are used throughout implementation to manage major deviations.

RP: “So eventually we had to go to the board and request a budget increase. Of course that’s always a difficult conversation to have. Of course that’s always a difficult conversation to have. So prior to that, we had some workshops with the leads to review the scope and check what really needs to be done, and what are nice-to-haves. But that just wasn’t enough. So we needed another cash injection.”

Another interviewee stated that they are prepared to exceed the budget, increasing resource numbers, to compensate delays due to inconsistent information:

PN: “I’d rather go over budget, and get the job done.”
The above quotes provide examples of coping mechanisms for information management for project managers. These provide workarounds and tricks to manage their concerns around the soundness of their planning due to lack of information. They bridge the division between the planning stage and the determined implementation stage to accommodate change to the plan. Such tricks include calling out planning assumptions or risks and issues, adding contingencies, and relying on change requests.

From an information perspective these methods provide the opportunity to allow for a limited amount of new information to be taken into account after the planning stage, in the form of filling information gaps and challenging non-purposeful information, as well as false certainties. However, as discussed in 2.5, these methods only offer a limited room for manoeuvring. They become insufficient if the amount of information additions or changes are so great that they fundamentally challenge the way the project was planned.

6.3.3 Ignorance of fundamental uncertainties in planning

As discussed in the previous section, project managers describe a number of tricks to be able to accommodate a limited amount of new information in the project plan. However, where projects carry a significant amount of known unknowns and / or unknown unknowns, these methods do not provide sufficient flexibility to accommodate large amounts of new information, and to continue fundamental probing of information (cf. 2.5). This is because the traditional PM approach cannot accommodate fundamental changes once a plan is baselined and being implemented, but merely provide the opportunity for minor adaptations (cf. 3.1.2).

The above discussion described the traditional view on project planning, and the practical workarounds that 9 out of 11 interviewed project managers admitted to using to manage changes in the information that initially informed the plan under the traditional paradigm. However, the traditional mind-set is geared towards certainty, so that the chance of large amounts of new information that could fundamentally challenge the plan, are hardly considered a possibility in the L4 concepts that form the mind-set of a traditional project plan and implementation approach. Even if such significant new information is available post-planning that could challenge the information base of the project fundamentally, this
is unlikely to be acknowledged, as the L4 PM concepts do not offer such a possibility (cf. 3.1.2). Therefore it is harder for additional information, and particularly such that does not comply with the mental representation of the project plan, to enter the L3 representation of the project. Where new and challenging information is acknowledged, the traditional body of knowledge does not offer any methods to deal with it. In that case projects are aborted, or fundamentally re-planned in the sense that an entirely new traditional upfront project plan is developed which can be understood as a new project. An example for this is discussed in the data warehouse project, described in the statement in section 6.1.1, where the project went ahead, and eventually had to be aborted and re-planned. Another example is provided by JG:

JG: “I produced a project plan, and I consulted the workstream leads that were on board at the time. We pulled our plan together so we could go ahead with the hiring, etc. to get the project going. We were on a set deadline for delivery so we had no time to waste. But we kind of went ahead of ourselves a little. So as we went into implementation, and then quite a few things came up we hadn’t considered, so we had to review and adapt the plan and the budget a few times. This was quite difficult for a while, and after a lot of forwards and backwards, and quite a bit of senior stakeholder management - of course they weren’t happy about the changes, and it was also a bit frustrating for the project team at times. Well, then in the end we had to sit down and say ok, this is not working, and we took a step back. What is it that we need to get to, and what do we really need to do here. So we re-planned from scratch. And that was the right thing to do. We should have done it earlier.”

The assumption of increased certainty after the planning stage also makes it less likely to question the information items that construct the plan, once the planning is complete. Only where the false certainties, which were used to close information gaps for planning, become increasingly challenged by the informational project reality, the project team is forced to review the false certainties and planning information used at the outset because the plan is severely threatened from a mismatch of the false certainties and project reality.

The literature review (section 3.1.1) discussed how upfront project planning and separation of planning and implementation is required for PRM, as the idea is for PRM to prevent or mitigate threats to that plan. Section 3.1.2 critiques the deterministic character of this approach, where the project goals and scope are assumed to be fully knowable at the
project start, an appropriate project plan can be developed to deliver these, and the challenge of project control merely relates to keeping the progress to the forecast (Winch 2004). The various sources of uncertainty which complicate this, such as lack of clear goals, novelty or lack of experience in a particular area, complexity of impacting factors and their interdependencies, unforeseen events or conditions that can affect the project, or optimism bias from the project planner (Atkinson et al. 2006) are not considered in this approach, as there is no room for new information to be considered past the planning stage. Interviewees, hence, discussed that project plans which were developed in this traditional mind-set, changed during implementation, as the amount of uncertainty was greater than acknowledged in the project plan. Therefore, the application of PRM becomes less beneficial and less effective, as PRM should prevent or mitigate such changes (cf. 3.1.1). DM describes a different mind-set to project planning, compared to the methods outlined by the statements above:

DM: “And then you start putting a plan together and as you go along, you can change. You can say: This is the overall plan. You start with it. And your goal has to be based on the budget and then you define everything within that.”

His statement suggests formally satisfying the traditional requirement for the provision of an upfront plan. The information gaps are then managed by adapting and changing this plan as the project progresses. This is a different uncertainty management strategy to the traditional approach of separating planning and implementation work. While DM works within the constraints of a traditional paradigm in his organisation, where he is forced to produce a traditional upfront plan, in practice he manages this differently from the traditional methodology as far as possible to allow for new information to be taken into account past the planning stage. He uses L4 concepts that differ from the traditional understanding in that they accept that new information will constantly need to be taken into account. The remainder of his interview statements suggest that the discussed project was successful in terms of delivering a solution to the client on time.
6.3.4 Degree of planning detail

As discussed in section 2.3.3, increased detail of a plan traditionally assumes increased control. Section 3.1.2 describes that a project plan at the start of a project may be merely a starting point, and approaches are suggested where the plan is developed as the project unfolds. DMs quote in the previous section reflects this view, by arguing that an initial plan is put in place, which is adapted as the project moves forward. It does not assume determination of all details at the start, and hence offers more flexibility for additional information to emerge.

Increase detail in plans requires increased effort and so in section 3.1.2 considerations found in the literature were discussed, implying that a balance has to be found between the level of informational detail and planning effort, assessing to what level of detail value is still added to the plan. This discussion highlights that it is difficult to determine the right level of informational for the project plans. It may lead to the conclusion that plans may not be an ideal way of managing project information. Potentially other methods and tools may be more appropriate, as described by interviewee TA, for instance:

TA: “We had so much information around the progress of all these documents to manage, that it didn’t really work with a project plan. We had tried it, but it didn’t give any visibility of where we were at all. It was also difficult to keep it updated. So the effort for updating it – it was really tedious – didn’t give us the benefits that justified this approach. So eventually we switched to excel spreadsheets with dates and status updates and comments on why things were an amber or a red status. That worked much better. It also allowed us to extract management information, such as percent signed-off, etc.”

This quote highlights that a project plan was not able to represent the large amounts of detailed information in such a way that it was practical for project members to manage. It also did not easily support project members to develop a mental representation of the status and progress made. Other representations of the project progress information were preferred, which could hold the information better, and facilitated an understanding of the status more easily.
In summary, the interview findings around planning, re-interpreted from an information perspective, yield that the traditional purpose of planning is to create certainty in the form of a complete project plan which is used as a baseline for implementation control. The final plan theoretically determines all subsequent activities, their durations and interdependencies. This imposes a determined structure of interdependencies and time relationships, as the planning process develops representations for all involved of how all the project information fits together and what tasks need to be completed. The planning stage is the last stage after the goal clarification and scoping stage to allow limited exploration of the project information. There is theoretically no room for new information to be accommodated after the planning stage. This view separates the information exploration phases at the start of the project, from the implementation phases. The above findings suggest that planning assumptions, degree of confidence of estimates, and risk and issue lists provide an indirect means under the traditional paradigm to point out lacking information in the project plan, and contingencies and change requests provide room to adapt the plan following the discovery or acknowledgement of new information past the planning stage. It could also be established that the traditional mind set does not provide information filters that would allow for fundamental new information to enter the realm of possibilities. Finally, the level of detail of planning is reviewed, and it was found that traditional project plans and Gantt charts may not always be most purposeful and effective to plan projects and control their implementation.

6.4 Project Control

Traditionally, project control is based on a pre-determined plan (cf. 2.3.3). The literature established that control mechanisms are used to check that the outcomes of project tasks and work packages match the progression of the project plans. Project control was a common topic in the interviews:

DM: "I try to establish a control framework early on. The quicker you get it in place and make sure everybody follows the routine... well, so it becomes a routine... the easier. It's best if you get it set up right from the start."
PN: “Yes, we did, we had weekly meetings for progress reporting. Attendees also complete progress reports, which are distributed as part of the meeting pack. We review the RAG status, and progress against milestones.”

MM: “There were all kinds of controls – physical and visual checks, stakeholder review meetings, progress documentation, and of course the usual project stats, etc.”

The above statements offer examples of traditional project control measures. The traditional paradigm suggests that early control increases project success. However, ten out of the eleven interviewees mentioned or discussed problems around the topic of project control. These are detailed in the following sections.

6.4.1 Control focus

The following account raises a question with regard to how well the traditional approach to project control reflects and informs about the status of the project. ML stated that they had to change the reporting that formed part of their project control mechanisms:

ML: “We used different progress reports at the start of the project, but I changed them after a few weeks, because they didn’t really give me the information I needed.”

The above statement highlights, that while traditional PM provides clear control methods and tools, it is not helpful in guiding how these are best applied to get a reflection of the project status that is useful and precise for control purposes.

From an information paradigmatic point of view, the above statement suggests that the design of the control mechanisms determines what project information is focused on. The reporting, hence, directs what project information is visible for the management team to check progress against the plan. The information outside the focus of these control mechanisms is less visible. Thus, if this focus does not cover critical topics within the project, these are likely not to be identified by management, or may be identified with a delay that can have cost and time implications.
The project team, in turn, focuses their efforts to progress tasks on that highly visible information which the project team reports and is controlled against, so that progress can be reported. This is demonstrated in TA’s quote:

TA: “I report per workstream. So I’d give a weekly update on activities completed during that week, and activities planned for the next week. I’d do that per workstream that I manage.”

JW: “Does that work well? Or has anything ever gone wrong with that approach?”

TA: “Well, in general that works well, and it is well structured. We missed a bit around the contracts, because that wasn’t part of our reporting, and it also wasn’t covered by the other PMs. So that caused a bit of a concern and we then had to work hard to get that up to speed and completed in time with the acquisition dates. But we managed.”

In the above example, work packages that did not form part of the reporting did not have sufficient visibility, and were hence not reviewed and progressed sufficiently. From an information perspective, it can be concluded, that the control focus creates L3 information filters in the form of boundaries: Information within the control focus is more thoroughly considered. These dynamics shape the project progress in addition to the project plan, because even though activities may be planned as tasks, where these are not focused on in reporting, they may be less thoroughly managed and progressed. This also entails that due to less visibility, information related to these tasks outside the control focus is less thoroughly shared, incorporated, and reviewed for artificial certainties and lacking information.

In summary, the above statements highlight that control structures direct and focus attention to certain information. Control structures determine what information is reported and hence gets visibility, and all other is unlikely to be feed-back into the control mechanisms, even if it is critical. Critical information that is outside the control focus feeds-back too late, only after significant impact to the plan already occurred.

What is reported on for project control should ideally be derived from the project goals and scope to ensure attention is directed purposefully. However, this informational link
from the goals through to the scope and the controlling appears not to be made under the traditional paradigm, as is not obvious in task-based thinking.

### 6.4.2 Information granularity for control purposes

Under the traditional PM lens, increased level of detail in project plans is linked to an increased level of project control (Turner 2009). In practice different interviewees approach this in different ways. Some of the interviewees work with high level control, such as JG:

> JG: “I’m happy with condensed reports and check-ins, unless I feel there are issues or the progress isn’t what I’d expect it to be. Then I stay a bit closer to the concern and work more closely with the team until I feel things are on track again.”

Other interviewees took a constantly detailed view to control:

> ML: “I’m uncomfortable if I’m too far away from the matter, I always want to know a bit more than what is written in the reports, or reviewed at the official status meetings. I like knowing the details, and my boss expects that as well.”

The above quotes pose a question around adequate detail of information for project control. Too little is not informative, in the sense of not being meaningful. On the other hand, a lot of information, or too much, creates a reporting overhead and can be too time intensive to review. The challenge lies in representing the project status accurately, at a sufficient level of granularity. Otherwise, there is a risk that artificial uncertainty, or information challenging such false certainty, is not identified.

This discussion relates to the accuracy of control achieved through reported information, because accuracy correlates with level of informational detail, i.e. granularity. Granularity here is used meaning more information. More information allows for the controllers’
mental representation of the project to be amended, and hence to become more reflective of reality, i.e. more accurate. Therefore, increased granularity offers a more realistic\textsuperscript{11} account of the project status, which is better for control purposes. It makes the identification and challenge of false certainties and information gaps more likely, as derivations from the plan are more likely to be acknowledged earlier if the control is more accurate. This could then allow for the activities to be adjusted to match the plan, or to question the plan. However, there is a limit with regard to level of detail that can practically be reported, due to reporting deadlines, time pressure, and reporting structures and tools.

The following account describes the difficulty of determining the right granularity of information for accuracy of control:

\textit{JW: “Did you feel your control system kept you well informed, and clear on where the project stands?”}

\textit{AR: “Yes, well, I suppose, I mean it’s difficult. There is so much going on. It is hard to stay on top of everything. But you do get the general state of where things are. Sometimes things slipped. But that still became visible, even though it was a little later than I would have wished for. And it is hard to make sure you know enough but don’t get dragged into too much detail – there is just not enough time for that.”}

The above quote shows that the traditional paradigm offers no guidance or support in determining adequate granularity. The following quote shows that because this guidance is lacking, there is a reactive culture, rather than proactive adjustment of the control granularity. Project managers mostly go into more detail after things have gone wrong, as this example highlights:

\textit{MM: “If there is significant slippage in one of the workstreams, I tend to talk through the problems in a one-on-one with the workstream lead. I try to understand what is going on, what his or her concerns are, etc. and we agree an action plan. I’d stay close to the issue to make sure I see an improvement.”}

\textsuperscript{11} Realistic in this context refers to a correct representation of L1 information, i.e. the observer independent facts
The above discussion around control granularity, together with the discussion in the previous section around control measures focusing on selected information, creates an illusion of control. Increased detail of reporting on certain focused project areas, may give the illusion that more control can be exerted and that the project is under control, as more informational detail is fed-back. This poses the risk of creating false certainty for the project controllers assuming that sufficient information is available to control, as other areas remain to be not covered by the control mechanisms.

### 6.4.3 Correctness of control information

Some accounts, such as the following, show that the control mechanisms do not always appear to work:

> RP: “We had a problem with the training team - they reported steady progress, with a few issues along the way, which I thought we addressed. However, once delivery started, it became clear that actually the training materials weren’t up to scratch, and quite a few of them not finished. The progress reports had shown some complications, but then the actual extent of the issue was much greater. So we then had a lot of problems trying to sort this out urgently, as there was pressure to deliver the training in time for the staff to go live with.”

This example shows that while regular reporting was in place, the information reported did not provide a realistic account of the status of this work package. The true extent of delays and incomplete work only became apparent once the output of that work was required for the next phase, and could not be delivered. From an information perspective this can be explained through the information layer model. The mental representations of the reporting party held a view of the status that did not match with the L1 reality. The reporting party reported from their understanding, i.e. their mental representation. The controlling project manager did not question the informational errors in the reporting party’s representation until reality, i.e. L1 information unavoidably challenged everybody’s representations of the project status, so that the mismatch with the L2 and 3 representations clashed, and it became clear that the mental images were not founded in reality.
This example highlights that while traditional control mechanisms may be in place, these may not be able to provide management with a realistic account of the project status and issues. This shows that traditional control mechanisms do not support the reporting staff to challenge and critically review their work and to assess and challenge their mental representations in order to provide realistic information, and assess the extent of issues earlier. Under the traditional paradigm, project control does not appear to have suitable mechanisms to question the consistency and correctness of L2 – L4 information.

In summary, even if the reporting focus and granularity is correct, the degree of realistic reporting depends on the correctness and completeness of the mental representation of who reports. If the reporting party holds false certainties, these are most likely to be conveyed in the control mechanisms.

Control works with measuring activities, and feedback on activities. Therefore, everything that falls outside that focus of activities, i.e. the task-progress, cannot be fed-back. If activity would be re-evaluated, not as activity, but as an information state, with degrees of uncertainty, the feedback would more likely be correct. The traditional model structures control information in terms of activities. If it was defined in information terms, different, more purposeful information may be considered, to produce more suitable control.

6.4.4 Ignorance of fundamental uncertainties in project control

The literature established that traditionally, early control was found to be most useful, as deviations early in the project are less difficult and less pricey to manage, because projects usually apply budget and staffing curves. Alternatively, the project can be terminated before too much cost was incurred. However, various testimonies of interviewees highlight that in practice, deviations were often not managed in that manner. The following quote offers an example:

RP: ‘We thought we had a good start by defining clearly what the project was meant to achieve. A team was set-up, who started working on the implementation. After a few of our regular status meetings, and well, you could see it in the reporting as well, things didn’t look too good. I had a few conversations with the PM, but let her proceed, assuming most of these were teething problems.'
Well, after a while it became clear we approached this all wrong. The project went on for some more time. But eventually we decided to terminate it early and went back to the drawing board. That was a difficult moment for all of us, but in the long run it was more sensible, and we found a better approach.”

JW: “Why do you think it wasn’t clear earlier on that this was the wrong approach?”

RP: “Hm, it took some time to realise this. The team tried to make the original approach work. And they reported on that original approach, rather than looking at the bigger picture, reconsidering the entire proposition.”

Similar to the findings around ignorance of fundamental uncertainties in the planning phase, discussed in section 6.3.3, the limitations of the traditional paradigm to acknowledge and manage fundamental uncertainties could be identified around project control as well. The traditional mind-set prescribes that the project plan determines proceedings. Traditional controlling compares progress against the plan and identifies deviations. It is not designed to question the plan where fundamental uncertainties appear. The controlling was not able to represent and convey such unknown unknowns. There was no L4 concept available to the project team that allowed them to shift the control information received from the reporting into a wider context, where it could have been questioned whether the project plan was purposeful to meet the project goals.

The feed-back from the control processes, i.e. the reporting of progress, forms the informational basis for deciding corrective actions, if the control mechanisms highlight deviations between the planned and measured performance. Interviewees reported different approaches to such corrective actions, such as:

DM: “I tend to ask my PMs to review the issue and present it, together with an impact assessment, reviewing possible solution options.”

Again, this quote demonstrates that no fundamental challenging of the information available takes place. The traditional approach expects the project manager to present a solution. That solution can only come from within the parameters of project manager’s
limited view on the project information, their L3 information filters, and from their mental representation of reality and their applied L4 concepts. No challenging of the information outside these restrictions, accommodating new information, is taking place. It can be argued that the project manager is forced to reflect on their mental representation, which can lead to challenging these. However, external challenge would likely be more effective, as that allows introducing new concepts and new information. If that external challenge is not restricted to traditional PM concepts, it is more likely that the project approach can be fundamentally questioned.

In summary, project control measures provide the information required to compare the project progress against planned progress. However, the above findings revealed that it is challenging to set up control measures that provide a true account of the project state, i.e. receive the right quality and quantity of information to assess progress and identify and manage uncertainty. This is because the control measures focus on particular aspects, only provided limited accuracy, and only check the information status related to the project plan. This paradigm is restricted, in that it cannot pick up the reverse challenge, i.e. how relevant the plan is for the current information conditions of the project. Traditional controlling cannot challenge the plan outside the given parameters of tasks, time, and cost. More extensive information challenges that would require a re-consideration of the plan itself are unlikely to be picked up within that framework.

6.5 Project Organisation and Communication Structures

As established in 2.3.4, the traditional PM paradigm assumes a functional and mechanistic approach to the organisation of project members, applying top-down centralised organisational and control structures. In this view, management gives orders, which are cascaded and implemented down the hierarchy. This view assumes that the central project manager knows best. It also assumes that the tasks that are planned and triggered are fully understood by the management who orders them, and that they are started and implemented in line with the forecast. Here, project communication serves to facilitate
information exchange among project members and stakeholders to shape and progress a project and to create governance structures and audit trails.

The following sections discuss interview findings around the effectiveness of traditional project structures from an information perspective, showing findings of the use of informational information channels, and highlighting issues around information availability depending on structure.

6.5.1 Impact of structure and communication on uncertainty

AR discussed the practice of traditionally structured project hierarchies. He describes a problem of a traditional top-down structure with related communication challenges in a large project as follows:

“And in large projects, this is rather complicated because it, this is my experience, to communicate that all the way. Because the colleagues of course, the whole project is planned so that, there is a starting signal and then the implementation starts. Now something changes. Sometimes you have these back-and-forwards effects, meaning when the customer toggles in their requirements and the problem is not to grasp the requirement and to change the project, but the problem is the communication all the way down. I sometimes compare that with a helicopter. The project leader is sitting right in the middle, and the last implementer in the hierarchy, when you turn the rotor only 30°, a little bit, the one who sits at the outer end of the rotor turns in crazy speed, while you only turn it a tiny bit in the inside. This is how I try to explain this, that this is the actual problem that so much feature changes and then so much has to be changed and the more information has to go down to the implementers ... and those guys have to move very fast then.”

This quote highlights how an information unit, such as a requirement or functionality change described in the example above, originates as a smaller communication piece at the top of the traditional hierarchy. As it is communicated down the hierarchy, this small information trigger has an increasing informational impact. This can cause issues with regard to precision of information cascaded down the hierarchy, as no information is being added to manage the increasing impact on existing information, and no feed-back loops exist to clarify, hence introducing uncertainty.
Corresponding to ARs statement, ML discusses issues with information travelling up the hierarchy:

“The status reports give me an overview, but if I don’t know at least a little bit more than is written there, that isn’t good.“

She describes information communicated to her management level as being too condensed and abstracted to get a clear view of where the project stands. Such issues around information being communicated down the hierarchy, and similarly issues around formalising and thereby condensing information up the hierarchy, challenge the literature which established that such traditional hierarchies create clearly definable and understandable reporting structures and channels. While the channels and structures may be clear, it needs to be questioned how effective these are in transporting the information through the project. In line with MLs statements above, 5 other interviewees statements lead to the conclusion that such structures reduce the information richness as the information is presented to the next hierarchy level. This reduces the opportunity to develop and amend mental representations down the hierarchy, and to identify and manage uncertainty.

The literature review established (cf. 3.1.4) that information filters can inhibit information flows if the information contradicts expectations (Schrader et al. 1993). This correlates with the information model, where the use of certain L4 concepts will hinder the absorption of information which does not comply with the concept. The following statement by TC shows an example of this, where the L4 concept applied is that of a traditional PM paradigm, which does not allow the project manager to take in those communications on the concerns around lack of information which do not fit with the traditional methods and reporting:

TC: “I only picked up very late that it wasn’t really clear to everybody where we were going. It slowly appeared that many of the colleagues had too little of an understanding what the project goals really were, and where we were going. So that then brought us into trouble once it kind of became clear that the critical mass to get going wasn’t really there. So we got stuck and took much more time to understand what it was we were going to do, and how to tackle it.”
JW: “How come you weren’t able to notice sooner?”

TC: “The reports showed progress, and the risks that were called out were addressed. So the updates were all right, and it seemed that things were moving. But after a while the information got thinner and less cohesive among the teams. And then only when drilling down a bit more, and speaking to individuals, it kind of emerged that we had to go back and do some more ground work.”

Hence, where a project manager is used to viewing the project information landscape through a deterministic and reductionist functional paradigm, communication about uncertainties is less likely to be picked up. Both of these circumstances, the tight information flow structures, and the reporting and control mechanisms that do not fully support the acquisition of information around uncertainty (cf. 6.4), lead to the development of less realistic L3 representations of the project state. This discrepancy between the L1 reality, and the representation on L3, then inevitably leads to complications, such as deviations or inadequate project delivery.

6.5.2 The utility of informal information structures

The literature established that despite traditional formal communication structures, the communications driving the project content-wise are taking place at a more granular interpersonal level, and are of a more dynamic nature. It has been established in the literature that various project success factors relate to individuals’ relationships and informal communication was considered less time consuming (3.1.4). However, this phenomenon was not explained. The interview findings offer explanations if considered from an information perspective.

The interviews confirmed that projects often have complex informal project structures, however only the formal structure is controllable, and can hence be project-managed. This is shown in the above quote, where the formal management and reporting did not reveal the uncertainty issues the team were facing. Then speaking to project members informally brought the issues into the open. This discrepancy between formal reporting and informal information structures is also confirmed in MLs quote above, explaining that while there is
formal reporting, she wants to know a bit more than just the information she obtains from the formal reporting. These examples confirm the literature, in that information available through traditional formal reporting does not offer the quality or quantity of information required to get a true sense of the project. In particular, there seems to be difficulties getting a clear view on what uncertainty is faced. This may be due to the fact that the traditional reporting structures and methods do not foster the identification and communication of such challenges, other than in highly formalised risk and issue logs.

Hällgren and Manninen-Olsson’s (2005) research yielded that once a project deviates from the plan due to uncertainty impacts, this is managed through more intense communication (cf. 3.1.4). Similarly De Meyer et al. (2002) established that with increasing uncertainty in projects, the information structures need to be adapted from a structured set-up, to more unstructured approaches where interaction among project parties arise based on information needs. The following quotes provide examples of such measures:

DM: “At that point I got all people together into a room, to make sure everybody was in the loop. At the end of each day we had a meeting to review where we stand, what the concerns are, what points need specific attention, etc.

JW: ‘With all 70?”

DM: “Yes, with all of them, to make sure everybody was in the loop, build momentum…”

ML: “At some point so much was happening and so many details had to be kept an eye on, that I set up daily check-in calls, progress calls really - every day at 5:00 pm we’d have the business and the delivering PMs dial in and the PMs would talk through the progress and key issues and concerns. And the business stakeholders could ask questions, challenge some of the things that were done or had to be done. That way everybody was in the loop and we made sure we caught issues early, or misunderstandings, and it made sure everybody was aligned, even in the details. At this point, so close to merger, we couldn’t afford any of the key parties not being in the loop, as the pressure increases so much at that point. And the calls allowed us to discuss some of the issues quickly, didn’t have to wait for the weekly updates or having to rely in e-mails or chasing people individually. That way everybody who wanted, was in the loop.”
Both examples highlight different measures of increasing information exchange under conditions of uncertainty, both with very little structure, and a view to enabling more informal communication, in order to level participants’ information representations. Communication was found to be more important in such situations than formal change and risk management, probably because these formal tools are based on the traditional paradigm, and hence not adequate to manage such situations, so that project members resort to unstructured ad-hoc information exchange outside the traditional PM methods.

The literature established that highly structured organisational environments restrict communication channels, and the amount of available information becomes limited. The interviews yielded that informal structures are less restricted, and therefore allow gathering and processing higher quantities and increased quality of information, as no communication structures and methods are imposed, hence there are no restrictions for project members to exchange information and increase the representation of that information on all information layers in terms of precision and completeness. This may be an explanation for why the literature discussed informal communication to be less time consuming. However, it has also been acknowledged that these informal channels lie outside the formal control mechanisms, so that these cannot be project managed.

DM: “The consultants will organise their own communication channels very quickly if you don’t step in and set up a structure and enforce that structure. And then it becomes difficult to control who talks to whom and how to progress things.”

The following situation described by interviewee HM, highlights how informal information exchange offers a more open and creative exchange of ideas, leading to a more suitable solution:

HM: “We considered different options around the planning. We had the difficulty that we thought the usual approach would not get us the result in the relatively challenging time frame that had been imposed on the project. So we talked through different options. We did this in an informal session with some of the PMs. That allowed us to really consider the different options openly, and discuss their pros and cons openly, without having to immediately explain ourselves or presenting an approach in a positive light. Once you talk to the senior stakeholders, you need to present an option confidently and comprehensively, and steer their view on things, because we don’t
want to make them nervous and give the impression we’re all over the place. So the informal session allowed us to talk things through more openly. Only once we worked through all of this, we produced a more formal assessment, which we took to the stakeholders.”

The above quote highlights that one of the reasons why informal information exchange forums are used, is because the formal channels where the project stakeholders have a traditional view on how their project should be delivered, do not allow for open considerations of information to project challenges. They are restricted to progress reporting. In other words, there appears to be no forum in the traditional structure that allows for exploring and reviewing the information landscape, and hence the uncertainty status of a project, as these are focused on vertical transportation of information, in the form of progress reporting up the hierarchy and task allocation down the hierarchy. The above quotes also highlight that where the formal communication structures are not able to support the required information logistics, alternative informal routes develop to compensate.

6.5.3 Inaccessibility of existing information

The literature review criticised that there is no integrating function or focus on functional relationships across the hierarchical silos in the traditional project communication structure (cf. 3.1.4). The interview findings showed that this can lead to unknown knowns (cf. 2.5), where information may exist in the project, but is not known by parties who would be impacted by this information:

JG: “The legal team were working on the agreements, taking into consideration the new legislation. It only became clear that this impacted how we would handle this in the other teams when we had already worked through most of it. So when it became clear that there were quite a few implications the new legislation had on our approach, we had to review the approach. So we tried to learn from that and introduced a cross-functional weekly meeting. We also encouraged the PMs (Project Managers) to catch up more and align their bits.”

In line with the unknown knowns concept (cf. 2.5), the literature review on information structures discusses situations where the required information is not accessible due to restricting information and communication structures (Schrader et al. 1993) (section 3.1.4).
As discussed in the preceding section 6.5.2, project members may resort to informal information channels to get hold of that information, if it is known that this information exists within the project and who to target. However, this becomes an even greater concern if there is no awareness that this information is available and if the informal channels are not good enough to compensate for the information segregation of the formal challenges, as explained by PN:

PN: “The testing team had a lot of problems, as they didn’t know a lot of the environment config. The developer team knew a lot of this, and in some case it had to go all the way back to the suppliers. But the teams weren’t linked very well, basically because the structure kept them apart, but also because they grew so fast that people didn’t know each other and didn’t know who was responsible for what, so there was a lot of time spent on trying to find answers.”

This quote shows that a lot of effort is directed at information search, which could be used for other project activities. It also highlights that due to staffing curves and due to multi-skilled teams, communication channels and communication requirements for different project members and teams become less clear. Conscious effort must be made to re-establish these, as discussed by DM in 6.4, who got all project members into a room to level information statuses.

If it is not even known that information exists which could help project members to reduce uncertainty, the resulting uncertainty could be avoided, and may even have multiple impacts of more than one project members or teams are dependent on that information.

The literature established that project members focus their communication efforts along those paths where information is readily available (section 3.1.4). If certain information is easier to access, this can influence the direction of the project, as the following example demonstrates:

PN: “We had planned on using the reporting tool from our main supplier, because that was part of the package. It was more expensive than some of the other options, but it was well integrated with the core solution, so meant we didn’t have another additional supplier to deal with. It could just simply be covered off with the main supplier – less additional meetings, documentation, etc. So we didn’t consider other options. But there was some pushback. At first that wasn’t really picked
up on. But then there were continued objections, particularly around the cost. So then it was re-
considered. A decision paper was presented to the sponsors, and it was then decided to consider
other suppliers. So we did some research and started the tender process. In the end that was much
cheaper, and the functionality was better as well.”

The literature findings, together with the above example highlight that it may be useful to
challenge readily available information and information routes, for example by the PMs and
other leading functions. Alternatively, mechanisms need to be put in place that regularly
challenge the information paths chosen by the project team.

Structures, such as the strict hierarchical traditional silo project structures do not provide a
lot of horizontal communication linkages, which appears to inhibit information exchange
and may hinder access to information which would be available in the project (unknown
knowns). However, interviewees raised the question of how communication can remain
efficient and purposeful if communication is not restricted and many teams and project
members communicate with each other.

PN” So we adopted a more overlapping approach for the project phases. That meant that more
teams were involved in parallel, and these teams had to be co-ordinated in much more detail. So I
was worried that much more communication was required, and that we would actually create
communication overhead and still not be on top of things.”

TC: “As the teams grew closer together, it became more challenging to keep an overview, because so
many things were happening, progress was fast and updates were really only fresh right that
moment when they were received, because there was so much movement on so many granular levels.
So we had to re-think how we could keep everybody in the loop, and also the reporting approach,
we had to re-think that. There was no point using weekly reports that were drafted and submitted
some days before the review sessions, so they could be pulled together and distributed to attendees.
But these would be outdated by the time the sessions took place. So we switched to much more
frequent, but leaner reporting. We did daily stand-up meetings for example, with everyone. That
allowed me to get a more immediate picture, and of course to intervene immediately, rather than
feeling removed from the burning issues, only hearing them after they were urgent, or feeling one step
removed and informed too late all the time. That way I had more timely and direct control again.”
While both examples point out the concerns around increased communication, the second statement offers examples of how to manage this. As the restructuring increased the information load and co-ordination of keeping everybody up to date, reporting intervals were shortened, and formality of reporting was decreased from formal documentation to stand-up updates. This allowed information to be distributed more timely, intervene in unknown known effects, and appeared to offer more direct control of information dynamics for the project manager.

