The appropriateness of using the living systems theory by James Grier Miller as a diagnostic tool

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I hereby certify that all material in this dissertation which is not my own work has been identified and that no work is included for which a degree has already has been conferred on me.

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Abstract

This work is a research in the field of systems science, emphasising the importance of applying models and theories that have been developed in this area. This work studies the possibility of using James Miller’s living systems theory (LST) as a diagnostic tool. The application area was project management processes used when developing computerised information systems. The focus on the analyses was on the critical subsystems that process information. Based on this study it was found that LST function as a diagnostic tool according to the following criteria: it was possible to identify the critical subsystems in the application, the critical subsystems covered relevant information flows in the application and LST could make a unique contribution in the analyses of the application.

Keywords: Living systems theory, Group, Diagnostic tool, Information processes

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1 Introduction

In 1978 James Grier Miller presented living systems theory (LST). A theory that, according to Miller, functions as a general theory for all systems that wants to be accounted for as having life. Several researchers in the systems theory community (Linstone 1993, Holmberg 1995, Taormina 1991, etc.) have expressed the need to find ways to apply system theories and thereby give more legitimacy to the systems theory research area. The aim of this work is to investigate the appropriateness of applying LST as a diagnostic tool. The application is project management processes when designing and developing computerised information systems. This study will analyse Miller's critical subsystems with a focus on the information processing critical subsystems and their connected processes. An analysis of the specific application situation will also be carried out and finally LST will be applied to the investigated situation.

This work is an attempt to examine and analyse LST in a real world situation and to see how LST can contribute to the analysis of the flow of information in project management processes when developing computerised information systems.

2 Background

In this chapter a brief explanation of what systems science is will be described followed by a presentation of Miller’s LST, which is the main theory in this work. A discussion about the growing need for finding ways to apply systems science in real world situations will then follow. Finally, the information flow in management processes when developing information systems will be addressed, since this is the application area for this work.

2.1 What is Systems Science?

According to Klir (1991), systems science is the field of scientific inquiry whose objects of study are systems. In order to understand what this means it is necessary to explain what a system is. A system is a set of related elements in an organised whole (Flood & Carson, 1993). This means that there are elements grouped together that has relations to each other and interact with each other in some way or another, and the constitution of these elements and interactions is seen as a whole. Ackoff (1981) has a similar definition of a system. A system is a whole that cannot be divided into independent parts. This means that every part of a system has properties that it loses when separated from the system and that every system has some properties, the essential ones, that none of its parts have (Ackoff, 1981).

An important concept, when talking about wholeness, is emergence, since these two concepts are tightly coupled together. Emergence is something that happens when the whole is greater than the sum of its parts (Flood & Carson, 1993). Systems science is therefore the study of systems seen as wholes. This means that systems theory has a holistic approach when confronting systems. Having a holistic approach means that one does not only focus on the system at hand, but also on other systems in the environment and the impact these systems have upon the system under study (and what impact the system under study has on the surrounding systems, not to be forgotten). The systems are thus seen as open (exchanging material, energy and information with its environment across a boundary) and interacting with its surroundings. The main initiator of a general theory for systems science is recognised as Bertalanffy (1969). Bertalanffy´s work on his General Systems Theory (GST) in the 1940´s was based on the idea that homologies exists between disciplines that traditionally had been considered as being separated by their different subject matters (Flood & Carson, 1993).

Since then the systems research community has brought forth several important theories and models that have had important bearing on bringing the systems theory idea forward. One of them is James Grier Miller who in 1978 presented his living systems theory (LST).

2.2 The Living Systems Theory

Living systems theory (LST) is a general theory about how all living systems function, how they preserve themselves and how they change and develop. LST is thus a conceptual framework for identifying and defining important functions and processes that should be applicable to all living systems that is of interest to study, from the individual cell to systems of national magnitude.

LST has made important contributions to the field of systems theory. As György (2000) puts it:

> *"Living systems theory (LST) has enabled many of us to see the extreme complexity of living reality in a much clearer way and has served as an important framework for further discovery in the vast area of living systems" (pp. 289).*

According to Miller (1995), van Gigch (1991), Flood & Carson (1993) and others, living systems are open and self organised systems that have the special trademarks of possessing life and interacting with its surroundings. Self organised and open systems are also called autopoisesis, a system property according to which a system is self-renewing and where the product of the system is the system itself (van Gigch, 1991). This is done from the information and materia-energy interchange with other systems. A living system can be as simple as an individual cell and as complex as a supranational organisation (e.g. the European community). Despite the degree of complexity, all living systems depend, to different degrees, on twenty essential subsystems (or processes) for their survival (Miller, 1995).

Some of these subsystems handle materia (materia will from here on be called matter, according to Miller, 1995) and energy for the metabolic processes. Others handle information in order to co-ordinate, manoeuvre and control the system. Some subsystems handle both matter/energy and information. If the process of matter/energy and information ceases to exist, so will also the system. The distinctive features for life is the ability to maintain, during a period of time, a steady-state where the disorder in the system is within the boundary of the homeokinetic plateau (van Gigch, 1991). Living systems can maintain the steady-state criteria because the systems are open and self-organising and have the ability to take up and process information and mater/energy from its surroundings.

LST postulates that systems possessing the essential characteristics of life exist at eight levels: cell, organ, organism, group, organisation, community, society and supranational systems (Tracy, 1995). These different levels consist in their turn of different critical subsystems that are more or less critical to these levels in order for them to be able to exist (Tracy, 1995). These critical subsystems are twenty in number and they handle matter/energy and information. These critical subsystems are found to exist at all of the eight levels (Tracy, 1995). But not all of the critical subsystems handle all these three characteristics. Half of them handle information and the other half handles matter and energy, and two of them handles both information and matter/energy. The levels mentioned are eight and consist of cell, organ, group, organisation, community, society and supranational system (Miller, 1995). The ten critical subsystems that handle matter and energy are reproducer, boundary, ingestor, distributor, converter, producer, matter-energy storage, extruder, motor and supporter and the ten critical subsystems that handle information are input transducer, internal transducer, channel and net, timer, decoder, associator, memory, decider, encoder and output transducer (Miller, 1995). The two critical subsystems that handle both information and matter/energy are the reproducer and the boundary (Miller, 1995).

2.2.1 The levels of Living Systems Theory

Everywhere in universe hierarchies of systems exists. Each of the systems are more advanced, or at a “higher level” than the system below it (Miller, 1995). It is at the level of the cell that life begins. All systems “lower” or that has a constitution that is “simpler” than the cell can not, according to Miller (1995), be considered as living. Miller (1995) has identified eight levels ranging from the cell to supranational systems, all considered as having life. The number of levels was increased from seven to eight by the addition of the level of the community (Miller & Miller, 1992). The level of community will be explained under *2.2.1.1 The level of Community*. The levels are:

1. *Cell.* A cell is a minute, unitary mass of intricately organised protoplasm. All living systems are either free-living cells or have cells as their least complex living components (Miller, 1995).
2. *Organ.* Subsystems of organisms, animals or plants. A part of the body (system) having a special function that in most cases are vital for the systems survival. The organ can not survive outside the organism by itself, although some tissues can be kept alive for varying lengths of time outside the organism if the temperature and chemical environment are like their usual surroundings (Miller, 1995).
3. *Organism.* The size of the systems at this level ranges from microscopic plants and animals to giant trees (Miller, 1995). Human beings belong to this level.
4. *Group.* A group is a set of single organisms, commonly called members, which over a period of time or multiple interrupted periods, relate to another face-to-ace, and processes matter-energy and/or information (Miller, 1995).
5. *Organisation.* Organisations are systems with multiechelon deciders whose components and subsystems may be subsidiary organisations, groups, and (uncommonly) single persons (Miller, 1995).

An echelon is a level at which deciders exist. In the same system there can be different deciders, but they are (mostly) at different levels (echelons) within that system.

1. *Society.* A society is a large, living, concrete system with organisations and lower levels of living systems as subsystems and components (Miller, 1995).
2. *Supranational system.* A supranational system is composed of two or more societies, some or all of whose processes are under the control of a decider that is superordinate to their highest echelons (Miller, 1995).

2.2.1.1 *The level of Community*

LST had from the beginning only seven levels since the difference between a community and an organisation was not big enough to justify that community should be seen as a level of its own (Miller, 1978). Anderson & Carter (1974) did not agree with Miller on this point. They suggested that communities, like cities, rural districts or metropolitan areas are not organisations but a higher level of living systems, placed between organisations and societies (Anderson & Carter, 1974). Miller (1978) meant that many communities are themselves organisations, such as banks, schools, hospitals, etc. Communities do not seem enough unlike organisations to be classed as a different level (Miller, 1978). Later, Miller changed his point of view and in 1992 Miller & Miller published the *article Cybernetics, general systems theory and living systems theory* in which the level of community was accepted. Today LST consists of eight levels.

The fundamental processes involved in the functioning on one level are basically the same as in all the other levels (Merker, 1985). It is these fundamental processes (called the twenty critical subsystems) and the eight levels that form the basis of LST. LST is unique in that it is the only framework in which all known processes necessary for system functioning have been identified. This focus on the critical processes of a system differs from traditional approaches which focus on the activities and the structures of, say, organisations or groups (Merker, 1985). A living system processes inputs of information and matter/energy. This processing, performed by the twenty critical subsystems, consists of bringing in, changing, storing and sending out various types of information and matter/energy. The types of inputs, throughputs and outputs processes by the system depend on the particular system and its purpose (Merker, 1985).

2.2.2 The critical subsystems of Living Systems Theory

Miller´s twenty critical subsystems will be presented in the sequence mater/energy subsystems followed by information subsystems.

Matter/energy subsystems:

- A living system is, according to Miller (1995), van Gich (1991), Flood & Carson (1993) and others, an open system. This means that there is a possibility for matter, energy and information to flow into and out of the system. The system is so surrounded by a border that can open and close if needed to. This is realised by the *boundary subsystem* (Miller, 1995). The boundary subsystem is thus the subsystem that holds the components of the actual system together, protects the organisation, and permits various sorts of information and matter/energy (Merker, 1985).

- *Ingestor and extruder* are the subsystems responsible for importing and exporting matter and/or energy into and out from the system (Miller 1995, Merker, 1985).
- In some cases the systems can reproduce itself, sometimes on their own, sometimes in co-operation with other systems (Miller, 1995). But there are also systems that cannot reproduce themselves at all. Not even with the help from other systems. So the subsystem that handles the reproduction, the *reproducer*, does not always exist in every system (Merker 1985, Backlund 2000).
- Once matter/energy is inside the system, it must be moved or carried about to parts of the system where it is needed or stored. This process is carried out by the *distributor subsystem* (Merker, 1985).
- In some instances matter/energy entering a system may not be in a proper form to be readily used by the system. If it is not, it must be transformed through some kind of converting process (Merker, 1985). This process is carried out by the converter subsystem (Miller, 1995).
- Every system that has a purpose always produce something, being it something that the system needs for the systems own existence or something that should be extruded from the system. The *producer* subsystem handles growth, repair damage upon the system, replaces components and provides the energy that is being needed to move the systems outputs of products (Miller, 1995). It also provides for health and welfare of system members (Merker, 1985).
- When the system has gathered mater/energy, the system must be able to store it. *Mater-energy storage* is the process that stores matter/energy in the system over time (Miller 1995, Merker 1985).
- The *motor* is the subsystem that moves either the whole system or parts within it in the physical space, in relation to its environment and itself (Merker, 1985).
- All physical systems that takes up space in some form always has a physical body that must have some support that prevents it from collapsing. The *supporter* subsystem enables that support, but the supporter also maintains the spatial relationships among components in the system (Miller, 1995). It also provides rigidity to the system. The support is accomplished by buildings, floors, walls, desks, dividers, etc. (Merker, 1985).
- All systems have some sort of executive system, which receives information from all other subsystems and in return transmits to them information for guidance, co-ordination and control of the system. This is realised by the *decider* subsystem (Miller, 1995).

Each and every one of these subsystems exists at each of the eighth levels, but the contribution and the importance of each subsystem can be different among the levels. As mentioned above, not all levels have a reproducer (Backlund, 2000), thus not all levels have all possible subsystems. The reproducer subsystem is not needed in all systems once the system has been established (Merker, 1985). The systems differ individually, among types and across levels, depending on which subsystems they have and how these subsystems are constructed (Miller, 1995). But all living systems has either a complement of the critical matter/energy subsystems that carries out the functions that are essential for life, or the system have some kind of intimate association and interchange with other systems that carries out the missing and matter/energy processes (Miller 1995, Merker 1985). Now, it is not enough for a system to just possess the matter/energy processing systems, since the materia and the energy in the system must have some kind of guiding system that tells the system to do with the materia and the energy. How should the materia and energy be used, stored and processed and how should the system be able to communicate with the surrounding systems? To be able to do this the system needs information processing subsystems.

Information subsystems:

- For the system to be able to communicate with its surrounding systems, the system must be able to take in and extract information. This is realised by *the input transducer subsystem* (Miller 1995, Merker 1985).
- But not all information originates from outside the system. Some of it enters the information channels from inside the system through the *internal transducer subsystem* (Merker, 1985). The internal transducer is an information handling subsystem that receives from subsystems or components within the system information about significant changes in these systems or components, and changes them into other types of mater/energy forms that can be of use to the subsystems or components (Miller, 1995).
- Information not readily usable by the system is translated or decoded by the *decoder subsystem* (Merker, 1985).
- The *timer* (first introduced in Miller, 1990) subsystem functions as the time co-ordinator in the system. The timer transmits to the decider subsystem information about time-related states of other subsystems and components or processes within

the system. The timer also times co-ordinates the decider of the system to deciders of subsystems (if they exists).