The literature concluded that projects with high uncertainty would benefit from a communication and information culture that is organic and informal to supplement the formal structures, with a flat management hierarchy (Collyer and Warren 2009) (cf. 3.1.4). Based on insights from the interview data, this can be explained from an information perspective, as organic and informal information exchange was found to increase the information quality and quantity, and can adapt to information availability, where information channels are otherwise restricted within traditional hierarchies. Flatter hierarchies were found to allow more team members to communicate directly with each other, increasing the chance that required information is available for those who need it.

6.6  Project Life-Cycle

The literature established that the PLC shapes the development sequence of a project and facilitates its organisation by dividing it into phases the project runs through until completion (cf. 2.3.1). The findings detailed in the subsequent sections demonstrate that the PLC inadvertently shapes the project from an information perspective.

6.6.1  Project Life-Cycle structuring and pacing information management

It was established in section 2.3.1 that most projects follow a similar PLC structure, from conception or initiation, to planning, to execution or implementation, and finally to closure and review. Each of these phases has a different purpose and associated performance
criteria, as well as different progress patterns. The following quote contrasts two PLC phases, highlighting the different organisation and communication structures and activities:

RP: “At that point [during initial project planning] we were a small core team, because the project had just started, and we had to do the resource estimates and then get people on board once we knew what we were doing. We worked closely together in this initial group, and had also started formal reporting to the sponsors. But amongst ourselves of course we didn’t need that because we were working so closely together defining the scope and working through the plans. So we often sat together to chat, or sometimes to brainstorm how best to do it, and to get everybody’s views on the pro’s and con’s of some of the activities, and to make sure we hadn’t missed anything, like vital dependencies across deliverables, etc. Then we would all go off and work through the points we had identified to require more detailing. And then we would come back together when we had done that to put it all back together. And we did that sometimes daily, sometimes we would go off for a few days and talk to suppliers and sponsors, and then come back together. Then as we went into the design phase, the team grew a lot, we brought people on board for the development and implementation. Then we had to focus more on supporting and guiding these people. We still caught up regularly in the core management team, but things were more formal and structured, because otherwise you don’t get through all the points you need to work through. “

JW: What do you mean by that?

RP: “Well, the more people you have on board, the more you need to co-ordinate and the more you need to make sure everybody knows what they need to do, what we all want to do or to achieve together, so basically, where we are going, the goals. Also, you have more parties to engage with in more detail, like the suppliers, lots more stakeholders, etc. And one of the tasks of the management is to pull that all back together regularly, to understand where we stand, what everybody is doing, if they are still working in the same direction, what issues need addressed, what to do next, so we progress as planned. You basically need to keep an overview on what’s happening, and based on that, you need to direct so what is happening is what you want to happen, so steering the team and the project if you will. And it’s a back and forth of the two – understand what’s happening and then influence, see if it goes in the right direction, and correct again, and get the blockers out of the way, and so forth...”
The above interview excerpt is an example of how the project structures and also the type of communication change in different PLC phases. As projects tend to apply staffing curves, the project organisation grows as the PLC evolves. Also, the traditional PM approach only explores information in the early PLC stages, and then switches to implementation where information structures are established and new information is less likely to be considered (see findings in section 6.3.2). Hence, due to changes in organisational structures, and change of the type of work undertaken across different phases, different information climates appear to exist in different PLC phases. This change in organisational structure and information climates across the different phases implies that the pace of the information management is influenced by the structure the PLC imposes.

The above quote makes it evident that at the start of the project the team tends to be smaller, which puts more focus on iterative information flows (cf. 3.3.6) to explore what information is available and how to shape this into a project plan. Due to the high amount of new information and initial uncertainties that need to be processed to produce this plan, it can be assumed that this informal and close communication facilitated working through great amounts of information and producing quality information on all information layers, but particularly helped to develop the L3 representations of the management team and get a better grasp of the project, in order to critically assess how to best implement it. This allows working through the informational complexities of developing the project goals into a project plan and considering the uncertainties, while deconstructing the tasks, considering interdependencies, required skills, etc.

As the project team grows during subsequent implementation phases, the information focus appears to shift to managing the information flows among the project team. Here, top-down information flows were found to communicate the project plan and implementation approach, and bottom-up information flows provide feedback to control progress and escalate issues, so that these can be resolved and the project can be progressed. In this PLC phase, less new information is considered, but more progress on the planned information items is focused on. There is also much more focus on formal reporting, in order to manage the control that forms part of the traditional implementation phase. As discussed in 6.4, this was found to reduce the quality of the information. It bears the risk of reducing the information to a point where uncertainties become difficult to identify.
The literature discusses a number of alternatives to the sequential PLC, such as iterative loops, spiral models, ladders, or a series of overlapping stages for fast tracking (cf. 2.3.1). These vary the ways of how planning, controlling, and implementation activities are undertaken and managed. Such different PLCs also imply different pace and require different information logistics than the traditional PLC outlined above, as described by PN:

“We adopted an incremental approach, so we did lots of small iterations, rather than one big bang delivery. As we delivered one of the packages, the SIT (System Integration Testing) team could start testing, and then the UAT (User Acceptance Testing) team could also start in a staggered way. It’s a great approach, but it also needs a lot more co-ordination, because these people all work in parallel, in staggered phases. So you need to make sure that everybody knows what’s going to happen, what is delivered when, how do the SIT team get on with it, when will the UAT team get it, and how do you manage issues across the teams. So basically they all had to be talking to each other all the time. But that is good if you manage it well, because that way you see progress and issues much earlier than in the traditional approach. But it also requires a lot more co-ordination and people need to work a lot more closely together, and you have a much more constant feeling of progress.”

The above quote, which describes an incremental PLC, demonstrates that PLCs determine the underlying structure and pace of information management, because it highlights the contrast to a traditional waterfall model discussed in the quote above. Here, teams work through incremental cycles, which requires more intense co-ordination, and hence puts increased focus on constant, and well functioning information management. In this example the phases are less separated into different logistics per phase.

The interviewee explained that this overlapping of phases only took place during implementation. The planning phase preceded this approach, which was a standalone phase, as per traditional PLC. From an information perspective it can be explained that there was not enough information to do a traditional implementation, so an incremental PLC structure allowed proceeding with incomplete information, and for new information to be considered.
RP describes an example where the project stakeholders were not involved well enough, due to a complex project being under intense time pressure:

*JW*: “And why do you think you had so many changes?”

*RP*: “Hmmmm, I think we had a lot of parties involved, and some were not fully engaged, so as things unfolded what we did became clearer to them and then they started to give their opinions and ask for changes. For us that was quite late in the process. Also, we were under a lot of pressure to show progress. So we moved forward quickly. So that made it more difficult as well then, trying to get people back on board that felt a bit left out because of the pace. It was a complex project, even we were not fully aware of the implications ourselves at the start. That also made it difficult for the team. They were struggling at times to stick to the end game, there was some stress and frustration. So you have to do a lot of that kind of stroking the egos, and keeping everybody happy, to keep productivity up.”

From an information perspective it can be concluded that this project had a very fast information pace, but the information management structure did not support this pace. The information exchange could not keep up with the speed of progress. In this case it may have been sensible to consider restructuring the project over time with a different PLC, to allow stakeholders a longer window of influence, for example through an iterative or incremental PLC.

These insights demonstrate how PLCs shape the project information dynamics. It could hence be concluded that different uncertainty profiles (cf. 3.3.3) imply different degrees of quality and quantity of the project information and hence require a different PLC.

### 6.6.2 Information phase gates

The preceding section established that information requirements and structures differ in different stages of the PLC. A second finding regarding the impact of the PLC on
information management relates to the consolidation of information. It is based on the fact that the information developed in preceding phases is built upon and used in the following phases, as exemplified in the following quote:

MM: “The developers developed the design together with the architects. We came in a bit later and developed the project plan, organised and structured the project. We then engaged the contractors and sub-contractors, as it became clear who needed to be involved. So that went through a bidding process.”

JW: “How does that work?”

MM: “For that you need the bill of quantities that the quantity surveyor produced. Based on that the different companies submit estimates. Once you have worked through the process, we then established their contracts. But we needed the design work and negotiations with the developer to progress a bit for that first, because depending on what you want to achieve, different contract types, have different advantages and disadvantages. ... Once the contracts were in place, and the design was ready, we had a detailed picture of what was required, and we could agree how to develop that. When the design and funding for the next stage was signed-off, we could finally start the development on site.”

In this example the design phase provided the information required to develop the project plan. The design and project plan provided the information required to start a bidding process. The outcomes of these phases then allowed establishing the contract types. This is one example offering insights as to how the information established in previous PLC phases forms the basis for subsequent phases. This example matches other interviewee’s descriptions.

The interviews highlighted that as a PLC phase comes to an end, the outcomes of the tasks undertaken in that phase are usually consolidated. Depending on the PLC phase, the traditional paradigm suggests various forms of outputs, such as project plans, requirements catalogues, architectural designs, or a contractual agreement. Often, these outputs are reviewed in some form, for example in client presentations, stakeholder review sessions, or
various forms of tests or checks. Outputs also tend to be documented, often with an associated review and / or sign-off process, as the following quotes document:

HM: “At the end of the process design, the documentations are sent out for review by the stakeholders a week before the stakeholder review sessions. In the sessions, often some more amendments or changes come to light. After the sessions the process designs are updated with these comments and changes, and then the maps are sent out for sign-off. Once all processes are finished, well sometimes even when they are not signed off yet or we are still working on some remaining ones, then they are passed on to the developer team, who develop their requirements and designs from these.”

ML: “We developed agreements with the board of how the staff would be transferred over. These were drafted in formal legal documents, contracts, and reviewed by our legal team and by their lawyers. That was quite a lengthy and delicate process. ... Once the contracts are in place, they provide the basis for how we plan, and manage, and - very importantly - communicate that to the staff that was going to join us.”

From an information perspective, these phase end-points can be viewed as information consolidation points. At these points, the information that has been gathered and processed in the PLC phase is collated and often documented. Reviews at this stage offer the opportunity of establishing the soundness of the information that has been produced for the next PLC phases, as the collated information can be exposed to scrutiny by other stakeholder groups. This process makes identification of inconsistencies or gaps more likely. In other words, the quantity and quality of the information produced in the preceding stage can be reviewed, and hence its soundness and usefulness, in view of the following stages. However, the traditional paradigm does not highlight this, so that often the opportunity is not taken at these stage gates. AL provides an example for such a missed opportunity, as he describes that documentation with insufficient informational depth passed a phase gate:

AR: “We had passed two checkpoints, XX1 and XX2, and the documentation seemed far too thin for the stage we were in. And that usually means trouble. If the documentation is too thin here, at that XX2, then I know something is not right.”
As established in the previous section, often different teams or teams increased in size take over in subsequent PLC phases. Therefore, the information consolidation and documentation of previous phases is vital, so that sufficiently detailed and precise information is available for the new team members in the next PLC stage, who need to develop an understanding of the project, i.e. develop their information layers, from that documentation, as a basis for their work. The following quote describes the issue where this information is insufficient to do so:

JG: “There was a requirements gathering phase. But they were not detailed enough. The organisation design team tried to use these to review the business processes, but they had a very difficult time, as the documents basically didn’t provide enough information to do this. And most of the people who had worked on this had left, so they had to find other ways of getting the information they needed.”

This quote highlights that such a separation of stages can actually hinder information logistics, as the wealth of information, i.e. the detailed information layer representations about the project which the previous teams have developed, cannot be fully captured in documents. These can only pass on information L2 information in the form of L1 documentation. Moreover, if the documentation is not detailed and sound enough, then this information is lost, creating uncertainty in the subsequent PLC phases. Therefore, overlapping PLC phases may provide an informational advantage, as this allows the different teams to pass on information while they work on their tasks, rather than having to rely on documentation or on consolidated accounts of previous PLC phase outputs. It can be concluded that a project is losing information, and is at risk of increasing uncertainty through the traditional separations of PLC phases.

As the information from the previous stage is used and built upon in the subsequent PLC stage, it becomes apparent whether the information from the previous stage is of good enough quality and quantity to proceed, i.e. lack of information from the previous stage is likely to impact at the next stage. Uncertainty is carried forward and impact of that uncertainty increases. However, the following statement highlights how such checks at the end of a PLC phase may be too late, because the entire development phase of a project has been completed before quality and uncertainty levels of the designed systems are re-assessed:
DM: “After the development phase, the code gets delivered into testing. The development phase took about eight months. As we started testing, it became clear that the code was of much lower quality than we had anticipated. So our estimates for the test phase were way too low. Because we found so many defects, testing progressed much slower. If we hadn’t waited for such a big code drop, but would have had a means to review the code earlier, then we could have intervened earlier. But that way this became clear far too late in the project, and it cost us a lot of delays.”

Due to the delayed availability of information after the completion of the development phase, the project lost valuable time, as an entire phase has passed before information quality and quantity are assessed, and correcting measures can be put in place. If more regular uncertainty checkpoints or constant uncertainty regulating mechanisms were in place, more immediate corrective actions could be applied. Such checkpoints can be determined by imposing a different PLC.

In summary, the interview findings relating to the PLC demonstrate that it significantly shapes the underlying information dynamics in a project and regulates their pace. It became apparent that different types of PLC can be suited to different information conditions in projects. An iterative or incremental PLC can allow for new information to be accommodated, whereas a traditional waterfall shape requires the information landscape to be complete upfront to a greatest possible extent. Furthermore, it could be established that PLC phases act as information phase gates, where information is consolidated. This provides an opportunity for uncertainty checkpoints by reviewing the quality and consistency of the information, but also bears the risk of losing information across the phases.

6.7 Conclusions and Research Questions

This chapter presented findings of a series of 11 early exploratory interviews. The goal of this pre-study was to gain a topical overview, identify practitioner-perceived issues and challenges associated with uncertainty dynamics in projects to establish the value of this study, and to assess the utility of the information paradigm and the information layer
model to achieving the objectives of this study. Interviewees had been asked to discuss their approach to PM, with a focus on the different project phases and key project elements identified and discussed in the literature review. The findings presented in this chapter detail traditional PM approaches, and in particular challenges and issues interviewees faced throughout their projects, and how these led to deviations in management approaches, with a particular view to uncertainty implications of these.

6.7.1 Confirmation of the value of this study

In can be concluded that interviewees from different projects discussed similar problems, uncertainty management tricks, and insights. This demonstrates a coherence which confirms these as critical issues. This converging tendency of findings also confirms that not just one particular view is represented. As the interviews were undertaken in different organizations, contexts, and for different types of projects, the above discussions establish the scope of the problem addressed in this study. Inadequate understanding of uncertainty and management under the traditional paradigm could be established as a general issue. The findings also showed that project managers across different projects apply the discipline’s core uncertainty management methods, techniques and tools, such as traditional control mechanisms, documentation, and risk and issue logs, experiencing similar consequences around loss of information and unaddressed uncertainty, leading to implementation issues, project delays and in one case a termination of a project. It could therefore be established that achieving the aims of this study can add valuable insights to the discipline.

6.7.2 Confirmation of utility of the information paradigm for this study

The traditional task based normative understanding of projects was contrasted with the project “actualities” (Koskela and Howell 2002) discussed in the interviews. These were then further analysed under the information paradigm, applying the information layer model. Throughout this chapter it could be demonstrated that there is a discrepancy between the traditional paradigm and the actualities of projects. It could also be shown that the traditional paradigm in many cases does not provide the methods, tools or language to support project members in addressing uncertainty adequately.
It was demonstrated that the information lens with the information layer model was able to offer deeper insights into underlying information dynamics resulting in the symptoms discussed by interviewees, in comparison to the traditional task-based view, hence establishing the value of this perspective for the purpose of this study. From a critical realist point of view it can be argued that the information paradigm offers a better access to the domain of the real to understand the causal mechanisms of project uncertainty dynamics. Specifically, the paradigm provided the following insights:

- Interviewees were often not acknowledging uncertainty, as they were unable to identify and grasp incomplete or inconsistent information conditions. Therefore, it was also difficult to address these proactively and in a structured manner. Their descriptions of uncertainty merely comprised the symptoms or effects of such, which puts people in a reactive position. Reviewing these through the information lens offered more comprehensive insights on the underlying mechanisms around lack of information, lack of sound information representations on L2 and L3, or lack or false use of L4 concepts to anchor information.

- The value of project goals is restricted under the traditional paradigm. They are not fully exploited to guide uncertainty identification and search of purposeful information. They appear not to be used after the development of the project plan. They are not exploited to reconcile diverging stakeholder views about the project, and hence uncertainty, or to challenge the project scope or adequacy of the project plan to deliver the project, i.e. to distinguish important information and uncertainty from irrelevant units.

- Under the traditional paradigm there is pressure at the start of the project to create certainties, such as pre-determined plans. This pressure, created by the certainty focused traditional project tools, leads to the creation of false certainties, such as upfront fully detailed project plans, to be able to proceed.

- There is a separation of initial information exploration, and the determination of all information for implementation. This approach offers a limited room for manoeuvring once project plans are in place. The interview findings detail coping
mechanisms, such as contingency and planning assumptions that allow the exploration of further uncertainties, as well as the management of new information, after the completion of the information exploration PLC phases. These workarounds only have a limited impact though; they become insufficient if the amount of information additions or changes are so great that they fundamentally challenge the way the project was planned. The findings around project planning and control allude to the fact that the traditional PM approach does not allow for the possibility of fundamental unknown unknowns or large amounts of known unknowns. These cannot be handled within the informational limitations of the traditional separation between upfront planning and subsequent implementation focused control structures.

- The analysis of the interviews, furthermore, yielded that activities are performed that do not form part of the traditional methodology, but are required in practice for the project to be able to proceed. An example for this is the goal definition phase, discussed in section 6.1.1. This shows that the traditional principles and methods do not always support the project actualities. They force project managers to take improvised steps outside the traditional methodology to cope with uncertainty, particularly where there is insufficient information, or where information needs to be assessed before it can be used further.

- The information paradigm offers concepts to explain the different understanding project members may have of a project, which can create uncertainty. These may relate to the use of different L4 concepts, or different degree of mental representations. This explains a lot of the interview statements, for example relating to project goal clarity (cf. 6.1.2). This creation of L3 uncertainty due to different mental representations has not been identified in the literature so far.

- There are no information feedback loops, for example for the scoping work to further challenge and refine the project goals. Therefore initial uncertainty in the project is taken forward and accumulates. These dynamics are not visible under the traditional paradigm. The traditional paradigm progresses information in a linear fashion, no iterative information reviews are built in to assess the quality and uncertainty of the information used to proceed. The information paradigm helped
understanding this, and the effects of such an approach. For the use of feed-back loops, the information paradigm can add value by driving more precise and directed feed-back loops, for example by guiding these from the project goal information.

Control structures direct and focus attention to certain information. Critical information that is outside the control focus, at times feeds-back too late, only after significant impact to the plan already occurred. The granularity of reported control information determines whether the project state can be realistically represented. The traditional paradigm provides no support to determine how to direct the control focus beyond a general focus on the Critical Path, and to what degree to adjust control granularity. An information based view is more likely to add value in this context, as it can give a conscious understanding how to guide control focus and how granular information is required to manage uncertainty. It was found that great control granularity, together with a focus on critical path activity under the traditional paradigm creates an illusion of control, as more informational detail is fed back. These causal relationships only come to light under the information paradigm.

The information paradigm provided the insight that traditional control mechanisms merely provide controllers with the view of the reporting party, not with an overarching view of the project status. Under the traditional paradigm, reporting does not question the consistency and correctness of L2 – L4 information, so that reporting does not reflect that understanding of the status of all project members, but merely of the person reporting.

It was established that traditional, heavily structured communication reduces the information richness as it travels through the structure. This reduces the opportunity to develop and amend mental representations across the hierarchy, and to identify and manage uncertainty.

There appears to be no forum in the traditional project structure that allows for exploring and reviewing the information landscape, and hence the uncertainty status of a project, as these are focused on vertical transportation of control
information, in the form of progress reporting up the hierarchy and task allocation down the hierarchy. Where the formal communication structures are not able to support the required information logistics, alternative informal routes develop to compensate.

- Different PLCs impose different information management structures and pace. This provides awareness to consider which PLC to apply, depending on the degree of uncertainty in a project, progressing Pich et al.’s (2002) work on project uncertainty profiles, where it could be argued that different uncertainty profiles imply different degrees of quality and quantity of the project information and hence require different management pace. These need to be managed by choosing PLCs and information structures which match these conditions.

- PLC phases act as information phase gates, at the end of which information is consolidated. This provides an opportunity for uncertainty checkpoints by reviewing the quality and consistency of the information, but also bears the risk of losing information across the phases.

These insights demonstrate that studying the situations interviewees discussed from an information perspective provided additional insights on the occurrence and handling of uncertainty, such as:

- Project members are often not aware of the information or respectively uncertainty state.

- There are no principles, methods, or language to address uncertainty and take corrective actions proactively, beyond risk and issues lists, and degree of confidence measures in assumptions, managing uncertainty fall-out only possible with change requests and contingencies, re-planning projects or shutting them down.

- Discussing uncertainty compromises confidence with the stakeholders.
Uncertainty was often only addressed when it already made a significant negative impact on a project, as there is no early warning system, or early warning signs are not noticed as this is not part of the traditional PM thinking.

More experienced project managers develop methods to allow for exploration of uncertainty during and after the planning phase.

False certainties are constructed to be able to comply with the traditional methods which require more information than may be available for the methods to work, so information gaps are plugged by assumptions.

Pressure of progressing and reporting progress appears to result in less thorough uncertainty exploration and communication. This is due to the fact that traditional PM methods require information, particularly upfront. Therefore project members appear to be forced to construct false certainties, to be able to provide inputs for the use of traditional methods and tools.

Uncertainty is often not acknowledged; there are no tools to describe it, and manage it, other than very limited ones (CRs, change requests, contingency).

Evidence suggests that some of the PMs had a feeling for lacking or insufficiently sound information, but were not able to formalise it.

Highly formalised hierarchies and communications structures with formalised control mechanisms tend to reduce the complexity and quality of information that can be conveyed, reducing the opportunity to identify and address uncertainty.

Tightly structured organisation of people and progression over time with the PLC, which does not allow for an adaptation of PM depending on the uncertainty conditions of the project. Information conditions have to be made fit to be able to work with the traditional methods and tools.
The review and contrasting of these findings from a traditional and an information logistics perspective demonstrated that there is merit to the application of the information perspective, as it offered more insights towards the underlying mechanisms of the uncertainty dynamics. These findings confirm the relevance of the study and the value this information perspective could add for the discipline in terms of understanding the underlying mechanisms of information dynamics and their manifestation as uncertainty in cases of inadequate information management.

6.7.3 Research questions

This pre-study has demonstrated that there is an opportunity to understand the root causes and dynamics around the development and management of uncertainty, to contribute to the currently limited body of literature. From the understanding gained through these preliminary interviews and the application of the information paradigm, resulting in the above listed insights on the occurrence and handling of uncertainty, the following research questions could be developed to guide the main body of investigation:

Research Question 1: What indicators for the existence of uncertainty and false certainty can be observed?

Research Question 2: What observations that facilitated the identification of uncertainty and false certainty could be made; How are mental representations challenged for correctness and completeness?

Research Question 3: What aware and unaware information management approaches can be observed to cope with uncertainty and false certainty?

Research Question 4: How can traditional task-based PM concepts be re-framed under the information paradigm to provide a more accurate conceptual framework for the understanding of uncertainty dynamics in projects?
Having proving the value of the information paradigm to achieving the objectives of this study, the information lens was used to investigate the topic in detail, with the core research method of this study. The findings of the observational research are detailed in the following chapter.
Chapter 7 - Observation Findings

7.0 Introductory Remarks

This chapter addresses the first three research questions, identified at the end of the previous chapter. It describes the findings obtained from observational data collection at the NX Programme, at DHL Global Mail. The context of this programme and the observation practice are detailed in 5.5.

The results of the observation data analysis relating to existence, identification, and coping with uncertainty and false certainty, are presented in the following three parts of this chapter. Some specific observation examples are detailed to illustrate the findings. Six key concepts that emerged during observation and from the analysis of the observational data are detailed as part of this account.

The previous chapter has demonstrated the utility of the information paradigm for eliciting the mechanisms underlying the empirical evidence of uncertainty dynamics in projects. It has demonstrated the superiority of this view over the traditional functional decompositionalist paradigm in deconstructing the empirical uncertainty indicators, and uncovering the uncertainty events in the actual domain. Therefore, the information paradigm was employed during observation data collection and analysis.

Table 6 lists the acronyms used throughout the following descriptions, to identify those observed within the NX programme, together with their roles in the program. The observees’ actual initials are not provided, so as not to compromise anonymity.
Table 7: List of acronyms and roles of those observed within the NX program

<table>
<thead>
<tr>
<th>Identifier</th>
<th>Role</th>
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<tbody>
<tr>
<td>AM</td>
<td>Facilities Manager (Business Owner)</td>
</tr>
<tr>
<td>AS</td>
<td>Data specialist NX Program</td>
</tr>
<tr>
<td>BF</td>
<td>Tester NX Program</td>
</tr>
<tr>
<td>CG</td>
<td>Facilities Manager (Business Owner)</td>
</tr>
<tr>
<td>CS</td>
<td>Facilities Manager (Business Owner)</td>
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<tr>
<td>CY</td>
<td>Business Owner</td>
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<tr>
<td>DA</td>
<td>Project Manager TMS Project</td>
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<tr>
<td>DK</td>
<td>Senior Developer Legacy Systems</td>
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<tr>
<td>DS</td>
<td>Developer NX Core Project</td>
</tr>
<tr>
<td>DR</td>
<td>Lead Change and Release Manager NX Program</td>
</tr>
<tr>
<td>DV</td>
<td>Developer NX Core Project</td>
</tr>
<tr>
<td>EC</td>
<td>Developer NX Core Project</td>
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<tr>
<td>FK</td>
<td>Project Manager DW Project</td>
</tr>
<tr>
<td>GV</td>
<td>Test manager NX Program</td>
</tr>
<tr>
<td>LF</td>
<td>Programme Sponsor Deutsche Post</td>
</tr>
<tr>
<td>JS</td>
<td>Senior Business Analyst Requirements Team NX Program</td>
</tr>
<tr>
<td>KC</td>
<td>Developer DW Project</td>
</tr>
<tr>
<td>MH</td>
<td>Senior Architect NX Program</td>
</tr>
<tr>
<td>MR</td>
<td>Facilities Manager (Business Owner)</td>
</tr>
<tr>
<td>OF</td>
<td>IT Business Analyst TMS Project</td>
</tr>
<tr>
<td>OM</td>
<td>Project Manager Training and Roll Out NX Program</td>
</tr>
<tr>
<td>OV</td>
<td>Developer NX Core Program</td>
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<tr>
<td>PG</td>
<td>Test Lead NX Core Program</td>
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<td>PH</td>
<td>Developer NX Core Program</td>
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<tr>
<td>PN</td>
<td>Development Lead NX Core Project</td>
</tr>
<tr>
<td>PS</td>
<td>Developer NX Core Project</td>
</tr>
<tr>
<td>RP</td>
<td>Programme Director NX Program</td>
</tr>
<tr>
<td>WW</td>
<td>Senior Architect NX Core Project</td>
</tr>
<tr>
<td>TK</td>
<td>IT Business Analyst NX Program</td>
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<tr>
<td>TL</td>
<td>Business Champion NX Program</td>
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<tr>
<td>TM</td>
<td>Project Manager NX Core Project</td>
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</tbody>
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7.1 Research Question 1

What indicators for the existence of uncertainty and false certainty can be observed?

The observations confirmed the interview findings that uncertainty, and particularly false certainty, is not obvious to the individuals experiencing it, or to peers or management. Therefore it is often not addressed immediately. In the observations, uncertainty and false
certainty could be identified indirectly by observing their effects in the empirical domain. The following sections detail observations relating to different uncertainty and false certainty indicators.

### 7.1.1 Surprise, irritation, frustration

The first three indicators for uncertainty and false certainty in the NX projects comprise surprise, irritation, and frustration. The following episode provides an example of observations relating to surprise.

The task of the requirements specification team was to develop an understanding of how the new system is expected to support Operations, and from that understanding to then detail the functionality required, the order of system process steps, and the design and sequence of user interfaces. Once the spec team had progressed this piece of work for several months, a session was set up for the business to review and sign-off the specifications, so that these could be passed on to the system developers to design an IT infrastructure and software based on these. Business stakeholders were flown in from different mail facility locations for this meeting.

The session took place in a large board room, with all invitees sitting around a large wooden table. After the introduction, JS, one of the more senior requirements analysts started describing the end-to-end mail logistics process, including required business steps, underlying business logic, and IT support. Very early on in this presentation various stakeholders, who were typing or reading on their laptops, started to look up with questioning faces and increasingly focused body language. They were sitting up or leaning forward with their hands on the table. After a further few sentences describing this process, a stakeholder from the Chicago facility interrupted JS with a question which showed that the point JS made seemed to be unexpected. As if reassured by this intervention that they were not the only ones not understanding, other stakeholders joined in with further questions. Most of these were closed questions, in the form of “Shouldn’t the tracking consider... ?”, “Wouldn’t we expect to...”. Rather than aiming at gathering more information, the questions appeared to serve the purpose of describing their understanding and to express surprise that JS’ presentation suggested something different.
This observation highlighted that the L3 information on how the business processes work appeared to be different between the spec team and the business representatives. The tone in which questions were asked and the facial expressions suggested surprise, as if this information was new and unexpected.

Then a Power Point presentation was projected against the wall at the front of the room, which showed a series of input masks that the staff in the letter facility should use to ID parcels. At this point more and more questions arose and stakeholders argued that this is not how they had imagined certain functionality to work. The facial expressions, statements and questions asked indicated that people were taken aback by the presented designs. Follow-up interviews in the lunch break and at the end of the day confirmed this observation. Stakeholders explained that they had a different understanding of how the processes and systems currently worked, and what was expected of the new system. Such surprise has been observed in cases where information provided appeared not to match the expectations.

Other observed instances relate to decisions taken in meetings which were subsequently communicated and received with astonishment, documentation reviews, unexpected statements from colleagues in conference calls or meetings, leaving people startled. The information appeared to be perceived as new, indicating an unknown known. In other cases follow up interviews yielded that the information was different from the thinking of the receiver, indicating false certainty. Here, the mental representations of the project information were considered complete by the person reacting with surprise, or the boundaries of the project information were considered complete. The possibility that there could be additional fundamentally important information was not expected.

Apart from surprise, feelings of irritation and frustration could also be observed in the NX programme, in situations where uncertainty prevailed. Continuing the above example of the requirement review session, as the session progressed, surprise was replaced by irritation and frustration as further interfaces were reviewed, detailing how end-users should be inputting mail item data into the system. Stakeholders would indicate with concerned faces “Hold on, this doesn’t make sense ... why are we doing it in this way?” or “Can we take a step back and discuss again how the tracking process works now end-to-end?” Or “How does this represent the process” or “How does this relate to the previous
step?” The tone in which the questions were asked became much more serious and concerned and it appeared the questions were aimed at eliciting information. Such feelings of irritation, frustration, and worry also pointed at the existence of false certainty for the involved individuals, or the existence of L3 and L4 uncertainty. This shows that while this L3 information appeared to be complete and consistent to the requirements team, this was not in line with the understanding of the business representatives, and hence appeared as new information. The L3 understanding of the system design was different between the spec team and the business stakeholders, and the L4 concepts employed between the spec and the business were different, too. This created incongruent information representations and hence false certainty for both parties.

Following up in individual informal interviews with senior project managers and some of the business representatives after the meeting, and then again circa one month later, NX colleagues argued that the spec team had developed the requirements based on an incomplete understanding, i.e. incomplete L2 information abstracted from the existing L1 processes, systems, and business needs. They had not been exposed to L1 information of how things are currently done, and subsequently developed incomplete L2 representations. From such incomplete representation, misrepresented L3 information was abstracted, i.e. not fully understanding how things worked in the business and what the underlying rationale was for the current approach. Furthermore, the business analysts (BAs) in the spec team anchored this business information to different, less adequate, L4 concepts than the business representatives, due to their IT background, and lacking logistics concepts. Therefore, these concepts could not guide adequate search of additional appropriate L3 and L2 information during the BAs analysis of the current business process and systems.