- When information enters the system it must be distributed to various processes in the system. The *channel and net* subsystem has the function as the distributor in the system (Miller 1995, Merker 1985).
- The *associator subsystem* manages the first stage of the learning process and involves the formation of enduring associations or relationships between items of information (Merker, 1985).
- The *Memory subsystem* allow storing of the information within the system (Merker, 1985).
- The *decider subsystem* controls and regulates the system (Merker, 1985). All decisions of some importance to the system goes through the decider process (Miller, 1995).
- The *encoder subsystem* changes the information from the systems code to a public code that can be understood outside the system (Merker, 1985).
- Once information is encoded (prepared for release) it is sent from the system by the *output transducer subsystem* (Merker, 1985).

These subsystems work in conjunction with the matter/energy processing subsystems in forming the necessary abilities that a system must have in order to function as a living system. It is the same with the information processing subsystems as it is with the matter/energy processing subsystems, it is not so that all levels contain all of the information subsystems (Miller, 1995). But just as with the matter/energy subsystems the system contains either a complement of the critical information processing subsystems that carries out the functions that are essential, or the system have associations and interchange with other systems that carries out the missing and vital information processes (Miller, 1995).

2.3 Living systems and mortality

Since this work is concerned with information systems development processes and since these kind of systems, as all living systems, is mortal and subject of threatening pictures, difficulties and obstacles must be dealt with for the system to stay alive. It is thus important to mention functions that serve as threatening to the system and its survival.

LST is not only concerned with the attributes and functionality of healthy living systems, but also with aspects that function as menacing for the system (Tracy, 1992).

Processes that function as menacing for the system must be exposed and outlined, in order to find ways of dealing with them in appropriate ways. These malfunctions can cause the system to go towards states that is pathological. LST makes it possible to determine whether the condition of a system is pathological, by establishing a set of situations that, if not dealt with in time, functions as mortal for the system (Miller, 1995).
Miller & Miller (1991) has identified eight such situations:

1. Lacks of matter or energy inputs
2. Excesses of mater or energy inputs
3. Inputs of inappropriate forms of matter or energy
4. Lack of information inputs
5. Excesses of information inputs
6. Inputs of maladaptive genetic information in the template
7. Abnormalities in internal matter or energy processes
8. Abnormalities in internal information processes

Examples of each of these pathological situations are here given from the project management view (since this work is concerned with information systems development processes).

1. *Lacks of matter or energy inputs:* The equipment needed for the project did not arrive when agreed upon (computers, hardware, laboratory equipment, etc.).
2. *Excesses of mater or energy inputs:* Too much material and equipment arrived and had to be sorted with (equipment must be sent back to the supplier, invoices had to be corrected and revised).
3. *Inputs of inappropriate forms of matter or energy:* The wrong kind of equipment arrived for the project (the wrong hardware or software, computers, laboratory equipment, etc.).
4. *Lack of information inputs:* The project manager does not get the needed information in time during different phases in the project.
5. *Excesses of information inputs:* The project manager gets too much information from various sources and finds it difficult to screen out appropriate information from inappropriate information.
6. *Inputs of maladaptive genetic information in the template:* The account manager finds irregularities in the bookkeeping.
7. *Abnormalities in internal matter or energy processes:* When the computerised production system was implemented, the system broke down and an analyse shows the new system had some incorrectness in the code.

8. *Abnormalities in internal information processes:* A further investigation shows that the incorrectness in the code was due to some misunderstandings in the mapping of the new production flow.

In order to keep the system within its preferred steady-state and thus not allow the system to go beyond the thresholds of the homeokinetic plateau, it is important to expose and define all the different situations who functions as threatening to the system (van Gigch, 1991). Dealing with living systems does not only concern dealing with the critical subsystems that is important for life, but also with the different pathological states that is threatening to life (Miller, 1995).

2.4 The need for applications of systems science

In recent years a request concerning the application of systems theories has emerged among several of the researchers in the systems theory community. There exists an expressed need for finding ways to apply system theories to real complex and 'messy' situations in the world and so strengthening and give more legitimacy to the systems theory research area. Linstone (1993) for instance, has expressed the need for brand new system theories that "focus on new thinking in both theory and praxis relevant to messy real-world problems" (pp. 293). There are also others that have addressed similar thoughts and demands particularly to LST.

Holmberg (1995) for instance, means that the applications of LST has been limited to an academic group of researchers and one can se very little or no impact of the theory in the world of professional practitioners. Holmberg (1995) also means that there has been little work for developing supporting methodologies and tools. LST is a versatile and powerful theory, but it still needs to be made more operational and application oriented.

The aim of this work is to examine the appropriateness of using Miller´s LST as a tool for analysing management processes when designing and developing computerised information systems. This work is thus an attempt to investigate the ability of making LST more operational and application oriented in the area of project management situations.

2.5 Information systems management processes

2.5.1 What is information and what is data?

When discussing information systems it is of importance to clarify what information really is and the difference between information and data. The term information is used in many different ways, and has different meanings to different groups of people (Langefors, 1995). Information has been defined as something that reduces uncertainty. That is, when information makes it easier for a decision-maker to make the decision, the information has reduced the decision makers level of uncertainty (Langefors, 1995). But in this perspective, information is tied to the relevance of the knowledge to the decision to be made. Knowledge that has no bearing on the problem at hand will not reduce the uncertainty associated with the problematic situation (Langefors, 1995). This means that not all information is really knowledge. Information is something that bears with it some kind of meaning to the user of the information.

Information is knowledge and not physical signs and we inform by communicating knowledge (Langefors, 1995). Data, in turn, is these physical signs that we use to communicate the information. These data signs are being sent from the sender to the receiver. The receiver must then be able to interpret the signs in such a way that the received message has the same meaning for the receiver as it had for the sender. Otherwise the sender and receiver can not communicate properly. This leads us to the infological equation. The infological equation (Langefors, 1995) is an equation that states the difference between data and information:

$$I = i(D, S, t)$$

D = the data that represents the intended information
I = the information (or knowledge) produced from the data D
S = the pre-knowledge of the receiver
i = the interpretation process
t = the time available to the receiver for interpreting the data D

(Langefors, 1995, p. 144)

The equation shows that people who interpret the data are included in the information system. Langefors (1995) means by this that data is not the same as information because there is a significant interpretation process involved when understanding the data. Langefors (1995) thus means that a data system must be combined with people in the organisation before an information system emerges.

Miller (1995) has a somewhat different view on information. When Langefors (1995) means that cognitive performance function as the basis for information, Miller (1995) means that is a question of “meaning”. Information carries with it a meaning. Miller (1995) is inspired in his definition of information by Shannon (1949) definition of information; information is the data that is transmitted between the sender and the receiver. The data is the same whoever (or whatever) sends it or receives it. To me it seams that if information is defined according to Shannon (1949), information is something that is unambiguous and precise irrespective of whoever reads (or in other ways takes in) the information. Information is therefore something universal and synonymous for each and everyone. But does different people really interpret the same information in the same way? Is it not so that different people have different pre-knowledge that influence the meaning of the information? Even though Langefors (1995) definition of information seems more appealing and accurate than Miller´s (1995) definition of information, for this work Miller´s (1995) definition is used. This is due to the fact that if one uses another definition than Miller (1995) uses, this could have affects on the meaning of the critical information handling subsystems that Miller (1995) neither has meant nor predicted.

2.5.2 Computerised Information Systems – a definition

Since this work is about management processes used when developing and designing computerised information systems, it is important to define what is meant by computerised information system in relation to information systems to avoid any misunderstandings between the two concepts.

According to Euromethod (1996), Information Systems (IS) is defined as the aspect of the organisation that provides, uses and distributes information. It is so an aspect of a human system, possibly containing computer systems, automation certain elements.

Also according to Euromethod (1996), Computerised Systems (CS) is the automated part of the information system. It may contain one or more computers or peripherals, and software that perform data processing. Hicks (1993) has a definition of information systems that is similar to Euromethods (1996) definition of a CS; an information system (IS) is a formalised computer system that can collect, store, process and report data from various sources to provide to provide the information necessary for managerial decision makers. Also Aktas (1987) and Kendall (1992) has definitions similar to Euromethods (1996) CS, but the difference is that Hicks (1993), Aktas (1987) and Kendall (1992) all calls it an IS.

One can from this see that there are major differences between an IS and a CS. An IS includes humans and the interventions they have with the system. An IS thus has the human activity system (Checkland, 1981) as a part of the IS. Human activity systems mean that people are involved in the IS. They use and affect the IS in a number of, not always predetermined ways, and this makes an IS difficult to build in ways that satisfies as many parties as possible in the organisation (Avison & Fitzgerald, 1995). A CS is the more technical part of the IS and can thus be seen as a subsystem of the IS (since most IS have computers and the like as parts of the system). A CS is also affected by human activity systems, but to a lesser extent. This is due to the act that many CS is autonomous to different degrees. Being autonomous means that the system is self-regulating to a great extent. The system is thus capable to adjust itself by feedback and feed forward inputs to the system.

This work is concerned with the project management processes used when designing and developing computerised information systems. This entails both systems with a high degree of human activity (administrative systems) and more autonomous systems (productions systems). For this work a definition will be used that captures a meaning of computerised information systems that better fits this the applied situation. According to Ahituv and Neumann (1990): *a Computerised Information System (CIS) is one of the components (or a subsystem) of an organisation and the components of this system are people, hardware, software, data and procedures. The organisational information system thus collects transmits, processes and stores data. It also retrieves and distributes information to various users in the organisation (Ahituv & Neumann, 1990).*

2.5.3 The management process of developing information systems

The main role of information systems development processes is to develop effective information processing systems in the most efficient ways (Jayaratna, 1994). The process of information systems development has during many years been seen as a broadly linear pattern of tasks that shall be completed (Avgerou & Cornford, 1993). The systems development life cycle model (SDLC) emerged as the dominant framework to structure the tasks of computer-based systems development in the 1960´s. Over this period the SDLC model has been used to provide a basis for rigorous development processes (Avgeou & Cornford, 1993). This simple model has been extensively used for more than 30 years and has given shape to the practices of systems development (Jayaratna, 1994). For most of those involved in information systems development, the SDLC model is appealing not so much for its rigour, as for its simplicity. Developing information systems today are recognised as a much wider process than just the engineering of computer software.

Even if the efficiency and correctness of software systems under development remains a very real concern, it is not engineering rigour which is valued most, but the ability to manage effectively the long and complex development process (Avgeou & Cornford, 1993).

When developing an information system there are mainly two kinds of management processes that occur. The management process that first comes to mind is the management process of the actual building of the system. This means managing the design, development, building and testing of the system. This is done by the use of development methods like the waterfall model which has its origin in the SDLC process (Boehm et al. 1977), and lately the spiral model (Boehm, 1988).

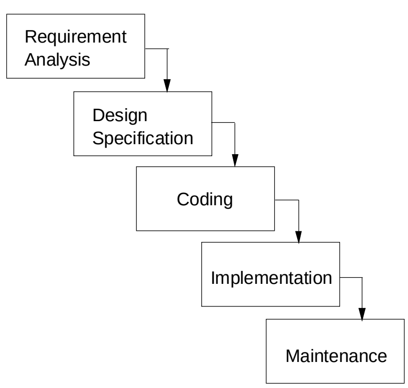

Figure 1. The waterfall model (Boehm et al. 1977).

The spiral model has a strong focus on iterating between all of the stages of the development process. The focus on iterating between the different stages of development in the spiral model is stronger than in the waterfall model (Boehm, 1988).

No further explanation and discussion about the spiral model will be conducted in this work, since the development method used at Volvo IT belongs to the family of waterfall models, thus it is the waterfall model that is of interest in this work. The utilised development method at Volvo IT will be further explained and discussed in section *6.3 The AU-model*.

These models describe the different stages that one must go through in order to secure the quality and reliability of the information system. These stages are of concern to the project manager, programmers, designers and others that is involved in the actual building of the system.

The other management process is the process of managing (or controlling) the project of developing an information system. This means that it not the process of managing the actual building of the information system that is of concern, but the process of managing the project of building an information system. The managing of a project concerned with building an information system is something that does not concern the programmers, designers and developers etc. But it concerns the department manager, the project manager, the account manager, the customer and others that hold a managerial position and is in some way is involved or responsible for the project.

Just as when managing the design and development of the information system, the managing of the project must have some kind of model or method in order to secure the quality, progress and advancement of the project. The utilised project management method at Volvo IT also belongs to the family of waterfall models. The project management method will be explained and discussed in section *6.2 The PCM-model*.

For this work I will claim that the process of managing information systems development projects experience a life cycle. By that I mean that the management process also experience a birth and a death and life in between. The management process is in fact similar to a living system. A management process is something that is initiated, has a goal, performs a process, have parts that interacts and is eventually terminated. These are some of the criteria's that living systems has, according to Miller (1995).

3 Aims and objectives

The aim of this work is to examine the appropriateness of using Miller´s LST as a diagnostic tool for analysing the flow of information in project management processes when designing computerised information systems. *Miller's group level is of interest here, since most projects is done using the group constellation.*

To reach this aim three objectives have been specified. They are:

- Describing and analysing Miller´s critical subsystems at the group level
- Describing and analysing a project management process used when developing a computerised information system. *The focus of the analyses is on the critical information processes and transformations.*
- Analysing the consequence of applying LST to a project management process when developing a computerised information system

The analysis is based on finding Miller's critical information processing subsystems in the applied situation and on assessing the application based on the specifications given by Miller.

As a measure of how well LST is appropriate to use as a tool for analysing management processes when developing information systems, some criteria have been specified that must be fulfilled:

- It must be possible to identify the critical information processing subsystems in the applied business
- The critical information processing subsystems must take into consideration such information flows that are significant in the application
- The transformation of the critical information processing subsystems shall, when analysed, make contributions that would not have been possible if LST would not be applied

4 Methods

In this section different research methods are discussed. Short descriptions and brief evaluations of possible methods are presented. Selected methods are then discussed.

4.1 Different research methods and techniques

In order to conduct good research serious efforts must be done in finding the appropriate methods in order to find answers to the questions one has. Several research methods are presented in the literature. Patel and Davidsson (1994), Shaughnessy and Zechmeister (1997) and Dawson (2000) all present ways of conducting research. Methods like experiments, action research, case studies and surveys are examples of different research methods, but for this work, a case study are the research method that will be used. Techniques to collect data are the use of questionnaires, conducting interviews, conduct observations and searching and evaluating the literature. A short description and evaluation of the research methods and techniques mentioned are given in order to clarify how these different methods and techniques work, and why a case study as a method and interviews, observations and literature studies as techniques are selected for conducting this work.

Experiments are suitable when one for example is trying to study the behaviour of people in a given context. This approach is often used in psychology research because in this research area one is often interested in studying behaviours of people which they are not aware of themselves (Shaughnessy and Zechmeister, 1997). In this work it is not interesting to do experiments, since we are not interested in setting up situations where the behaviour is studied, thus conducting experiments is not a suitable method for this work.

In *action research* the researcher is participating in the actual work that are studied (Shaughnessy and Zechmeister, 1997). The researcher is involved in solving a problem or to change a situation. This could involve working in an organisation of any kind and evaluating the result. In this work the aim is not to be contributory in a systems development project in the way one must to be able to carry out action research, thus action research is not a suitable method for this work.

A *case study* is an intensive description and analysis of a single individual event or case (Shaughnessy and Zechmeister, 1997). A group, a person, an organisation or some kind of process is studied during a shorter or longer duration of time through observations, interviews or tests (Dawson, 2000). Since this work is about how a group works together when conducting an information system development project, the case study approach is a suitable research method to use.

Surveys are usually undertaken through the use of questionnaires or interviews. By using questionnaires, which is a technique to collect data, many persons can be reached. The disadvantages is that some people are often reluctant to answer the questionnaires (Dawson, 2000). This means the one does not always reach the number of answered questionnaires that one hoped for. Using questionnaires is not a suitable technique for this work.

By conducting interviews, which is another technique to collect data, a greater understanding of how people think may be obtained - why they think in that way, how they do things etc. The advantages of using personal interviews are as follows. The personal interview allows greater flexibility in asking questions than does the surveys through questionnaires (Shaughnessy and Zechmeister, 1997). The interview also allows the respondent to obtain clarification when the questions are unclear and the trained interviewer can follow up incomplete or ambiguous answers to open-ended questions (Shaughnessy and Zechmeister, 1997). This is a suitable research technique for this work, since this work is focused on how members in a group interact with each other and work together. For further reading about interviews, the reader is referred to *4.2.1 Interviews*.

Observation is also a technique for collecting data. Observation means that the observer observes and makes records of what happens in the applied situation. This is a suitable research technique for this work. Since there is no possibility to follow an entire information systems development project due to the restricted amount of time accessible for this project (information systems development projects can take several months to complete, sometimes years), only a special kind of observations will be conducted. An explanation of the chosen method of observation, and other methods, is described in section *4.2.2 Observations.*

A *literary study,* which is a fourth technique to collect data, differs from the above research methods in an essential way, the absence of respondents. The material comes from books and articles and the documents are studied and analysed. The ideas, theories and outcomes of the documents are critically analysed and evaluated in order to find similarities, differences or new ideas that enriches the research area (Dawson, 2000). This is a suitable research method for this work. For further reading on literary studies, the reader is referred to section *4.2.3 Literary studies*.

4.2 Selected method and techniques

A case study is selected as the research method that will be used when dealing with the aim and objectives of this work. The techniques to collect the data are interviews, observations and literature studies. The aim of this work is to examine the appropriateness of using Miller´s LST as a tool for analysing information systems development processes. It is necessary to study the literature in order to reach the objectives of this work. The objectives to reach are:

- *Analysing Miller´s critical subsystems at the group level.* The living system theory is a theoretical framework for identifying and analysing living systems. In order to analyse the theory itself the literature in the area must be studied and analysed.
- *Analysing an information systems development process used when designing computerised information systems.* A literature study is important when analysing the system development process in this work since the system development process first must be studied and then analysed in comparison with other similar systems development methods.
- *Analysing the consequence of applying LST in the process of designing a computerised information system.* In order to do so conducting interviews and observations is important. Interviews give the researcher a chance to ask questions to the respondents that are open-ended and allow the researcher to adjust the questions as more knowledge is gained about the systems development process. Observations give the researcher a chance to observe the group and how they interact with each other in different phases of the information systems development process.

4.2.1 Interviews

When conducting interviews there are mainly two things one must think of. First one must much consider how much responsibility that the interviews shall have when it comes to the design of the questions and reciprocal order. This is called standardisation (Patel & Davidsson, 1994). One must also consider to what extension the respondent is free to interpret the questions based on his or her own point of view or previous experiences. This is called degree of structuring (Patel & Davidsson, 1994).

Interviews with a low degree of standardisation are made when the interviewer himself formulates the questions during the interview and arranges the questions in the order that is suitable for a certain respondent. If one conducts completely standardised interviews one asks the same questions in the same order to each respondent. If one wants to compare and generalise the outcome of the interviews standardised interviews are used. These kinds of interviews are easy to measure due to the standardised format (Patel & Davidsson, 1994).

When it comes to the degree of structuring it is about the space that the respondents gets for responding to the questions. A completely structured interview leaves very little room for the respondents to answer and one can predict which alternative answers that is possible. In an unstructured interview the questions leaves maximum space for the respondent to answer (Patel & Davidsson, 1994).

There is also the possibility to use a mixture of high and low degree of standardisation and a high and low degree of structuring. The disadvantage of interviews is that the interviewer depends on two things; first, the willingness of the respondents to attend the interview, and secondly, the willingness of the respondents to answer the questions in a way that really makes a contribution to the study (Patel & Davidsson, 1994). This means that one must motivate the respondents in some way. Sometimes some kind of reward is used, but when conducting interviews at peoples workplaces the best way to motivate the respondents is to explain the reason for the study and the benefits that may be obtained by the study and possible contribution the interviews have on the respondents working environment.

4.2.2 Observations

Observational methods can be classified according to the degree to which an observer intervenes in an observational setting as well as according to the way in which that behaviour is recorded (Willems, 1969). One distinguishes between observation with intervention and observation without intervention. Observation with intervention means that the observer in some way intervenes in the situation that is observed.

In order to reach the aim of this work there is no need to manipulate any situation or in any way interfere when doing the observations. Observation with intervention is a technique of collecting data that will not be used in this work.

The other way of conduction observations is without intervention. Observation of behaviour in more or less natural settings, without any attempt by the observer to intervene is called naturalistic observations (Shaughnessy and Zechmeister, 1997). An observer that is using this technique of collecting data acts as a passive recorder of what occurs. The events witnessed are those that occur naturally and have not been manipulated or in any way controlled by the observer (Shaughnessy and Zechmeister, 1997).

A system development process is a work process conducted by professional systems engineers, systems developers, project managers and the like. The process also includes the customer, the end-users, account managers and others. This is a process that can not easily be tampered with and manipulated. It is also a natural occurring process, which makes it observable without intervention. Observation without intervention is a way of collecting data that is suitable for this work. But since the development of information systems is a process that reaches over months, sometimes years, traditional observation techniques can not be used in this work. For this work observations will instead be conducted during the interviews and function as complementing to the interviews. This means that no special process will be observed, outside the process that occurs when interviewing the respondents.

4.2.3 Literary studies

When conducting a literary study, it is important to critically evaluate the literature that is studied (Patel & Davidsson, 1994). Otherwise there is a risk that the researcher may be too much influenced by the views that different authors found in the literature. It is thus important to have a critical approach and evaluate if the documents have a sound foundation. How close is the reported description to the deliverer of the information? Eyewitness descriptions and firsthand reports are called primary sources, other descriptions and reports are called secondary sources (Patel & Davidsson, 1994). Who is the writer? What relation did the writer have to the occurrence, episode or reported work? What purpose did the writer have with the document? Under what circumstances did the document come to life? These are question one might ask before and during the literature study. But the most important question are; how are these document related to my work? In what way can they contribute both in a positive and negative sense to my work? The relevance of the documents in relation to my work must always be in focus.

5 The group level and the information critical subsystems

In this chapter some elucidation of the group level and the critical subsystems will be made. After that, in chapter *6 Description of the utilised project management method at Volvo Information Technology*, a descriptive account of the application will be made.

For this work the assumption is made that information systems are developed in the constellation of groups. That is, people that work together on information systems development projects, do so in groups. There is also a co-operation between groups when designing and building information systems. This means that this work is neither focused on the level of organisations that is located below the level of groups nor are this work focused on the level of organisms that are located above the level of groups. Level here is refereed to Miller's (1995) definition of level. Miller (1995) defines organisation as being located below the group and organism as being located above the group.

5.1 The group level

The group level is located between the organism and the organisation (Miller, 1995). Basically every information systems development project is realised in groups (teams). The constellation of the group as a system has some advantages when developing information systems which other levels do not have. The levels next to the group level, the organism and the organisation, are the levels most similar with the group level (Miller, 1995). An evaluation of the similarities and dissimilarities between the two levels next to the group level will be discussed, in order to illuminate the appropriateness of using the group level when developing information systems.

Figure 2. Relationship between the levels of organism, group and organisation according to Miller (1995).

According to Miller (1995), there are more differences between the organism level and the group level than between any other level of living systems. One of the differences is that groups in general survive longer than organisms. Groups have a longer duration of survival. The greater complexity that resides in groups provides them with processes that allow adjustment against stress. Processes that organisms do not have. Groups can also span over a much larger spatial and time region than a single organism can. It is the co-operative activities that enable groups to control a large territory.

- The group has the ability to shift a subsystem process from one member to another. In some groups most of all the members have the ability to carry out most of all subsystem processes. In other groups the members complement each other in this area. This is what makes the group flexible and powerful. If one member is worn out, another member can take over. The different members with their different skills complement each other. This is not possible at lower levels.
- Autonomous mobility of components in physical space and physical separateness. The ability to communicate makes it possible for a group to be a cohesive system. The group can also co-ordinate as a system when its members are in motion or dispersed. (Miller, 1995).
- The sharing of a single component by multiple groups. A member in a group can be a member in different groups. This characteristic property is something that an organism can have to some extent. An organism can be a member of a second organism if the two organisms form a symbiotic relationship or if one parasite on the other. An organism initiates a symbiotic or parasitically relationship with another organism in order to survive, but a member of a group that shifts from one group to another does not have to do that in order to stay alive, but just to make a contribution to the different groups.
- The ability to use symbolic languages to communicate, integrate, co-ordinate and control different members. Through symbolic languages one can integrate the members in the group in order to reach mutual goals one can space and time co-ordinate different events in the group. One can also use the language as a mean to control the different group member’s trough orders encouragement and decelerated expectations. A structured language makes the essential communication possible.
- The sharing of effort reduces fatigue. Groups can find tasks less fatiguing than single organisms because shared efforts cost each participant less. Groups are superior to organisms when it comes to solve tedious and complicated tasks. Not only because groups have more organisms with nervous systems, each processing less information or because different members have different past experiences to

call upon. But also because multiple members can correct each other's mistakes and profit more from error feedback. Inputs are also more likely to be attended to and observed if there are multiple input transducers (members) in operation.

The main differences between the group level and the organisation level are according to Miller (1995):

- The structure of echelons. The echelons are not found at this level, but they are found at different higher levels (organisations and upwards). This is due to the fact that by the definition of the organisation level, an organisation is a system with echelons composed chiefly of groups.
- The complexity of relationships. The relationships with the subsystems or components of organisations are more varied than those at the group level (or at any level lover than the organisation level).
- The dissimilarity of position and status between members. Members that work together in groups have a similar position and status. This means that there exists a similar base for both authority and status in groups, but in organisations this is not always so. At the organisation level different relationships between people arise from their position and status and here we have a different base for authority and status. Members of a group that are composed of members with unanimous and similar goals, and ways of working together that are compatible, do not tend to emphasis issues as authority and status.

5.2 The critical subsystems that process information at the group level

How the information critical processes function at the level of the group will here be discussed. As mentioned in a previous section (*2.2.1.1. The level of Community*) the fundamental processes involved in the functioning on one level are basically the same as all the other levels (Merker, 1985). It is even so important to clarify how the information critical processes function on this level since this is the level that is the basis for the whole project.

- For the system to be able to communicate with its surrounding systems, the system must be able to take in and extract information. This is realised by *the input transducer subsystem* (Miller 1995, Merker 1985). Members of the group that receives the initial incoming information can be the project manager, the project secretary (if such a profession exists in the group) or any other member of the group. But in order to manage and have a control over the incoming information it is desired that the project manager or a certain dedicated member of the group (project secretary) receive the information when it enters the system. Those not dedicated as responsible for bringing information into a system, but through whom information occasionally enters, should be considered as permeable boundary components (Merker, 1985).