The entire process of abstracting the required information from L1 to L4 was flawed from each layer to the next, creating greater and greater discrepancy with the business stakeholders and with reality (L1). This led to false certainty among the spec team, assuming they understood the business needs sufficiently, which then resulted in the development of an inadequate and partly unrealistic or wrong set of requirements. The business review session provided the opportunity to challenge these representations through the more adequate L4 concepts and more complete L3 and L2 representations of the business needs which the requirements team were trying to ma This meeting revealed false certainty for the spec team, but also indicated uncertainty of the business with regard
to the technological aspects, both indicated in the empirical domain through surprise, irritation, and frustration.

7.1.2 Conflict and avoidance

The uncertainty symptoms of irritation and frustration, described in the previous section, were in some instances observed to escalate into conflict. This conflict was experienced in the empirical domain, but the uncertainty or false certainty underlying conflict in the domain of the actual was often not acknowledged, or only acknowledged once the effects of the uncertainty had obvious effects in the empirical domain.

An example for conflict as an uncertainty indicator relates to mail routing. The routing of a letter is determined by entering its weight, delivery speed (e.g. express), and delivery options (e.g. signature upon receipt), into the routing database. The routing table details which route the mail items are to take (for example via Seattle or Chicago), depending on these specifications. The database details for example that all items weighing 50-100 grams, to be delivered to Alaska, should go through routing 150 in the routing table. The programme then produces a code which is printed on to the letter. These routings are changed regularly. However, older routings needs to be saved in the database and made available beyond their expiry, so that the routing code for a mail item sent in March, which may have been dropped in a facility during sorting for example, can still be checked from the routing code printed on that mail item, once the item is found in April. Though a new routing may be in place, valid for example from April to May, the database needs to hold information for the previous and expired January to March routing.

The problem of having to hold routing information historically had initially been ignored, so the database had to be re-built to accommodate this requirement. However, since this database keeps growing constantly, a “cleanup concept” also had to be devised to establish when a routing could be deleted. For instance, when the customer has paid, all mail items have been delivered, and there were no claims for 3 months, the system could delete the routing. This was unacknowledged by various programme members, who considered this not to be a great concern, hence experiencing false certainty. On the other hand JS and WW were aware of the unknown unknowns from complexity related to this topic. They
did not fully grasp the extent of the unknown unknowns, but had established a sufficiently
detailed view of the issues to understand that the impacts of this uncertainty would be
significant and that this hence would need to be analysed further. These two opposing
positions initially created irritation and frustration. However, this remained unresolved,
and eventually turned into conflict between the colleagues with false certainty, and JS, WW
and PN, who identified the information gaps and were concerned about these.

Repeated arguments between the spec team around JS, the developers team including WW
and PN, the programme team including TM, RP were witnessed. These started off as
discussions, which were increasingly accompanied by physical signs of frustration, such as
aggressive body language, angry facial expression, and elevated tone of voice. JS, PN and
WW argued their concerns about the difficulty and complexity of the clean up concept and
the technical implications, and got increasingly upset as they did not feel heard, or their
corns actioned. The majority of programme colleagues on the other hand got upset
that this topic was brought up again and again, as from their point of view there was no
concern, hence showing false certainty. Eventually this frustration escalated into conflict.

Conflict in the observational context of NX was identified as a symptom of differing
perceptions of the integrity of information, with an emotional attachment. The escalation
from irritation and frustration to conflict was observed as the recurrence of interaction
around an uncertainty topic. This recurrence was coupled with a strong emotional
discharge, and a shift of the informational focus from a factual approach focused on the
uncertainty topic, to peripheral information exchange around related topics, often
significantly less factual and a lot more irrational. These factors of recurrence, together
with loss of focus or shifting to adjacent topics, and high emotional irrational involvement
distinguished irritation and frustration from what was observed and categorised as conflict
in the findings. This differentiation is also made because conflict resulted in different
information and uncertainty management compared to irritation or frustration (discussed
further under research questions 2 and 3).

In the example introduced above, RP was eventually observed to avoid the topic.
Concretely, this meant that when the topic came up in meetings he used his authority to
move the conversation on or managed to divert from these points to a different subject, or
cut the time of the meeting short. In delayed information exchange, such as e-mail, he
would not respond or omit the topic in his response. Such avoidance could, hence, be established as another uncertainty symptom. This avoidance resulted in a lack of facilitating the establishment or resolution of the underlying uncertainty. The unknown unknowns thus remained latent and unresolved and the symptoms continued.

A further example for an observed conflict as an indicator for uncertainty relates to environment use. DR initially brought up a concern about the environment set-up, which then escalated into conflict about who should own which environment, what is available on the environments, and who does the configuration. Similar to the previous example, the NX core project manager TM initially avoided the topic as he did not share DRs uncertainty concerns. Speaking to TM about this, he explained he thought the set-up and responsibilities were clear and only DR did not fully grasp this. Whereas in the previous example the conflict rooted in false certainty opposing unknown unknowns, in this case it initially appeared to be caused by a mismatch of unknown knowns for DR versus certainty for TM. As the conflict recurred repeatedly and TM felt it took up too much of his time and energy, he eventually explored the topic with DR and some of the other colleagues who used the environment, such as the developers team’s OF, and the test manager GV. In this meeting it turned out that actually TM had experienced false certainty, as indeed the issue carried uncertainties as per DR’s concerns. This episode is discussed further in relation to how uncertainty and false certainty are identified in section 7.2.1, where a change in the representation of the related information helped all involved to acknowledge uncertainty.

7.1.3 Inadequate task completion

The observation analysis highlighted that uncertainty and false certainty, particularly on L3, are indicated where tasks are not completed as expected. An example for this was observed as a programmer was asked to implement a small piece of functionality for an input mask. The senior architect MH sat with the programmer in the morning to explain the requirement. Later in the afternoon the programmer presented the completed task and MH was slightly puzzled, as she had implemented something considerably different. The outputs did not match the task that was given so that the function had to be reworked.
My hypothesis was that the uncertainty driver of this outcome was either unknown knowns or false certainty. The former relates to the observation that the programmer may not have been able to build a sufficiently comprehensive L3 representation from MHs explanations. Possibly she did not dare to ask questions to complete her understanding, as she was new in the team and appeared to be rather shy, which would point to unknown knowns. The hypothesis of false certainty could have been the case as the developer may have thought she had sufficient information to proceed with the task, but actually understanding did not match the L3 representation of the software architect MH and there were information gaps of significant and relevant information. After MH spoke to her, he stated that “she was not clear on the wider context of how the task fitted into the overall piece of work”, which appears to relate more to not having been able to identify adequate L4 concepts to anchor and search more adequate information on L3.

In other observed cases of inadequate task completion the other hypotheses around unknown knowns and false certainty described above seemed to be confirmed. Examples for such were the writing of a piece of code documentation which was not completed as expected due to unknown knowns, a presentation of an implementation approach, which did not meet expectations due to unknown knowns, and a functional diagram detailing the split of a number of tracking functions which was not drawn up as expected due to false certainty.

Mismatches of L2, L3, and L4 representations, resulting in false certainty and unknown knowns could be observed repeatedly in small scale instances around particular tasks, but also around larger issues relating to entire work packages, seemingly agreed approaches, or parties to be involved. Where such small scale signs were addressed early and thoroughly, further false certainty and unknown knowns could be discovered and eliminated, thereby limiting negative impacts to the project. In the above example MH sat with the programmer to provide more procedural context of what the functionality formed part of and was intended to achieve. Also, more background was provided around the architecture to help explain why certain technologies were used and how this piece of work integrated into the bigger picture. As MH explained, colleagues who sat nearby listened and some of them joined in, so that this conversation turned into a wider lesson for some of the programmers. In this way, potential further false certainty and known unknowns could be
eliminated by providing a L4 context, i.e. helping to chose and shape appropriate and
shared L4 concepts, and providing further L2 and L3 information on the task context.

7.1.4 Thin documentation

The analysis of documentary artefacts yielded that the original project scope
documentation was very high-level and rather brief for the size of the programme.
Reading it prior to the start of the observation did not provide sufficient of the NX goals,
or a clear picture of how NX was going to achieve them. The initial feeling was that this
document was insufficient, however as this was reviewed prior to the observation, this was
only noted as an open question at this point of the study.

The concern that the documentation felt too short and high-level, was confirmed when the
programme management was eventually forced to do another round of scoping exercises
with the business and IT, as both parties were not clear on what needed to be done and
how to take the programme forward. The project board, senior business stakeholders, and
the head architect met in Atlanta for a scoping session. This session drove out a number
of false certainties among attendees around the proposed implementation schedule,
architecture, and functional scope of the solution. It also drove out known unknowns in
the form of points which had not been considered, or thought through, such as phasing
out of legacy systems, roll out, or global communication.

Another case where MH and WW thought in sufficient detail was provided to help them
plan and design their IT implementation related to the documentation of the technical
architecture. MH mentioned that he had a lot of questions when he read this document,
which was produced by the head architects in Germany. The document was meant to
provide the principles for a consistent IT framework for NX and detail the high-level IT
infrastructure. However, this appeared not to be the case from talking to MH and WW.
Both of them spend a lot of time in conference calls with the head architect in Bonn, to ask
questions, in order to point out the information gaps they identified. Some of these turned
out to be unknown knowns, which the colleague in Bonn was able to clarify and hence
amend MH and WWs L3 representation. However, in these conference calls MH and
WWs questions also identified a number of known unknowns, which the head architect
MH and WW also spent a lot of time trying to close information gaps and add another layer of detail to establish an overall IT architecture and design framework. They explained that the original version did not provide “enough depth” (i.e. information) to proceed.

These observations and documentary analysis confirmed thin documentation as an uncertainty symptom, which had initially been established in the interview findings, where AS stated that if the documentation is thin, he knows there will be a problem (cf. 6.6.2).

7.1.5 Mismatch of plans to progress and ad-hoc management

Another symptom for the existence of both, false certainty and uncertainty, which could be identified from the domain of the real, throughout the observation, related to issues with project plans and progress.

As TM, the project manager of the core solution, walked me through his project plan, it seemed not to reflect all the work packages and activities, or the progress reports gathered in status updates, in various meetings, and from talking to project members in different teams. It also appeared that TM had to do a lot of ad-hoc management. For example questions pointing to topics which were not part of the plan appeared in a meeting discussing end-user training, or were pointed out to TM by a project member because they stopped progress, for example relating to the availability of a test tool. TM then had to address these information inadequacies in a reactive manner in meetings or ad-hoc conversations and gatherings, or e-mails, by aligning views and/or agreeing an approach and next steps for different parties involved.

This evidence of ad-hoc management and missing representations of tasks showed that the project plan did not reflect the actual project progress and did not represent all required tasks. This discrepancy between the project manager's understanding of the project scope and status, which was detailed in the plan, compared to the observations, and the subsequent need for a lot of ad-hoc management of unexpected uncertainty symptoms, indicated the presence of a lot of known unknowns or unknown unknowns. Not all pertinent information was available and reflected, either in the mental representation of the
project in the views of the project manager, or in the project plan which is a L1 output of that mental representation. These also highlighted the false certainty of the project manager TM, who assumed that the project reality was adequately represented, and was surprised at the uncertainty symptoms and subsequently required ad-hoc management. In this context the project uncertainty and the project manager’s false certainty related to:

- Not knowing how different work packages are related (for example TM did not link the work of the new Data specialist AS with the developer’s work),
- Not knowing all required work packages (for instance TM was not aware that a data mapping was required to migrate the legacy system data into the new data warehouse),
- Not knowing or falsely assuming progress made on work packages (for example TM assumed that the training design had progressed further than it was),
- Not being aware of information required to feed into work packages (for example TM was not aware that the training team needed to know how and when the software would be packaged and distributed to plan for the training),
- Not distinguishing which information is not relevant or lacking for a work package,
- Not being clear which resource had to be involved in work packages to contribute information to reduce unknown knowns and challenge mental representations and false certainty of other parties (TM did not realise that the architect of the legacy system could have provided valuable information for the design of the new software).

Another observation indicating uncertainty was consistently identified: updates rarely reflected actual progress. In fact, at one stage, the configuration manager DR gave the same update with different words in two consecutive weeks, and then a slightly modified update the following week. Furthermore, issues raised throughout the project by other team members were not reflected or answered in DRs status updates. In informal conversations DR and other colleagues explained that there is an expectation of progress in these meetings, so the information is represented in a positive light or it is focused on
different aspects to infer that progress has been made. Additionally, in an informal conversation with TM, it was elicited that he genuinely felt the status update reflected actual progress, whereas other colleagues communicated that they did not.

In summary, observations on uncertainty indicators around project progress and ad-hoc management show that mental representations may indicate a false certainty relating to project progress or the general information state of the project. It could also be observed that progress was presented in status updates, but often no purposeful progress was made. Uncertainty indicators observed that relate to a mismatch of actual and observed progress were:

- Stopped progress to address an issue, agree who needs to be involved and which steps to take next;
- Progress updates remaining the same in consecutive updates, and/or differing from the plan;
- Ad-hoc and reactive management of issues that appear to arise;
- Project plan not reflecting work packages and tasks existing in practice;
- Project members disagreeing ownership of a task or issue.

Reporting may not always realistically reflect the actual uncertainty status of a project, due to false certainty carried by those reporting or by the project manager. This shows that those individuals are not fully aware of the information state of the project, with regard to how complete the information is, how consistent it is, and how much detail and goal guidance is given to progress the work packages. The mismatch of reporting and actual progress indicates that there are information gaps, i.e. uncertainty, or falsely assumed certainty. Ad-hoc management is another symptom which follows from this uncertainty, to quickly address and manage the symptoms caused by the information gaps, in order to allow the project to progress.
7.1.6 Increased volumes of Change Requests

While the management of change is part of PM (cf. 2.1), great amounts of change reveal that issues have not been worked through. This indicates the presence of underlying uncertainty. While it can be expected that CRs may temporarily rise once specs have been signed off and subsequently come under change control, the extent of the changes in NX highlighted more severe uncertainty issues. All in all, reviews of documentary evidence of the NX change management process identified in excess of 700 CRs.

As part of the NX observation I attended the weekly change decision board (CDB). An example observed in the CDB for the uncertainty inherent in CRs relates to a mail sorting programme. A CR for the mail sorting programme came back to this forum three times. The IT design team devised a first change to the system, which was presented at the forum in a relatively high-level discussion, and the forum members agreed to sign it off quite quickly. The required changes PH presented appeared to be quite obvious. However, once this first implementation was complete and ready to be checked, the developers realized that the system as devised in the CR did not actually work in practice. Feedback from the business showed that it did not actually allow the facilities team to do their work of sorting the mail because the tasks they had to do were either not supported at all, or as pointed out by CG “the functions made the work so much more difficult that the system was not useful”. As a result, the CR had to be changed a second time, and was reviewed again some weeks later in the CDB forum.

This time the explanation of the underlying issues was much more complex, but CDB members had inadequate L4 concepts to anchor this information, or to build a solid L3 representation of the topic. An indicator for this was that a lot of questions were asked and topics were explained several times. Conversations with colleagues outside the CDB, who were involved in this piece of work, demonstrated that “those responsible for the system design did not fully understand the complex process, but assumed they did” (FK). With this false certainty, the re-design had been approached. The large number of factors playing a role in the sorting process, and their interactions was underestimated. This complexity created unknown unknowns, which manifested during testing. Subsequently, another re-design was done to rectify the system by taking more of the critical factors which were identified after the first re-design into account. Once the component was
ready for test again, conversations with the business champion TL and one of the developers DS highlighted that there were further information gaps around the sorting steps and interaction of these steps, which were not closed, so that the system still did not adequately support the facilities team.

The CR came back to the CDB a 3rd time. At this point the CDB finally found that the underlying problems could not be adequately explored in this forum and a separate task force was set up to do a “drains up” on this recurring issue and present an analysis of the issue to the programme manager RP and to the NX core manager TM, to then work on a more detailed resolution concept.

Another example of the uncertainties resulting in CRs relates to a piece of work that had the goal to offer the NX software to the DHL customers locally, so that they would be able to print labels, attach these to the mail items, and put the individual mail items into large boxes, ready for shipping. DHL would then pick up these boxes with the pre-sorted mail items. The facilities staff would only have to do some sample tests to ensure the items were in the right boxes, and then ship these. The attempt to integrate this new component into the core system, which itself was still under development, caused major issues. The core system had some challenges to overcome, which were exacerbated when attempting to add on this component. One of these challenges related to the system being constantly up to date with regard to routings. Routings can change regularly (cf. 7.1.2) and the client based system needs to allow for updates of such routing matrix changes, so that these are taken into account immediately.

Similar to the mail sorting programme example above, the developers thought they understood the problem statement which had to be solved by this piece of work. The CDB dealt with two CRs related to this client system. Discussions at the meetings highlighted, similar to the above example, that a system was designed which in practice did not work as all the different functions, data requirements, and business processes were so complex that their interaction created unknown unknowns which were not overcome. The developers had a false sense of certainty, as MH argued:
“they thought they understood how it worked and designed a system, but the discussions with the business showed that they did not really understand the complex intricacies which then led to failure and the two CRs”.

It could be argued that this indicator is actually a result of uncertainty. However, if a tendency of increasing CR volumes is established, it can be helpful to use this as an indicator to review the information state for any work packages and project phases going forward. Increased volumes of CRs could also relate to a specific PLC phase, or a particular piece of work within a project which may need to be reviewed.

7.1.7 Early signs of delay and failure

A further indicator, particularly for false certainty, was identified in the form of delays in projects, or project failure. The NX Core project experienced delays, firstly due to requirements re-design resulting from the false certainty issues detailed in 7.1.1. Delays were also incurred during the core development work in the implementation phase. The process was for the spec team to detail the requirements and then pass these on to the IT developers, whose then had to design the new IT infrastructure based on the requirements catalogues, and subsequently programme the new systems. The IT developers used the requirements catalogues the spec team produced as informational input for the IT infrastructure design and the programming. They also had frequent conversations and a handover with the spec team. The requirements documentation and the communications with the spec team provided the information around what business processes the systems had to support and what functionality was required. Based on this information a technical architecture was devised and technologies were chosen. The developers then started to implement the design piece by piece. Delays were incurred in that phase for different reasons. False certainty around an understanding of the system from the specs led to inadequate implementation. Similar to the discussion in 7.1.1 this related to a mismatch of the developers’ mental representations with those from the spec team and with L1 reality of how the actual business worked. Therefore re-work was required, incurring delays.

In addition to this false certainty, known unknowns (risks) caused delays to this development process. These known unknowns were information gaps which the team could identify. WW argued though that “despite having some awareness of the concerns,
the team was focused on progressing with the information which was available. That is easier than trying to deal with these risks…” and trying to find the needed information which was not readily available to turn these risks into known knowns. For example, the system design for the components where the design and technologies and approach taken were clear were implemented first. The functions which carried more risk and unknown unknowns from complexity would be tackled later on. This approach of working on the low-uncertainty work first, led to issues with regard to integrating the parts that carried more known unknowns and unknown unknowns with those low-uncertainty functions developed earlier. This required redesigns and additional integration work, which generated delays.

In this specific example the uncertainties appeared to be created because there was no sufficient L1 information absorbed by the spec team and the developers team, in order to develop a sufficiently accurate L2 representation to be able to design the entire system, clearly identify interactions, and clearly identify and manage information gaps. The developers team had to rely on the abstracted L3 info that was passed on from the spec team. This shows that where information is handed over, which takes place between L2, 3, and sometimes 4, uncertainty and false certainty are passed on, as no L1 checks are available.

Other observation examples discussed in 7.3.3 will demonstrate that effective uncertainty management must allow parties to refer to information L1, i.e. physical reality, more frequently, rather than remaining on the higher layers across various project phases and teams, in order to validate L2 and L3 information and reduce uncertainty. This observation example also shows that progressing certainties, which are closely linked or dependent to topics with high uncertainty can create difficulties as the interactions are uncertain as well.

Further observations on delays and failure could be made in relation to unknown unknowns. For example, in the US two address softwares to identify and validate customer addresses were approved. The company producing the address validation software for NX was acquired by SA SAP then decided to terminate this product line, so NX had to switch to the competitor’s product. The impacts of this unknown unknown led to delays in the programme. Another example, also relating to the reliance on third party systems, was that the NX programme expected to use the Oracle Application server. This was taken over by Weblogic Ltd. who also decided to use a new technology, which NX had to adapt to. This
required extra effort which could not be planned for, and resulted in delays. In both cases these unknown unknowns did not provide any indicators which could be observed in advance of their impact. Only once these impacted on NX, a number of known unknowns about how to manage this change could be identified and their symptoms observed.

Apart from delays, failure of one of the projects in the NX programme due to known unknowns, and unknown unknowns from complexity was observed. These observations provided valuable insights into the relation of uncertainty indicators to project failure. For the TMS project, it had been decided to buy an out of the box system which had to be configured. The vendor selection followed a standard procurement process. The integration process of this system then experienced various unforeseen complications, which the team kept trying to resolve. These unforeseen complications were the first uncertainty indicators contributing to the eventual failure.

Further complications kept happening, and this recurrence of issues which could not be brought to a resolution were another early sign of failure. Dates for the TMS project were repeatedly moved out, in an attempt to manage the integration and configuration work, leading to delays of the project, which was another early sign of failure. Furthermore, there was an information vacuum for an extended period of the TMS project. For a long time at the start of TMS, the project team did not receive any deliverables, or progress feedback, while the vendor was working on the system. Then a lot of consecutive milestones were set at short intervals – from business acceptance testing, to integration into the NX IT environment, importing data, and testing milestones. The first of these milestones were delayed as the vendor did not deliver as expected. In the weekly team meeting OF explained to the project manager DA that this delay was due to the vendor being unable to install their components on the NX servers. This was an unforeseeable complication, an unknown unknown which caused delays. In various calls, meetings and e-mail exchanges it was then agreed that the vendor had to programme an update to complete the installation, which was eventually successful.

Attempts were then made to enter the network data, but further difficulties were experienced representing the business logic on the system logic. Finally it was found that the system produced the time estimation for deliveries separately. It was not able to support requests to be aligned with updates of data tables. OF also mentioned that the requirements for transmission volume of data across Europe and America was underestimated as well, which created a bottleneck.
After months of trying to resolve uncertainty impacts and moving project milestones and end dates out repeatedly, it was finally agreed to stop the project and go back to the drawing board. In conversations with other NX PMs and with the TMS senior project staff, it was discussed that the “complications”, i.e. uncertainties, around this project, which eventually led to its failure, could have been reviewed more thoroughly sooner. Early uncertainty indicators, such as delays of the first milestones, several consecutive but unrelated issues, and recurrence of issues, should have been picked up on, but were not acknowledged and addressed as efficiently as they should have been.

Similar to the previous indicator around increased volumes of change requests, it may be argued that delays and failure are a result of uncertainty, not a symptom, and that this finding has a limited merit for identifying uncertainty in time for it to be managed effectively. Once a project has failed, there is no more use to understand that project failure is caused by uncertainty, other than to inform future projects. However, as delays and failure tend to happen gradually, watching out for early signs can serve as a symptom, so that the project can be re-planned to acknowledge and address the lack of information.

7.1.8 Stakeholder alienation

In the NX core project an increasing disengagement of the business customers could be observed. This manifested in them providing less feedback, having less physical presence, less and shorter interaction, more confrontational interaction, complaints, and informal negative remarks. Informal conversations and interviews with this stakeholder group confirmed these observations. For example AM said

“I don’t think the programme really understands what we need to be able to be competitive and offer a good service to our customers, and now the system does not really do what we need it to do. It does not really support our work as I would expect it to. I’m worried we’re gonna lose clients to competitors. And even if that’s not the case we may have to compensate for these issues with a lot of manual workarounds.”

Feed-back from other stakeholders was similar: they felt the new systems are not making things better, and they often could not understand why things were designed in the way they were. Some individuals also stated that they lost several large customers because the systems do not work. The senior management team tried to engage in more extensive
stakeholder management, for example setting up more meetings between IT and the business, as well as holding town hall meetings, comms sessions, and arranging social gatherings. In one of the meetings the new routing strategy was explained. However, the meeting offered additional evidence that there was a gap in understanding, as outlined in section 7.1.1, where the business felt that the programme, spec, and IT team did not have the understanding of the business context and business needs. Key to this appeared to be the difference in L4 concepts among the business, the programme, and the spec and IT teams, which manifested for example in observed different use of terminology.

The observational data analysis highlighted that stakeholder alienation is a particular concern where the topic is very abstract, so that it is particularly difficult to relate to a common L1 to develop a shared understanding, i.e. sufficiently precise and similar L2 and L3 information, and possibly the same L4 concepts. Therefore, in abstract, soft project contexts (cf. 2.4.4), there is more likely to be more uncertainty. The alienation stemming from lack of mutual understanding due to too much uncertainty creates further lack of information due to reduced interaction with the stakeholders. This in turn creates more uncertainties and false certainties, because the information held by the different parties is not exchanged to synchronize mental representations, and create a shared understanding of the project.

This indicator of stakeholder alienation may not be quantifiable, but it is experienced in symptoms, such as stakeholder availability, response times, shared terminology, degree of ownership, involvement, and support. In the NX projects where stakeholders were more closely involved, less unknown knowns, known unknowns, and false certainty could be observed.

7.1.9 Conclusion of research question 1

The observation findings detailed above answered the first research question, by identifying a set of indicators for the existence of uncertainty and false certainty, attempting to deconstruct the root cause for the symptoms from the observed data.

The observations of uncertainty indicators yielded a surprisingly great presence and impact of underlying false certainty, often relating to the fact that different project parties used different L4 concepts to anchor information. Similarly, unknown knowns were found to
be a regular occurrence, so that information was perceived as lacking or new, though it was available from other project parties. These unknown knowns would likely be experienced by individuals in the same way as known unknowns present themselves. No indicators for unknown unknowns out of the blue could be identified, which was to be expected by definition.

### 7.2 Research Question 2

**What observations that facilitated the identification of uncertainty and false certainty could be made; How are mental representations challenged for correctness and completeness?**

A range of means for identifying uncertainty and false certainty in NX were observed. These mainly relate to probing the validity and relevance of the information held by project members on L2 - L4. In order to do so, project members had to have opportunities for information exposure. Findings are thus grouped in three sections around these three themes of informational validity, informational relevance, and opportunity for synchronization.

#### 7.2.1 Informational detail and context to establish validity

The following two identifiers for uncertainty and false certainty were observed frequently; the first where project members changed the level of detail at which information was shared and reviewed, and secondly, were the information context was changed, i.e. where information was used for a different objective. Both of these topics brought forth the theme of informational validity relating to integrity of information.

*Change of informational detail*

A very frequently observed uncertainty and false certainty identification mechanism relates to changing the detail of the information that is being worked with, for instance through
abstracting or summarising a topic, or detailing it in the form of specific examples, scenarios, or anecdotes. Instances of this mechanism were often observed in meetings and conversations. For example during stakeholder sign-offs or witness testing, a lot of changes to information quality were observed which helped reducing uncertainty. In one meeting, when JS explained the routing rules in general, it became clear from subsequent questions that information was missing, so he resorted to a concrete example, and talked through a specific routing step by step. Using an example required a more precise and more detailed presentation of the information. He thereby presented more concrete information on a more granular level. This detailing helped establish validity of information, by checking for consistency. It hence, also made information gaps more obvious. As JS was walking through this concrete example, unknown knowns could be cleared, some false certainty of the developers was identified, but also a known unknown was identified around a specific step in the tracking process. Everybody agreed that this point was a concern and had to be reviewed, and added to the project risk register. The change of quality to a more detailed example, allowed probing the validity of the L2 and L3 information.

Another type of information quality change, similar to the example above, relates to using anecdotes. The business stakeholder CS, who ran one of the facilities, asked a question of how a quote would be generated for the customer. JS explained how the system would do this. However, this appeared not to answer CS's concern, so CS presented an anecdote where a customer had requested a particular type of good to be sent, with a pick-up time, and other specific delivery options. This anecdote provided JS with more detailed information to understand CS’ concern, which then developed an unknown unknown into a known unknown that the IT team subsequently could review. In the same meeting, another facility manager MR used a scenario to concretize an issue, explaining “...for instance if we would want to do this with several orders, how would that work?” similarly to CS’s use of an anecdote.

The concretizing of information through specifics in examples, anecdotes and scenarios, discussed above, could also be observed in reverse where NX colleagues would change the information representations through abstraction or generalisation. OM, who was

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12 Witness testing is a software test phase where the business watches as the IT developers demonstrate the system to show the business witnesses that it works, before they accept it and sign it off
responsible for the training and roll-out of the systems, for instance, summarised a
discussion with the project manager TM, the programme manager RP, the senior architect
MH, the change manager DR, and various senior developers who had all discussed various
specific steps of how the systems would be packaged and then rolled out to the different
facilities. As OM summarised the steps, DR interrupted her and asked how they would get
from the previous step she talked about, to this step she just advised would follow. MHs
facial expression changed to a contemplating concerned look, and TM and RP had an
anticipatory facial expression. It turned out that the process had a gap the way OM
summarised it. Only by summarising the process, so that the steps could be contemplated
in a sequential manner from end to end, the overview was provided for other project
members to identify an information gap, which was then taken away as a task for OM to
analyse and clarify. Such summaries were also commonly used at the end of updates or
status reviews, where the project or programme managers would summarise what was
discussed and what actions had been agreed. This allowed highlighting where the L2 or L3
understanding of different attendees may have diverged, so that these could be levelled,
and attendees could leave the meeting with a shared, synchronized L3 representation of
what was discussed and agreed, to then move forward with the actions.

In summary, the change of informational representation into additional detail by
developing specific examples, anecdotes and scenarios, allowed scrutinizing the
information for consistency and gaps, which appeared to work as a validation mechanism
on information L2 and L3. Similarly, abstracting and summarizing provided an end-to-end
view on the information which also validates consistency and synchronizes L2 and L3
representations.

*Change of information context*

Change of information context as an uncertainty and false certainty identification
mechanisms relates to situations where project members had to apply information about a
topic in a different context. For example, PN who was one of the senior developers asked
PS, one of the developers, to document a piece of code that a group of them had written.
PN later admitted that when she reviewed this document, she was “rather shocked how
little it reflected an understanding of the overall solution …” and how things were even
“flat out wrong”.

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This example demonstrates that the purpose of the information developed on L3 by the developers initially was to be able to programme the system. For the task given by PN in this instance, the informational model (understanding) developed by the programmers had to be used to produce a documentation of the code. This change of context in which the information had to be applied seemed to highlighted gaps in the L2 and L3 representation, i.e. uncertainty. Presenting the information on L2 and L3 of a specific topic in a different context was repeatedly found to put emphasis on different information units. This required re-assembling and hence re-assessing how these fit together in a different order or form. This re-assembling appeared to be an underlying mechanism of validating the information.

Similarly like most software projects, the NX system development was followed by various test phases, to check that the systems had no defects, and that the interfaces and functions work as expected for the business, that they integrate with other systems, that they are stable and can handle the required work load, and that they are secure and cannot be penetrated. In a first round testing was conducted by IT test analysts, who developed a set of scenarios and test scripts. They also developed fictitious customer data which they used to simulate the business activities. This testing phase went relatively well. However, when the testing changed context, and systems were used by the business in the real world, they did not work very well at all. It turned out that the initial tests were designed by IT test analysts who developed IT driven scenarios and data, which, as the context changed to a business environment, was found to be unrealistic. Since that test team relied on the IT developers’ L4 context, they did not create realistic scenarios. Once the purpose of using the systems had changed from testing to business application, the L1 information could be challenged in a different manner and the false certainty of the testers was identified. Had this lack of context awareness been considered earlier on during testing issues stemming from IT testers’ false certainty would have been uncovered prior to the system going into production.

This episode also highlighted that the assessment of which information is relevant and stored on L2 and searched for on L3 is goal, or task, or requirement driven, i.e. related to some form of purpose. Information which is required to perform a task or achieve a goal seemed to be stored in that context. It could be observed that changing the informational goal, i.e. what the information is used for, made it difficult to reproduce it. This discussion
on how informational purpose impacts information management and uncertainty identification is detailed further in the following sections on informational relevance.

7.2.2 Change of information representation and relation to specific purpose – establishing informational relevance

Two types of activity relating to informational relevance were observed in the NX projects: Changes in the representation of information; and the application of information to a specific purpose. The former was also found to establish validity, so that both aspects are discussed in the following section.

Change of information representation mode

A frequently observed pattern for the identification of uncertainty or false certainty could be established where the presentation format of the information changed, for example from oral to a textually documented form, or into an image or mock-u

For instance an episode was observed where in a catch-up meeting with various colleagues from different teams the conversation drifted to IT environments. DR started to bring up a concern about upgrades, which led to various discussions about who should own which environment, what is available on the environments, and who is responsible for the configuration. The NX core project manager TM tried to facilitate the discussion to clarify, however the conversations seemed to go in circles and more and more questions were asked. Various colleagues became aggravated, disagreed, and points which TM thought he had answered were raised again as the conversation continued, because attendees had different views or no knowledge on some of the things others brought up, or it was not clear who owned which tasks.