- But not all information originates from outside the system. Some of it enters the information channels from inside the system through the *internal transducer subsystem* (Merker, 1985). When information is originated from within the system and enters the information channels it is done so through the *internal transducer* subsystem. Group meetings, reporting on the state of the affairs, issuing status reports, internal faxes, internal e-mails are good example internal information flows.
- Information not readily usable by the group is translated or decoded by the *decoder* subsystem (Miller 1995, Merker 1985). An example of decoding would be the transformation process when modelling enterprises into conceptual models that can be more easily understood by the information systems development team. Another example of decoding would be a law department advising the group members of legal aspects considering information systems development (Merker, 1985).
- The *timer* (first introduced in Miller, 1990) subsystem functions as the time co-ordinator in the system. The timer transmits to the decider subsystem information about time-related states of other subsystems and components or processes within the system. The timer also times co-ordinates the decider of the system to deciders of subsystems (if they exists).
- When information enters the system it must be distributed to various processes in the system. The *channel and net* subsystem has the function as the distributor in the system (Miller 1995, Merker 1985). The information is thus distributed to the various members or components of the group. Examples of this can be the use of telephones, faxes, memos, meetings and interoffice mail.
- The *associator subsystem* manages the first stage of the learning process and involves the formation of enduring associations or relationships between items of information (Merker, 1985). For a system to be able to live the system must learn new things. This is in order to manage to deal with the sometimes increasingly

complex world that the system lives in. The associating process involves the formation of enduring associations between items of information (Merker, 1985). An example of this can be when members of the group learn new ways of data modelling or new system development methods.

- The *memory subsystem* allows for the storing of the information within the system (Merker, 1985). Also when engaging in planning processes the system must have a memory capacity (Miller, 1995). The memory subsystem allows for the storing of information within the system. This is routinely performed in groups by the inputting, storing and retrieval of information using files, computers, notebooks, human memory, etc. (Merker, 1985). The ability to remember past actions and past perceptions without actually interacting with the environment provides the group with the ability to “think through” possible actions and possible consequences (Powers, 1973).
- The *decider subsystem* controls and regulates the system (Merker, 1985). All decisions of some importance to the system goes through the decider process (Miller, 1995). This is a subsystem that can not be parasitically or symbiotically dispersed to any other system (Miller 1995, Merker 1985 and Vancouver 1996). This subsystem is the controller and regulator of the system. Organisations typically have designated organisation structure such as depicted by a typical line or a staff diagram (Merker, 1985). While these diagrams outline the primary echelons of the decider subsystem, almost all organisational components play a part in the decision process at one time or another (Merker, 1985). Even though the group level does not have any echelons according to Miller (1995), it can have several deciders. Say that a group member is the manager for the group and another member is the project leader for a particular information systems development project. Even though the manager of the group has the overall decision authority for the group as a whole (and has the overall authority for the projects), it is also so that the project manager has a decision authority over his or hers particular project. The project manages responsibility is to deliver an information system that meets certain specified functionality and performance at a certain price at a certain time. This demands for some managerial authority and power to make decisions. A systems development team can in fact have several projects in pipeline at the same time, thus having several project managers. Even if it is so that there exists more than one decider in the group, this is OK if these deciders have different areas or different responsibilities to manage (Miller, 1995).

The importance of the decider becomes very clear when one investigates the outsourcing possibilities of different subsystems. It shows that you can contract out for any of the system processes (basically at any level), except for the decider process (Merker, 1985). This does not mean that the other subsystem processes are not critical, but singles out the decider as the keystone subsystem in the system.

- The *encoder subsystem* changes the information from the systems code to a public code that can be understood outside the system (Merker, 1985). When the group has processed the information and is ready to extract it from the system, there sometimes must be some changes to the information in order for it the code that resides outside the group. For this the encoder subsystem processes the information and so making the necessary changes from group code to external code. Individuals who prepare letters, documents, contracts, reports, speeches, etc. are examples of system components who perform this function (Merker, 1985). Another example may be that the information system that the group has developed is moved to computers where it shall reside, and in order to do this some alterations must be made in the code.
- Once information is encoded (prepared for release) it is sent from the system by the *output transducer subsystem* (Merker, 1985). Output transducing processes is accomplished by a variety of means such as through the use of telephones, mail, meetings and personal communication (Merker, 1985). The way of transducing an information system to where it shall be deployed is by implementation of the information system into the various business areas where it shall be resided.

5.3 Demands on living systems

Miller (1995) has also formulated nine demands that must be met in order for the system to be classified as living:

- The system must be an open system. The system must be able to exchange information and mater/energy with its surroundings.
- *Homeostasis.* The system must be able to maintain itself within the homeokinetic plateau[1].

[1] The state at which organic systems try to maintain themselves within the boundaries or thresholds of viable equilibrium (van Gigch, 1991).

- The systems must be considered as complex. This means that neither statistical nor mathematical or any other statically methods for studying the system are sufficient to form a comprehension of the system.
- Genetically material. This means that there are inherent possibilities for the systems structure and processes to change. DNA has this function in the cells.
- Amino acids or possibly non-living material construct the system.
- There are decision levels in the system.
- Integration of subsystems. The human organ consists of many organs that must co-exist and interact for the body to function. The system must be self-regulating.
- The system must exist in a certain environment. Living system is adapted to fit in the environment they live in.

The group level, according to LST, satisfies all of the above demands. A group is an open system, which strives towards holding itself within the thresholds of the homeokinetic plateau. A group is composed of multiple members that are more or less individual. If the group is a constellation of humans, this means that the group is composed of multiple human activity systems. Hence a group can be considered as highly complex. A group is constituent of genetically material since the group is made up off multiple organisms. A group has one decision level, but can hold several deciders that have different decision areas. A group is an integration of subsystems, since the group is composed of several organisms. Since the group is composed of several organisms that strive for survival, the organisms are self-regulating, thus must the group be self-regulating. All groups live in a certain environment, as every other living system, which it is adapted to live in.

6 Description of the utilised project management method at Volvo Information Technology

This work is a case study at Volvo Information Technology AB, located at Skövde. The aim of this work is to examine the appropriateness of using Miller´s LST as a tool for analysing the project management processes used when designing computerised information systems. Since most projects are conducted in teams (groups), it is the group that manages the project process that will be studied. Miller's group level will thus be used. One of three objectives to reach is to describe and analysing the project management process used when designing computerised information systems. In order to analyse the project process that occurs at Volvo Information Technology, it is essential to first look into the project management method that is used since this method form the basis for the work in the project management team. This method is the tool that is used to guide the different professions in the project development process and are thus essential for the outcome of the work of the project management team.

Project management is conducted in management teams (groups) and all management teams use management methods to guide them through the management process, thus the management methods that are used has a great impact on how the management teams conduct their work. This work studies the working process in a management team when controlling and managing the project of building of an information system. Mapping the working process of a project team means that one indirectly maps the management method that the team uses (this depends of course very much on the degree to which the management team actually work according to the management method). Since members off the group and processes conducted enters and leaves different phases in the management method during the course of a project, it is essential to describe and analyse the management method that is used by the team. This is important for two reasons:

1. In order to make a proper investigation of the management process that occurs it is essential to understand the conditions that governs the management process, i.e. the management method that is used.
2. When conducting the analysis of the study, it is essential that the management method used is described thoroughly, since the management process that is studied and the management method are tightly connected.

Thus, in order to enable an analyse and a discussion of the people and processes entering, working on and leaving different stages in the management process, a thorough description of the management method may simplify the understanding of the process. This description is made in the following section.

6.1 The project management and systems development models

Volvo Information Technology is today using two different tools when developing information systems: the PCM-model, which is a method for controlling the development process (the management method), and the AU-model, which is a method for the actual building of the information system (the development method).

A project is a goal-oriented activity that is demarcated to a specific area, quality, time and cost and is organised with a specific responsible management and has co-workers from different units, divisions and/or external companies. In order to control and manoeuvre a project within the specified cost, quality and time frame, it is important that there exists some sort of method that one can use to support the management of the project. Using some kind of project management model usually does this. The project management model that Volvo Information Technology is using is the PCM-model (Project Control Model). This model will be described under *6.2 The PCM-model*. The development method (the AU-model) is described under *6.3 The AU-model*.

6.2 The PCM-model

The PCM-model is a Volvo Information Technology specific model, developed by Volvo IT for use only within Volvo IT. This means that the description about the PCM-model conducted in this heading originates from Volvo IT internal material, basically from Volvo IT's internal PCM-model homepage and course material describing the PCM-model.

PCM is used in order to control, support, monitor and follow up a project in order to ensure that the agreed result of functionality is delivered at given cost and at a given completion date. PCM is based on a number of concepts like gates and checkpoints. PCM is mandatory for all assignments defined as Volvo projects. PCM does not put any restrictions on the development method. Different development environments can be used. All agreements affecting a project must be settled according to this model. The management of new requests is not included in PCM.

The description of the PCM-model will be made in two different ways; a shorter description for the reader who only briefly wants to understand the model and a more thorough description for the reader who wants to follow the analysis and discussions over the results from this work in a more detailed manner.

6.2.1 Short description of the PCM-model

This PCM-model entails five different parts: roadmap, gates, checkpoints, project organisation and project documentation.

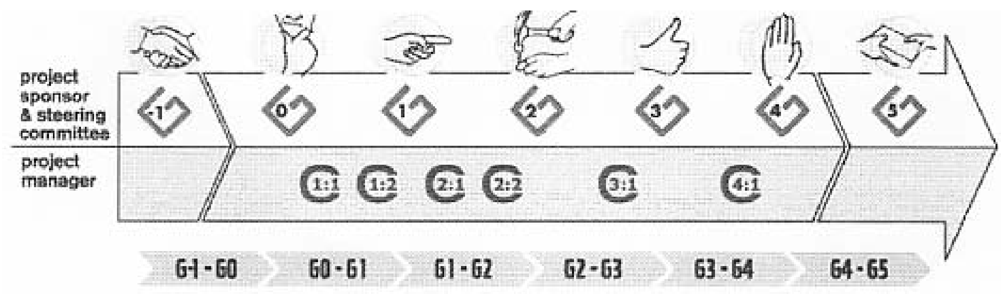

Figure 3. The PCM-model (PCM-Model, 2001).

- *Roadmap.* In the PCM-model the term roadmap is used to denote the activities and the responsibilities between two gates. There are six roadmaps in a project: G-1 to G0, G0 to G1, G1 to G2, G2 to G3, G3 to G4 and G5 to G6.
- *Gate.* A gate is defined as a point in a project when the Steering Committee evaluates the achieved project results and makes a decision about the future of the project. There are seven gates in a project: -1, 0, 1, 2, 3, 4 and 5. All gates are considered closed at the start of the project. Gates are opened and closed when different project results are met.
- *Checkpoints.* A checkpoint is defined as a point in a project when the project manager must verify that the expected results have been achieved. There are six checkpoints in a project: 1:1, 1.2, 2:1, 2:2, 3:1 and 4:1.
- *Project organisation.* The project organisation has three different levels, top level, second level and third level. The project sponsor and the steering committee (SC) with

the appointed chairman are located at the top level. On the second level one find the project manager and on the third level the members of the project team is located.

- *Project documentation.* In every project a number of documents must be created and in the PCM-model five main documents are created. They are the:
    1. *Business agreement.* The purpose of the business agreement is to define the agreement between the customer and Volvo IT.
    2. *Steering committee plan (SC plan).* The purpose of the SC plan is to point out the top decision level activities and preparations between gate meetings. The SC plan will also point out the timing of the gate meetings.
    3. *Project directive.* The purpose of the project directive is to give all the directions necessary for delivering the results stated in the business agreement.
    4. *Final report.* The purpose of the final report is to describe the achieved project results compared to the expected results stated in the project directive.
    5. *White book.* The purpose of the white book is to follow up the impact of the project results with focus on business value and to ensure knowledge sharing based on business experiences.

6.2.2 A more thorough description of the PCM-model

This PCM-model entails five different parts: roadmap, gates, checkpoints, project organisation and project documentation. Figure 4 describes the PCM process.

6.2.2.1 Roadmap

In the PCM-model the term roadmap is used to denote the activities and the responsibilities between two gates. There are six roadmaps in a project: G-1 to G0, G0 to G1, G1 to G2, G2 to G3, G3 to G4 and G5 to G6.

6.2.2.2 Gate

A gate is defined as a point in a project when the Steering Committee evaluates the achieved project results and makes a decision about the future of the project. There are seven gates in a project: -1, 0, 1, 2, 3, 4 and 5. All gates are considered closed at the start of the project. The project results that must be achieved before a gate meeting are defined in the preparation checklist (for each gate there is a special preparation checklist). The project manager will manage all such checklists except for the G-1 and G5 checklists, which are owned by the project sponsor (the different actors are described under *6.2.2.4. Project organisation*). At gate meetings the SC makes decisions about the future of the project. The timing of the gates are linked to important events in a project life cycle, where critical decisions must be made.

Gate decisions. When a project has reached a gate the SC evaluates the achieved project results and makes a decision about the future of the project. The SC is the only decision forum that can open a gate or keep it closed.

	G -1	G0	G1	G2	G3	G4	G5
Timing	When formalised inquiry is in place.	When the project directive and the business agreement have been proposed.	When alternatives have been de-signed and decision on direction must be taken.	When solution has been designed.	When solution is built and tested.	When the results are ready to be handed over to the maintenance organisation.	When the results have been used for about six months.
Decision	To start the agreement process.	To start the project.	To start analysis and design.	To build solution.	To make use of project results.	To close the project.	To approve the white book.
Decision maker	Project sponsor	Chairman of the SC	Chairman of the SC	Chairman of the SC	Chairman of the SC	Chairman of the SC	Project sponsor
Purpose	Ensure that the inquiry is in line with the Volvo IT imperative.	Ensure that the project sponsor is committed to invest the required amount of resources for the entire project.	Make a buy/reuse/ make decision. Ensure that all risk areas are identified, and that there is a plan for how risks are to be managed.	Ensure that the project results are such thet the project sponsor can commit to alloctae resources for the entire project. Ensure that the lifecycle costs are calculated and in line with the revenues for the proposed alternative.	Ensure that the project results are of such a quality and reliability that they can be used without damaging side effects. Ensure that the involved parties are ready to go live.	Ensure thet the maintenence organisation is capable of handling the product, as the project will be closed. Ensure that the solution are accepted in the organisation.	Ensure that Volvo iT can benefit from the major experiences.

Figure 4. Gate decisions (PCM-Model, 2001).

6.2.2.3 Checkpoint

A checkpoint is defined as a point in a project when the project manager must verify that the expected results have been achieved. There are six checkpoints in a project: 1:1, 1.2, 2:1, 2:2, 3:1 and 4:1. These checkpoints are of three types:

1. Predefined checkpoints with mandatory results to be achieved.

2. Checkpoints defined and specified by the development method applied to the project.
3. Optional checkpoints defined and specified by the project manager.

For each predefined checkpoint there is a checklist defining the expected results that have to be achieved at that checkpoint. The project manager is the owner of the checkpoint checklists. The project manager uses these lists to verify critical issues between gates in a project. At each checkpoint the project manager must evaluate the progress of the project. This evaluation is based on the outcome of the checklist verification.

Checkpoint evaluations. At each checkpoint the project manager must evaluate the progress of the project. The evaluation is based on the outcome of the checklist verification. The predefined checkpoints are presented in the table below.

	CP1:1	CP1:1	CP1:1	CP1:1	CP1:1	CP1:1
Timing	When possible solutions have been identified.	When possible solutions have been defined.	When analysis is completed.	When design is completed.	When coding, configuration and testing is completed.	When product is ready for hand-over to operations.
Purpose	Ensure the architecture alignment.	Ensure the feasibility of the technical infrastructure.	Ensure the development environment and the support.	Verify the feasibility of the technical infrastructure.	Verify that the solution is ready for rollout.	Ensure that both operations and the costumer accept the solution.
Achievements	Agreement on the preliminary infrastructure specification.	Agreement on both the development and the run-time environment.	Installed development environment with support.	Verification and approval on design.	Verified and approved solution.	Acceptance from the customer and operations.

Figure 5. Checkpoint evaluations (PCM-Model, 2001).

6.2.2.4 Project organisation

Decisions levels. There are three decision levels: top level, second level and third level. On the top level one will find the project sponsor and the steering committee (SC) with the appointed chairman. The project sponsor is responsible for the business agreement and the chairman of the SC is responsible for the project directive. On the second level one find the project manager responsible for acting as stated in the project directive that the project manager and the chairman o the SC have agreed upon. On the third level the members of the project team is responsible for acting as stated in the project plan.

Project sponsor. The project sponsor could be the account manager or the business process unit manager or the Volvo IT president, depending on the agreement manual requirements. The project sponsor must ensure that the results defined in the business agreement are delivered to the business, monitor project progress, show an active interest in the project and support the project manager, make the project visible in the organisation and approve the white book (which is a document that is produced at the end of the project where reflections on the project, difficulties and experiences, and the customer satisfaction are documented).

The project sponsor has the authority to sign the business agreement and appoint the chairman of the SC.

Chairman of the Steering Committee. The chairman of the SC take responsibility for all decisions made within the project, ensure that the results defined in the project directive are achieved, monitor project progress, prepare gate decisions, show an active interest in the project and support the project manager, make sure that the line organisation performs activities and delivers results that are within the defined responsibilities, secure project resources, promote the project and decisions to the organisation and sign the minutes of SC meetings.

The chairman of the SC has the authority to constitute the SC, appoint the project manager, make gate decisions, sign the project directive and convene SC meetings.

Steering Committee (SC). The chairman constitutes the SC, taking the business agreement requirements into consideration. The members of the SC must have enough power in the line organisation to make gate decisions. A member of the SC must prepare gate decisions, monitor project progress, make the project visible in the organisation, make sure that the line organisation performs activities and delivers results that are within the defined responsibilities, secure project resources and promote the project and decisions to the organisation. A member of the SC has the authority to make gate decisions (if decided by the chairman of the SC).

Project manager. The chairman of the SC appoints the project manager. The project directive is the agreement between the project manager and the chairman of the SC. The project manager must formulate and communicate the project directive, manage the project according to the project directive, monitor project progress, deliver results as stated in the project directive, contract resources, communicate with all parties involved and report to the SC.

The project manager has the authority to appoint project members, commission assignments throughout the organisation and raise issues to the SC and propose new gate meeting when necessary.

Project team member. The project manager appoints the project team members. Each team member is responsible or acting a stated in the project plans. A project team member has the responsibility and authority to act as stated in the project plans.

6.2.2.5 Project documentation

In each project a number of documents must be created. The overall purpose must be clearly defined at the start of the project and the activities required to reach the desired result need to be listed. The end result must be reported when a project has been completed. There are basically five documents that must be created in the PCM-model. They are:

Business agreement. The purpose of the business agreement is to define the agreement between the customer and Volvo IT. The business agreement must be created before G0 and must be completed prior to all gates except G5. The project sponsor and the customer sign the business agreement at G0. The agreement is signed again, if it is changed, at all gate meetings except G5.

Steering committee plan (SC plan). The purpose of the SC plan is to point out the top decision level activities and preparations between gate meetings. The SC plan will also point out the timing of the gate meetings. The SC plan is the responsibility of the SC. The plan must be created before G0 and must updated prior to all gates before G5.

Project directive. The purpose of the project directive is to give all the directions necessary for delivering the results stated in the business agreement. The project directive is the agreement between the project manager and the chairman of the SC. The directive is a master document for all project plans, for example the risk management plan and the communication plan. In the project directive there are two sections. The purpose of the first section is to describe the entire project, including a summary of the remaining project activities each time the directive is updated. The purpose of the second section of the directive is to describe the current roadmap in the project. The project manager of a project is responsible to create and communicate the project directive. This document should be updated by the project manager and signed by the chairman of the SC at all gate meetings, with the exception of G-1 and G5.

Final report. The purpose of the final report is to describe the achieved project results compared to the expected results stated in the project directive. The final report must also ensure knowledge sharing by describing the experiences gained during the project. The project manager creates the final report. The chairman of the SC signs it. The project manager must have the final report ready in time for the G4 SC meeting.

White book. The purpose of the white book is to follow up the impact of the project results with focus on business value and to ensure knowledge sharing based on business experiences. The project manager creates the white book prior to G5. It is the responsibility of the project sponsor to approve the white book.

6.3 The AU-model

To control and manoeuvre the project is not enough. A project is a commissioned work and that means that something that is ordered must also be delivered. In this case, it means that if an information system is ordered, the information system must also be built and delivered. Building an information system is a highly complicated task and in order to manage the complexity and different obstacles when building an information system, there is a need for a common frame of reference. A frame of reference is a way of working when developing information systems, from the first vague ideas to a realised change, and to give concrete support in the development process. This frame of reference is usually called an information system development method. Volvo Information Technology is using the *AU-model* (Volvo Data AB, 1995). The word AU-model stands for Administrative Development Model. But since this work is focused on the management method used, the development method will not be discussed any further. The AU-model is only mentioned here in order to be able to refer to the development method in the report where it is needed in order to describe the entering and leaving to and from the management process into the development process. This is important in order to describe the flow of information to and from the management process.

6.4 The relationship between the PCM-model and the AU-model

All projects at Volvo Information Technology start with the first stage in the PCM-model, the G-1 gate (se figure 4). G-1 is started when a formalised inquiry is taking place. A decision is made whether to start the agreement process or not (this is done by the project sponsor) before the G-1 gate is being closed.

The G0 gate starts when the project directives and the business agreement have been proposed. A decision is now taken whether to start the project or not (this is done by the chairman of the SC) before the G0 gate is being closed.

The G1 gate starts when alternatives have been designed and decision on direction must be taken. A decision is made to start the analysis and design of the solution (this is done by the chairman of the SC). Now the preliminary study phase of the AU-model is started and carried out. The project phase in the AU-model starts after the ending of the preliminary study phase and when a solution is approved. The purpose of the G1 gate decision (which ends when the preliminary study phase and the project phase is ended) is to make a buy/reuse/make decision. One must also make sure that all risk areas are identified, and that there is a plan for how risks are to be managed before the G1 gate can be closed.

The G2 gate starts when a solution has been designed. A decision is made whether to build the solution or not (this is done by the chairman of the SC). Here the realisation phase of the AU-model is taking place. The purpose of the G2 gate is to ensure that the project results are such that the project sponsor can commit to allocate resources for the entire project. One must also make sure that the lifecycle costs are calculated and in line with the revenues for the proposed solution before the G2 gate can be closed.

The G3 gate starts when the solution is being built and tested. A decision is made whether to make use of the project result or not (this is done by the chairman of the SC). The purpose of the G3 gate is to ensure that project results are of such a quality and reliability that they can be used without damaging side effects. One should also make sure that the involved parties are ready to go live before the G3 gate can be closed. This means that the G3 gate decision is a prerequisite for implementing the solution into the business.

The G4 gate starts when the results are ready to be handed over to the maintenance organisation. A decision is made whether to close the project or not (this is done by the chairman of the SC). The purpose of the G4 gate is to ensure that the maintenance organisation is capable of handling the product when the project will be closed. One must also be sure that the solution is accepted in the organisation before the G4 gate can be closed.

The final gate, the G5 gate, is started when the solution has been used for about six months. A decision is made whether to approve the white book or not (this is done by the project sponsor). The purpose of the G5 gate is to ensure that Volvo Information Technology can benefit from the major experiences.

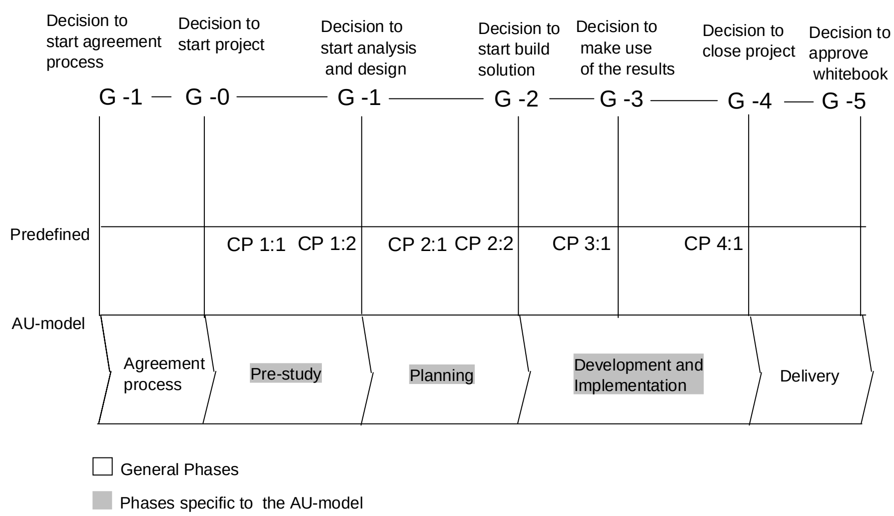

Figure 6. Relationship between the PCM- and the AU-models

6.5 *Analysis of the PCM-model*

As one can see, the PCM-model consists of several activities, which are to be conducted in a sequential order. The PCM-model belongs therefore to the commonly known family of waterfall models. The model does not express the use of iteration between the levels anywhere in the model and thus emphasises that each level should be finished before entering the next level. The model in fact emphasises the importance of finishing each level as much as possible before entering the next. Each level is thus a prerequisite for the next one. The PCM-model functions as a tool for the control and manoeuvre of information system development projects, and thus the way one uses the AU-model. It has the function of initiating and closing a project and it controls the building of the solution in between. It functions as a decision tool for going from the preliminary study phase to the project phase of the AU-model, and the PCM-model is the supportive tool for making stop and go decisions in projects.

7 Material

This chapter is divided into two parts:

1) A description of why it is essential to study the documents in the PCM model

2) The interviews and the flow of information

The first part of this chapter describes how the documents in the PCM model contribute to the managing of projects at Volvo IT and why it is important to study them. The interviews and flow of information is presented in *7.3 Interviews and flow of information.*

Note to the reader: If the reader is interested in studying a description of each single document, the reader is refereed to appendix B where they are presented. The description of each document in appendix B and the text in section *7.3 Interviews and flow of information* complement each other. The documents (formal information) the respondents receive is described in appendix B, and the way they receive it is described under *7.3 Interviews and flow of information.* Thus, in order to receive a full understanding of the text in *7.3 Interviews and flow of information* the reader is urged to read the description of the documents in appendix B.

7.1 Sources for the documents

The documents described compose all of the formal information that the different members of the SC shall receive or send to one another (or to people outside of the SC) during the process of managing a project. These documents are described at Volvo IT's internal PCM-model homepage and course material describing the PCM-model. A deeper understanding of the documents (facts not covered by the internal PCM homepage and the course material), was covered by the interviews of the respondents.