Eventually, TM got up and stated to draw the “boxes”, i.e. servers, on one of the whiteboards behind him. As he started to draw, people asked specific questions, and TM subsequently added on further details to the illustration. This allowed colleagues to establish validity of the information, for those who held uncertainty about the L1 physical set up of the systems to add to their L2 information representation, closing some information gaps (reducing unknown knowns uncertainty). Furthermore, the concept of
informational relevance could be identified in this observation. The drawing and detailed discussion of the server set up, and establishing who used the servers for what purpose, and hence should have ownership of which tasks helped to clarify which information was relevant, and in which way. The drawing also helped elicit known unknowns, where none of the colleagues attending the meeting was able to add to the drawing but an open question remained. It could then be established which of these known unknowns to discard as irrelevant uncertainty, for example the question who managed the hardware turned out to be a central task and therefore not one the NX programme team would have to address. This establishing of which uncertainty was relevant and had to be resolved focused the information exchange and the search for information to close the gaps.

Another example where information gaps were identified by changing the information representation was where textual design documentations, including screens, were assembled into a mock-up. This presented the same information, but was more closely related to the end product, as users could click through the screens, rather than seeing these on a written document. This mock-up drew out known unknowns, as it became clear that some functions did not work as intended on paper. This helped to validate the L2 and L3 representations the developers developed the systems from. It, furthermore, supported establishing informational relevance by understanding where more work was required to close information gaps and complete designs and what items and uncertainties were irrelevant.

These are two examples for frequently observed changes of information representation, which due to the different format, draw out inconsistencies and gaps that help establish validity. Additionally, this change of representation was found to help discarding information which was believed to be relevant, or identifying additional relevant information which was not previously represented on L2 or L3.

Relating information to a specific purpose

In various observed episodes of collaborative and multidisciplinary interactions and reviews, such as the ones discussed in the previous section, a second activity of relating topics to a project purpose or requirement was identified as an uncertainty identification method. Relating the information on L2 and L3 to a specific purpose appeared to help
establish information which was relevant to that purpose. Such relating to a specific task or requirement focused the information and helped establish information gaps.

An example of the means of identifying uncertainty and false certainty relates to business acceptance testing. As discussed in the previous section, the purpose of this test phase is to review the information in the form of the designed systems and processes to establish their readiness for release into the business. For the NX programme, three mock-up facilities were set up, with three coding stations each, to simulate the business processes using the new systems. The facilities owners nominated super users, which were business experts, mostly facility supervisors. These stakeholders used the software in the mock-up facilities to establish if it was ready for roll out to the wider business.

During the testing of some of the first releases, a lot of defects were found, but also quite a number of uncertainties and false certainties were identified. It became evident that the information representations that informed the developers who design the system, were out of sync with the business information representations. For example, in the first test run of NX core coding, the business could not get past the first system screen, as the application did not allow a piece of information that was needed to start the process to be entered. DS from the IT team, who triaged this defect to assigned it to someone in the IT team for fixing, was quite surprised. He called WW to explain the defect he was looking at, and they were concerned as they had not expected this issue. This shows there was uncertainty between the business and IT functions with regard to this process step. The L3 representations of this process step appeared to be different between the two project parties. To resolve this, and a number of related defects, DS, WW and some of the other IT colleagues had a meeting at the mock up facility with two of the super users who tested and identified the issue. After showing the problem, some discussion took place where IT explained how they thought it should be done, and the super users explained their approach. This led to more detailed discussion, which appeared not to resolve the issue. Eventually WW led both parties to take a step back and discuss the purpose of this piece of work, i.e. what they needed to do. This discussion of the user’s requirements appeared to be a crucial suggestion, which helped both parties to align their thoughts, and subsequently mutual understanding was increased.
Analysis of these observation findings lead to the conclusion that by reviewing the information in the context of the purpose or requirement of a piece of work, it could be established which information was relevant to achieve this purpose, and along with that also which uncertainty was relevant and needed to be addressed. This helped to focus establishing a shared information base, and provided guidance with regard to which points were correct in the IT solution, and which points were not covered from a business point of view, to then agree how to alter the current design to make it work. This example demonstrates how initially uncertainty prevailed, as the different stakeholder groups between the business and IT did not have sufficient interaction, and how the information representations and uncertainties could be overlaid to be identified and shared, once the different groups reviewed the information together in view of its purpose.

Another example for how relating information to a purpose identifies uncertainty concerns a lessons learned session with the IT developers, led by the senior architect MH. The team met in the meeting room off the main floor space. MH set the scene, explaining the value of gathering the learnings from the previous design increments and building on these. He then presented a list of points to discuss related learnings, and asked if anyone had to add any topics. Once this introduction was complete, the team talked through each of the agenda points. One of the discussions was around a specific programming framework - the Java Spring technology. Some of the developers thought it was not appropriate, others found it practical. As they challenged each other’s views with different arguments for and against this framework, DA mentioned a specific function they had to implement and challenged whether this would not be the ideal technology. There was a moment of puzzled looks and contemplating, and then MH picked up the thread again, explaining that they were “not quite clear yet how to tackle this one”. This episode is another example where uncertainty was identified and put on the radar by relating the information and lack of information discussed to a concrete project requirement. This provided a focus to measure the information about this technology against, to assess which information items were relevant, and which relevant uncertainties still had to be resolved to make a decision, and which points were valid for this discussion. This clarified that more information had to be gathered to close the information gap and establish whether this was the appropriate technology.
In summary, relating information to a specific purpose appeared to be a mechanism for establishing critical uncertainty that needs to be addressed, and distinguish it from non-purposeful uncertainty and information. Such purpose could be derived from benchmarks in the form of end user requirements, legislator or policy changes, customer focus. These function as benchmarks to establish informational relevance and to validate information against throughout the project. This is different from the traditional concept of project goals or strategic alignment for example, which shape the overall project as they are focused on the end product of a project, and therefore need to be baselined and remain steady upfront. Instead, these smaller scale benchmarks which are based on true end-user and sponsor needs offer gradual and intrinsic measures, which can develop throughout the project, as the understanding of the project members and stakeholders grows, and therefore incorporate development of the project information and the uncertainty conditions.

7.2.3 Opportunity for information exposure and reviews - synchronization

The two uncertainty and false certainty identifiers discussed in the following comprise the opportunity to be exposed to information, and collaborative and multidisciplinary information reviews. Both were found to facilitate the identification of uncertainty and false certainty by providing the opportunity to exchange information and thereby check and probe L2 and L3 representations and L4 concepts used, with the outcome of a greater shared understanding among individuals or project teams. This information sharing and collaborative checking mechanism was termed “synchronization”.

Opportunity for information exposure

In line with standard PM practice, a reporting structure was put in place across the NX projects. Various types and frequencies of reporting were done, from daily 15 min stand-up meetings for the developers, and weekly team meetings, to more formal workstream reporting, monthly programme reporting and milestone reviews, as well as half yearly board reviews. The following two examples contrast different opportunities for information exposure, and the implications for uncertainty identification.
Within NX core, weekly reports had to be completed by the different workstream leads for requirements, development, training and roll out, configuration management, testing, etc. These were then reviewed in weekly progress meetings. These meetings were tightly structured. Each week the workstream leads met with the project manager TM in the large meeting room, which was situated off the developer’s floor space. It was a white room with 4 tables pulled together and chairs around it in a u-shape, no windows, and a projector on the front of one of the tables to project presentations against the white wall. In this room the workstream leads sat around the table and presented their completed reporting templates via the data projector. Each week the same agenda was followed. Each workstream lead would show and talk through their report - what had been done, what was planned to be done next week, and what the key risks and issues were. Then the next colleague would do the same, until all workstream leads had given an update. The templates, as well as the reporting itself, were tightly structured.

Due to this repetitive approach, attendees were observed to be quite disengaged a lot of the time. Over several weeks it became quite monotonous to observe. It appeared that not much valuable information could be gained from these meetings. In individual interviews three of the attendees confirmed that there are certain expectations about what should be presented, and the information provided in these meetings is hence chosen to stay within the framework of these expectations. For example, even if little significant progress was made in a week, some progress will be presented; or where a lot of different issues appeared, only a few are picked, and where no significant issues appeared a few will be presented so as not to appear as if things were not considered thoroughly. As the room allowed no distraction through lack of windows, small size, and being quite warm and tight, attendees appeared to be quite weary and jaded. This set-up and structure caused the information reviewed in these meetings to be quite restricted and repetitive. Therefore, the quality of the information exchange and processing was low, so that consequently the opportunity to identify uncertainty and false certainty was limited.

In contrast to the above, the developers team had a daily stand-up meeting. Each day at 1:00 pm, all developers would come together in the room next to the floor space which was set up with some gym equipment. They would gather quite quickly, stand in a circle, and then each person would talk about anything that they were doing, or concerned or excited about. There was no particular format other than letting people speak in the order
they stood in the circle and not speaking too long in order to keep the meetings short. At
the end of each meeting, people who had a thought or question or concern about the
developers’ updates would walk up to them and they would continue the conversation,
sometimes in groups of three or four if several colleagues wanted to talk about the topic.
This approach appeared to allow a lot more flexible information exchange, and hence
drilling down to issues and identifying uncertainty and false certainty, in terms of bringing
together who had the need for more information to engage in more information exchange,
rather than the same group, and to focus on the topics that were of concern in terms of
lacking information, rather than formalised reporting restricted by a framework of
expectation and a stiff structure that did not allow an in-depth information exchange and
shared processing to take place. This approach was also much shorter, so that attention
seemed to be higher, whereas in the longer sitting progress meetings body language and
facial expressions showed that attention drifted more often.

Other observed examples of the effect of opportunities to identify uncertainty include that
colleagues were to walk up to each other’s desks to gather information and quickly reduce
unknown knowns, or ad-hoc meetings at whiteboards which were mounted on walls along
the open plan developers area; and conversations in lunch breaks and at the coffee
machine. The observation analysis yielded a general tendency for uncertainty identification
to be more regular where people worked closely together and had a lot of interaction
points. Project members who were spatially removed or less engaged in a topic, appeared
to build up more unknown knowns, and the opportunity to reduce information gaps and
false certainty was lower. For instance in a weekly conference call between the corporate
IT infrastructure team and MH, this was evident as MH spent most of the meeting
describing why the meeting was required because colleagues on the phone kept providing
answers which did not directly relate to the purpose of the meeting. This process showed
that there were a lot of unknown knowns present. The same could be observed for
business customers, such as the facilities managers, who rarely met face-to-face with the
programme staff, so that the informational L2 and L3 representations between these
parties were significantly out of sync. One example for this was provided at the start of
this chapter around the requirements sign-off meeting. Similarly, where the senior
programme staff, based in Germany, engaged with the programme team by phone or in
person in only 4-weekly intervals, symptoms for increased unknown known, known
unknown and false certainty issues could be observed.
The above examples, along with other observed instances, refer to different opportunities for synchronization. The observation analysis yielded that increased opportunity for synchronization allowed identifying more known unknowns by eliciting the informational boundaries of the project, turning existing known unknowns into certainty by exploring them, allowing identification of false certainty in mental representations, and uncovering unknown knowns across project members and teams. This was achieved due to providing the opportunity to level information and develop a shared understanding. This increased the opportunity for challenging information representations, thereby identifying gaps and false certainty, which in turn strengthens the common information base of the project, i.e. the information project members share, validating information, and discarding invalid information.

Collaborative, multidisciplinary information reviews

Uncertainty and false certainty were almost always discovered where information was reviewed or questioned in a collaborative setting, particularly in multidisciplinary contexts. For instance, the data specialist AS came into the project to review which data needs to be managed, how it needs to be mapped and where and how it feeds into the new systems. AS set up meetings with his different stakeholders, to understand the current structures and what needed to be done. In one of these meetings AS reviewed a specific piece of data mapping with developers. In this meeting he asked a lot of questions, initially to get an overview and then also to get the information he required to deliver his work package. When AS asked these questions, they probed the information MH, the software architect, PN, WW, and other developers held. A while into the conversation MH appeared to be holding back his initial response, turning his gaze to the top right and contemplating some of AS’ questions. AS’ probing from the point of view of a data specialist with his different L4 concepts that drive a different search for information on L3, seemed to MH to validate the information model he held. Together they identified a complexity unknown unknown information gap – an issue MH had not considered. MH looked astonished, and then contemplated how to address it.

Such probing from different backgrounds and different L4 concepts again validates information and helps identify if all relevant information needed to complete a task is available. In the process of synchronizing information among project members, a
validation process can take place across different backgrounds and hence L4 concepts. This sharing and levelling of information, which has previously been identified as synchronization of information representations leads to co-operative validity and relevance checks.

Other examples of such opportunities for synchronization are information reviews, such as stakeholder reviews, test entry or exit reviews, phase gate reviews, or business sign-off’s (cf. 7.1.1). Less formal and more regular meetings can have the same effect. For instance, the programme manager RP had one-to-one meetings with some of the senior project staff. At a meeting between RP and TM, where TM gave a general update on how things were going in NX core. RP asked a number of very specific probing questions, eliciting more specific information, which was causing TM to think about the issues in more detail and from a different angle, for example issues concerning stakeholder LF. This caused TM to validate his view, i.e. his information representation of the project. It turned out TM carried false certainty about LFs views of the test scope. RP and TM agreed a number of actions, some of which involved TM getting more information, and others involved the dissemination of RPs information to other colleagues. RPs specific and open-ended questions helped to probe TMs information representation with regard to completeness and consistency, thus validating TMs information model about a specific topic. It also helped synchronize the information between RP and TM to a shared level. This oral structure worked better than the regular update meetings, which were too tightly structured into a one-way update to the senior management, and therefore unable to facilitate sufficient synchronization both ways for the probing of the information with regard to validity.

These examples for cross checks allowed transferring the topic into a different L4 frame of reference, thereby checking the completeness and consistency of the information. In various observed episodes of such activities, synchronization helped establish which information was valid, and which information was inconsistent or incomplete and hence not sufficiently sound to proceed. This demonstrates that synchronization is linked to the concepts of validity and relevance, in that synchronization facilitates the establishment of validity and relevance.
7.2.4 Conclusion of research question 2

The analysis of the observation data yielded various approaches to identifying uncertainty and false certainty. These all related to mechanisms transforming information or the view on the information held on L2 - L4 in various ways, by compressing, or detailing the information, changing its context, representation, format, or audience. The findings on uncertainty identification also brought forth three general themes, concerning information concepts: termed validity; relevance, and synchronization.

It was found that reductions in uncertainty can be made by change of informational detail, brought about by different representation formats, drawing out inconsistencies and closing gaps by cross-checking the L2 and L3 information project members hold about a topic in a different format. Such change of information representation also allows discarding irrelevant information, or identifying additional information which was not previously represented on L2 or L3. The L2 and L3 information representations could thus be scrutinized for informational soundness, including false certainty, and information gaps, i.e. unknown knowns, known unknowns, and unknown unknowns from complexity. This process can help to establish validity of the information project members base their work on. The use of additional information through examples, anecdotes and scenarios, or abstraction for an end-to-end view through summaries similarly allowed checking for informational validity. A change of context where the information was applied highlighted gaps in the L2 and L3 representations, as it puts emphasis on different information units, and requires re-assembling and hence re-assessing how information units fit together in a different order or form, and this validates the project information base. Information required to perform a task is stored in that context and changing the informational requirement makes it difficult to reproduce the information. In summary, the first theme identified as informational validity, relates to how sound information on L2 and L3 is to work with, build on, and share. The above discussed identifiers facilitated scrutinizing and probing the information held on L2 and L3, and the concepts used on L4 for gaps, falsely assumed information, and inconsistency.

A second concept of informational relevance emerged from the observation analysis. Changes in information representation with a view to the purpose of a topic, help clarify which information related to the topic was relevant, and in what way. This change of representation was also
found to allow discarding information which was falsely believed to be relevant, or identifying additional relevant information which was not previously represented on L2 or L3. This similarly helped to establish which uncertainty was problematic and needed to be addressed, and which could be disregarded as irrelevant to the project, thereby reducing the chances of further false certainty developing. The establishing of which uncertainty was relevant and had to be resolved focused the information exchange and the search for information on closing the gaps. The importance of establishing a purpose, against which to measure relevance became apparent in the analysis of the findings. A change of purpose or context in which the information is applied highlights gaps in the L2 and L3 representation, i.e. uncertainty, as it puts emphasis on different information units, and requires re-assembling and hence re-assessing how these fit together in a different construct. This re-assembling is a means of validating the information, and also of probing which information units are in scope, i.e. relevant. In summary, the theme of informational relevance relates to establishing which information is purposeful for the project, and which uncertainty needs to be addressed. This allows discarding information items which are not relevant to the project and could lead to false certainty, and uncertainty which does not need to be addressed, so that efforts can be directed more efficiently.

The third concept of information synchronization emerged from the observation findings relating to uncertainty and false certainty identification also. This relates to project members levelling each other's information representations and concepts, through information exchange, with the goal of developing a shared understanding. The observation analysis yielded that increased opportunity for information exposure allowed identifying more known unknowns by eliciting the boundaries of the project, turning existing known unknowns into certainty by exploring these, identifying false certainty in mental representations, and uncovering unknown knowns across project members and teams. This was achieved by providing the opportunity to synchronize with other project members, and allowed the challenging of information representations to identify gaps and false certainty, which in turn strengthened the common informational base of the project. The opportunity for synchronizing was found to be closely linked to the project structure, further discussed under research question 3. Collaborative, multidisciplinary information reviews also added a co-operative aspect where different L4 concepts from other project members or specialists could probe validity and relevance from different backgrounds, separating false certainty and information gaps in the form of known unknowns and unknown
unknowns from complexity. Such a collaborative context facilitates synchronization, which can lead to co-operative validity and relevance checks.

The findings relating to research question 2 also established that often identification was key to handling uncertainties, because false certainty of individuals, or unknown knowns, could immediately be eliminated by eliciting the information of other colleagues to close the information gap. Therefore identification of false certainties and unknown knowns is often equal to reducing it. As false certainty and unknown knowns were found to form such a significant part of the uncertainties prevailing, the suggestion is employing identification techniques such as those observed in this research. The following section discusses cases where uncertainty cannot immediately be addressed, and how it is handled and managed.

### 7.3 Research Question 3

**What aware and unaware information management approaches can be observed to cope with uncertainty and false certainty?**

The following section discusses findings regarding what coping mechanisms\textsuperscript{13} could be identified to deal with uncertainty. Coping mechanisms may relate to identified or unidentified uncertainty and false certainty. If uncertainty or false uncertainty have been identified and acknowledged, coping mechanisms will be conscious and more likely follow a clear direction. The symptoms of unidentified uncertainty or false certainty, which have been discussed under research question 1, were observed to eventually trigger unaware coping mechanisms, depending how significant the impact of these symptoms was on the project. Both, aware, and unaware coping mechanisms are discussed in the following sections, including a consideration of their effectiveness. The findings are structured into four key themes, which relate to:

\textsuperscript{13} These findings relate to coping mechanisms on a PM level, as opposed to an analysis of individual internal cognitive coping strategies.
1) Creating visibility of uncertainty;

2) Attempting to collate and exchange more information to clarify or resolve uncertainty;

3) Structural changes to alter information availability for the handling of uncertainty; and

4) An adaptation of pace or rhythm to accommodate varying information availability.

The findings under research question 2 on identification of uncertainty and false certainty are closely related to the analysis of research question 3. Findings relating to research question 2 also helped reduce uncertainty instantly, particularly with regard to unknown knowns and false certainty. Therefore, some of the points discussed in 7.2 are picked up and extended in the following sections. Additionally coping mechanisms relating to known unknowns, and unknown unknowns out of the blue are discussed.

7.3.1 Creating visibility of uncertainty – the concept of transparency

The following uncertainty coping mechanisms relate to attempts to create visibility of a topic in order to communicate the uncertainty, or define the uncertainty more clearly, or obtain more information to resolve uncertainty. Patterns were observed around recurring queries and topics, forcing resolution of open issues, and raising issues. These are discussed in detail in the following three sections.

Recurring queries and topics

Certain topics were observed to re-appear repeatedly, being discussed by the same colleagues in the same or different forums over several weeks, for instance by posing a variation of a question repeatedly, or asking how to take an issue forward, or requesting clarification on a topic. In some of these cases management attempted to address the topic, other queries appeared to incur a discussion in one instance and were then considered solved, and hence considered redundant if brought up again.
An example of such a recurring topic relates to release notes. This is a type of documentation provided by the developers team that accompanies a software release. The release notes detail the version number of a software release, when the release was made, where it can be found, what the content is, which defects it fixes and which change requests it has implemented and tested, which components of the systems it relates to that hence need to be re-installed, etc. These release notes form part of a workflow where the release is prepared and provided for testing together with the release notes, and once the test team advises that testing is complete, it is then made ready for deployment by the IT infrastructure team. There were recurring queries on the release notes: what had to be included, whether a certain defect was fixed in a certain release, whether the release was ready, or some information missing in the release notes to be able to implement the release, for example a screen shot, or someone realizing that a certain described feature was actually not included in the release, etc. These points were brought up by the release manager DR, by various testers and by the test manager PG, by the infrastructure team, or by developers. The queries were observed to recur in weekly team meetings, and daily stand-up meetings, in ad hoc queries on people’s desks, phone calls and e-mail exchanges.

Such recurring questions about release notes indicated that the information management for this topic was not working well, as it kept causing unknown knowns for various project members, and could also carry unidentified known unknowns. The recurring questions appeared to be a way for project members to try to deal with the uncertainty by sharing it, so that other team members were aware of it and new information towards a resolution strategy could be obtained if available from other project members. This made other project members aware of the uncertainties. Due to awareness of more project members these topics were then also brought up more regularly by different people in different forums. While it took a long time and many repetitions, eventually these multiplication dynamics led to the topic being addressed, as it was brought up by so many different parties repeatedly, that a critical mass was reached.

In the majority of cases this approach of sharing an uncertainty issue, thereby creating transparency, helped to get it addressed and reduced successfully. This iterative approach also meant that more programme members were aware and very clear on what the uncertainty issue was. Thus, when a resolution was attempted, several project members, in some cases the majority, had already had time to consider the uncertainty, and a variety of
useful suggestions were made towards resolution. Eventually, licenses for a software was acquired which produces release notes automatically and asks for certain specific input, and the owners of this piece of work, as well as handovers were clarified. This episode shows that a critical mass had to be reached for the uncertainty to be actively managed.

This episode, in line with other observed cases, points at a general theme that emerged, termed informational transparency. This theme relates to how much acknowledged and unacknowledged uncertainty is present, and how aware project members are of other project members’ information L2 and L3 states, and the L4 concepts used. The degree of informational transparency in a project or among a team or stakeholder group appears to be high where uncertainty is clearly identified and colleagues have a relatively precise awareness of what information other colleagues in the programme hold (L2 - L3), and what backgrounds they have (i.e. which L4 concepts different stakeholder groups use). On the other hand, low transparency prevailed where uncertainty is unacknowledged or undefined, and individuals or workstreams are not aware of the informational landscape and boundaries of other colleagues or teams. In that sense, transparency is a temperature gage for the informational awareness and clarity in a project, and also relates to where there are information gaps.

**Forced resolution of open questions**

Recurring incidents where the root causes of an issue were not thoroughly explored were observed. In these cases a resolution, a way forward, or decision was forced, often by senior management. This means that impacted parties are not heard properly and buy-in is not there. It also implies a lack of thoroughness and precision to establish an informational base and understand underlying uncertainties, i.e. to increase transparency, so that these topics prevail but disappear from the radar as they are considered resolved by the management. This was in some cases observed to be linked to the uncertainty indicators conflict and avoidance, discussed in section 7.1.2. Uncertainty from these unresolved issues then keeps impacting the project. Hence, this uncertainty coping mechanism tends not to be particularly effective.

The data base conflict with JS and WW, discussed in section 7.1.2 flared up again in different forums. In this case and various others it was observed that where conflicts
escalated, eventually the topic was then forced to a resolution while uncertainty remained unacknowledged. After various cycles of avoidance, the uncertainty around the routing database eventually had to be attended to by RP, as an increasing number of defects appeared, which slowed down project progress. RP then pushed for a solution. He asked the developers to assign one of their colleagues to do an analysis of the issue and develop a solution. In RP's view this meant the issue was addressed, and JS and WW felt acknowledged in their concerns. However, it became evident after three weeks of KC working on a fix, that this was more complex than had been suggested by R. The unknown unknowns from complexity had not been established with sufficient precision to allow for a suitable resolution. They turned out to be too great to be governed in this manner. Eventually an external consultant had to provide expertise. Only then the uncertainties were reviewed thoroughly and a sound clean-up concept was devised. The forced resolution coping mechanism was not effective, as it did not fully acknowledge and establish the underlying uncertainty.

Another example for forced resolution, in this case without a prior conflict (however accompanied by irritation and frustration symptoms - cf. 7.1.1), relates to a component for end-customer data. The idea was to allow finding customer data through a barcode, rather than having to enter end-customer data manually. This customer data, and any updates to it, should download automatically from the business customers’ ftp servers. A small task force in the NX programme reviewed how best to implement this and consulted various parties, such as the business representatives, the developers, and the programme manager. The task force looked into different alternatives; one of them was to use a database component by Oracle.

In one of the meetings MH described the technical background and the difficulties which had to be solved from an IT perspective. In this meeting it appeared that the task force argued a case for an Oracle product which they thought would be able to solve this problem. In another meeting MH then addressed a series of concerns on behalf of the developers team with regard to the Oracle product, for example that the software was not designed for the NX intended use, but rather it was designed for organization-internal processes and is hence much too slow. MH stated that “It was not designed for data processing the way we intend to use it. Each of our customer systems have a different interface and a different data encryption.” The task force argued that some of these points
were not a concern, and took away some others for investigation. The task force attempted to answer some of MHs concerns by e-mail. MH then tried to speak to some of the task force colleagues again to ask details regarding how the integration would work and what issues had to be overcome. One of the developers who MH asked to look into this topic in more detail from a technical perspective also sent an e-mail to the project manager. Two weeks later MH mentioned that a decision had been made to go with the Oracle product. A decision had to be made to be able to move forward with this topic, and that all sides had been evaluated and considering all advantages and disadvantages this appeared to be the best way forward.

As the implementation of this system started, the developers team very soon got stuck. So Oracle consultants had to be brought in to answer questions, provide specific information about the system, and help resolve issues. Ultimately, Oracle consultants had to be requested repeatedly. In one of the discussions a consultant had to admit that the system was still buggy, so Oracle provided a fix. This happened several further times. Then the system became very slow. Crisis meetings were called several times with the developers, the project manager, and Oracle. Pressure was put on Oracle by the NX programme manager. Subsequently a consultant was put in place for several weeks, a number of hot fixes were applied, but these never sufficiently tackled the issues. Various crisis meetings were held between the NX core manager TM, some of the developer representatives, and Oracle representatives. Finally, TM said he had to consider how to escalate this politically, since a lot of money had been spent but due the recurring issues, which continued. Eventually this approach was terminated and the developers started to work on designing a new solution from scratch internally. MH explained that it was quite a complex problem and that the developers team had to spend a lot of time understanding the details to come up with a good solution. He also felt that the people who made the decision to go with Oracle either were not interested in or not able to understand the complexities around the initial problem.

From MHs conclusion it becomes evident that there was an insufficient attempt made by the task force to increase informational transparency, in order to make a sensible decision. This example of a forced resolution highlights how this coping mechanism reduces transparency as the unknowns are not addressed. The underlying problem was never resolved, the L1 information was not thoroughly checked, and stakeholders’ information
representations were not probed to sharply identify the information gaps. Therefore the uncertainties were not adequately addressed, and symptoms had to be battled constantly, while transparency was reduced. This coping mechanism of forced resolution mostly related to unacknowledged uncertainty. Eventually the impacts of uncertainties were so great that the topic was raised in various different forums, as discussed in the previous sections around recurring topics. This then allowed addressing it and transparency increased.

**Raising issues**

A coping mechanism observed mainly for some of the senior and more extrovert individuals who had a strong position in the group related to repeatedly raising uncertainty issues which they were concerned about in various different forums and contexts. This could be due to a conscious acknowledgement of the uncertainty, or due to the fact that uncertainty symptoms were experienced and caused an unspecific concern. This can be classified as an uncertainty identifier, but also a coping mechanism as by bringing the uncertainty issue to the attention of other project members to share, the intention is to manage it. It is different to the above discussed theme of recurring topics, in that it is an active coping mechanism initiated by individuals, rather than an uncertainty topic which appears repeatedly as its consequences have to be addressed.

An example scenario observed was JS raising an issue in relation to mail sorting. When a letter is processed, a label is printed onto the letter for the United States Postal Service (USPS). There is also a DHL Global Mail internal code printed onto the letter, which is made up of letters and numbers that specify how to sort the letter. For example, if the first digit is letter A, then the letter goes into container A, and if the second digit is a 7, then the letter in the second sorting step goes into pigeon hole 7. For every mail facility there is a big reconciliation for letters from A to F, and then there is a second reconciliation for pigeon holes. The spec team had to consider how many steps there are for mail sorting, and how to split these up, e.g. ABCD for USA north, south, east, and west. These sorting codes and steps have to be adjusted, depending on how much mail there is. If there are few items, it may be sufficient to sort to the first 2 digits to be able to fill up a mail truck from Atlanta to San Francisco. Or if there is a lot of mail, it may need to get sorted to the fifth digit.
JS criticized this: when the letters get coded, the system checks in the data base and for instance the mail may have to be sorted four times – three times in the LA facility to get it to the airport and fly it to Atlanta, and then in Atlanta so that certain mail items go onto the truck to for example downtown Atlanta. However, there was uncertainty as to what happens when mail items that were prepared on a Friday, and took 2-3 days to travel from the west coast to the east coast, had had then sort codes changed during the travel time. In order to manage this business process of changing the sort codes, the system needs to have a functionality to allow managing changes flexibly, and temporarily support the old and the new sorting system. JS raised this again and again – in a weekly status meeting, in a one on one with the project manager TM, in a conversation with the programme manager RP, in various e-mails, in discussions with the developer teams, and on various other occasions. However, this was never addressed. Having interviewed various parties with regard to what the issue may have been, WWs view was that this was never picked up. Low transparency may result in uncertainties not being acknowledged and managed. DR similarly thought that it was not picked up, but specifically stated he thought it drowned among all the other issues that had to be dealt with. In other words, too many uncertainties were present at that point, which goes in line with the finding that if transparency is too low, not all uncertainty can be addressed. JS felt that it was ignored because it was not understood. This conclusion of JS points at a lack of relevance identification, suggesting that low transparency also implies difficulties in identifying which information is relevant. Raising the issue repeatedly was an attempt to increase transparency.

Eventually, JS was successful, as similar to the dynamics discussed above under “recurring topics”, the problem was picked up by the core project manager, and escalated to the programme manager. This was facilitated by the fact the symptoms from the unresolved uncertainty started to impact other parts of the project. Due to these increased impacts, the project members who previously may have ignored the issue, or did not pick up on it, were more receptive to it. Whereas previously this information was not anchored on L3 as it could not be related to a relevant information gap (similar to the black swan example in 4.3.2 to explaining that if the concept is not available to guide the search and anchoring for information on L3, this information will not be recognised as relevant and stored and used on L3).
This repeated raising of an issue was an aware coping mechanism, in an attempt to increase transparency. However, only JS was aware, which demonstrates that isolated awareness of uncertainty is not sufficient until key staff who own a topic also acknowledge the uncertainty. Therefore, this coping mechanism initially was not very successful. However, once uncertainty symptoms started to increase, the coping mechanism helped to acknowledge the issue in a wider audience and initiated active search for more information and design of a solution.

This observed episode demonstrates that uncertainty may not be addressed due to too many uncertainties prevailing in a project, which need to be attended to, hence creating a state of low transparency. This scenario, along with the one discussed in the previous sections, also offers the finding that where information may be particularly complex, transparency is reduced, as it is difficult for other project members to understand, either due to lack of time or capacity (having to deal with many other issues) or due to ability (lack of L4 concepts that guide a search and anchoring of L3 information related to the issues of concern). Therefore the unknown known for which theoretically sufficient information would be available within the project, is not picked up and its symptoms and effects eventually impact the project.

7.3.2 Structural changes affecting information flows

The following sections discuss coping mechanisms relating to a further theme identified from the observation analysis. It became evident that how a project is structured has a significant influence on how information is distributed and shared, because project structures determine the degree of synchronization that can be achieved, which directly relates to facilitating or hindering the establishment of transparency.

Observations described below detail instances where the project structures did not support the information needs of the project, which leads to the need for coping mechanisms in the form of informal structures to satisfy information needs. Secondly a set of findings is discussed around a formal structure being unable to support uncertainty management efficiently, and evidence of how change of the structure as a coping mechanism improved the information availability and hence the management of uncertainty.
Informal information channels – chats, gossip, and asking around

A few weeks into the observation informal information channels became increasingly perceptible. Developers were observed to very frequently use informal information exchange and chats outside the official project structures to deal with uncertainty, mostly relating to unknown knowns and known unknowns, for instance in relation to requirements.