7.2 Why describing the documents?

The documents cover the formal information to and from the different respondents in the SC during a project. This formal information is of special interest since it stipulates, or establishes, the roles that the respondents have in a project. In order to be able to do the mapping between Miller's critical information processing subsystems and the project management process applied (which are one of the objectives to reach), it is essential that the different roles that processes information is identified and studied. Studying the formal flow of information thus enable the accomplishment of this objective.

Why then, is not the informal information (telephone-calls, e-mails or “spur of the moment meetings”) that is a part of any project, studied? This is due to two things. First, since there is a tight connection between how management of a project should be carried out according to PCM, and how it is actually carried out in the application, following the formal flow of information in the application give an accurate enough description of the application in order to do a mapping between Miller’s LST and the project management process under study. Secondly, there is no possibility to study the informal flow of information in the applied situation within the time frame that is given for this work.

The documents are described under a header of its own (Appendix B) due to the fact that the different respondents sometimes receive the same kind of documents and that makes it unnecessary to describe the documents more than once in the report. The interviews describe the flow of information (in chronological order) that the respondents come in contact with during a project.

The reason for describing the documents that the different respondents receive, and later on describing the *way* they receive this information, is because of the necessity of mapping out the flow of information that the group comes in contact with. One of the criteria in this work is the ability to make the transformation from the project management process at Volvo IT to Millers (1995) critical information processing subsystems. In order to do so a description of the flow of information among the chosen respondents is vital.

7.3 Interviews and flows of information

In this section the interviews are described. There were a total of five interviews conducted. The type of professions that where interviewed were partly the same as the main professions described in the PCM-model.

7.3.1 Conditions for the interviews

All projects at Volvo IT always entail people that have the roles described in the PCM-model. This means that to be sure that one map out the project management processes in general at Volvo IT, one can find help from the PCM-model with locating the persons that hold the key parts in a project. Of course, using the PCM-model as a help to identify the key roles in the development process depends heavily on the fact that the PCM-model is actually used and followed properly in all projects. Hence, before the respondents where identified and selected an inquiry where made to ensure that the PCM-model was used in all projects at Volvo IT, and confirmation on this matter was given from the head of the department where the interviews where made. This means that a project sponsor, a chairman of a SC, a team-leader for a development team (which is also a member of a SC) and a project manager were interviewed.

A representative from the customer side, a manager of purchasing, was also interviewed. The manager of purchasing do not hold a position in the PCM-model but it is important to interview someone with this role in order to grasp the major flows of information in a project. The development process starts with the initiation of the customer and ends with the approval of the customer (in both these cases it is done by the manager of purchasing), thus the importance of interviewing the one responsible for the purchasing from the customer side. The customer thus holds a key role in projects even though he does not hold a key role in the PCM-model.

All the respondents where men in the age between 35 to 55. Their personal experience of system design and development varied from 5 to 20 years. All of the respondents, except from the project sponsor, have a previous background as system developers or programmers. A more specific description of each respondent will follow later in the text.

7.3.2 Some general views on the PCM-model

Since this section describes the flow of information to and from the respondents in a chronological order (also containing processing and transformations of the information) the description starts with the manager of purchasing followed by the project sponsor, the chairman of SC, the team-leader and the project manager. For the respondents to remain anonymous they are named A, B, C, D, E and respectively.

All the respondents said that they where forced to use the PCM-model as the control-model for the projects (except for the manager of purchasing that does not come in contact with the PCM-model). Some alterations in the PCM-model are allowed, but the allowed alterations can only be of minor significance. The project manager (who is the one that comes in contact with the AU-model) also said that he was not forced to use the AU-model as strict as he had to use the PCM-model in a project. The project manager was allowed to do adaptation within the AU-model in a project and also introduce techniques that are not incorporated in the AU-model, such as use-case modelling. The project manager thus had possibilities to exclude or make exceptions from parts of the AU-model, but the exceptions or exclusions had to be well defined and motivated in the documentation of the project. All of the respondents said that the PCM-model is a good model to work with, but there was some dissatisfaction with the large amount of reports and checklists that is incorporated in the PCM-model. The AU-model was also easy to work with, but it lacked some important parts, such as use-case modelling. The use-case modelling part is borrowed from UML (Universal Modelling Language), which has the necessary use-case technique incorporated. All of the respondents said that the system development method used functioned as a supportive framework, since the methods are to general to fit all the different projects. The control model (PCM-model) functioned both as a supportive and a governing method. All different document concerning the project management is stored in a Volvo IT PCM monitoring database. All of the different SC members can used this database to retrieve information on ongoing and closed projects. There is also a PCM homepage retrievable from Volvo IT's Intranet. Here members of the SC can find templates on how to write different reports and documents when following the PCM model.

The goal with these interviews was to specify the flow of information in a typical project management process when developing a computerised information system. In all projects there are a huge amount of information that flows within the boundaries of the project. This information spans from such that is well defined and should be reported on a regular basis to different members in the group (formal information) to information that is shared between to or more members of the group on a coffee break or via e-mail or telephone (informal information). There exists no possibility to trace and document all the informal information, but the major part of the formal information can be traced and documented. It is also this information that is of interest here since this project is focused on the general flow of information in a development project in and not with every detailed aspect of the flow of information.

7.3.3 The manager of purchasing

The manager of purchasing (named A) that was interviewed is responsible for all of the purchasing of information systems and related objects at Volvo Engine Plant in Skövde. All of the initiating and ordering of information systems purchasing for Volvo Engine Plant goes through this person. A has also previous worked as a system developer for Volvo Data (Volvo Data later became Volvo IT). He is thus involved in many projects at Volvo IT and has a good knowledge of how the initiating and ordering of information systems is done, and also how the developing process function at Volvo IT. When asked he said that he was not a member of the project steering committee (SC) but got some reports from the SC when asked for. When A purchases an information system from Volvo IT the general way to go about it is as follows:

First A receives a request or an information system from some department at the engine plant. A and the department in question discuss the request more in detail. A summons these requests and prepares the information that is to be discussed with Volvo IT. If the financial manager at the engine plant approves the project an initiation for purchasing the system is made to Volvo *IT. It is at this point where the first contact with Volvo IT is made.* A contacts the department manager at the department at Volvo IT, which develop information systems to the engine plant, and explains the request and the general idea of the system.

The request for the information system is handed over to the chairman of the SC and the project sponsor. The request is presented in different forms, documents, orally, etc. This means that there is no formal way to present the request, in the form of a formal in advance predefined type of document. The first encounter at Volvo IT with the request for a new information system often comes in form of an informal telephone call or an e-mail from A. To sum it up, the requests enters A from the department in question, is processed first by A and then together with assigned people at Volvo IT. The agreement process (which is located at Gate -1 in the PCM-model) has now started.

After that A awaits a preliminary report, which describes the prospects for the project a more in detail, expected cost, expected time and the technical possibility for building the system, etc. When A, the project sponsor and the chairman of the SC have discussed possible changes to the preliminary report, the project sponsor takes over and writes the business agreement. A and the project sponsor sign the business agreement. *The request for the information system and the preliminary report has now been transformed into a business* *agreement*. The way to write the preliminary report and the business agreement is not defined in the PCM-model.

After the signing of the business agreement A does not await any more formal reports beside the final report from the project manager at the end of the project. A does not do anything with the final report so there is no processing or transformation occurring on the final report as far as A concerns. But during the project, A does have sporadic meetings, phonecalls and messages via e-mail with the project manager about the progress of the project, but the project manager mostly initiates those meetings. A also may have contact with members of the SC during the project, just as with the project manager via small meetings, phonecalls and e-mail, but they are also initiated to the most part from members of the SC.

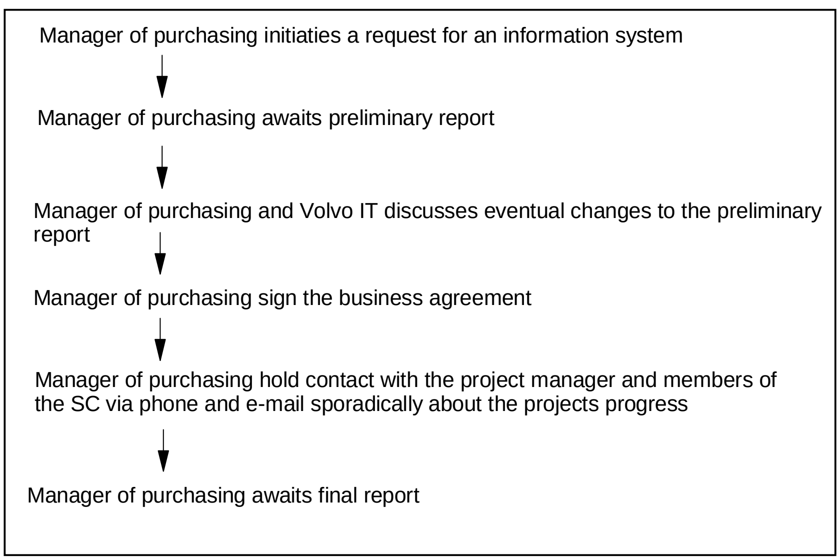

Figure 7. The general flow of formal information to and from the manager of purchasing

7.3.4 The project sponsor

The project sponsor (named B) says he is responsible for the allocation of funds for the project within Volvo IT. A also says he is a member of the SC. when the customer, via the manager of purchasing (A), makes a request to Volvo IT for an information system, A, B and the chairman of the SC have a first meeting. This is the G-1 meeting and it is here where the agreement process starts. B says that he some times gets information about the project prior to the G-1 meeting (which he prefers), but that is not always the case. B is responsible for writing the business agreement together with A, and here it is not a question about a one sided reception of information from A to B, but it is rather a dialogue between A and B during the writing of the business agreement.

The transformation from a request or an information system to a signed business agreement and later to a project charter can be summarised as follows: B receives the request for the new information system from A. The request is thus the input to B. A, B and the chairman of the SC processes the request from A, and later return to A with a preliminary report. After the processing and approval of the preliminary report A signs the business agreement together with B. The request for the new information system has now been processed by A, B and the chairman of SC and via the preliminary report it has been transformed into a business agreement. When the project has started, at the G0 gate, B and the chairman of the SC together writes a charter which is the project directives (or project specification) that is later handed over to the project manager at the G1 gate. The business agreement has now been transformed into a project charter.

Before every SC-meeting B gets the reports, charters and other information (se result report and risk management plan) that is to be discussed at the SC-meetings. B reads the reports, charters, etc. and discusses his point of view at the SC-meetings or directly with the project manager. If there has been any changes to the project B may summon to a Change Management Council (which B is the chairman of) and discuss these changes. These changes is written down in the Change Management Council Meeting Minutes. If such a meeting has been held this document is also subject for processing at the SC meetings. If such a document is processed at a SC meeting it is transformed into measures to be taken to handle these new changes to the project.

Finally B writes the white book. This is done after the system has been in use for six months. B questions the line managers at the engine plant which are affected by the new information system on how well the system has meet the requirements and how well it has increased the business value. B processes the information and transforms it into the document called the white book. In some projects the white book is not written at all. It is the customer that should pay for the white book and sometimes the customer does not want to pay for that cost.

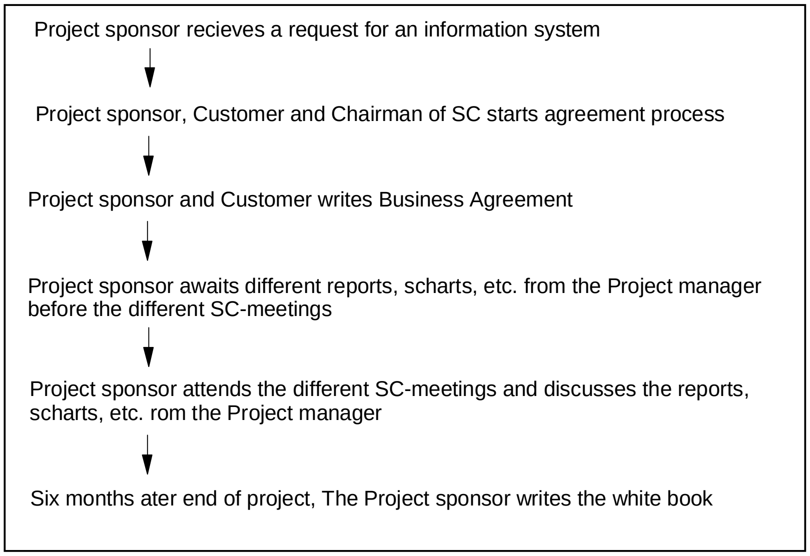

Figure 8. The general flow of formal information to and from the project sponsor

7.3.5 The chairman of the SC

The chairman of the SC (named C) says he is the main responsible for all of the projects that is undertaken at his department. C also says he is a member of the SC, which of course, he must be. When the customer, via the manager of purchasing (A), makes a request to Volvo IT for a new information system, A, B and C have a first meeting. This is the G-1 meeting and it is here the agreement process starts. C says that he most of the time get information about the project prior to the G-1 meeting (which he prefers), but that it is not always the case. B writes the business agreement which A and B signs. A copy of the business agreement it is handed over to A. After that a project charter is put together.