The new NX system was developed from scratch, based on requirements documentation produced by the spec team. However, as the developers worked from these specs, often discrepancies or contradictions were identified, or particular requirements were not plausible. A specific observed example relates to a problem identified by CL, around system updates. The software developed in NX would eventually run on many stations, which are supported by 18 facility servers. A technical process had to be devised for updating the systems, for instance when issues get fixed, or a piece of functionality is changed. From the requirements documentation it was not clear how large updates of several hundred megabytes could be distributed to all systems through a very thin connection from Atlanta and within a short time window during the night. As the developers identified this information gap, i.e. known unknown, rather than raising an issue for the spec team to analyse, or to produce a Change Request, two of them went to DKS office, to have a chat with him regarding how this was managed in the legacy systems. DK at this point was not part of the NX core project. He just happened to work in an office near the developer offices, and one of the developers knew that he had designed the legacy systems. They had met as they were all sharing the same kitchen.

As the developers stood in the door to DKS office, DK explained that he wrote a process where the update is initially saved, and then deconstructed into smaller pieces which are saved and deployed bit by bit. This informal chat quickly and efficiently helped the developers to break down this known unknown into a known known, and to consequently develop a solution for the new NX system.

A lot of such informal chats, as well as gossip, could be observed on a daily basis within NX, where people would go up to each other’s desks, or catch up in the kitchen over coffee to hear what people knew about an executive decision or progress on certain pieces
of development or testing work for instance, or what certain colleagues were working on, often helping to cope with unknown knowns, but also to address known unknowns and unknown unknowns from complexity. In the example above, eventually the project structure was adapted so that the designers of the legacy system were more closely associated with the developers’ team.

Another example of active and directed informal information sourcing is instances of project members asking around. For example, developers needed to understand which serial port on the computers letter scales are connected, to be able to send and request data to and from that port. DL from the developers’ team asked JS from the spec team. However, neither JS nor his colleagues knew. DL asked colleagues from the legacy systems, who were not able to provide an answer, so finally he asked a colleague to go and speak to the facilities hardware team directly. The same happened for the hand scanners which are used for barcode scanning, and for the naming convention of the printers. This asking around and queries were a very common observation with several instances each day. It often was related to acknowledged uncertainty, using very specific questions, and in some instances related to unacknowledged uncertainty with less directed questions. Another example was when there was uncertainty between the developer team and the test team which structure to store test protocols in the Test Director software. One of the developers EC checked with MH first, and then approached a colleague from the test team, BF, who advised the structure and where to store EC’s specific scripts. This asking around was a very direct, proactive, and efficient way of coping with uncertainty by reducing it. Again, it mostly relied on informal information channels outside the official project structures, and was often a one-to-one information exchange.

The observations related to informal information channels suggest, further to similar findings from the interviews (cf. 6.5.2), that the official project structures did not provide sufficient opportunity for synchronization, and hence transparency, or the synchronization paths were too long. Informal structures were therefore created to satisfy the information needs. These informal structures developed organically, and existed outside the control of the formal structures. This may have allowed a more direct and efficient synchronization, which appears to have increased transparency locally. Such direct communication can also reduce the potential for false certainties or unknown knowns to enter the information representations where information is passed on and synchronized across a chain of people.
However, informal structures provide no mechanisms for systematic synchronization across a wider and specific audience. A potential consequence may be a fragmentation of information, reducing transparency across the project. As discussed, in one of the instances detailed above, formal structures were eventually adapted to support the information needs that had temporarily been satisfied through informal channels. However, this was not always found to be the case. Where this adaptation of official project structures did not take place, unknown knowns could be reduced for some of the project members, for example around the ports for the hand scanners, however this information was not passed on to all other developers, and was not added as amendments to the requirements documentation for future reference. Therefore, unknown knowns were not addressed systematically. Also, known unknowns were at times reduced among people that were part of an informal information route, but insufficiently resolved locally into false certainty, as aspects covered by other project parties were not considered.

*Change of structure*

Within the observation period, the structure of one of the NX Core sub-projects was changed. It was initially organized in a traditional top-down project structure, with the project manager TM managing the project, reporting into the programme manager R. There was a group of spec team members involved in designing the systems and business processes, which were given to the developers team to implement. The project manager TM would do the project plan and the reporting for all of these activities.

A lot of unknown knowns and false certainty prevailed as the requirements catalogues were passed on from the spec team to the IT developers. Furthermore, unknown unknowns from complexity prevailed which had not been fully acknowledged or explored by the spec team, and hence passed on to the IT developers’ team, who should merely implement the work assuming that all issues were resolved at this point. WW explained:

> “There was too much micro management done by the project manager, and it became evident that there was a gap between the PM work, the planning and so on, on the one hand, and the spec team, and particularly the IT team. They needed to be engaged in a better way, with more responsibility for the overall piece, being involved and understanding it from the start.”
This quote points at insufficient transparency and lack of synchronization between the PM colleagues, the spec team, and the IT teams. In one of their one-on-one’s RP asked TM to take a step back, and reorganize the increment in such a way that IT would be part of the end-to-end process from the start. While this may not have been a fully aware uncertainty coping approach, there was a degree of awareness that the current structures did not work.

TM spoke to MH asking him to delegate a team and a team leader, who then joined TM in a kick-off meeting. That was quite unusual, as normally IT would come in much later, once the requirements are ready. This meeting went very well, with a lot of engagement by IT, who afterwards mentioned they were excited to be able to be “in there from the start”. TM explained in the meeting with the stakeholders that they were now “trying to have the IT team involved from the beginning, to understand the piece of work right from the start and be involved in the design and analysis process.” MH, following RPs guidance, also asked the IT team to develop the detailed project plan and do their own reporting. RP initially had to keep asking TM to remove himself from micromanaging. Eventually MH was very pleased about this, and said to me

“This is much better, because before unrealistic solutions and unrealistic plans were developed when the business analysts worked with the business. Because the business analysts had no idea how the business worked, and the business had no idea about IT. This always then escalated during testing, when it all had to come together. “

The project structure was altered from a traditional top-down reporting structure and topical silos into a triangle between test, implementation team, and analysts to develop the basic design. RP argued that

“This allowed all involved parties to develop the basic understanding of the problem, and develop a plan together on how to tackle this which they own, and which the project management picks up and supervises. There is much more ownership this way.”

This alteration of the project structure increased the opportunity for synchronization among the teams with a view to increase transparency. The involvement from the start allows building a shared understanding of the topic and its information gaps. This shared understanding is achieved by developing the L2 and L3 information representations of the
problem together, probing and challenging regularly, so that it is unlikely that false certainty occurs. It also allows developing understanding of each other’s L4 concepts so that it is clearer how colleagues from other topical areas search for, and resort to information that is collated and discussed. This more interactive structure hence has a significantly increased number of synchronization points, where the information amount and quality can be probed, and information gaps, i.e. uncertainties can be established.

7.3.3 Adapting project pace to accommodate uncertainty conditions

Finally, coping mechanisms were identified that related to the adaptation of the speed of information dynamics, depending on information availability. These findings are detailed in the following four sections, discussing:

- A change of meeting frequency to work through uncertainty by speeding up synchronization;
- Postponing a topic to allow the uncertainty to clarify and more information to emerge;
- Slowing down and breaking down uncertainty; and most significantly
- A change in the fundamental approach to address uncertainty in cycles.

Increased meeting frequency

To cope with uncertainty, the frequency of meetings was observed to increase, in particular to deal with unknown unknowns from complexity, or to reduce known unknowns to risks (known knowns). This was for example observed in the context of the reporting component of the data warehouse. The developers’ team led by DL found out bit by bit by e-mail and telephone conferences with the business, that a lot of ad-hoc reports were required. This was another unknown unknown which the team suddenly became aware of, and successively realized the importance of these reports to the business. These ad-hoc reports had to be available in real time, while the facilities team were processing mail, to be able to do certain checks. An example for such reports are for a floor manager in the letter facility to know how much work is left to do for a customer, i.e. how many tons or pieces of mail are still to be worked, or how fast the mail is currently being worked, because if the
machines work too fast more letters are likely to go into the rejects and need to be worked again. These reports could not be produced from the data warehouse, as there is a delay while the data is written into the warehouse and the reports can then be extracted. DL retrospectively said that the entire ad-hoc monitoring was underestimated. So once the significance of this piece of work sank in, a lot of activity suddenly started, and the weekly meetings with the business were increased initially to three times weekly, and then to daily meetings. This was needed for DL and his team to get more information around the requirements the business had, who in the business would be made available to specify and support this development process, and how it was technically implementable without slowing down the system. This increased meeting frequency was a coping mechanism to closing the information gaps on L2 and L3 for the developers, i.e. to reduce the uncertainties and to enable design and implementation of this piece of work.

DL said they thought they were on the home straight when this uncertainty hit the programme, and the constant interaction with the business for a period of several weeks and resulting increased speed of synchronization and progressing of the topic, helped to address and solve it. This example shows that the information management speed had to increase to resolve uncertainty, and subsequently the meeting frequency increased to satisfy the increased need for synchronization.

Other observed instances of increased meeting frequency related to the resolution of a set of interrelated defects which caused uncertainty from complexity, so that the test team, the developers, and the business had to have an initial review, and then set up daily progress calls. Another example related to a vendor selection process, where responses to a request for proposal (RFP) were reviewed with IT to establish technical feasibility, and with the programme to establish cost and business integration. Once the vendor proposals were available, the frequency of meetings with the vendors increased to reduce the uncertainties about the solutions, cost, timescales and support model, and also internal meeting frequency increased to establish the best solution.

Postponing

An uncertainty coping mechanism, which was observed over a longer period, was to postpone topics. This was often an aware coping mechanism, to allow for more
information to be gathered. It was also observed in cases where the owners of the topics did not actively address related uncertainty, as they were not clear how to take it forward, and instead focused on other topics with less or no uncertainty. In such cases postponing was an unaware coping mechanism. It was observed also where there were unknown unknowns due to complexity, and postponing allowed for some of the complexity to be resolved, so that the unknown unknowns could be reduced and managed.

An observed example of the postponing coping mechanism was for uncertainties around dimensional weight routing. In recent years, many mail items have become lighter, and an increasing number of them are transported by air in flight containers. In the past the containers were often limited by the weight of the mail items. Today, parcels tend to be larger and lighter, as companies “ship air”, such as Amazon sending items in large parcels with a lot of packaging and small contents. Therefore, volume, rather than weight, is now more critical when filling the flight containers. This volume should ideally be taken into consideration for billing and routing considerations, rather than purely billing and routing based on weight. This volume is referred to as “dimensional weight”. If dimensional information is available during encoding, a different routing decision can be made, for example not to send the items by air. However, research by the IT team established that volume scanners are very expensive. Furthermore, they found that it takes circa 15 seconds to scan each parcel, and handlers have to take their hands away to allow the scanners to establish the parcel size. The business advised that this is not feasible as it would slow down productivity too much. As the IT colleagues established this information, and all uncertainty that could be tackled at this point was resolved, it was agreed that dimensional weight would currently not be considered for the pricing and routing strategies, and this topic would be deferred.

A few days later KS e-mailed the project manager TM and the developers regarding a new scanner he had sourced, which included a conveyor belt and could scan 3000 parcels per hour without human intervention. This finding opened up the topic again. It introduced additional information, but also new uncertainty as to how this equipment could be used. Upon researching this option, KS pointed out that now a solution was available for the scanning, the question was how to encode the items. So with one uncertainty around the scanning resolved, reducing complexity of the topic, the known unknown around encoding could now be tackled. After further investigation the developers established that there was
no obvious solution how to link the scanning to the encoding. Since there was too much uncertainty at that point regarding how this could be implemented in a cost effective, robust, and technologically sound solution, all stakeholders agreed that a solution around dimensional weight checking would be postponed.

Two months later a compromise was agreed between the programme, IT, and the facilities owners, to put a scanner at the entrance of the facility, where the parcels are checked for their dimensional weight. This data is use for billing the customer. However, it is not yet used to determine a routing decision. This approach was devised after a period of time had passed. In this example, postponing a choice or decision appeared to allow more project members to complete their mental representations of the uncertainty issue, by adding more context information and sharpening the issue. It allowed letting the information base mature through further synchronization. While such postponing may be criticised for impacting project cost and timelines, RPs view was that while this approach may initially appear to be more labour and time intensive, it is still significantly less expensive than having to correct a technological failure for the business.

These examples demonstrate how changes to the project and information processing pace in the form of postponing, allow for new information or developments outside the project to transpire into the project’s information space, and reduce uncertainty. It also allows stakeholders to mature their information representations by providing additional time to have further opportunities for synchronization and reduction of uncertainties.

_Slowing down to break down uncertainty_

It has been observed that under conditions of uncertainty where several attempts at resolution have failed, a coping mechanism of slowing down progress was employed. This allowed more time to explore and break down the complexity from unknown unknowns by allowing for more synchronization with a greater number of project members. More time means that more information can be actively sought, and there is more time for synchronization to ensure sufficient transparency across all stakeholders, and to develop an uncertainty management approach. This is different to the previous point of postponing where information management around a topic is temporarily discontinued to allow for new information from outside the project to transpire.
An observed episode for slowing down relates to the address validation software. This system is used to identify and validate a mail item’s target address by entering part of the address data. Due to false certainty, it was initially assumed that this would be a very simple process. One enters a post code, and if this post code does not provide a unique address, the system jumps to the next field in the mask to request a second data item. However, it turned out that the interaction with this address validation component, and the way in which it would request further data items, was very complex. For example, upon entering a post code, the system may identify an address in Miami or Clearwater. The user interface then has to support further identification by jumping into different address fields. However, this was not a sequential process. Instead, the cursor had to jump to different fields in each instance, depending on what data was entered, how much further information was required, and what type of information was the fastest way of identifying the unique address. For example, when 5 numbers are entered, it can be assumed that this is a post code. However, when only 2 digits are entered, the cursor may then jump into a different field assuming it is a house number. This is, furthermore, complicated by the fact that addresses may contain different data. Some may require a floor, a campus, or a suite, or for instance in Puerto Rico, there are districts which need to be specified.

Various nervous conversations could be observed among the small group of developers working on this. Eventually, they shared their uncertainty by talking to the senior developers, PN and WW, to explain that the system process did not seem to work as expected. WW and PN took some time to sit down with DV and the other developers to hear their concerns. It took DV and the others a few attempts to explain what the problems was, i.e. to break through the false certainty PN and WW had. They attempted this by providing contradictory evidence to challenge PN and WW’s mental representations.

Once the uncertainty was established, PN and WW took this away to consider how best to approach it. Based on the conversations and e-mails with DV and the team, it then became clear that rather than being a simple process, this was in fact complicated. TK, for example, explained on one of the whiteboards in the open plan office that the addresses are actually much more complicated, though the original spec of entering a post code was very simple. TK said “well, it’s not that straight forward” and talked DV and the team through an example, with PN and WW watching as well. The developers team around DV tried to
implement this piece of work based on the requirements which caused a lot of errors to occur. So bit by bit all these complexities were uncovered each time an error was made.

While PN and WW understood at some point that there was an unknown, they were not able to grasp the full extent of this, to reduce it to a known unknown and known known eventually. As more and more errors were discovered, they eventually called a meeting with TM to discuss this issue, particularly the project impact. Based on learnings from previous failures they agreed to take more time to explore the issue. Effectively the progress of this work package was slowed down to provide the time to cope with the uncertainty by first fully establishing the extent of it, and then devising an approach to break it down and address it.

PN and WW agreed to stay close to this topic to support DV and his colleagues. They tried to find some experts from the legacy systems, and from the business, as well as documentation, to try and understand how it would need to work. This search for information, involvement of other disciplines and colleagues who may be able to provide more information and more adequate concepts, and additional synchronization helped to initially identify where the mental representations of the topic were incomplete for the spec team who detailed this piece of work, and for the developers team who were working on it. This then allowed establishing and reducing information gaps, i.e. the uncertainty, of what originally appeared to be a simple problem. The slowing down also provided the time to break down the complexities into smaller parts to reduce the uncertainty stemming from this complexity. It allowed probing the information and exploring it to understand how to build the most adequate mental representation through trial and errors, testing, consulting and talking through with business experts to allow for more information to be collated by involving more people, etc. Eventually these unknown unknowns were reduced and an adequate solution was developed.

Iterative uncertainty management

Another, coping mechanism was identified later into the observation. It emerged from a failed management of unknown unknowns due to complexity. Due to this failure the extent of uncertainty was eventually acknowledged, and led to this coping mechanism of a switch from upfront to iterative management of unknown unknowns from complexity.
The approach moved away from detailed upfront planning and design of a work package followed by its implementation, to iterative planning, implementation, and end user use of the solution, then moving on to improve details of that solution. This was a learning for the project team in order to cope with the various uncertainties and their interactions in iterative levels of detail. An example of this coping mechanism is detailed in the following paragraphs, related to managing the packing of mail items.

In Asia the programme team observed that nylon sacks were closed, and a label attached, detailing where the sack was to go and how many mail items it contained. For example, there may be a sack for mail from Singapore to Germany, containing letters for express delivery. The business owner CY explained that Management Information (MI) was required, comprising a detailed report how many sacks there are at the end of the day, and how many pieces these contain. The programme team had to develop a solution to collate this data. One option to tackle this type of task was to count all sacks and number of pieces per sack at the end of the day after they have been loaded on the trucks. The developers thought a smarter solution would be for the computer to count the items while the sacks are being filled, and that the system has a digital barrier built in, advising when the sack weighs more than 50kg at which point it prints a label with the requested information, which the handler attaches to the sack. The IT developers designed such a test system, and then asked the business to try it out in a virtual facility which had been set up as a test bed.

The business tried this solution for two days and found there was a fundamental mismatch between how the system was designed, and what in practice had to be supported. This mismatch came about due to unclarified unknown unknowns from all the complexities that feed into the packaging process. The business was unable to convey a detailed and comprehensive explanation of the processes they wanted the system to support, as they did not hold the L4 concepts to understand what is technologically feasible and sensible. The developers did not hold the L4 business concepts to help understand all the business needs and complexities of the work, and they did not have sufficient L1 exposure to the process. Sufficient information could subsequently created gaps in the developers’ L2 and L3 reorientations to help design the system.

Though the system did not work at all, instead of requesting a change, the end-users tweaked this system within the given limitations, and used it, but in a way that was different
to that intended by the IT developers. This was possible because the system was relatively flexible, and did not prescribe the work steps in too much detail. The system was then iteratively adapted to increasingly support the business needs more precisely.

It became evident through interviews with WW that he and some of the programme managers knew that when a system is thought through in too much detail, then this flexible wiggle room to deal with unforeseen uncertainty effects from complexity is lost, and the entire system has to be changed. So WW argued it is sometimes better to develop a system which is not perfect.

The programme and the IT teams fundamentally changed their stakeholder interaction as a result of this experience, away from designing and implementing immediate perfectionism and fully detailed and controlled systems upfront, to starting off with more manual steps and basic systems, then adding on more automated and detailed functionality in iterative design and release cycles after project completion, realizing that time to market was more important than a fully integrated solution. This approach gives all involved more time and opportunity to get a clearer L2 and L3 understanding, and develop more of each other’s concepts. This approach shows more tolerance for uncertainty, and allows for resolving the complexities in an iterative manner, rather than following the traditional approach of attempting controlling them from the start.

Another uncertainty coping finding emerged from this episode, related to the fact that all involved parties regularly went back to the systems which existed, and the new systems which were programmed, to see how the system would behave, and which steps colleagues in the facilities had to do. These observations brought forth another valuable finding in that a regular L1 check of an uncertainty topic, or a regular reduction of the topic to L1 for example in the form of a software implementation which is used in a facility, helped identify uncertainties and work on their resolution more efficiently and effectively. This approach also reduces the possibility of false certainty, due to more regular L1 checks than in other work packages where people could remain for too long on the higher levels. It also helped to regularly validate L2 and L3 representations by checking these against L1. This finding was similarly established from the example for slowing down project progress (cf. 7.3.2) where the developers reviewed and tried different options with the business. In other observed cases, such as the address validation software or the routing issues, people
worked and interacted on higher information layers for much longer periods, with no opportunity for validation and checking of representations by going back to the L1 checks.

WW, DS, PN, and MH, found that the programme took valuable learnings from this piece of work, and from various others, such as the Oracle address issue, to change the approach to unknown unknowns which stem from complexity. Instead of running a predetermined workshop with the business and predicting that three days will be set aside to develop a solution, and then implement, it was accepted that sometimes no best solution may initially be found. WW said:

“This is about acknowledging that there are so many unknowns that it cannot be managed in one go. So better to start small, because we have to acknowledge that we cannot grasp the entire problem upfront, instead of developing a more elegant, intricate and complicated automated solution in advance, which carries more risk that it cannot support the situation”

So the sack problem was initially solved in a more manual and simple manner, where all sacks were scanned by hand with a barcode scanner. Furthermore, as a general approach going forward, the head architect MH suggested the production of rough specs documenting basic assumptions around the “essential business flow” and producing a prototype or a basic version of the final application which could then be finessed and aesthetically improved later. This prototype or first core piece should be used, and then further work done to complete it. This approach allows the project to grow more organically as the available information, and the representations of this information, grow for all involved. This observed process was about accepting uncertainty, and introducing more flexibility to cope with it. This acceptance and provision of space for uncertainty to unfold was found to be one of the most advanced coping mechanisms in NX, however, it took the programme team various failures to arrive at this approach.

7.3.4 Summary of research question 3

In response to research question three, various aware and unaware coping mechanisms could be identified. The findings could be grouped into three themes: Increasing transparency in order to increase information and uncertainty awareness; adapting project
structures to improve information exchange; and changing the pace of the project to allow for uncertainty exploration or for more information to become available.

The increase of informational transparency was achieved through recurring topics and queries to identify additional information. The coping mechanism of forced resolution of topics was mostly related to unacknowledged uncertainty, so that uncertainty was not properly explored and resolution tactics ineffective. This tended to result in a reduction of transparency. Raising issues was an aware coping mechanism, in an attempt to increase transparency. However, only the individuals raising the issues showed awareness, which demonstrated that isolated awareness of uncertainty is not sufficient until key staff who own a topic also acknowledge the uncertainty. While this coping mechanism initially was not very successful, it helped acknowledge uncertainty across a wider audience and initiated active searching for more information once uncertainty symptoms started to increase.

Uncertainty coping mechanisms around project information structures were identified in the form of changes to the structure to satisfy information needs. This helped increase synchronization opportunities, to establish informational relevance and validity, and increase transparency. Where official project structures did not provide sufficient opportunity for synchronization, informal structures developed in the form of informal chats, gossip, and asking around. This increased transparency locally, however lacked a systematic approach across a wider and specific audience, so that as a result information was fragmented, reducing transparency. Hence unknown knowns were not addressed systematically. Also, known unknowns were at times reduced among people who were part of an informal information route, but insufficiently resolved locally into false certainty, as aspects covered by other project parties were not considered.

Project information pace was another theme identified which various coping mechanisms relate to, such as a changes in meeting frequency, which increased the synchronization pace and allowed establishing relevant and valid information items faster to increase transparency. Postponing was identified as another pace-related coping mechanism, which allowed for new information or developments outside the project to develop into the project’s information space, and reduce uncertainty. Particularly in cases where other coping mechanisms had failed, slowing down the project pace was identified as a successful strategy by providing time to involve other teams and colleagues in the search for more information or more adequate
L4 concepts. It was also established that slowing down pace provided the time to break
down complexities to reduce unknown unknowns from complexity.

7.4 Conclusion – Conceptual Inability to Grasp Uncertainty

The findings from the observation conducted within the NX programme at DHL Global
Mail were detailed in this chapter. These findings provided answers to research questions 1
to 3, on the indicators, identification, and coping mechanisms for uncertainty and false
certainty.

Eight indicators, some of which with more detailed symptoms, could be identified from the
observation and analysis of the observation data and documentary evidence. Some of these
symptoms, such as surprise, irritation, frustration, conflict, or avoidance become directly
apparent in interactions with project members. Other indicators, such as inadequate task
completion and thin documentations relate to outputs. Further indicators, such as delays,
failure, increased volume of change requests, and stakeholder alienation are broader
symptoms which become apparent with some delay. It could be argued that these only
appear once effects of unmanaged uncertainty have struck, however developing an
awareness of these allows addressing them earlier with a greater chance of proactively
managing the related uncertainties. Overall, it could be established that these symptoms, if
known, can facilitate an earlier realization and acknowledgement of uncertainties, so that
these are more likely to be managed to the project’s advantage. It was, however, not
possible to link one symptom clearly to a particular type of uncertainty or false certainty. It
is suggested that unknown knowns seem to manifest in the same manner as known
unknowns for project members, and that no indicators for unknown unknowns out of the
blue could be established. A surprisingly great number of instances relating to false
certainty and unknown knowns could be identified. The range of indicators presented in
this research should help acknowledge and subsequently reduce these earlier.

In response to research question two, six ways of identifying uncertainty and false certainty
were observed in the NX projects. During this analysis three key themes transpired, in the
form of informational validity, informational relevance, and synchronization. The identifiers are roughly grouped around these themes, though some of these were found to touch other themes as well.

A change in the presentation of informational detail to either a summary or a focus on a specific event facilitated the validation of information with regard to its soundness and integrity, and hence freedom of uncertainty or false certainty, so as to ensure a solid base for further distribution and use of this information. In a similar manner, the change of context of information provided a different focus in which existing information had to be re-established. This again facilitated validation through checking consistency in a different context.

Change of information representation and relating information to a specific purpose facilitated establishing informational relevance by offering a clear focus to check the information and uncertainties. Often such identification was key to handling these uncertainties, because false certainty of individuals, or unknown knowns, could be eliminated by providing the missing information to close the information gap or by challenging the false certainties with a view of eliminating them. Therefore identification of false certainties and unknown knowns was in various instances found to be equal to reducing them.

The third theme of synchronization was observed around sets of findings relating to opportunity for information exposure and co-operative reviews. Both of these indicators are concerned with sharing information, often in a multidisciplinary context, which facilitates probing of project members’ information representations and concepts. Hence, synchronization was found to facilitate the establishment of validity and relevance.

Research question three could be answered with the findings of eight coping mechanisms. From these findings, a further three information concepts could be generalised, in the form of informational transparency, project information structure, and project information pace. Informational transparency appeared to be a gauge for the levels of uncertainty and false certainty present in projects. Coping mechanisms of recurring queries and topics and raising issues comprised attempts for increasing transparency by increasing visibility of
uncertainties or false certainties within the project so that these could be addressed. Forced resolution of uncertainty was a coping mechanism that reduced transparency, and often symptoms of the unresolved uncertainty impacted the project further, until the topic had to be addressed again.

The theme of synchronization appeared to be closely related to transparency, as the frequency and intensity of synchronization appeared to relate to the degree of transparency. Depending how systematic synchronization took place, transparency could be local or across the project on different topics.

On the theme of information structure, it is suggested that project structures determine the opportunity for synchronization, and hence impact on transparency, as they determine where information flows, and to what extent, and which project parties synchronize at what intensity depending how closely they are working together. Findings on project structure related on the one hand to the impact of official project structures, but also to the establishing of informal structures to compensate for the inadequacy of official structures for satisfying information needs of project members. This had the advantage of organically growing information structures based on information needs, but at the risk of increasing unknown knowns through creating local transparency without considering a systematic synchronization and increase of transparency across the programme.

Finally, the informational theme of project pace relates to a range of findings involving the speed and rhythm of information processing, adapted to suit the uncertainty conditions of the observed projects. Such coping mechanisms related to increasing the interaction frequency to speed up the synchronization pace in order to deal with uncertainty; postponing a topic until more information was available; and slowing down progress to allow for more synchronization to take place in order to challenge mental representations and reduce uncertainty. Relating to the theme of pace, a fundamentally different coping mechanism was identified, which altered the rhythm of uncertainty management by working through the complexity which is creating unknown unknowns in iterative cycles, initially providing a simple and still largely manual and flexible solution, which is iteratively refined and automated as the complexity is, at the same time, step by step broken down.
A range of insights on project uncertainty dynamics could be gained from the observations. It was established that a great part of uncertainty in the observed projects constitute unknown knowns, which may be managed through more effective synchronisation and project structures. False certainty was identified as one of the most frequent uncertainty types encountered. Observations yielded that it appears to arise where the process of abstracting information from L1 to L4 is flawed from each layer to the next, creating increasing discrepancy between different parties, particularly where different L4 concepts are used, and insufficient challenging and correcting of the L2, and L3 representations and the L4 concepts is taking place. The identification of false certainty and unknown knowns appears to form a significant step to uncertainty management in projects. The key to managing these appears to be acknowledging them, so that information gaps can then be closed. Addressing these more effectively then provides more capacity to focus on known unknowns, unknown unknowns from complexity, and the effects of unknown unknowns out of the blue. Unknown unknowns out of the blue cannot be foreseen, however it appears if the structures to address uncertainty through synchronization, validation, and relevance checks are optimised, and uncertainty is identified and brought to awareness more efficiently, their impacts may be addressed more effectively and more confidently, reducing any negative impacts to the project. Identified unknown unknowns from complexity appeared to be successfully managed through the coping mechanism of breaking the topic down into iterations, rather than aiming to manage these upfront end-to-end.

In summary the findings on uncertainty dynamics led to the insight that uncertainty is often unaware and unacknowledged, remaining latent as negative impacts on the project increase. It is concluded that uncertainty in projects may be managed more efficiently if awareness could be developed faster. However, the findings highlight that the traditional paradigm does not provide adequate concepts to help acknowledge and handle project uncertainty. Many of the observed coping mechanisms constituted unaware responses to uncertainty symptoms, and where aware responses were observed, these could not be formulated under traditional lingo, methods, or tools. This seems to be rooted in the fact that the traditional PM framework mainly provides managers with the mindset to understand a project as a hard one, no matter if the project is soft, or exhibits (temporary) soft aspects. Soft project uncertainty (unknown unknowns from complexity; large amounts of known unknowns; false certainty, cf. 2.5) was hence often found to be forced into hard-
paradigmatic project structures and methods. The conceptual and methodological standardizations imposed by the traditional PM methodology provided no room to explore uncertainty.

The following sections detail a number of traditional hard-paradigmatic concepts which appear to contribute to the inability to acknowledge uncertainty, and their implications:

The imposed method of upfront planning forces inadequate reduction or ignorance of uncertainty

A discrepancy between the official planning required for the project sponsor and clients, and the actual state of the NX core project could be observed, discussed in 7.1.5. Official plans were made at relatively infrequent intervals, and were therefore out of date most of the time. Project planning, in reality, was mostly communicated verbally to project staff with short time horizons, as the impacts of uncertainty did not allow for longer term plans. Most work hence appeared to be organized in an ad hoc manner. The traditional requirement of upfront planning appeared to force the project manager to baseline plans at an early stage in the project where there is still a lot of uncertainty present. This yielded the plans unrealistic very quickly, and led to disregarded uncertainty or assumed as false certainty in order to yield to the pressures of presenting a plan. These points expand the general critique on traditional project planning in the literature (cf. 3.1.2), and demonstrate the inadequacy of decoupling planning from implementation and reducing the opportunity to thoroughly identify and manage fundamental uncertainties.

Inability to acknowledge fundamental uncertainties due to standardization of reporting

The NX program was observed to employ standardized reporting, for example for progress reporting, and for the description and tracking of risks, detailing the impact, mitigating actions, owners, time frame, progress, and RAG status. This traditional reporting reduced the opportunity for identifying uncertainties which did not fit into these recording standards (e.g. unknown unknowns from complexity). As discussed under 7.2.3, the standardized and repetitive presentation of progress and risks, for example in status meetings, also caused project members to become desensitized to uncertainty considerations. Such standardization reduces the opportunity to thoroughly identify, communicate, and manage any uncertainty beyond traditional risks and issues.
Implementation to a pre-determined schedule and project life cycle leaves no room to consider uncertainty

The observation findings in section 7.3.3 established that project progress is traditionally forced by the need to complete tasks against a tight schedule, and by imposed PLC phases. This standardized approach did not allow for considering uncertainty, for example by offering the option to flexibly adapt progress where there is too much uncertainty to proceed with the planned tasks. It was, hence proceeded despite information gaps, which reduced the soundness of the informational foundation for related tasks. This led to inadequate solutions for the end users, as discussed for the sac scanning problem. It also resulted in delays, as for example discussed relating to the ad-hoc monitoring problem. These examples provide testament to the fact that the pressures of progressing implementation reduce the opportunity to manage uncertainty adequately, resulting in inadequate solutions and delays.