The transformation from a request or an information system to a signed business agreement and later to a project charter can be summarised as follows: After that C have received a request from A about a new information system, C summon A, B and himself for a first meeting. At this meeting B and C get briefed about the request from A. Information about the request enters B and C. C later returns with a preliminary report based on the requests from A. If A, B and C decide for a go on the project B takes over and writes a business agreement. A and B signs the agreement and C receives a copy on the agreement. The request for the information system has now been transformed into a business agreement. When the project has started, at the G0 gate, B and C together writes a specification for the whole project. The request for a new information system is now being transformed into a detailed project specification. The project charter is now being processed. C and the assigned project manager then sign the project charter together ensuring that the project manager approves the project charter. The project charter has now been transformed from a project specification into a project foundation for the project manager.

During the whole project C receives in advance information (see result report and risk management plan) from the project manager that is to be processed later at the SC meetings. C does not process this information before the SC meetings. This is done in co-operation with the other SC members at the SC meetings. C writes the Steering Committee Meeting Notices and Steering Committee Meeting Minutes. They are placed on a special page at the departments intranet which makes it every SC member's own responsibility to keep them informed of when the next meeting is scheduled and what was discussed and decided at the last SC meeting. C has thus processed and transformed what has been discussed and decided into a document. C has also updated the meeting minute document. C is not expected to write any more formal reports or documents during the project.

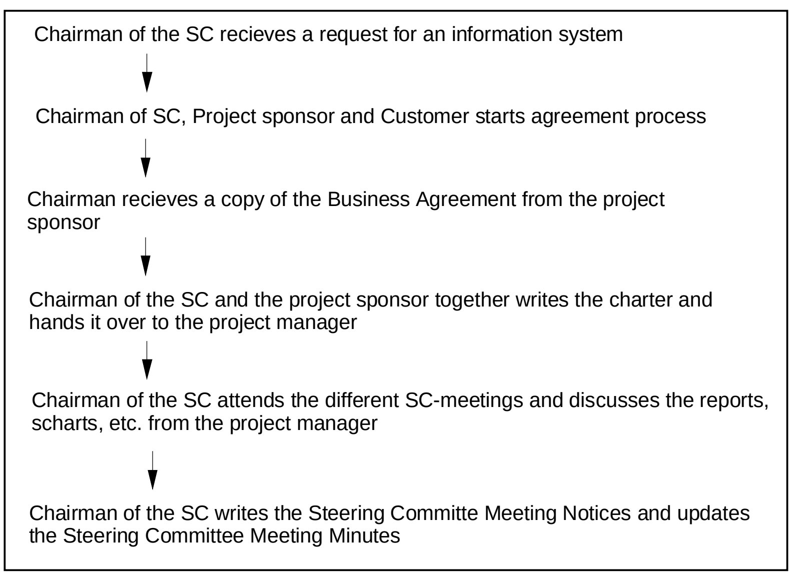

Figure 9. The general flow of formal information to and from the chairman of the SC

7.3.6 The team-leader

The team-leader (named D) interviewed is a team-leader for the development team responsible for all of the development of information systems to the engine plant for heavy truck engines in Skövde. D says he is a member of all the different SC's at his department.

This means that he is involved in all the projects conducted at his department. Just as the chairman of the SC and the project sponsor he gets reports, charts, etc. (see result report and risk management plan) from the project manager in advance before every SC meeting, so he can study them and later discuss them and leave comments on them at the SC meetings. D also has the special responsibility of allocating resources (personnel) for the different projects. This means that the project manager makes a request for personnel to be included in the project (programmers, designers, etc.). D then allocates suitable and available personnel and informs the project manager of his choices. D and the project manager then discuss the choice of personnel and if the project manager has a special request for a specific person. When an agreement is reached D and the project manager writes a human resource agreement. This is an important contract for the project manager thus he now has a guarantee that he has the personnel he needs or the project, and that no one can use the resources he is guaranteed. D and the project manager also write a Resource Agreement on machines, computers, databases, software and the like.

The transformation of request for recourses from the project manager into resource agreements can be summarised like this: D receives a request from the project manager of personnel and equipment (database, software, computers, etc). This request enters D and he starts the process of finding personnel and equipment suitable for the specific project. The project manager may have some desire (certain personnel and material). D tries to meet those wishes as well as possible, but generally it is D that decide which personnel and material is to be dedicated to the project. D writes a Human Resource Agreement (for the personnel) and a Resource Agreement (for the equipment and material) which is signed by the project manager. A request from the project manager to D for personnel and material has now been transformed into two contracts.

During the project there is a constant dialogue between D and the project manager about the use of resources. Even if the project leader has a contract of agreement on collaborators he may need additional personnel not mentioned in the contract, or he can let go of personnel that he does not need to another project leader that has a shortage of personnel. In such cases D reallocate the personnel to where they are needed the most. D is the sole responsible for the management of resources. Beside the reports, charts, etc. that D receives before every SC meeting and the dialogue between the project leader about the allocating of resources, D is not expecting any more information during a project. The only formal and in advance expected document that D is expected to write during a project is the resource agreements between D and the project leader.

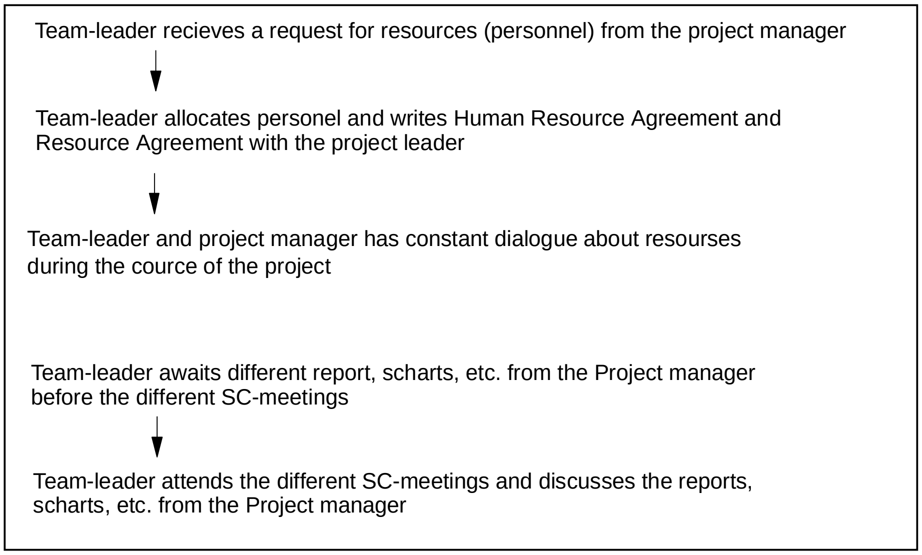

Figure 10. The general flow of formal information to and from the team-leader

7.3.7 The project manager

The project managers have maybe the most central role in projects at Volvo IT. The project manager interviewed here is named E. He is the initiator and creator of much of the information in a project in which he is a project manager. E is the one that supplies the different members of the SC with information (see result report and risk management plan) about the progress of the project. He is also the one upholding the contact with the customer (or rather the project manager that manages the overall project at the customer side, in which the project at Volvo IT is a sub-project) during the course of the project.

E is appointed by the chairman of the SC (C) at the beginning of the gate G1. E and C together sign the project charter, which is to be complete and finished by B and C at the end of gate G0. The charter is a very important document for E, since the charter constitute the basis for the whole project and hence the information system that E commits to manufacture. If the charter does not give E the information he needs the start of the project may be delayed. If E has signed the charter and the charter has flaws or is not finished, the project manager himself has to make the necessary complements to the charter before the next step of the building of the information system can begin. When the charter is satisfactory, E goes on to the next phase in the project (which is to be conducted in G1), the analysing and design of the information system. In many cases the project manager himself does all of the analysing and design and he creates the data model (which forms the basis for the system). In some cases, if the appointed project manager is not skilled in the art of data modelling and design of information systems, he can use someone to help him with the modelling and analysis. In most cases however the project managers at the department at Volvo IT, where this study is made, the project managers have backgrounds as programmers and system developers and is thus skilled in the art of analysis and design of information systems thus themselves draws the data-models.

Once the design and the analysis are finished, E summons for an SC-meeting (gate G2 meeting) and sends the foundation for the solution (result report and risk management plan) to the members of the SC. This solution, eventual risks and a plan for managing the risks is then discussed at the SC-meeting. E also calculates life cycle costs and makes sure they are in line with the revenues for the agreed solution (see the project charter). This is also discussed at the SC-meeting.

If the solution for the system and the plan for managing the risks are approved, E then goes on to the next phase in the project, the G2 gate. The G2 gate is entered when the solution has been designed and approved by the SC (likewise for the managing of risks and life-cycle costs). This is where the actual building of the system is conducted. At the end of G2 gate, E summons the SC for yet another gate meeting (the G3 gate meeting). E also sends the foundation (reports on the progress, see result report) for the meeting to the various members of the SC. They now discuss the final information system, how it has turned out and the problems that occurred during the building phase. If the final system is approved the G2 gate is closed and the project moves on to gate G3. Now the solution is being tested and if it has to be revised it is done in this phase. E writes a result report that describes how well the project has met the quality and reliability criteria's that is defined. E also write a new risk management plan where eventual new damaging side effects that may occur and what measures one must take to manage these side effects are explained. If measures are already taken to manage these eventual side effects, they are to be explained. E also makes sure that the involved parties are ready to go live and implement the system. Before the implementation of the system, E summons for a third meeting with the SC (gate G4 meeting).

Now the test results, eventual side effects and the solution to these side effects is to be discussed (a new result report and risk management plan). As usual the members of the SC receives the material to be discussed at the SC-meeting from E in advance before the meeting so that they can get up to date before the meeting. If the solution and the test result, etc. is approved by the SC the solution gets a go for launch and is implemented at the customer. E then writes a final report that is handed over to the members of the SC and the manager of purchasing that made the initial request for the information system. E also writes the project experiences collection. The system is now in operation for about three months before the system is handed over to the maintenance organisation. This is done at the G4 gate. At this gate the decision is made to close the project and hand the system over to the maintenance organisation. At this point the project manager is finished with the project and the SC team is dissolved. The G4 gate is now closed.

If the customer has agreed on paying for the white book, the G4 gate is not closed until the white book is written. This means that the G4 gate is open during the six months when the system is in operation. The G4 gate is closed when the white book is finished. Now yet another SC meeting is held (gate G5 meeting). Gate G5 is now opened and if the white book is approved the G5 gate is then closed.

The transformation from the project charter to the final report and project experience collection can be summarised as follows: When E has a proposed solution for the information system to be developed, he summons the SC-members for a SC-meeting (Gate 2 meeting). Before the meeting he sends the proposal in the form of a result report and a risk management plan. In the result report E has also calculated estimated life cycle costs for the whole project. If the SC approves the solution and plan for managing risks the solution is now set in progress. The proposal for the new information system has now been processed and transformed into an approved solution. The G1 gate is now closed and the G2 gate is open. This means that the solution is to be to be manufactured.

When E and his development team have manufactured the solution into a functional solution it is time for the test session. Once the test session is complete E once again summons for an SC-meeting (Gate 3 meeting). Now he has written a new result report with test results and he has updated the risk management plan. If the manufactured and tested solution gets an approval from the SC the result report with the test results and risk management plan is transformed into an approved manufactured solution. The solution has now got a go for launch and is to be implemented at the customer. The gate 3 is now closed and gate 4 is open.

It is now time for the system to be implemented. E makes sure that the involved parties are ready to go live and implements the system. E then writes a final report and summons for a fourth SC-meeting (gate 4 meeting). The report is discussed at the SC-meeting and if approved the report is transformed into an approved final report. The final report is now handed over to the manager of purchasing that made the initial request for the information system. E also writes the project experiences collection.

The project manager is the one who initiates the SC-meetings G1, G2, G3 and G4 since he is the one most familiar with the progress of the building of the system between the G1 and G4 gate. Except for the meetings with the SC-members and the members of the project group (programmers, designers, and technicians), the project manager also uphold communication with the project manager on the customer side. Since the project at Volvo IT is a sub-project in a larger project on the customer side, the project manager at the customer side must be updated on a regular basis. This is done by meetings, phonecalls and e-mail. The project managers at both sides, Volvo IT and the customer side, is free to initiate communication when they see fit.

Since there is quite some time passing between the gate meetings, sometimes weeks or months, the project leader is free to summon either the SC for meetings in between the formal gates to discuss problems etc. Or he may discuss these problems with any of the members via phone, mail or informal meetings at any time he see fit. But if no major problem occurs between the gate meetings, these sporadic occasional SC-meetings occur very seldom and communication via phone, mail or small informal meetings usually does the trick. Sometimes the project manager also gets the responsibility of being the system manager for the system that he has developed. This means that he is the expert on the system and the one to be contacted at Volvo IT if there is any problems with the system or if some alterations are to be made to the system during the course of the lifetime of the system. Sometimes someone else than the project manager is chosen to be the system manager, but in all cases, the one that is chosen must know the system very well. Preferably he was a member of the project team who built the system. Every change to the system is logged and saved so that others can se what have been done to the system after the implementation.