Lack of uncertainty awareness and lack of feedback and review mechanisms

There appear to be no triggers or mechanisms under the traditional paradigm that prompt project members to consider uncertainty throughout the project, as the traditional principles are built for hard project environments with limited amounts of known unknowns (cf. 2.5). Project members who tried to bring uncertainty related concerns to others’ attention were observed to be ignored because concerns were brought up in what was considered to be inadequate forums (cf. 7.3.1), for lack of adequate ones. The roots of conflicts, as well as their thorough resolution, were avoided as there was no feedback mechanism that facilitated considering these and exploring their underlying uncertainties (cf. 7.1.2). The project brief documentation discussed under 7.1.4 was rather concise. However, this was neither an indicator for the authors, nor the readers, that there are uncertainties prevailing, as the traditional progress driven mind set does not offer triggers or feedback mechanisms to consider the quality of documentation or other intermediate outputs with regard to identification of uncertainty. In summary, the absence of forums and feedback mechanisms to develop awareness and review uncertainty under the traditional paradigm, led to much unidentified uncertainty remaining latent and being dragged on and accumulated throughout the observed projects. As a side effect it created disruptive and frustrating occurrences, such as discussions of recurring themes, and conflict. The roots for these never seemed to be clearly understood by the project team.
Organisational fragmentation of information reduced opportunity to identify uncertainty

Traditional, steeply structured silo hierarchies were observed to reduce the opportunity of project members to synchronize, due to the traditional focus of top-down information flows and delegation of isolated tasks. Therefore, identifying uncertainties which span across different project disciplines or workstreams specialisms, or were complex in nature was complicated. Where subject matter experts or different specialist groups did not have the opportunity to interact, or interact at the right time, uncertainty was frequently not recognized because information was not passed on or sufficiently disseminated. Furthermore the opportunity of using people coming from a different perspective to challenge views and thereby uncertainty could not exploited either (cf. 7.1.1 and 7.2.3). If the selection of people attending meetings was inappropriate to the information requirements, or those whom the information was relevant to were not informed, uncertainty and false certainty were created (cf. 7.2.3).

Task breakdowns reduce the opportunity to establish uncertainty

Section 7.1.3 discusses instances where tasks are not completed adequately, and the uncertainty preventing adequate completion is not identified. This is due to the fact that the decompositionalist approach to task breakdowns and allocation isolates tasks, and thereby defragments the informational context. This isolation provides insufficient context or relation to the greater purpose or goal the task contributes to, to be able to validate the task information against. This reduces the opportunity to identify and resolve uncertainty. In contrast, the observation findings under 7.2.1 establish that where topics are related to a particular context, or are embedded into an end-to-end understanding of a piece of work, uncertainty is more likely to become apparent. The same appears to take place if task progress is reviewed related to a specific purpose or project goal (cf. 7.2.2). However, the observations showed that such mechanisms did not take place consciously, and happened rarely, as tasks were mainly broken down, rather than integrated to validate them, including their uncertainty state.

The points concluded above reveal shortcomings of the traditional paradigm in the form of a lack of thoroughness and precision when resolving uncertainty. Where it was assumed that uncertainty was resolved after action had been taken, but this was not the case because it had not been addressed adequately, it prevailed and, moreover, disappeared from the
radar or led to recurring issues (cf. 7.1.2 and 7.3.1). Furthermore, in various instances the traditional mind sets and PM tools created false certainty when insufficient information was available to use these methods with, for example, when devising project plans (cf. 7.1.5) or specifications and design documents (cf. 7.1.1). Inevitably the uncertainty symptoms of these topics would recur and cause further disruption.

The six information themes established in this chapter can provide insights into why the above listed issues, resulting from the traditional paradigm, do not facilitate an understanding of uncertainty identification and management:

- The implementation focused traditional mind-set follows a pre-determined schedule and project life-cycle. It does not allow for uncertainty to be considered and managed throughout the project, as it does not offer the adaptation of the project’s information pace to be able to accommodate changing information states, i.e. slow down progress or adapt the frequency of information consolidation cycles for instance, when insufficient information is available to proceed at speed. The traditional paradigm does not provide any gauge to assess the information quality and quantity that would then allow adapting pace accordingly, as it is based on thinking in tasks.

- The lack of uncertainty feed-back and review mechanisms implies that there is less opportunity to establish validity of the information that is being worked with. This increases the likelihood of more unsound information being relied on in the project. It also means there is less clarity which information and which uncertainty is relevant. This inadequate management and resolution of uncertainty entails a reduction of transparency across the project, because information is not validated or checked for relevance, and symptoms of latent uncertainty may distort further work.

- Organisational fragmentation into steeply structured silos reduces the chance for identifying uncertainty, as such structures provide less opportunities to synchronize in order to validate information. The task-decompositionalist view tents to be facilitated by a structure that has a focus on bottom-up information flows to report progress and required decisions. Again, there is no gage for an adaptation of the
organizational structure based on the uncertainty state of a project and hence information needs of its members due to the task-focus.

- Decomposing tasks to be implemented by different individuals and sub-groups provide less context to check understanding against, i.e. to validate the information L2 and L3 correctness of understanding of a task, which reduces the opportunity to identify false certainty. This breakdown also reduces the likelihood of identifying uncertainty that spans across tasks and topics. This is based on the traditional view that completing the tasks will successfully complete the entire project.

The conclusions outlined above confirmed the tendency established in the literature review, that traditional methods are conceptually and practically limiting the scope for handling the entire spectrum of uncertainty beyond risk. This is due to the fact that they provide a highly structured, normative, and decompositionalist methodology which is task-focused, rather than information-focused. The traditional paradigm therefore does not offer a view on the uncertainty state of the project.

Nevertheless, from the interviews and the observation it became apparent that some project managers still appeared to have an intuitive sense of uncertainty. These individuals were observed to apply a number of management strategies outside the traditional methods to help them deal with uncertainty, such as increasing topical overlaps, restructuring project members, or adapting progress speeds (cf. 7.3.3 and 7.3.2). These approaches did not form part of an official methodology; they merely appeared to be practical and individual reactions, which confirms the literature and observations that the traditional paradigm appears not to facilitate a conscious consideration of uncertainty, and does not support the development of suitable new uncertainty management approaches or to adapt to the uncertainty state of the project.

From the findings detailed in this chapter it can be concluded that the structure of a project determines where information flows and in what units information will be processed. The PM methods and tools determine the processing and interaction structures and feedback loops between the different substructures, and which dictate the form of the progress patterns which set the pace for information processing. Since traditional PM thinking, as
well as its tools and methods, are task-based, the methodology is geared towards setting up structures, methods and tools that optimize task completion. Therefore, structuring of information flows and processing tends to happen indirectly and unconsciously, as a side effect of managing the project tasks, and therefore uncertainty is inadequately considered. Because information processing is not the focus of traditional PM thinking, there is also little awareness as to how the different structures and pace settings and changes in parameters, such as a switch of PLC, and delayed project planning in the sub-teams impact information flows and processing, and, hence, uncertainty management (i.e. whether they add uncertainty, help to recognize or reduce uncertainty, falsely reduce uncertainty in to certainty, overlook uncertainty, etc.). In other words: traditional PM does not have an adequate recognition of uncertainty, as its current task-based paradigm is not able to model uncertainty adequately. Traditional methods are based on certainties, e.g. for upfront planning and progress control against a plan. In the terminology of critical realism it may be argued that the observable events and the socially constructed interpretations of them do not adequately match the underlying structures of uncertainty reality.

Because of this lack of understanding, or inadequate representation of the real world mechanisms and the events that these cause, the cause-effect relationships which can be explained from an information-paradigmatic point of view often appear random from a traditional PM point of view and this causes disruptions and problems to projects which cannot be solved optimally, in the same way that the existence, development, and mitigation of uncertainty cannot be modeled, and hence not optimally tackled. From this point of view the occurrence of informational deficiencies can seem random, thereby adding uncertainty, and the responses can appear re-active, random and chaotic.

The findings detailed above confirm that more, and more precise uncertainty insights can be developed under the information paradigm than previous research is able to establish under different paradigmatic lenses. Therefore research question 4 in the following chapter discusses the six information themes identified in this study, together with the information layer model, in an attempt to provide a more suitable conceptual foundation for an understanding of uncertainty dynamics in projects under the information-based paradigm.
Chapter 8 - Discussion of Findings and Conclusions

8.0 Introduction

The literature review critiqued the traditional views on project planning, project goals, and project structures with regard to their applicability to capture and manage the uncertainty conditions prevailing in novel soft projects (cf. 3.1). It was, furthermore, established, that the concepts offered by the traditional functionalist deconstructive paradigm are increasingly challenged with regard to their ability to facilitate the understanding and theoretical integration of soft projects and their uncertainty conditions (cf. 3.2). Findings presented in the previous chapter supported this, establishing that project members working under the traditional paradigm often exhibit conceptual problems with uncertainty. In response to this, the final research question 4 proposes how traditional PM concepts may be re-framed under the information paradigm to offer a more suitable conceptual framework for the understanding of uncertainty dynamics in projects. The response to research question 4 is based on the six information themes identified in the observation findings (cf. chapter 7). Following the discussion of research question 4, this chapter examines the study’s contribution to knowledge. Finally, different strands for further work are suggested.
8.1 Research Question 4 – Discussion of Findings

How can traditional task-based PM concepts be re-framed under the information paradigm to provide a more accurate conceptual framework for the understanding of uncertainty dynamics in projects?

The findings detailed in the previous chapter demonstrated the merits of the information layer model in terms of understanding project uncertainty dynamics, as it facilitates a deeper view into their causations than the traditional task-based paradigm. Observed lack of conceptual support for uncertainty management in the traditional paradigm provides an impetus to look for a more adequate conceptual framework, which can better represent the uncertainty state of projects and provide the basis for more adequate management methods and tools. The novel information themes identified in chapter 7 have shown promise for a contribution towards a more adequate epistemological and ontological foundation for the discipline, particularly with regard to the integration of soft projects. These concepts are hence applied for the construction of a more suitable conceptual framework for the understanding and management of project uncertainty dynamics under the information paradigm.

8.1.1 Re-definition of projects under the information paradigm

By replacing the task as the elementary concept of the traditional paradigm with information, a project can be reinterpreted under the information paradigm as a temporary information management formation, which has the aim of producing new information on either one or more of the four information layers, in the form of a new product or service. This takes place by adding, modifying, transforming and regrouping information on several or all of the four information layers. This understanding of a project makes PM the support and optimisation function of these information dynamics. By focusing on information management, these definitions naturally include information gaps, i.e. uncertainty.

These definitions are founded in the observation findings, which exposed this information management formation in the form of the organisational information structure and the
information pace. Adding, modifying, transforming, and re-grouping information on the four information layers could be indirectly established through the findings relating to synchronization, transparency, validation, and relevance.

In the following, the six information themes and their interactions are discussed in view of the information-based project definition provided here, with a view to integrate them into a conceptual framework for PM.

8.1.2 Informational relevance and validity in the project information sphere

To integrate the information layer model and the information themes identified in chapter 7 into an overarching framework, all information relating to the project is summarized under the term project information sphere. This abstract concept is introduced as a facilitating element, which comprises all information, known or unknown (certain or uncertain), that is relevant to the project, including organizational, as well as content-related information. This may be hidden information, information related to the project environment, sponsor's preconceptions and/or visions of the project, and so forth.

In keeping with the information layer model, the information sphere relates to all four layers of information, from tangible L1 artifacts, such as plans, designs, and implementations, to the L4 concepts used to anchor an understanding of the project.

The interactions between the information layers in the project sphere and the uncertainty and false certainty emerging in its journey through the layers are visualized in Figure 6. This figure highlights how information in the sphere travels through the layers, and is either correctly or incorrectly represented. The uncertainty and false certainty consequences of incorrect abstraction are detailed for each step of abstraction from one layer to the next. For instance, there may be information units in the physical world (L1), which are relevant for project success, but there are no concepts this information could be anchored to on L4 (see L1: description). They are hence not represented on L2 and L3.
The observations demonstrated that information units in the project sphere were found to be:

a) Relevant and acknowledged, indicating certainty;

b) Mistakenly believed to be relevant, indicating false certainty;

c) Relevant but not acknowledged, or considered irrelevant, indicating uncertainty on L2-4 (cf. 7.3.1 detailing findings on recurring topics and raising questions).

Relating to points b) and c) above, the observation findings established that mechanisms, such as relating information to a particular purpose or context facilitated establishing true relevance (cf. 7.2.2). End user requirements, technical or infrastructural constraints, competitor analyses, or policies such as, budget, or deadlines were found to shape on L3 the information which is actively sought in the physical world (L1) (cf. 7.2.2). Hence, these factors determine which information and uncertainties lie within the boundaries of the information sphere and must be managed in order to successfully complete the project, and which are noncritical to project success, and therefore can be disregarded. In other words, these benchmarks provide incremental relevance yardsticks as the project develops which shape the project information sphere and determine its boundaries, even if the overall
project end goals are not clear enough to guide end-to-end information management. These dynamics become obvious with these information-based concepts, but are inconceivable under the traditional paradigm. The intermediate relevance benchmarks are hence under-used in the traditional paradigm which is focused on end deliverables, and therefore requires clear project goals from the project outset.

These relevance benchmarks are likely to be different for project members and stakeholders with different L4 concepts. For instance, in the observations it became obvious that the developers used benchmarks relating to technical limitations, whereas the business staff related to logistics benchmarks. This cross-disciplinarity is likely to increase information quality within the sphere, as this means validity and relevance can be checked from different standpoints (cf. 7.2.3). This also creates a challenge for convergent information management, which is addressed in the following sections discussing project information synchronization, transparency, structure and pace.

Apart from establishing relevance, the observation findings (cf. 7.2.1) also established that validation of information in the project information sphere is an essential and fundamental mechanism to ensure quality and accuracy of the project information, in view of managing uncertainty. The term ‘validation’ has been chosen to subsume observed actions which related to ensuring that information in various forms, such as requirements and specifications, problem statements, solutions, input from stakeholders or the project environment and decisions were accurate and free of uncertainty or false certainty, or at least highlighting uncertainty so that it can be acknowledged and actively managed.

The observation findings showed that validation was achieved through synchronising available information with project members, particularly across different project disciplines (cf. 7.2.3). This put the information in different contexts which helped uncover inconsistencies. Other observed mechanisms to establish validation were making summaries (cf. 7.2.1); abstracting it or transferring it into a different quality (cf. 7.2.2); and reflecting on it and relating it to a specific purpose (cf. 7.2.2). In some cases management guided the process of validation by helping to structure the information and facilitate reflection (cf. 7.1.3).
Where validation of information did not take place or was not done correctly, information remained distorted, biased or incomplete, so that uncertainty and false certainty were not discovered, or not acknowledged to their full extent. The observations show that this may have been the case in meetings where information was not completely drawn out and abstracted to get to the bottom of issues. While the traditional body of knowledge acknowledges the importance of meetings for information management (cf. 2.3.5), their purpose with regard to uncertainty management appears to be insufficiently recognized. Validation was also insufficiently achieved where project members were left out who would have been able to contribute additional information, so that the information basis for validation was incomplete (cf. 7.3.1).

Where further information processing was based on such invalidated information, the problems widened, often resulting in substantial inconsistencies, faulty, incomplete or inefficient implementations with regard to both, functionality and stakeholder expectations, and political and personal power struggles, with consequent conflicts and frustrations (cf. 7.1.1, 7.1.2, 7.1.3, 7.1.7, 7.1.8).

While NX managers were in the position to gain, maintain, and re-distribute an informational overview by gathering information in virtually all areas of a project (cf. 7.2.3), information would, due to time restrictions, sometimes have to be presented to them at greater time intervals and in a more condensed way. NX observations showed that this typically took place in the form of status meetings or textual executive summaries or report overviews. Due to greater intervals and summarized reporting, validations were often delayed. Compressed and potentially outdated information provided less opportunity for management to validate information correctly and to identify uncertainty. Furthermore, presenting condensed information required making a selection on what information to present to the management and how. This selection, summarising and time-delayed process had the potential to introduce errors, bias and distortion due to misrepresentation, omission of critical issues, etc. (cf. 7.2.3).

In summary, it can be deduced that validation establishes the quality of information within the project information sphere, as it eliminates uncertainty and false certainty, or brings to light uncertainties in cases where validation cannot be conducted so that these can be managed. Informational relevance facilitates guiding information management to establish
the information and uncertainty which is purposeful for the project, and distinguishing it from non purposeful information units by relating it to incremental benchmarks against which information can be checked. Both concepts together ensure the quality and focus of the information within the project information sphere.

The project information sphere outlined in the above paragraphs hosts the information held about the project and creates a space for those information elements which are unknown. It delineates the information elements which are not relevant by making it clear that they lie outside the sphere. In creating a space for unknown information units, the information sphere integrates uncertainty into the comprehension and awareness of a project, rather than treating it as a disconnected factor which is dealt with separately through PRM. By containing unknown elements which are relevant to the project’s information processing, the concept of the information sphere provides much more visibility and awareness of what is actually unknown. Thus, it provides a better vantage point to manage uncertainty in projects.

8.1.3 Synchronization volatility and its effects on informational transparency

The observations revealed that over time project members experienced different states of awareness of the level of relevance and validity of the information available within the project. As discussed above (cf. 8.1.2), this degree of established relevance and awareness was related to the level of awareness of the uncertainty prevailing in projects. The gauge for the degree of clarity of informational relevance and validity and consequently for the level of acknowledgement of uncertainties was summarized under the concept of informational transparency.

Symptoms for low transparency were identified in the observation findings, for instance in the form of surprise, irritation, frustration, thin documentation, recurring topics, conflict, delays, failure, change requests, and raising issues. This led to loss of drive, focus, and efficiency, stakeholder alienation and duplicated processing efforts of project members as topics and queries recurred, tasks or tackling certain topics were postponed, or proceedings were slowed down (cf. chapter 7). The observation findings established that this was due
to fragmented information across the project. There was limited opportunity to obtain information needed to uncover which information was falsely assumed to be relevant, and lack of opportunity to challenge and check the information held on L2 - L4 for validity. Therefore uncertainties and false certainties could remain unacknowledged.

In contrast, in other instances there was full awareness of which topics needed to be addressed and by whom, with a clear view of the project’s uncertainties, which led to efficient and effective progress (cf. 7.2.1, 7.2.3, 7.3.3). This was due to the fact that people worked with a shared information base, which was achieved as the opportunity to obtain information or check one’s understanding was adequately provided.

These extremes highlight how the opportunities to challenge information for their relevance and validity leads to fluctuating degrees of transparency. Synchronization provides access to information. The synchronization process provides the opportunity to establish validity and relevance, which builds an awareness of information gaps other project members have. This increases the soundness and boundaries of the overall project information sphere, and hence transparency.

Where sufficient information and challenging of information was not possible due to inadequate synchronization opportunity, transparency was decreased. It can hence be concluded that in a state of greater transparency, project members are more aware of which information is irrelevant, they work with more valid information, and are aware of information gaps, i.e. uncertainties and vice versa. Thus, less unknown knowns and false uncertainties are likely to prevail in a state of high transparency of the project information sphere and vice versa.

Achieving optimal synchronization was found to be challenging. In NX dynamics of synchronization and its effects to project transparency could be observed as follows: Project members co-operating in small groups were likely to create a shared understanding. Such shared understanding refers to a state where people hold a particular representation of information in common which is congruent in those points critical to the information processing that is based on this representation, and there is awareness of the information gaps in this understanding. The more congruent the individual representations of those crucial points and information gaps, the greater the shared understanding. While the
project members in this group may be in sync at a particular point in time, they go off to
share and progress their information with other project members, so that they become in
sync with other project members also. As this new group becomes more in sync, the
original group will become more out of sync again, potentially creating false certainty or
unknown knowns. This is complicated by the fact that there also appears to be a challenge
identifying at which point it is optimal to extend shared understanding-with other project
parties. Too early may introduce false certainty, as information is not fully established and
too little synchronization or too late may introduce unknown knowns or false certainty for
other project parties.

These findings demonstrate that as the shared understanding among a group moves on,
transparency with others is reduced. This implies a fragmenting of the previously shared
understanding of the information sphere, with a risk of creating new uncertainty and false
certainty and paralleled processing efforts. These dynamics highlight how concurrent
processing of information in the project poses the challenge of how to keep all project
members updated with new information or informational outputs as a basis for other
project members’ progress. Otherwise this could lead to redundant or divergent processing
efforts, reducing transparency, and increasing interferences from unknown knowns. While
these information dynamics may not have been explicitly clear to the NX members, the
effects of this lack of understanding posed a major challenge to the project.

The above discussion shows how volatile transparency is, and how it is impacted by the
described synchronization dynamics. This notion of informational transparency offers a
concept that directs awareness to the information state of the project. The concept of
synchronization offers an understanding how transparency and hence uncertainty
awareness can be increased. Under the traditional paradigm none of these measures are
considered.

The observations showed that the opportunity to synchronize and establish transparency
was determined by the project information structure and pace, discussed in the following
sections.
8.1.4 Project information structure to manage synchronization and transparency through constellations

From the observations emerged the theme of project information structure. Observations confirmed the literature discussion (cf. 3.1.4), in that more open project structures are more adequate under conditions of uncertainty. The observations add further explanatory value to these points, as they highlighted that flat and less formally restrained project structures with topical overlaps offered more opportunity for synchronization, and hence establishing of transparency and uncertainty identification, compared to more traditionally top-down focused project structures. Hence, flatter structures were found to be useful in a project that carried great uncertainty from complexity (cf. 7.3.2). However, other than the statements that the project structures must be flattened with increasing uncertainty, the literature did not provide insight into the underlying causes for this proposal.

The observations highlight that information structures prescribe a constellation of project members, and the informational proximities between them. Informational proximity refers to degree of topical overlap and opportunity for synchronization of project members. Observations support the insight that the further apart people or subgroups are within the constellation, i.e. the lower the proximity, the less the opportunity for synchronization. As a result more condensed information was observed to be exchanged, for example in the form of:

- Meetings in larger intervals.
- Abbreviated executive summaries.
- Telephone summaries or e-mails.
- Potentially distorted informal conversations, depending on personal L3 presentation and L4 concepts used.
- Written documentation which, in order to keep reports concise, often summarises representations of reality or force it into pre-defined templates, and may therefore be unable to sufficiently represent uncertainty concerns.
- In many cases documentation was stored in central repositories and not communicated or accessed by parties for whom the information is relevant.
Infrequent and low quantities and quality of information makes establishing relevance and validity less likely. Thus, transparency tends to be lower among project members who are further apart in the constellation, and uncertainties are less likely to be identified.

The observations pointed to the insight that with decreasing proximity project members are less likely to share common L4 concepts. Therefore, exchanging L3 and L4 type information is more time intensive and uncertainty-prone, or may not be possible at all. This was found to affect the quality of information (cf. 7.1.1, 7.1.6, 7.2.3, 7.3.2). Conversely, at closer proximities in the constellation, which provide more opportunity to synchronize, this process it is more likely to work correctly, or to help the different parties develop a valid and relevant understanding of each others’ concepts (cf. 7.3.2). Therefore, under conditions of lower proximity, i.e. project members were organizationally far apart, information was increasingly found to be reduced to the lower layers in order to be exchangeable with increasing constellational distance. During the observation, the reduction to presentations onto L2, sometimes documented on L1, became evident in the frequent use of examples, sketches, mock-ups etc. (cf. 7.2.2). This layer reduction may also take place due to time restrictions, as parties with low proximity have less common time for information exchange and processing and so conveying information of L2 quality is more concrete, therefore easier and faster to exchange and more uncertainty-proof. However, the exchange of L2 information reduces informational richness and quality, and hence the chance to identify and reduce uncertainty and false certainty. Therefore, under conditions of increased uncertainty, it was found to be more functional for project members to be able to exchange information on any of the four layers in order to preserve the consistency of the information, because transformation of information between the layers entails a quality change of the information and thereby validates it, reducing uncertainty.

From this discussion, it seems logical to deduce that projects should aim to achieve close proximity between every project member to increase the quality of information, and the opportunity to identify uncertainty. This is clearly not feasible in large projects. However, certain subgroups, who are likely to cooperate closely because they are processing related sets of information from the information sphere, may benefit from closer proximity because of the relationship between their topics. This approach was implemented in one of the NX projects, and appeared to produce better results (cf. 7.3.2). Alternatively,
compensating mechanisms for project members with low proximity were observed, for instance in the form of increased meeting frequency (cf. 7.2.3).

Information structures in the form of people constellations may be shaped more or less actively by management in order to optimize information flows and processing and be more or less volatile or permanent, depending on information availability and needs. Under the traditional paradigm, structures were found to be less actively shaped to manage information conditions, as the relation between structure and information state was not apparent. Consequently, information conditions were often suboptimal.

The analysis of the primary data (cf. 7.3.2) found that under such conditions of inadequate information availability informal information structures increasingly emerge to compensate (cf. 7.1.2), which confirms the literature, discussed in 3.1.4. These informal information flows were observed to locally increase transparency, but were likely to reduce transparency globally, as project members were not always aware how the informally established information integrates into the project information sphere, so that this information is subsequently not systematically synchronized across the entire sphere. This is due to the fact that such information flows are most likely to be covert and therefore can rarely be comprehensively validated and corrected, so that incomplete or inaccurate representations may prevail. This creates a concern regarding information distortion or bias around the use of informal channels. Primary data revealed that the more formal structures match the project information needs and, the more clearly they are communicated and maintained, the less informal constellations and information flows are likely to emerge to compensate for deficits from formal structures, ensuring that potential for distortion from this source is kept low.

While the traditional literature mentions informal information structures, few considerations regarding their emergence, effects or their management are provided (cf. 2.3.4 and 2.3.5). Considered under the information paradigm, the above discussion shows that, depending on softness of the project, it is helpful to have an awareness of how project structures can be adapted to suit the information conditions by adjusting depth, proximities and topical overlap. These change synchronization opportunities, and hence establish transparency and uncertainty awareness. This is not considered under the traditional paradigm where structures mirror topical task breakdowns and are optimised around
efficient implementation and upstream reporting rather than considering information needs. The construct of the information structure with its information constellations challenges the traditional PM method of defining an organizational structure for a project, based on resource allocation to task. Under the information paradigm the focus is shifted to how the structure enables project members to attend to and share the information in the project information sphere in the most effective manner. The concept of structure can be used to regulate where information flows, at what quality and quantity. Optimizing these information dynamics shapes how uncertainty is discovered, to what degree of precision it is shared with other project participants, and to what degree of correctness it is cooperatively represented and/or reduced.

The traditional method particularly creates problems in soft projects, where task management can provide an illusion of predictability where in reality insufficient information is available to plan reliable task structures and work packages. This initial error prone assessment is often exacerbated by setting up an organizational structure which matches these task and work package predictions, ignoring the fact that they may have been built on insufficient information, i.e. bearing unidentified or ignored uncertainty (cf. 5.2.4). This problem implies an area of tension between an organic, requirement driven development of a structure, reflecting the development of the information sphere, progress, and people’s information processing capabilities versus artificial imposed administration and its consequences for motivation and effectiveness.

The information structure addresses the actual information needs, in contrast to the imposed predefined task based organization, by offering an approach which is able to reflect, as well as cater for the conditions required for soft projects more effectively. This is due to the fact that more structural parameters can be used and considered in relation to their information flow facilitation, than task-based thinking is suitable for, such as:

| Shape of structure       | Deep or flat, wide or narrow, larger or smaller sub-groups and how these alter the opportunity for unshared information to surface depending on project softness. |

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Staffing  Relating to constellation size in terms of human resources - increased number of resources requires more maintenance of a functioning information flow structure which may introduce additional uncertainty, but may also help to reduce uncertainty within the information sphere due to more expertise.

Fluctuation rate  By exchanging project members, the information quality within the sphere may become compromised, particularly relating to unknown knowns and false certainty, if large numbers of new members are unable to build sufficient representations of the information sphere.

Topical overlap  Implying more or less opportunity for synchronization.

Structural flexibility  More static or flexible constellation adaptation to information requirements.

Awareness  Providing more or less awareness of constellation for all project members in large projects, depending on softness.

All of these factors can serve as parameters to adjust the project structure to regulate the quantity and quality of information flows, and uncertainty detection and management. This shows that the concept of the information structure with its constellation uses more dimensions than traditional organizational structures, such as matrix organization, which merely define authority and topic. Considering the project structure under the information lens can allow the unique information and uncertainty conditions of each project’s information sphere to be catered for. It ensures that people interact in a purposeful manner which is rooted in the actual information requirements and availability for completing a project, rather than imposing, often in advance, a theoretical and standardized structure which is based on a set of assumptions about the future project.

Thinking of projects in such a conceptual way may reduce the likelihood of potential problems in the form of distortions, blockages in information flows or false uncertainty detection or reduction which can cause project delays and failure.
8.1.5 Project information pace to manage synchronization and transparency over time

The observations discussed in 7.3.3 drew attention to how meetings structure progress over time in a project. Weekly status meetings were observed to determine progress intervals (cf. 7.2.3). In an observed instance of high uncertainty meeting frequency was found to increase (cf. 7.2.3). These increased meeting cycles shortened the intervals at which different project members or groups and stakeholders came together to synchronize their information representations in order to consolidate and validate their understanding. This increased frequency of synchronization hence increased the speed of information progress. These observations of how synchronization frequencies affect information progress brought about the concept of project information pace.

The theme identified as information pace appears to help describing how information management in the information sphere is organised over time. This is achieved by setting consolidation points, such as status reviews, phase gates, etc. These were shown to create an information rhythm. Between these consolidation points information progressing intervals form where the informational starting point from the previous consolidation point is built on and developed. These cycles form an information management rhythm which was observed to determine project pace.

This rhythm would apply on various project levels. High-level consolidation points set an overall rhythm for the project, for example in the form of high level milestones, and sub-rhythms were created at various lower project levels, for instance in weekly and daily cycles through various meeting or output schedules (Figure 7). The larger or more uncertainty-laden the information sphere, the more sub-rhythms were likely to exist in order to handle large amounts of information that needed to be reviewed to improve the quality and consistency of the information sphere, as well as the sharpness of its boundaries.
At the end of each interval, progress is delivered, documented and reviewed. The information rhythm thereby provides a regular means of control over the information processing progress at the end of each interval, while granting the space for considering information during the intervals.

The consolidation points at the end of an interval could take the form of board approval stages, phase gate reviews, milestone reporting, production of some form of project documentation, or producing a piece of output, such as a mock-up or a piece of code, or even daily or hourly meetings or reporting. These were observed to allow for information to be consolidated and evaluated and/or distributed among project members in some way, as a basis for further processing, which increased transparency of the information sphere. They provided the opportunity to assess how the uncertainty status within the project information sphere developed by validating information and checking project members’ representations for unknown knowns and false certainty.

The interval endpoints can influence how the pace proceeds, i.e. how it is connected to the starting points of the next interval (Figure 8). This concatenation may be more easily determined upfront for hard projects with a traditional plan and implement approach. For soft projects, it may only become clear at the end point of an interval which part of the project information sphere to work on next, i.e. prioritizing and deciding informational relevance and uncertainty to be processed, and agreeing on outcomes of the subsequent phase. Hence, the representation of information at the end point for softer projects may influence the shape of the next interval.
The observations demonstrated that in the TMS project for instance, the traditional PLC was imposed, while the actual uncertainty state of its information sphere was not acknowledged. So the forced progress through the PLC phases of planning, design and implementation proceeded without adequate information to support these. This initially led to delays and eventually to failure. (cf. 7.1.7) The concept of a more flexible pacing of the PLC to match the project’s uncertainty conditions may have helped in this example to drive the project more adequately. Depending on the softness and size of the project, the shape of the information rhythm may then be varied depending on a project’s uncertainty state in the:

- Number and placement of consolidation points and, hence, number of intervals.
- Granularity of sub-intervals.
- Quality of intended outcome agreements at the beginning of an interval (the more uncertainty, the more abstract and qualitative may be the formulation of the intended outcomes).

Within an interval two divergent information processing activities typically take place: the initial exploration of an assigned part of the information sphere, and the gathering of additional information, its processing, and subsequent reduction of this information into a solution or decision. These counter movements of expansion and reduction are bounded by the information rhythm. The shape of this rhythm can be determined by two parameters. The first relates to when an interval should start, allowing people to start
searching for information and exploring uncertainty. The second would determine when and how an interval is brought to an end, so that information can be consolidated and synchronized and the information sphere status can be re-baselined. In contrast to a traditional pre-imposed PLC principle, these considerations offer a flexible approach to managing the project pace based on uncertainty conditions. They can be adjusted depending on uncertainty status, and therefore the perceived need to synchronize and increase transparency. The decision of when the bounds of the rhythm should go wide may take place when:

- Uncertainty levels are too high to consolidate and synchronize information, and
- Short term action levels compared to uncertainty levels are clear enough so that people can go ahead to progress information and shared understanding is great enough to maintain the common purpose when people go off into their individual or subteam processing

The decision to consolidate an interval can take place when:

- Sufficient information is available (saturation) to be able to present an outcome which must be consolidated and synchronized to form the foundation for a subsequent interval, or
- New information penetrates awareness which may have the potential to impact the project’s direction or requires exploring an alternative, which must be synchronized within the project and can then be used as a base for a next interval

Such factors are not considered under the traditional PM paradigm with the PLC concept. Here, the information-based approach can offer a more precise and adaptable concept by considering required information synchronization frequency in the form of the information pace, depending on a project’s uncertainty state.

An information pacing is already present in the traditional understanding of a PLC, but is not acknowledged as such. Both, the traditional task oriented PM and the novel concept of information pace use time as a reference parameter. The literature review established that traditionally the PLC is considered a control tool over time, as the division into separate
stages allows allocating particular tasks to different stages, and their timely completion can be checked at the end of each stage gate in line with resource and cost control (cf. 2.3.3). In contrast to this traditional PLC, pace is focused on information flow fulfillment rather than task completion over time. Indeed, it aims to match information processing to information needs in a project – a concept naturally related to uncertainty management, whereas task-orientated PM merely plans for and measures task progress, which does not necessarily imply efficient uncertainty management, as tasks may not reflect information conditions accurately.

Furthermore, in contrast to the traditional PLC, considering a project’s information pace and its rhythm through the setting of regular consolidation points offers a basis for the development of more accurate uncertainty control methods and tools. The information rhythm allows for safeguarded uncertainty management by dividing information processing in manageable chunks in each processing interval. By processing information in intervals, a controlled space is provided for uncertainty expansion and exploration during the interval, enforcing its reduction by bringing information down to L1 or L2 (Figure 8) at the end of each interval, in the form of documentation or part implementation of the end result. Presentation of intermediate results at the end of an interval allows for regular scrutiny of the information with regard to its validity and relevance (cf. 7.2.2), and an assessment whether uncertainty has been identified and reduced correctly or artificially. Even when this process of information concretization is not possible, irreducible uncertainty may at least be identified and communicated at the end of an interval in order to create awareness.

The regular consolidation points within the information rhythm provide transparent organisational project control on all levels. At these points the client can re-evaluate and revise direction or budgets, stop or change the way the project or a substream within the project information rhythm develops. This would be more difficult in pre-planned task-focused projects where an outcome is predetermined, even if better approaches that may arise after the project has started could be more feasible. Similarly, substreams of the information processing rhythm could change direction after a processing interval is required, which becomes a natural process in this approach, but may cause disruption and have cost implications in a traditional management approach.
The above discussion demonstrates that the concept of pace is universal, as it caters to traditional hard projects and their planning, as well as soft projects. It provides the conceptual understanding needed to handle uncertainty in a controlled manner and focuses attention to critical points of uncertainty scrutiny (i.e. interval endpoints). This is achieved by regularly agreeing relevance and priorities of the information sphere, and according to these insights, breaking the project down into (temporally) digestible information and uncertainty chunks to be processed successively in a number of intervals. This provides the potential to optimize project progress without falsely reducing uncertainty.

Because of its generality level in a project, the pace concept can be applied on a macro, meso, and micro level in a project. This universality of such a shared tool set allows for all project members to use it and therefore builds awareness throughout the entire project of what stage of their information rhythm colleagues are in. It can help manage this information layer journey much more awarley, and allows project members to actively state when they need to synchronize. In this way, information management becomes more inclusive as it becomes every project member’s responsibility to consider who they need to involve and make their work transparent to.

This approach implies a fundamental shift in focus. In traditional PM informing people is a side-effect of finishing a task, whereas in this approach it becomes a part of the information progress of a project and everybody's responsibility. The thought process, of who information should be available to, understood by and even useful to, streamlines information and focuses efforts. Hence, in the bigger picture such a PM approach focuses not on the alibi outcome, for example of completing a software system within time and budget, but on providing truly useful functionality to the stakeholders.

8.1.6 Integration of all concepts to manage the information layer journey and related uncertainty

The six concepts established in chapter 7 were observed to relate to different levels of project detail, and can therefore be grouped into micro, meso, and macro concepts. The findings indicate that the concepts of informational relevance and validity appear to apply to the project micro level, as they relate to the quality of specific units of information on an
elementary level, which are probed in the interaction of individuals, for instance in project members’ surprise, frustration, conflict among individuals, and inadequate task completion. The concepts of synchronization and transparency relate to observations among individuals and project and stakeholder groups, such as multidisciplinary meetings and co-operation or reviews, therefore forming meso-level concepts. The concepts of structure and pace appear to form the project-macro level, as observations on these related to the organizational structure, shaping of progress of the entire project or large parts of it.

From the findings described in chapter 7 it becomes evident that the micro, meso and macro concepts affect each other. The macro concept of structuring projects organizationally determines the opportunity for touch points, and hence synchronization on a meso level, to allow information to be validated and relevance to be established on a micro level. This opportunity for synchronization hence affects the degree of transparency as it allows more or less opportunity to reflect and probe information representations for uncertainty and false certainty. The concept of pace dictates the amount of time available for synchronization, and determines information consolidation points, which facilitate validating information.

The findings in 7.3.2 demonstrate that a conscious effort must be made to manage information in a project. It also concerns information journeys across the four layers to abstract and concretize information, thereby transforming it into different qualities to establish uncertainty. The macro and meso concepts help understand and manage information availability throughout the project team and over time through structure, pace and synchronization. The concepts of synchronization, validation and relevance relate to the transformation of information across the four layers on a meso and micro level. The following sections detail how the six concepts interact to manage information from a micro to a macro level across project members and across the information layers.

An information interval will typically start with processing information on L1 and L2 by reviewing an as-is physical set up, such as a mail processing facility, or by reviewing a specification or requirement documentation that provides input to a piece of work. This may be done by an individual, or by a group formed by the information structure. During the interval, information will typically transition between layers because it must be elevated to L3 and L4, as on L2 fundamental intellectual progressing of information is not possible
due to the nature of this information layer (cf. 4.3.1). Information then has to be reduced again to L1 and L2 at the completion of each interval so that the processing status may be synchronized with different stakeholders and reflection can take place with regard to the state of the information sphere, and prioritizing further processing. Who is synchronized with at the end of an interval is determined by the project information structure. How frequently this process takes place is determined by the information pace.

The reduction of information to L2 and L1 makes it representable, shareable, and documentable to be able to synchronize it with non-subject matter experts, such as presenting an output created by IT to the business owners, as discussed in the observation findings. This reduction and synchronization allows for validation and relevance establishing processes to take place.

In projects with a high degree of softness, the reduction to L2 and L1 at the end of a processing interval appears to be more difficult as the project topics are often more intangible and designs and end products are often more difficult to visualize. Therefore, soft project information conditions are more likely to prevail on higher information layers for longer periods. These conditions inhibit precise synchronization, as synchronization appears to be more complicated on the higher information layers (cf. 7.2.2). Figure 9 exemplifies the differences of information layer profiles for hard and soft projects across three intervals.

![Figure 9: Typical information layer journeys across three intervals for hard projects (left) and soft projects (right)](image-url)
The information layer model explains how the different degrees of project softness reflect on the different information layer profiles in projects, and how these different information consistencies of the project information sphere are hence likely to create uncertainty, and impact the ability to manage uncertainty. This understanding prompts the need for regular reduction of information to lower layers in order to manage uncertainty, or facilitating documentation in the form of mock-ups for instance to compensate where such reduction is not possible.

An understanding of these dynamics in the context of the information pace concept allows adjusting rhythms to such more or less abstract information conditions. An awareness of the concept of information processing structure allows considering flattening it to increase proximity of project members. This was observed to facilitate shared understanding in conditions of abstract L3 and L4 information were validation and establishing relevance is more difficult (cf. 7.3.2). Understanding the function of synchronization facilitates leveling information among project members, in view of validating and establishing relevance.

In interaction, these concepts across project macro, meso, and micro levels provide a comprehensive and precise understanding of the information and uncertainty conditions in the project information sphere, by informing its degree of transparency. These concepts can therefore form the basis for a methodology to manage these conditions.

It can therefore be concluded that these concepts and an understanding of how they interact offer a more suited lens to deconstruct the domains of the empirical to get through to the domain of the actual and the real, in order to gain more accurate insights into the complexities of uncertainty dynamics in projects.

8.1.7 Conclusion

In an attempt to reframe PM concepts under the information paradigm, a revised definition of the project as a temporary information management formation was constructed, based on the insights of the observation analysis. It was related to the information layer model to show that such information management concerns physical information on L1 in the traditional sense of a project, but more comprehensively also to
information on L2 – L4, which is not considered under the traditional paradigm. This information focus and the distinction of different types of information were shown to provide more accurate insights into the uncertainty dynamics in projects.

This re-definition under research question 4 was offered in response to the conclusions of the analysis of the primary data, which, in conjunction with the reviewed literature, demonstrated that the traditional paradigm is conceptually less capable to support an understanding of uncertainty dynamics in projects compared to an information based foundation.

Under the re-definition of projects as information management formations, the six informational themes identified in the analysis of the observations were discussed with regard to their ability to form conceptual building blocks for an information-based PM foundation. Their observed impacts on each other were reviewed to interrelate these in a systematic manner to form a conceptual framework.

Informational structure and pace were found to form the macro concepts that define projects as information management formations, as they determine information flows within the project team and over time. The meso concept of informational synchronization was found to offer a conceptual understanding of the information exchange dynamics within these formations. The concept of information sphere was constructed to allow consideration of the information quantity and quality in the project, and to allow a comprehension of the degree of clarity of its boundaries, as all of these determine the degree of uncertainty prevailing in a project. The meso concept of transparency offers a gauge for this degree of uncertainty within the project information sphere. The concepts of informational validity and relevance offer an assessment of the quality and quantity of the information within the information sphere on a micro level.

Together, these concepts offer an intellectual understanding of a project and its information dynamics that is more geared to uncertainty understanding and management that the task-based intellectual foundation, with its traditional top-down methods.
8.2 Limitations to the Findings

The findings presented in chapters 6 and 7 are subject to a number of limitations. While the general limitations related to the choice of research design have been discussed in chapter 5, the following sections consider the limitations specific to this study, particularly its generalisability, validity, and reliability.

The interviews of this study can be criticised for lacking ‘ecological validity’ (Cicourel 1982), meaning they may not capture the real daily conditions, views and beliefs, knowledge and experience of the individuals under study in their natural setting. While the interviews provide an overview of several projects and the repeated occurrence of certain topics in the analysis demonstrate their validity and relevance, the discussion of an entire project within one interview means that the topic could not be explored in sufficient depth to elicit all aspects related to project uncertainty management. This could be compensated with the in-depth observation of several projects. The fact that findings from the interviews were also identified in the observation analysis, such as the concern around thin documentation (cf. 6.6.2 and 7.1.4) adds confidence in the validity and relevance of the interview findings.

Cicourel (1982) raises the issue of “referentiality”, questioning what can be regarded as known about an original setting when it is discussed within another setting, namely that during the interview. On the other hand, Paget (1983), who interviewed artists in New York, argues that in-depth interviews are a joint way of creating a thorough understanding of the research subject’s experience in interaction with the interviewer, for example by explaining the researcher’s interest in the topic area. For the current research, having a PM background allowed drawing out critical issues by engaging with common experiences.

The case study approach adopted in this research may be vulnerable to criticism for lacking epistemological foundation, but merely providing rich descriptions of situations leaving the reader to make sense of it; or to only serve as examples to support theories or frameworks by quasi-deductive theory testing (Easton 2000, pp.211-212). This observation research attempted to address this concern by resorting to multiple sources of data, various methods of data collection, and by analyzing the data on different levels and in various iterations, thereby enabling a holistic discussion of the topic under investigation. Such triangulation
constitutes one of the strengths of case study research as the use of different sources improves validity and reduces bias, provided that findings are not overly generalized (Yin 1989). Furthermore, in order to ensure that this case study is built on a strong empirical foundation, a systematic approach is taken, following Yin’s (1989) and Miles and Huberman’s (1994) specifications.

In addition to this, Bryman (1999) identifies a potential drawback of the observation method:

“As among qualitative researchers there is a strong urge to ‘get close’ to the subjects being investigated to be an insider. … The insider standpoint may have its costs, the most frequently mentioned of which is the problem of ‘going native’, whereby the researcher loses his or her awareness of being a researcher and is seduced by the participants’ perspective.” (p.38).

This potential weakness is unavoidable, as it comes with the benefits of getting close access to the subjects of investigation. Robson (2002) critically questions whether it is possible for anyone who becomes part of a group and a setting, even as an observing researcher, not to take part in that constellation. The aim of the observer can only be to reduce this influence by minimizing disturbance and ensuring that observees get used to the researcher’s presence. Conscious reflection on this problem increases awareness during data collection and analysis. Furthermore, video recording many of the situations allows re-examining these situations with more distance, back in the research environment.

Another potential weakness in observation is that of reactivity, i.e. people feeling they are being watched and consequently acting differently. While this may have been the case initially during the NX observations, project members quickly became used to my presence, similarly to the descriptions by Atkinson in her clinical observations (Atkinson 1981):

“... I was generally taken very much for granted on the wards, and by the students as they went about the hospital... Indeed, for some doctors I became so much a part of the normal scene that they forgot who I was.” (p.129)

It can be argued that the researcher becomes part of the setting and therefore, their presence is essentially disregarded, which makes the data collection method unobtrusive.
This was further supported by minimizing interaction, such as eye contact during observation of meetings, not reinforcing attempts to make contact, such as reacting to smiles, and strategically choosing seating positions in the meeting rooms which were as unobtrusive as possible (Robson 2002). For example, this could be by sitting in a corner, or in larger meetings to deliberately share a space at the table so as not to stand out in the seating pattern.

As observation is an intensively human process, observers show bias to human factors, such as gender, age, appearance, or status hierarchy. Due to the initial contact with the most senior programme manager, the observations started top-down in the project structure. It was therefore easier to initially engage with more senior project members, which biased the collected data. As the observation proceeded, it was deliberately attempted to mix with different groups. For several weeks any obvious contact with the senior management was deliberately avoided, to focus on other project groups. In the 11 scoping interviews this seniority bias could not be avoided as mostly the project managers or senior project members were interviewed.

During observation, there may have been an initial bias in terms of engagement with certain topics where project members were more easily approachable, welcoming and supportive. However from the third week, once an overview of the project structures and topics was established, areas where involvement was low, and which appeared to be of interest were increasingly observed. Project members were actively approached to ask if meetings could be observed or documentation could be obtained, for teams where there was not much initial contact or natural comfort to approach. This was difficult initially, but was mostly rewarded with further insight, so that this approach was adopted more comfortably and frequently, and eventually most areas of the projects were observed.

It could be questioned whether the projects chosen for the observation were representative examples for the questions this research aims to address. It may be argued that they may have just been managed badly. However, the projects were undertaken by an organization and employees who have extensive experience in the management of projects. Furthermore, the mismatch of an accurately applied traditional PM approach and the inadequacy of it for the information availability demonstrated that the projects had exactly the problems that this research aims to enlighten, rather than just being badly managed.
hard projects. A further demonstration for the adequacy of the chosen program is the fact that topics were found which could also be abstracted from the interview data, which supports the validity and representativeness of this research.

It must be critically questioned to what extent the findings from the NX context are generalisable, as these were gained within a specific sector, namely the logistics industry, and with a project focus on software development and migration. This consideration relates back to the uniqueness vs. standardisation argument detailed in the literature review (cf. 2.4), which established that projects are by definition unique (Atkinson 1999; Söderlund 2004). This uniqueness relates to specific contexts and topics, and methods in which they are managed. The literature review nevertheless concluded that there are a number of general factors and patterns which all commercial projects exhibit, such as some form of structure in which project members interact, and a PLC of some shape. The findings of this study relate to the information dynamics of these general project patterns, rather than a specific context. They should hence largely apply to project across different fields. The findings also highlighted that the information paradigm appears to apply across hard and soft projects, further supporting the argument for generalisability. Finally, the pilot interviews which featured projects across a variety of fields demonstrated that similar issues could be identified across the sectors, proving that there are general trends. Nevertheless, further research would be useful to confirm generalisability across different project sectors.

Generalisability of this study could also be questioned with regard to the purposive sampling for the interviews and the case study method for the observation. However, particularly in the observation, data collection was continued to the point where saturation was reached, so that a comprehensive representation of the circumstances could be achieved, ensuring generalizability. In the context of the PM discipline, there is always a trade-off between identifying general patterns which have explanatory power, and too much generalization which may limit their applicability to the specific and unique conditions of each project (Smyth and Morris 2007). The information concepts presented as a result of this research (cf. 8.1) form a rather abstract theoretical instrument, which aims at changing awareness, and is presented in such a way that it offers flexibility to derive ways in which it may be applied.
One of the main deficiencies with regard to observation is the potential for biases in the data collection and analysis, and its potential threat to validity, such as:

- Selective attention following personal interest, experience or expectations.
- Selective encoding and too rapid interpretation which is not empirically sound.
- Selective memory in terms of completeness and accuracy; the interference of interpersonal factors through initial insecurity or easy bonding with certain subgroups. (Robson 2002).

Reflecting on the above deficiencies self-critically is a strategy to counteract these. The following paragraphs detail these reflections:

Previous exposure to PM in IT may have created biases based on previous experience. A brief description of the researcher’s background may offer an understanding of personal biases, and how these have influenced data collection and interpretation. Having managed and audited commercial projects, a range of issues was experienced repeatedly, unable to make sense of these or manage them satisfactorily. Project members became stressed or frustrated attempting to progress a topic which appeared not to move significantly. Involving other project parties or management often appeared to complicate the attempt to make progress, and outputs appeared to be less efficient than the effort invested. Though these topics created issues for the project, they were not fully grasped and managed by the senior management. Similar pressures were experienced relating to project sponsors pushing for plans and budgets. Despite lessons learned the same issues appeared again in subsequent projects, relating to rushed plans, and underestimated budgets, and pressure for too much overlap in project phases which in practice did not work due to delays of preceding project phases, so that the overall project then experienced delays. This pressure was never alleviated or managed realistically. Though people who experienced this across several projects had some form of awareness of this, there was a feeling of helplessness to approach this differently, running into the same problems with open eyes. This feeling of helplessness created frustration and weariness. All projects experienced had to deal with delays, several requests for budget top-ups, or some form of replanning. Management and reporting of projects often appeared overly bureaucratic and stifling, rather than facilitating and providing a true sense of progress. There was a mechanic application of PM tools and
lingo which were employed to exhibit professionalism, while often not finding these truly useful to manage the project. These were more applied out of tradition than out of genuine benefit. Due to this inadequacy informal ad-hoc or improvised management approaches often existed in parallel, and informal progress discussions would often sound different from the formal ones. The success of these often depended on the leadership personality and experience of the project manager. If that person was aware of this double-standard it could be openly addressed, otherwise these considerations remained hidden which compounded the issue. In many cases issues fell through the cracks because people assumed that other teams would pick up a piece of work. Any work that was interdisciplinary or involved handovers among teams appeared to be likely to go wrong. This was often the result from people refusing responsibility for a piece of work which had not been assigned in the planning stage, as these teams then were unable to make time or allocate further budget to this. This created long winded arguments to find a home for certain topics, and entailed lack of ownership and enthusiasm, instead of progressing a piece of work as efficiently as possible. Such issues of ownership and going round in circles trying to progress vital work led to stakeholders feeling disengaged. Top-down management approaches created chasms in people’s understanding across the project, particularly between end-users and IT. This often also meant that highly capable project team members were either underutilised or stretched extremely. Where such a highly structured approach had to be dropped to manage to a crisis, worked appeared to be more efficient. In these situations, everybody could attend to vital work urgently, more free from the official structures and pressures of reporting. Despite such phases being significantly more pressurised and work intense, there appeared to be a sense of enthusiasm, close engagement, and satisfaction. I was keen to understand why this was the case, and how the double management of a professional front and an ad-hoc experienced informal management could be avoided. This research was initially biased as these experiences directed my search for data.

Throughout the interviews and the observations I developed my understanding of the topic, and of the informational perspective. This altered the aspects of the observation I chose to document in the process of keeping research notes. My prejudices and biases again changed after the observations were completed, and during data analysis. During the interviews I very much viewed the topic from the traditional PM point of view which informed the literature review, with a chasm between the traditional methods and the new
practitioner developed approaches. As I became more comfortable and gained more experience with the information paradigm, I started to move away from observing the projects through the traditional concepts and worked more and more with the information layer model. My focus subsequently switched increasingly to observation of information flows and disturbances to these, and consequently the dynamics these created in the observed projects. This offered new insights, outside the conceptual limitations of the traditional paradigm. To ensure consistency despite this development of understanding, the data analysis not only relied on the observation notes. Cross-checks with the audio and video recordings were made throughout the data analysis. Also, reflecting on the results with academic colleagues and former NX project members compensated for this alteration of perspective, and allowed considering the dynamics and concepts outside my bias. Furthermore, during the interviews, the scope of this study was less focused. Therefore, the interviews were not particularly directed, which may have come at the cost of depth and detail.

Another bias to be aware of relates to the fact that human perception naturally and automatically closes information gaps. In settings where too few observations were made, the understanding of a situation may be filled in with invalidated assumptions. A rich set of data is needed from which to abstract findings, as otherwise trends may be inferred which are not founded in project reality. With an open end date, long observation days, and the use of different recording media, this study allowed to manage this concern. Reflection on the data took place in several cycles, the last cycle with quite some time apart to create a distance to the topic, which allowed for reflection beyond the initial predispositions. Also, established procedures for validating and verifying data analysis were followed to reduce distortions introduced from personal predispositions, such as testing alternative explanations for findings, examination from traditional and information based perspectives, and discussion of emerging trends were discussed with colleagues, supervisors, and project members to validate these. This addressed concerns relating to validity of this work through member checking. Member checking is used to

“... determine the accuracy of the qualitative findings through taking the final report or specific descriptions or themes back to participants and determining whether these participants feel that they are accurate.” (Creswell 2003, p.196).
The core factors identified in the observation analysis, as well as the concepts developed based on the data, were exposed to the head software architect and two other software architects of the observed IT project. The detailed and rich descriptions of the findings in chapter 7 are intended to provide a means for readers to follow the process and conclusions, which should also increase validity (Creswell 2003). Concerns regarding bias could also be reduced due to the video and audio recordings used. These allowed looking at the data repeatedly to explore different angles. This would not have been possible if a purely traditional note-taking approach were taken. Furthermore, different data sources were triangulated, such as video data, documentary evidence and interviews for certain episodes of the observation. This ensures “… coherent justification for themes” which were found in the data (Creswell 2003, p.196).

Reliability for this study can only be achieved as far as ensuring that all requirements are fulfilled for another investigator to repeat the study (Yin 1989, p.36), though not guaranteeing identical results. This means that the procedures followed in the data collection and analysis of the interviews and observation were documented and that the collected data in the form of verbatim interview transcripts and audio recordings, as well as observational data in the form of field notes, audio and video recordings, and collected documents may be made available to the researcher intending to replicate the study. While observational impressions on a large scale cannot be made available, as the observed situations cannot be reconstructed in real life, the additional recording of audio and video material, which is largely uncommon in observational research, increases reliability of this study, as it adds data which would otherwise, with pure reliance on field notes, not be available.

8.3 Contribution to Knowledge

The aim of this thesis was to investigate the nature of uncertainty in projects and to find more appropriate ways to understand and model the uncertainty dynamics. In this context, this research demonstrates innovation and contribution to academic knowledge in the following aspects:
The information-based perspective adopted for this research has rarely been assumed in previous management research (Galbraith 1973), and in PM research in particular (Winch 2002, 2004). While Winch (2002; 2004) opened the information paradigm to the discipline of PM and the handling of uncertainty, he resorts to other paradigms and traditional management theories to construct a response to the information and uncertainty requirements of projects (cf. Winch 2004, p.47). The research presented in this thesis for the first time consistently relates all PM concepts to information, establishing the value of the information paradigm as a suitable theoretical platform for research into project uncertainty.

The utility of the information paradigm to gain greater insight into uncertainty dynamics was confirmed in a series of interviews and observational case study research (cf. chapters 6 and 7, 8.1). Preceding research has not confirmed its applicability through any empirical study or other practical application. An original contribution of this study hence lies in establishing its suitability in an empirical context, thereby achieving one of the research aims of this study (cf. 1.0).

A further original contribution of this research relates to more precise definitions of information and uncertainty for the application of an information-based paradigm in project uncertainty research. While Winch (2010) and others (Galbraith 1973; Galbraith 1977) use the information paradigm as a foundation for their work, the concept of information is not defined.

Winch, and many other PM academics (Winch 2004; De Meyer et al. 2002; Loch et al. 2006; Pich et al. 2002), do not define uncertainty either, or resort to a general definition of uncertainty as lack of information. Previous approaches put forward isolated views on and definitions of uncertainty, often empirically-based, and valid only in a topical context (De Meyer et al. 2002; Pich et al. 2002; Hällgren and Maaninen-Olsson 2005; Duncan 1972; Buchko 1994; Avery and Zemsky 1998; Huber et al. 1975; Jensen et al. 2006; Tatikonda and Rosenthal 2000; Milliken 1987). As the literature review yielded that concepts of information and uncertainty appear to be fuzzy and multilayered, the adoption of both concepts without a clear definition has provided an insufficiently sound theoretical basis for academic enquiry.
This study attempted to address this deficiency by considering the various facets of the concept of information and offering more precise definitions. In line with the second research aim (cf. 1.0), an information model was devised which structures these as four layers in a stratified form. The stacking of these information layers allows contrasting the different qualities and degrees of abstraction of information, and models their relation and interactions. This information layer model offers a more precise understanding of information and thereby forms a significant original contribution to the theoretical foundation of an information based research paradigm.

Related types of uncertainty to each information layer were also established as part of the information layer model, demonstrating where uncertainty appears and how it develops as information is abstracted and concretisized across the information layers. It hence provides a structural model which reflects the various conceptions and definitions of uncertainty identified in the literature and relates these to each other. This model offers more precise insights into the uncertainty dynamics across different degrees of abstraction of information. It provides the theoretical skeleton that facilitates gaining insight into the originations of the different types of uncertainty, the conditions of their appearance, and their relation to each other.

The value of this instrument in the context of PM lies in the more comprehensive and precise consideration of uncertainty than is typical in the current thinking among PM theorists and practitioners. None of the existing suggestions provide an understanding which is as thoroughly theoretically grounded and all encompassing.

The application of this information layer model for the primary data collection established its ability to facilitate insights into the underlying mechanisms of the uncertainty symptoms experienced in the domain of the empirical. It therefore forms a significant contribution to knowledge in the field of (empirical) project uncertainty research.

Traditionally research on uncertainty in PM was dominated by quantitative, positivist and reductionist approaches (Yeo 2002, p.115; Smyth and Morris 2007), mainly with the goal of a prescriptive proposal for new methods and tools (cf. Winch 2004, p.47). In order to research this topic from a fresh perspective, a critical realist philosophy was adopted. This
is a relatively new epistemological tendency in PM, and this research followed PM scholars’ suggestion for a wider application of this philosophy, as it harmonizes with the nature of projects, because it allows considering the general and objective project structures, while acknowledging the value-based, contextual and interpretive nature of PM.

Hand in hand with the call for this new philosophy goes a new tendency to move away from normative prescriptive PM research, towards more interpretive approaches. Previous normative research has put less focus on understanding “actualities” of projects (Cimil et al. 2006), and may therefore have imposed theories which were unable to address issues adequately (cf. 3.3). Practitioners on the other hand offered pragmatic solutions which lacked the depth of research presented in this thesis. Studying the topic with the inclination to learn about the actualities of projects under the critical realist lens contributed to strengthening this new tendency, and yielded a detailed set of symptoms of uncertainty projects struggle with, indicators for uncertainty, as well as aware and unaware coping mechanisms.

Various literatures discuss the sources of uncertainty in projects, however, none appear to identify concrete indicators in the form that the results of this study offer. The concrete and practical insights, grounded in a detailed observation of project practice contribute to the discipline’s body of knowledge, providing useful guidance for project practice in the form of earlier acknowledgement and addressing of uncertainty, as well as a starting point for further research.

These concrete findings also facilitated a number of insights on uncertainty, the importance of which has not been widely acknowledged in the literature, such as the significance of unknown knowns, and the frequent occurrence of false certainty.

The findings on how project members coped with uncertainty and addressed its symptoms led to the insight that the traditional task-based paradigm provides inadequate concepts for the acknowledgement and management of uncertainty. As the majority of previous research is mostly normative and theory imposing, this insight has not been established as clearly previously. This study hence proposed a paradigm switch from task to information and re-defines projects as information formations. By offering the conceptual switch that
suggests organising a project according to information needs, PM becomes an intrinsic and, hence purposeful function, as opposed to forcing a preconceptualized management tendency (hard or soft) with its corresponding style and methods on a project.

From the observation findings, this study has abstracted novel information themes which, in conjunction with the information layer instrument, were constructed into an information based conceptual PM framework. These concepts should be more suitable to offer an understanding of the uncertainty effects in the domain of the empirical, and provide an awareness and understanding to trace these back to the domain of the actual and the real. This addresses the third research aim of attempting to develop a better understanding of the underlying structures and causal powers of uncertainty dynamics.

This conceptual framework provides an opportunity to flexibly adapt and scale the project organisation depending on information needs without losing sight of functional standards. Pich et al. (2002) explain that various approaches to PM are available and all of them address uncertainty to some extent. However “no conceptual model exists that enables project managers to understand why different approaches exist, which one to choose and when.” (1008). The insights gained in this study advance PM knowledge in that they offer a better understanding and conceptual placing of the different approaches by considering their information management qualities.

It has been established that further theory development is required in the field of PM, and it was noted that in the literature there is a growing concern regarding the assumptions on which PM is based (cf. 1.3). A paradigm change, away from the traditional hard paradigm (Koskela and Howell 2002, p.298) or an inclusion of additional paradigms (Pollack 2007), has been suggested. A key contribution of this research lies in the theoretical integration of hard and soft projects under a combined theoretical framework. The information layer model offers a way of integrating different, often mutually exclusively applied hard or soft philosophical orientations in the discipline of PM. It provides an explanation and an integrative basis for both views, highlighting that these tendencies depend on which layer information is primarily being processed on. Hard projects may be more concerned with L1 and L2 information, allowing for a reductionist, objectivity loaded, controlled approach, along the lines of positivism, as they are concerned with real world information and its representation. The nature of soft projects on the other hand requires increased
information processing on L3 and L4, where the search and matching of representations to concepts appears to be more of an interpretive and reflective process. The findings of this research, hence offer a unified theoretical model for hard and soft projects, transcending the limitations of the hard project positivist paradigmatic approach which could previously not include soft projects.

The perspective switch from task management to information management provides the basis for the contribution of a unified underlying theoretical foundation to currently distinct theoretical views on, and practical approaches to, hard and soft projects in the field. This has major implications for PM theory and practice. It creates new opportunities for researching PM and for understanding and developing the practice of PM. These proposals are intended to provide another stepping stone towards the development of a sound theoretical base in the comparatively young discipline of PM.

8.4 Future Work

Future work may be directed at further investigating the application of the information paradigm for the study of uncertainty in projects and further validate and develop the identified concepts. This could be achieved for example through a combination of theory and practice in action research "... aimed at solving an immediate problem situation while carefully informing theory ..." (Baskerville 1999, p.2). In several action research cycles, the proposed conceptual framework could be used to gain insights from different collections of primary data in different hard and soft projects, thus validating the previous research and advancing the framework.

The redefinition of projects under the information paradigm may lead to the exploration of more appropriate tools and methods to manage the information structures and processes that feature in projects. In following the new interpretive research tendency, these may have an opportunity to spring from a more intrinsic understanding of the actualities of projects, in comparison to the traditional normative imposing tradition.
While the framework in its current state is already believed to be useful and consistent, it could be extended with another conceptual element relating to the cultural conditions which influence information dynamics. It can be argued that an additional conceptual element of “information climate” should be explored, which looks at topics such as culture setting, participative safety, conflict management, familiarity, and other factors which determine how freely information can flow.

The model could be further detailed by exploring the information perspective on the level of individuals, for instance studying how information management between individuals in projects can be modeled, related to individual information processing, and uncertainty behaviours. Such exploration of individual information management capabilities could also be used to refocus the currently extensive debate on the skills and abilities of project managers (Prabhakar 2005; Müller and Turner 2007; Turner and Müller 2005) in view of information processing capabilities, and uncertainty and ambiguity tolerance. Such research may help PM practice to achieve appropriate staffing for a project.

When projects have gone wrong, tracking information flows may help in the analysis and correction of errors, identifying suitability of information structures, synchronization opportunity, transparency, and hence uncertainty awareness. Research into an audit trail of information flows may have the potential for a more fundamental analysis and a more productive learning process for future projects, as compared to the current practice of collecting a number of differently motivated opinions, potentially politically coloured, which typically appear unrelated or point to different root causes. The development of a project audit protocol based on the information based framework may provide a model and parameters which enable a deeper understanding of the relation between different issues which may otherwise appear not to be interdependent or to be of superficial nature.

Traditionally, teaching PM involves conveying a conventional normative approach (Geraldi et al. 2008, p.588; Stoyan 2008) which describes and discusses “the application of knowledge, skills, tools, and techniques to project activities to meet project requirements” (Cimil and Hodgson 2006, p.111). This conveys a PM approach which is effective in a limited spectrum of projects. Sometimes newer, practitioner based concepts, such as Agile PM, are also introduced, but often without explaining their relation to traditional approaches, their appropriateness, or theoretical underpinning. The findings put forward
in this thesis may encourage the development of a more inclusive body of knowledge to be taught, based on a unified underlying theory. Considering how PM may be taught from the information perspective proposed in this research may add an underlying conceptual understanding for students, within which they are required to link concepts, should appreciate the benefit of different approaches, tools and methods and may educate them to assess new projects and make the right choices about how to manage these.

As for any new proposal this thesis raises as many new questions as it answers. However, it also offers a new perspective on a topic which currently seems to be highly contentious, and hence may provide new opportunities to advance the field theoretically and in practice.
Appendix A - Information Layer Example

The following sections illustrate the context-independent validity of the information layer model, using the example of DNA discovery to explain the interaction between the different information layers, and the social influences which stimulate a transfer of information to a different level in a collaborative context, and subsequently reduce or create uncertainty. Information existing in the physical world on L1, independent of the observer, in this context is the DNA molecule.

Interaction between L1 and 2 and related uncertainty

The history of DNA discovery highlights the nature of the transformation process from L1 to L2, and the caveats inherent in the development of a mental representation of the physical world: Friedrich Miescher first isolated a molecule in 1869 from the pus of discarded surgical bandages and named it “nuclein”, as it was found in the nuclei of cells. While the physical bandages signified a research object to Miescher on information L2, for nurses the same bandages represented something that must be correctly disposed of. These perceptual differences highlight that information L2 determines how the physical world is perceived.

In the following years, researchers tried to develop a more detailed understanding as to what the DNA molecule looks like. This process demonstrates the incremental development of a more correct representation of DNA on L2. In 1919 Phoebus Levene (1919) hypothesized that DNA consisted of a string of nucleotide units which are linked by phosphate groups. He assumed the chain to be short and the bases to be repeated in a fixed order, which is now known to be incorrect. Hence, during Levene’s time the mental images of DNA were an insufficient representation of reality and carried too much uncertainty to be valuable for further research.

In order to reduce uncertainty, the accuracy of a L2 representation can be checked by looking for more evidence in the physical reality on information L1 which supports or
contradicts the representation. However, this process is initiated on L3, because L2 does not challenge the accuracy and adequacy of mental representations.

**Interaction between information L1, 2 and 3, and related uncertainty**

L3 directs an active search for information and thereby determines which L1 information is taken in. This layer can challenge the correctness of L2 representations. Levene’s L3 system of meanings led him to assume that the DNA molecule must be short as the possibility of a molecule as complex as we know DNA to be today was outside the scope of his imagination. This made it inconceivable for him to look for new information in the real world (L1) to improve the accuracy of his L2 representation. He could not find a confirmation for his understanding either, because his L3 concepts created his hypothesis of a short string shape which misdirected the search for confirming information in the physical world. Furthermore, the status of technology at the time did not provide enough contradicting L1 clues for him to question his L3 concepts.

In the 1950’s a new x-ray technique was developed allowing scientists to search for more information in the physical world. This delivered an X-ray diffraction image of DNA (Figure 10), taken by Rosalind Franklin in 1952, which provided a much more precise L2 representation of DNA.

![Figure 10: Molecular configuration in sodium thymonucleate, taken from Franklin and Gosling (1953, p.740)](image)

This new technology enabled James D. Watson and Francis H. C. Crick to apply their L3 understanding to search for more information in this photograph which shows a fuzzy X in the middle of the molecule. As a consequence they shifted to a mental representation of
the double helical structure of DNA on L2, which they proposed in Watson and Crick (1953).

In the interaction between L1, 2 and 3, uncertainty can be reduced by challenging the applied concepts and representations as to whether these provide the right information filters to anchor L1 and L2 information. This happens especially in an information-sharing, interdisciplinary approach such as researchers with different backgrounds progressing the DNA discovery. It allows checking each other’s representations and thereby helps to discover misrepresentations and, hence uncertainty. For example, Watson and Crick each independently discovered the double-helical structure of DNA by applying their own, differing L3 concepts. When the visually sensitive Watson, who was a molecular biologist, saw a cross-shaped pattern of spots in the X-ray photograph of DNA, he knew it had to be a double helix. From data on the symmetry of DNA crystals, Crick who had a Physics background and was an expert in crystal structure, saw in that same image that DNA’s two chains run in opposite directions. They both concluded the same concept of a helical structure on L3, though applying different L4 concepts to come to this conclusion. Their shared hypothesis on L3 of a helical structure reinforced each other and triggered them to look together for conformation on L1, the physical world. The resulting reality check was more likely to produce a correct representation, because its checking was backed up and confirmed by different conceptual worlds on L3 rather than resorting to a shared (i.e. same) system of meanings.

Checking L1 from different systems of meanings is more likely to reduce uncertainty. However, applying different concepts with different systems of meanings may create false certainties if some or all involved apply inappropriate concepts that do not allow searching for confirming information on L1 adequately or at all. Systems of meanings only facilitate the collection of further L1 information within those systems of meanings. Hence, uncertainty can only be checked within these, too. Uncertainty that lies outside these systems of meanings cannot be acknowledged unless new systems of meanings are produced or a switch takes place to a different system of meaning which then guides the search for different and new L1 information. This L4 process is added to this model in the following sections.
An example of the interaction between information L1, 2, 3 and 4, and related uncertainty

On L4, information purely relating to concepts is represented. Whereas on L3 a search for information takes place from within a given reference system, on L4 the reference systems themselves are challenged, contrasted, interlinked, and amended. This creates new L4 information bringing forth a cognitive “difference” and hence a new idea about the external world.

In the example of the DNA, L4 may take the form of placing the L3 understanding of DNA into a wider conceptual context by using the concepts of forensics, anthropology, philosophy and ethics, medicine and pharmacy, and so forth. For example, in philosophy, the conceptual understanding of our genetic information being passed on to the next generation raised the question of the extent to which our being is determined by our genes. Ethics links DNA to research limitations with regard to human stem cell and cloning research. Abstracting DNA in economic terms puts it into the perspective of, for example, agriculture, food production, pharmaceutical industries, altering the relationships between public and private enterprise and impacting the economy. Using this same analogy, placing L3 concepts into a framework often leads to the development of new concepts on L4, such as genetic engineering. Such construction of new concepts, or a connection of previously unrelated concepts, or a relation of L2 and 3 information to concepts it had not been related to before, directs the search for more real world information which is initiated on L3 and executed on L2 to anchor new L1 information.

Incorrect L4 concepts can introduce uncertainty in the transition from information L2 to L3 as information may be misinterpreted get lost by resorting to incorrect, incomplete, or faulty concepts, which then provide inappropriate cognitive filters. Such insufficient or wrong filters may not allow relevant information to enter the cognitive system. The following example demonstrates this, where biochemists may not have been able to recognize the inheriting function of DNA, in the way that geneticists and cellular biologists did.

During the establishment of the structure of DNA, a controversy about its function grew from three disparate and largely independent scientific fields: biochemistry, cellular biology and genetics (Dahm 2005). It was therefore necessary to reconcile the hypothesised
biochemical structure of DNA, as found by biochemists, with its suggested function as the molecule of inheritance, as derived from the research of cellular biologists and geneticists. These disparate views on the same L1 information, and subsequent different foci, demonstrate that the representations from information L2 are anchored with theoretical concepts from L4, such as genetics or biochemistry. This linkage takes place on L3. On this layer, information is abstracted and conceptually placed. In terms of finding a difference, the application of these L4 concepts sets information filters for the cognitive system, only letting information filter through which matches and supports the existing concepts. Hence, geneticists held a different view on the L2 representation of DNA from the view held by biochemists because they anchored it to different L4 concepts on L3.
Appendix B - Interview Guide

General starting questions:

− Your experience / background as a project manager
− Project context, size, duration, stakeholders, project life cycle (involvement until when? – increase/decrease of involvement in certain stages)

Questions to describe uncertainty of the project:

− How is the project planning and goal setting done?
− Which information was not available in the beginning of the project?
− Management of unforeseen problems (How do you identify uncertainty and how do you deal with it? How much are they thinking in terms of classic risk management and how much are they advanced?)
− Changes faced during the project? What do you do when you face large changes in the project? Do your scope and objectives sometimes change heavily (at what stage)?
− What happens if new information (e.g. knowledge, technology) is made available in a later stage of the project?
− How closely/actively/frequently (to what degree) do you involve the sponsor (client, users) and contractor in the project? Are they part of the core team or do you just contact them when you need information? How are the relationships with them (trust, contractual, formal, informal)? Are they part of the problem solving process?
− Types of project life cycles used
− How do you adapt to different markets and uncertainties?

Group composition

− Principles used to compose your organizational project structure (standard or new for every project)
− Main criteria for creating substructures and groups (Power based, capability based, information flow based – then we know already how the interaction is organized)

− What is your role in the project team? How is it decided who leads the team? - Decision making (consensus, autocratic)

− How independently do project members work?

− Does the project team work together in one office or is it spread out?

− Subteam size?

− What elements are required to allow free thinking, information flow, and creativity to flourish within a team?

**Interaction and information flows:**

− Spatial arrangements (close, far distance), influence of spatial arrangements on interaction

− How is interaction formalized (contracts or trust high/low formalization?)

− How is communicated in the project (means, frequency, style)

− How is information distributed and to whom (media, policies, meetings, regularity)

− During which phases is the interaction most intensive / least intensive?

− What are the perceived advantages of intensive/little interaction?

− Who interacts in the project with whom? Structures / Processes

− Are there conscious approaches to maximize/minimize interaction between project members/stakeholders? (kickoff meetings, constant customer representative, interviews, constant updates or meetings) If yes, on which level?

− Are the interactions always goal oriented/directed or also random and free? (e.g. business dinners or meetings general or to discuss concrete issues)

− How do you decide and who decides when to interact with whom? Hierarchy or information need driven?

**What would you do / have done differently in the project?**

**How was the interview for you?**
Appendix C - Observation Protocol

Notes 11.7.2007

2nd meeting day Business Sign-off Spec Release 8:00 am

I am allowed to video the meeting, which is the reason why I write less detailed accounts on my note book, but rather try to shift my attention to a more abstract level. It’s one of the first times where I try to look from a more coarse level.

They initially go through the business risks.

Some people write e-mails or surf the we

{Hypothesis:
  • In meetings that are of high importance for the project future, such as the Business Process Analysis and Spec presentation, high amounts of UandA are present
  • Every time info is passed from one bubble to the next (one MM type to the next), UandA are extremely high – e.g. business sign-off specs}
Hypothesis: If you have to follow someone from a different field, i.e. different mental model, speaker need to hang abstract descriptions on a concrete coat hanger, i.e. examples, anecdotes, sketches, scenarios; does not work on an abstract level

[Hintz’s hierarchy info distortion theory linked to politicking and power practice]

Some people are more active than others in the meeting – some know more about NX, others have been involved late and know very little [different knowledge levels]

<table>
<thead>
<tr>
<th>CD</th>
<th>Away from risk list “Let’s move on, we got a lot to do today”</th>
<th>[time as limiting factor for info exchange]</th>
</tr>
</thead>
<tbody>
<tr>
<td>JC 8:50</td>
<td>Presents Routing Matrix</td>
<td></td>
</tr>
<tr>
<td></td>
<td>He keeps clarifying terms, e.g. difference between</td>
<td></td>
</tr>
<tr>
<td></td>
<td>“tracking” and “tracing” to get clarity</td>
<td>[red. UandA]</td>
</tr>
<tr>
<td>MB</td>
<td>I find out he is IT Director Operations</td>
<td></td>
</tr>
<tr>
<td></td>
<td>I decide to see how often the different UandA levels show</td>
<td></td>
</tr>
<tr>
<td></td>
<td>in the conversation (I expect them to be quite high in this</td>
<td></td>
</tr>
<tr>
<td></td>
<td>type of meeting where people have to try to understand</td>
<td></td>
</tr>
<tr>
<td></td>
<td>people from a different field (business vs spec people)</td>
<td>During J’s presentation</td>
</tr>
<tr>
<td></td>
<td>How do you create business ownership so that they don’t</td>
<td></td>
</tr>
<tr>
<td></td>
<td>hide behind JS’s issue of not having enough time?? (see</td>
<td></td>
</tr>
<tr>
<td></td>
<td>chat yesterday) → make each one responsible for one area</td>
<td></td>
</tr>
<tr>
<td></td>
<td>helps?</td>
<td></td>
</tr>
</tbody>
</table>
| BREAK | Hypothesis {Ap more in situations where ppl with different MM’s try to understand each other (e.g. different lingo for same thing)
Up more in new situations
Ay: changing MM happens not too often}

Example statements for A
A=“You are talking about… right?”
Ay = “Oh I see, you have to do … to achieve that?!”

[MMs and info exchange strongly linked to lingo (Wittgenstein: “die sprache ist die grenze meiner welt”, because can TRIGGER PULLING UP the right MM in one’s head --> unify or clarify lingo / terms, keep repeating meaning of special terms and how they are related to the underlying concepts to ensure reducing UandA; e.g. project term wiki]
(more Up and Ax in IT project; more Up in engineering Projects; more Ay in design projects)

The different brains that process info differently ensure that a problem is viewed from a variety of angles and depths (e.g. PL vs CF) --> this is important to get a complete as possible picture of the P info pool (like all basic colours of light together make it white); on the other hand it makes common/same understanding of a topic very difficult, and that everyone has the same info pool is in such a scenario by default not possible because e.g. ME saves different info than e.g. an IMP --> {maybe it should NOT be the goal to have the same info pool at all?!?}

<table>
<thead>
<tr>
<th>Continued Business Sign-Off</th>
</tr>
</thead>
<tbody>
<tr>
<td>TelCo with RS-H and PF who present a training preparation tool they would like to sell to DP NX</td>
</tr>
<tr>
<td>After PF starts to explain what they will present (like a sales presentation), he states: &quot;That's the agenda. Any surprises there? Was that what you were expecting to</td>
</tr>
<tr>
<td>Finding out their MM and</td>
</tr>
</tbody>
</table>
Videos from that day:
1. Risk list
2. Routing Matrix Sign-off
3. Training Tool presentation
4. Presentation walkthrough NX status until now

While the meeting continues and I leave the camera running, I join other meetings in the mean time…

11:30 Server Environment inconsistencies meeting Developers team, Test team, etc.

(image from blackboard available)

RP, DR (CM), OW (Architect), M (Roll-Out), DA, BM (ATL Infra Structure guy responsible for the servers), San, TM (on the phone), TR (Test), MF (ATL Infra Structure)

DA called the meeting. It is basically a continuation of the topic DR dragged around for the last weeks, TM had tried to solve in his smaller meeting and in several stand up meetings --> apparently the issue is still not solved to everyone’s acceptance (information not complete, tasks and responsibilities still not distributed, protocols and procedures not “eindeutig”)

| DA | 1. lists available environments and equipment (what and where), softwares that are currently on the boxes (oracle version, etc.), configuration of the boxes | Provides information elements (her understanding of the current status) |
|    | 2. compares “I have an idea how it should work, I’m sure everyone else probably has, too.” --> tells her idea and where she’s coming from --> mentions who’s responsible for what | [RP is in the meeting but I realize that he actually is more busy with external Project marketing, not handling internal program overlaps and needs properly --> lots of |
He also does not coach his management team properly – many of them inexperienced, in adequate for the job, making basic mistakes, etc.

---

<table>
<thead>
<tr>
<th>TM</th>
<th>He gives his understanding (on the phone)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>He describes the layers (the image he drew last week on the blackboard). OW reproduces TM's image on the blackboard and extends it</td>
</tr>
</tbody>
</table>

---

<table>
<thead>
<tr>
<th></th>
<th>coordination necessary between the projects, also better portfolio management and correct nurturing of projects like TMS and DataPrep necessary not to make it a failure again</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>He also does not coach his management team properly – many of them inexperienced, in adequate for the job, making basic mistakes, etc.</td>
</tr>
</tbody>
</table>

---

| OW image last week | OW adds info that was not available in the last meeting only with TM --> maybe the last meeting in that sense was pointless as the wrong information carriers were there or not enough info carriers to paint a complete picture and agree everything; or he feels more free to add his view as he is the one drawing now as compared to the last meeting and TM is not in the room but on the phone |
Final image after this meeting (compare the two in complexity!! More information extracted! --> better info flow management (decision management)?)

Everyone agrees which components exist, but not everyone agrees who should be responsible for what.

Ensures common understanding of image by clarifying functionality under each image layer on OW's drawing.

[OW drew similar image as TM last week as he had been in the meeting - --> that image is the hook how ppl. Hang up their information on, it's also the TRIGGER for everyone to retrieve the same MM again as the last time they met]

{for intangible issues, images and examples replace reality – they give overviews --> necessary in SW projects as compared to bridges where overviews and}
<table>
<thead>
<tr>
<th>Discussion who should own Architectural document that describes the server ownership and configuration, rights, responsibilities, etc.</th>
</tr>
</thead>
<tbody>
<tr>
<td>DR</td>
</tr>
<tr>
<td>RP</td>
</tr>
<tr>
<td>DR</td>
</tr>
<tr>
<td>&gt; CM should own it</td>
</tr>
<tr>
<td>&gt; DR jumps to concrete problem</td>
</tr>
<tr>
<td>&gt; Pulls him back saying “Hold on, we have about 30 decisions in there, let’s do one after the other”.</td>
</tr>
<tr>
<td>&gt; He brings ppl back to the 1st issue “Does everyone agree that CM owns the architectural document?”</td>
</tr>
<tr>
<td>&gt; He brings up 2nd discussion: HW requirements: Who’s responsible for that? Double responsibility Architect (OW) + DA</td>
</tr>
<tr>
<td>Again throws up concrete issue: “Does CM touch the environment or not?”</td>
</tr>
</tbody>
</table>

Structures info flows and decision gates
Agreement = accepting info and acting according to it

Again down to concrete question – different layer
RP cascades U that needs to be solved with one issue after the next – in contrast DR throws in concrete episodes / anecdotes to show problems
<table>
<thead>
<tr>
<th>RP</th>
<th>Also resorts to scenario/example “If this happenend… then… “</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mi</td>
<td>He sets the decision process and thinks the issue is solved</td>
</tr>
<tr>
<td>DA</td>
<td>--&gt;brings up concrete example of problem that can occur --&gt; they get lost</td>
</tr>
<tr>
<td></td>
<td>Suggests to walk through concrete instances, i.e. who’s responsible for what:</td>
</tr>
<tr>
<td></td>
<td>OW responsible for HW</td>
</tr>
<tr>
<td></td>
<td>RP adds layer below HW --&gt; organization</td>
</tr>
</tbody>
</table>

[Everytime RP comes up with a decision, someone comes up with a concrete episode which poses Q if this will work --> general decisions difficult if concrete instances not thought through? = U]

<table>
<thead>
<tr>
<th>RP</th>
<th>For case-by-case decisions (exceptions), RP states that he would like to see the process that every expert team comes up with concrete options and then they decide which option makes most sense</th>
</tr>
</thead>
<tbody>
<tr>
<td>DA</td>
<td>“We always decide as a group with all experts on the table.”</td>
</tr>
<tr>
<td></td>
<td>--&gt; Explains history of why things didn’t work like that</td>
</tr>
</tbody>
</table>

[Power: Democratic decision making / consultative – just pretending to be democratic to keep ppl involved?]

Next issue: Operation Systems Installation

Elicits what is involved in installing (Steps, Decisions to be...
RP  | Mike  |  RP
--- | --- | ---
Argues “If I’m responsible for keeping the server running, I should also be responsible for the instalment.”

Asks how things will work internationally when the servers stand in San Francisco, Singapore, etc.

Builds info decision base

Broader long-term interest than that of Mike to make more general decision than Mike would care about [two different views for the decision] --> {different priorities influence how ppl evaluate info --> RP different view than DR or Mike --> if ppl from different granularity = different info processing]

in the different times this issue was discussed before, it helped to clarify what the problems were, who was involved, what incidences happened before that needed to be encountered for the future -->prepared ppl's heads and consolidated info <-->

BUT: could a good lead not also have done this in just one well-managed meeting?
<table>
<thead>
<tr>
<th></th>
<th>The image on the blackboard gets more complicated than TM' image last week</th>
<th>[RP (RI) better in eliciting all implications than TM?]</th>
</tr>
</thead>
<tbody>
<tr>
<td>RP</td>
<td>Asks what contains the Dev Environment. He describes it and then says “Am I right TM?”</td>
<td>Ax</td>
</tr>
<tr>
<td>TM</td>
<td>“Not completely” --&gt; TM explains as-is process</td>
<td></td>
</tr>
<tr>
<td>RP</td>
<td>“Execution is done by CM Team. And that should stay like that in the future?”</td>
<td></td>
</tr>
<tr>
<td>TM</td>
<td>asks clarifying Q “Are we or are we…?”</td>
<td>Still Ax present</td>
</tr>
<tr>
<td>Mi</td>
<td>explains using the words “should” …explains, then asking “correct?”</td>
<td></td>
</tr>
<tr>
<td>Mo (RI)</td>
<td>clarifies “Are we talking… doing this…?”</td>
<td></td>
</tr>
<tr>
<td>Mi</td>
<td>“Yeah”</td>
<td>I ↑</td>
</tr>
<tr>
<td>Mi</td>
<td>Keeps throwing restrictions (facts) to clarify the picture and provide more info --&gt; more complete picture</td>
<td></td>
</tr>
<tr>
<td>RP</td>
<td>The higher they go up the responsibility levels of the drawing, the more fuzzy the discussion becomes</td>
<td>Again not all required info clarified --&gt; postpones decision till more info available or just avoiding?</td>
</tr>
<tr>
<td>TM</td>
<td>“So should we leave this open right now? We should not invent solutions.”</td>
<td>Brings it down to I2</td>
</tr>
<tr>
<td></td>
<td>Explains his vision of how he is thinking of doing it --&gt; while he does that, Mona points at DA, whispering they do it</td>
<td></td>
</tr>
<tr>
<td></td>
<td>“I think TM is in the right way here.”</td>
<td></td>
</tr>
<tr>
<td>Time</td>
<td>Activity</td>
<td></td>
</tr>
<tr>
<td>--------------</td>
<td>--------------------------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>14:00 – 15:30</td>
<td><strong>“Lessons Learned” Meeting for NOC R1 Developers team Leads</strong></td>
<td></td>
</tr>
</tbody>
</table>

MH (leads meeting), AS, TMch, DG, DR

MH (CO;TW)  
Sets process of the meeting. They use a meeting template that contains: **Topic | Description | Lessons Learned | Suggestion for improvement | Priority | Decision / Action to be taken**

They go through some issues that have already been put into the table and afterwards each person on the table adds their issues and the talk each column of the excel sheet through

<table>
<thead>
<tr>
<th>1. Issue “Assembler”</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>MH</td>
<td>Explains the issue --&gt; explains importance</td>
</tr>
<tr>
<td>TMch</td>
<td>Argues it was communication failure because the issue was not</td>
</tr>
</tbody>
</table>

Why did he not ask earlier? Didn’t dare or slower info processing rhythm?
| AS | finalized, never clarified so it went on inconsistently  
Agrees “mainly driven by communication issue” --> argues that clever guidelines were missing  
He also argues it was a wording issue – in the middle of dev word changed from ‘counter’ to ‘assembler’  
|  |  
|  | setting and certainty setting?}  
|  | I wonder why they only do this lessons learned with so few people  
| MH | 2. Issue “Searching, Data Fetching”  
“During the stand-up meetings I heard…”  
BO issue discussed, everyone gives their point  
- some points rejected by others’  
- common solution searched for “How can we…?”  
|  | [Info from other meetings]  
| AS | “Maybe we can find a better naming…”  
| MH | “I have one question regarding the performance issues. Daniel, you said it was because…?” (clarifying AS)  
| DR | “Yes” … he explains the issue  
| MH | “And the solution to that is?”  
| DR | “Either… or…”  
| MH | Clarifies missing info “SO we still do …. that's…”  
| AS | “No…” explains his understanding  
|  | ↓Up
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<tbody>
<tr>
<td>MH</td>
<td></td>
<td>“So is there sth we can do about it or should we just live with it?”</td>
<td>Directs info flow towards decision</td>
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<td></td>
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<tr>
<td>TMch</td>
<td></td>
<td>suggests solution “What about using a table where we sign in DTO’s?”</td>
<td>[meta talk, higher level, out of fine grid]</td>
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<tr>
<td></td>
<td></td>
<td>different idea “DTO’s are so cheap, we can just hard code them.”</td>
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<tr>
<td></td>
<td></td>
<td>“I would just like to point out…”</td>
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<td></td>
<td></td>
<td>He is trying to elicit from the others --&gt; trying to get them to take a different view by asking TRIGGER QUESTION: “Why do you think that BO’s are…?”</td>
<td>[trigger Qs as tools to get ppl to switch their mental models or views on a piece of information --&gt; more sustainable than just presenting the alternative view directly]</td>
</tr>
<tr>
<td>AS</td>
<td></td>
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(in some meetings the information flows go together towards one goal like water running from all sides down a round)
hole to a center point, in other meetings information flows stop solutions, contributions not flowing towards goal, interrupted by jumping to different issues, jumping time lines, etc.)

Questions to MH:
- How did u choose whom to invite to this meeting?
- What about lessons learned in terms of teams, mgmt, organization, coordination?

MH

3. issue “Learning curve for application framework low”

“Is this the case?”

Tries to analyze, breaks down Q to two issues --> client and server side

Clarifies assumption
[breaks info down --> easier for ppl who think and work structured like programmers – as effective and necessary for unstructured]
They finished going through all the issues that had been prepared already in the excel sheet

**MH**

“Any additional issues?”

**AS**

“Somehow we have to improve this communication thing. We have to do something about it.”

“And what is your proposal?”

“Tmch

“I don’t have a concrete idea. Maybe we should…” – he suggests a new implementation method

**MH**

“The question is whether the price we have to pay for this feature is too high.” Trade-off

**AS**

He doesn’t really bring to the point what concretely concerns him about a technology called “Spring”, he is just generally concerned

Trying to elicit info on what it exactly is. AS can’t bring it to the point so MH asks: “So if we would develop the next version R2 in the same way, you would…?”

**TMch**

“So you would go straight to the J2EE side without Spring?”

**AS**

“Yes”

**MH**

“Do you think using all these different features make it more complicated? Do you think it is even necessary for all of them to know the bigger picture or should they just do you small features and not care about the bigger context?”

(indirect approach to AS’ concerns)
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<tbody>
<tr>
<td>TMch</td>
<td>“I don’t think that everyone understands now all of the context.” He gives an example</td>
<td></td>
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<tr>
<td></td>
<td>asks to provide more specific issues for re-considering the use of spring</td>
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<tr>
<td>MH</td>
<td>Next issue presented by him: “Our module structure”</td>
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<tr>
<td></td>
<td>He gives examples: e.g. two modules being too similar so that they could be one (ReceiveTransport and Receiving)</td>
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<td></td>
<td>…</td>
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<td></td>
<td>…</td>
<td>he shows both extremes of info</td>
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<td></td>
<td>He argues there are too many modules but then says: “On the other side, I also see that only having one module is difficult”</td>
<td>defence? Reasoning for info and decision</td>
</tr>
<tr>
<td></td>
<td>Throws in decision reason for having that number of modules</td>
<td>evaluates info</td>
</tr>
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<td></td>
<td>Throws in <strong>concern</strong>: “I would be careful, if we deviate too far from business, it becomes hard to talk to them.”</td>
<td>parallel info, experience – example</td>
</tr>
<tr>
<td>DR</td>
<td></td>
<td></td>
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<tr>
<td>AS</td>
<td>Gives example of how not to do it next time from his last project</td>
<td></td>
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<tr>
<td>AS</td>
<td>Next issue presented by him: “Reference Implementation”</td>
<td>concrete example clarifies and specifies expected info and quality level</td>
</tr>
<tr>
<td></td>
<td>Implement a small piece that everyone can then use as a reference to see how it should be done</td>
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<tr>
<td>e.g. TMch “How about if next time we do…?” --&gt; answered a concern by DR</td>
<td>[ppl process the description of a problem into a potential better scenario]</td>
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<tr>
<td>Ppl set rules for info processing, e.g. AS “If this happens, then…”</td>
<td>[info flow “Weichen” --&gt; if, then, else]</td>
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<tr>
<td>Ask AS how he found the lessons learned session. Any surprises from what the others mentioned as lessons learned?</td>
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<tr>
<td>Superficially the meeting seemed very positive, calm, safe atmosphere – only few times ego defences shining through or was just everyone guarding their ground?</td>
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<tr>
<td>Ask MH what happens with the lessons learned list when it is completed?</td>
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<td>When DG is asked what he had for lessons learned, he said “most of this stuff was already mentioned like…” --&gt; he repeats 2 issues more info</td>
<td></td>
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<tr>
<td></td>
<td>things</td>
<td>weight? Majority rule</td>
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<tr>
<td>TMch</td>
<td>His lessons learned: He doesn’t like XML configuration. He explains what he means</td>
<td>[info of one individual can trigger other individuals’ info retrieval]</td>
</tr>
<tr>
<td>AS</td>
<td>“I agree”</td>
<td></td>
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<tr>
<td>MH</td>
<td>His lessons learned: “Coding / Naming conventions”</td>
<td>[open question: unbiased elicits other ppl’s attitude towards the issue]</td>
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<td>He asks “Is this an area that requires our attention?”</td>
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<td></td>
<td>What’s the outcome of the lessons learned? How are they used?</td>
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AS came to my desk telling me he had a phone conversation with Jutta Brinkmann (now he is also involved in trying to help with the endless fights between DR (CM) and the German test team)

- Vorwürfe alle schon mal gehört worden
- Team in Bonn Datei nicht geändert --> hatte techn. plausible Erklärung
- Frage DR beantwortet u. bezügl. anderer Sachen an andere Leute verwiesen
- Jutta ist verärgert – findet Verhalten momentan unangenehm
- DR mail und Frage beantwortet

16:00 Uhr Stammdaten mini-project status meeting
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<tr>
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<tbody>
<tr>
<td><strong>AS</strong></td>
<td>Tells what they do, gives status update</td>
<td></td>
<td>[Q can indicate to other speaker that person who asks cannot follow; content of Q can indicate which grid level person is in or what basic knowledge is missing for them to follow]</td>
</tr>
<tr>
<td><strong>RP</strong></td>
<td>Asks clarifying question --&gt; takes AS back a step, so that AS realizes he cannot follow</td>
<td>Ask AS how the project is going, what problems they have, what they miss in terms of support, what to do better in cooperation, info flows, not enough info?</td>
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<tr>
<td><strong>AS</strong></td>
<td>Gives example for a problem they are currently working on</td>
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<td>Plan for the next weeks</td>
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<td>Difficulties they have</td>
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<td>RP</td>
<td>He clarifies their scope of work, i.e. “Sollen wir auch... übernehmen?”</td>
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<td>-------------------------------------------------------------------------</td>
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<tr>
<td></td>
<td>“Nein.”</td>
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<td></td>
<td>“Ok, ich wollte das nur klar fragen.”</td>
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<tr>
<td>RP</td>
<td>Clarifies „drei verschiedenen Arten von Aufträgen existieren“</td>
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<tr>
<td></td>
<td>He splits info</td>
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<td>AS</td>
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<td>I’m only looking at oral communication at the moment – i miss e-mails,</td>
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<td>subversion, wikki - -&gt; need to download these</td>
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<tr>
<td>AS</td>
<td>Uses meetings to collect information (questions – missing !) and</td>
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<td>asks RP so as to complete his MM of the scope of the projects, the</td>
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<td>interrelations, expectations</td>
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<td></td>
<td>Question to RP: “Hälst du für sinnvoll was wir hier machen?” --&gt;</td>
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<td></td>
<td>bekommt Evaluation vom Nutzwert --&gt; setzt ein dreimonatiges Zeitlimit</td>
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<td></td>
<td>um nochmal den Sinn zu evaluieren. [lets info grow and settle and then</td>
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<td></td>
<td>reevaluates it]</td>
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<tr>
<td>AS</td>
<td>States that the people don’t use him --&gt; indirectly he states that the</td>
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<td></td>
<td>people don’t know that he is there and donÂ’t ues him - they also don’t</td>
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<tr>
<td></td>
<td>know what he is good for</td>
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<thead>
<tr>
<th>RP</th>
<th>Explains AS's function to him with the use of an example: “Wenn jemand lieber selbst Daten verwaltet als eine Schnittstelle zu bauen, da must du einschreiten.”</th>
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<td></td>
<td>I ask AS after the meeting how he felt about it: He stated that he knows that RP is always fast and short, so he prepared the meeting well and put clear questions together. He said he got the answers he needed and it was good for going on now</td>
</tr>
<tr>
<td></td>
<td>[prepared to match RP’s information exchange pattern / habits]</td>
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</tbody>
</table>
Bibliography


ANSSTAND e.V., 2006. *V-Modell XT version 1.3*.


Flanders, N. 1970. *Analyzing Teaching Behavior* Addison-Wesley