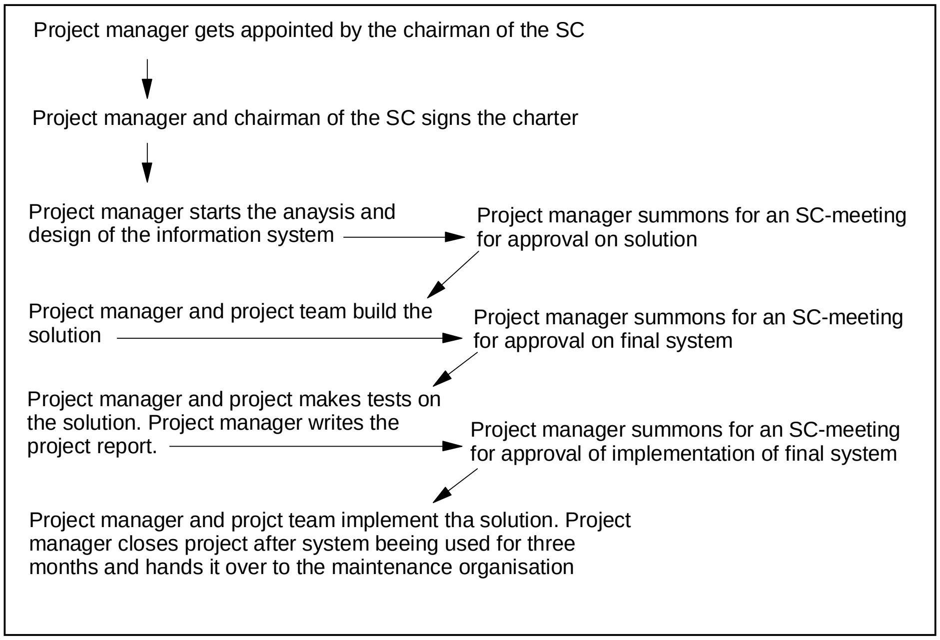

Figure 11. The general flows of development between gate G1 and gate G4

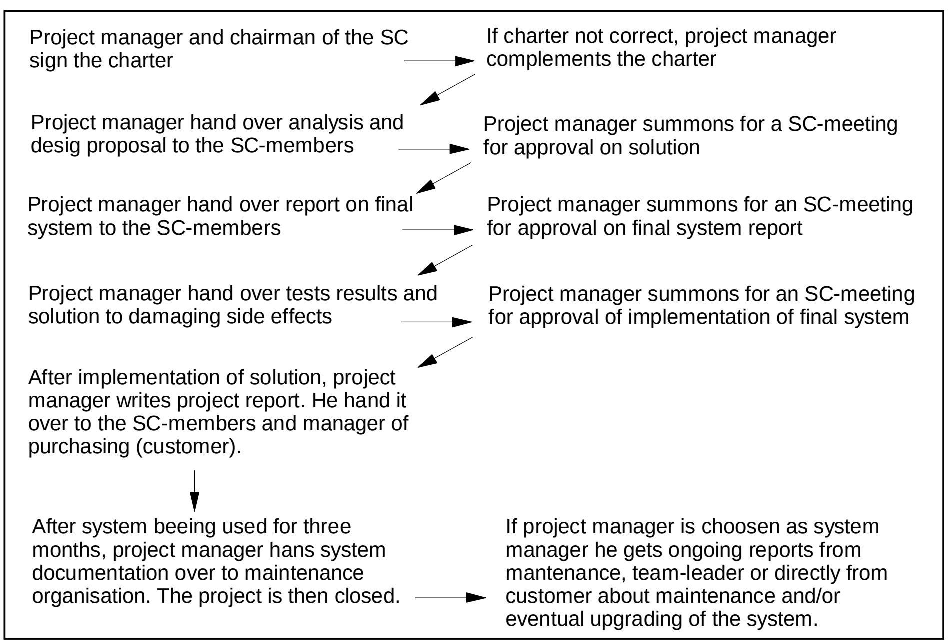

Figure 12. The general flow of formal information to and from the project manager

In Figure 13 the flow of information between the project manager at Volvo IT and the project manager at the customer side is not shown. This is due to the difficulty of illustrating the sporadically of these meetings.

7.4 Flowcharts describing the different flows of information

Here the flow of information between the different respondents is described via flowcharts. These flowcharts function as a summation of what is described in earlier texts, and as a means of facilitating the understanding of the different major flows of information to and through the respondents. The flowcharts also describe and facilitate the understanding of the different transformations of documents from one sort to another. Figure 13 describes the transformation process from the request for a new information to a signed business agreement. Figure 14 describes the transformation process from a business agreement into a signed project charter. Figure 15, which is more complex, describes the transformation process from a signed project charter into the white book. Figure 16 describes the processing and transformation of Change Management Council Meeting Minutes. Figure 17 describes the process and transformation of SCMN and SCMM (Steering Committee Meeting Minutes and Steering Committee Meeting Notices). Figure 18 describes input and output from the VIT PCM monitoring database.

Figure 13 and 15 contains several smaller figures named 1, 2, 3, etc. These smaller figures should be read from left to right in order to follow the flow of information in the appropriate way.

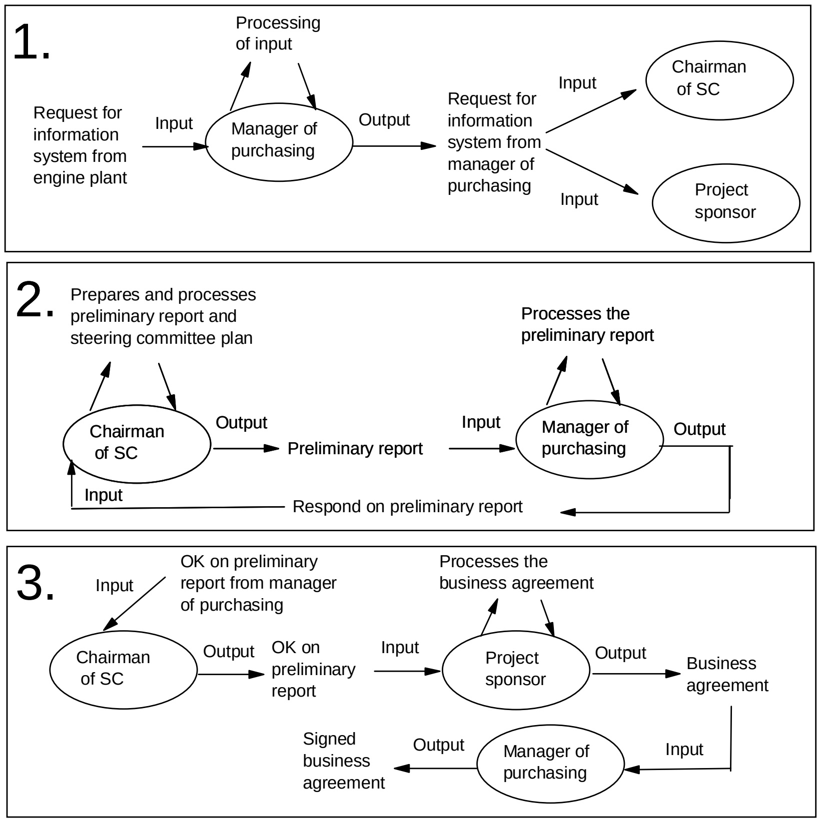

Figure 13. The transformation of request for an information system to a signed business agreement

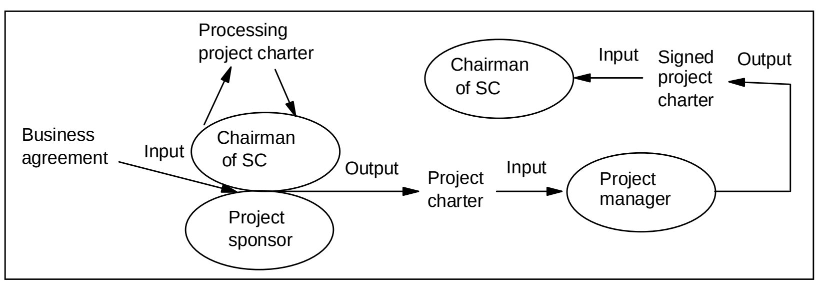

Figure 14. The transformation of a business agreement into a signed project charter

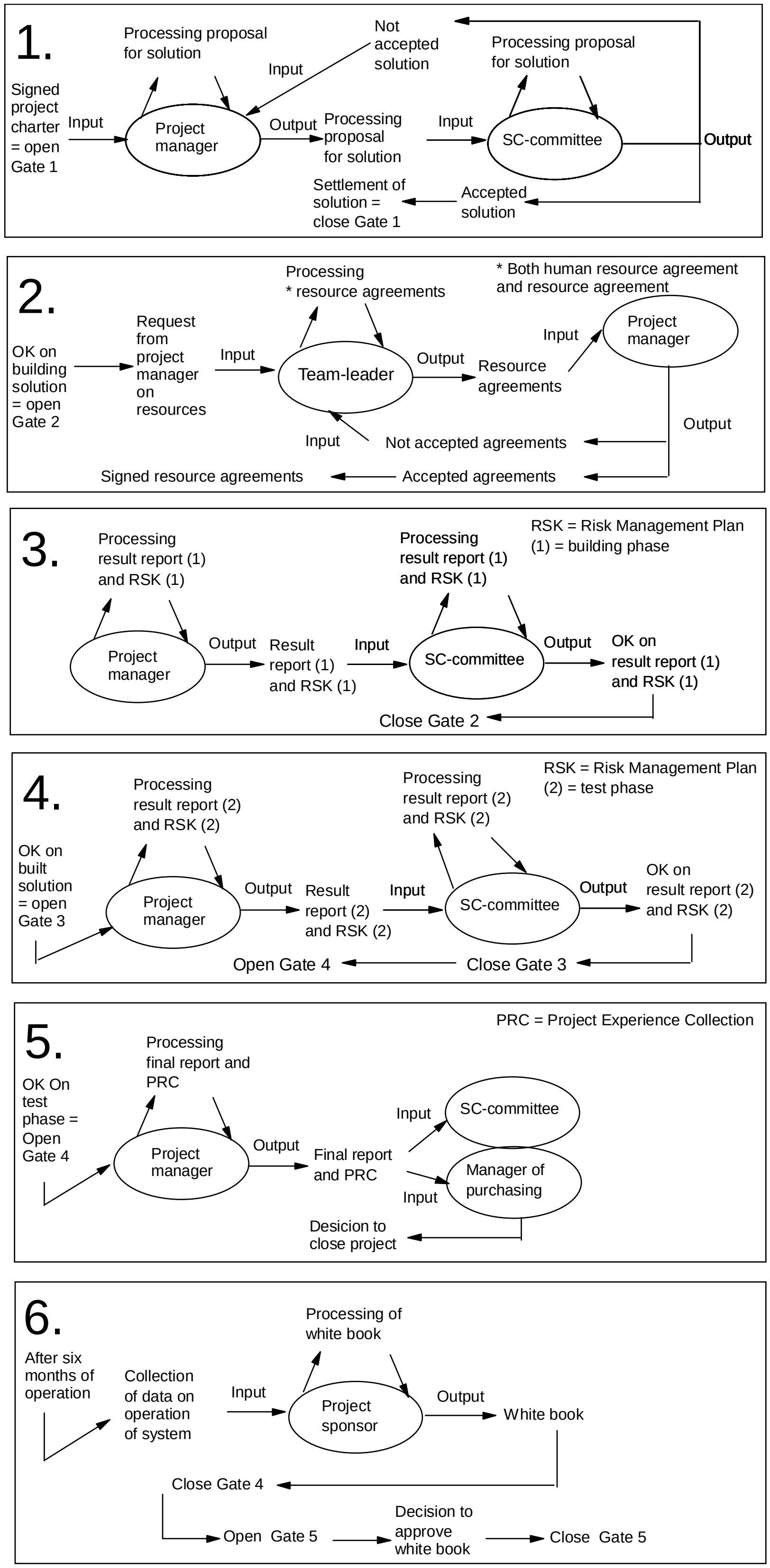

Figure 15. The transformation of a signed project charter into a white book

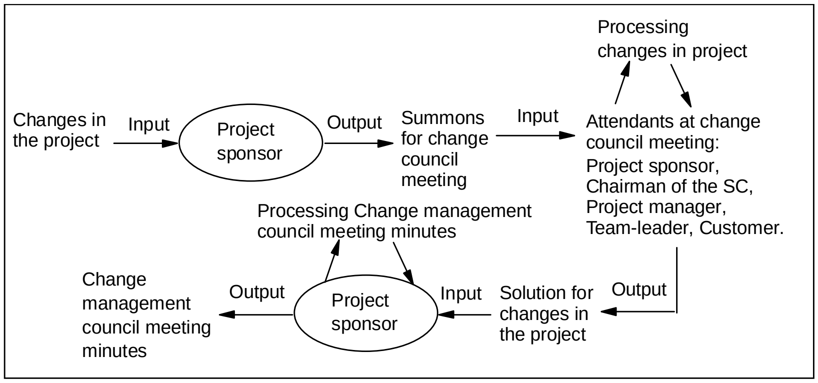

Figure 16. The processing and transformation of Change Management Council Meeting Minutes

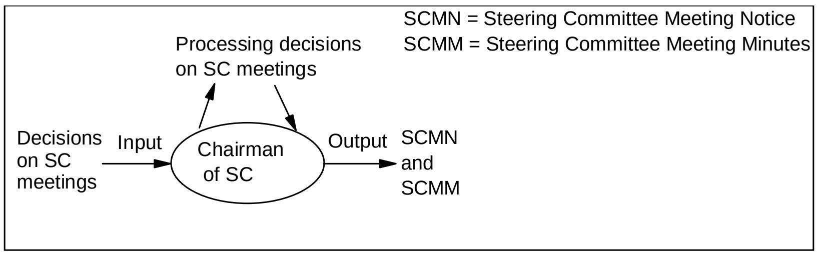

Figure 17. The process and transformation of SCMN and SCMM

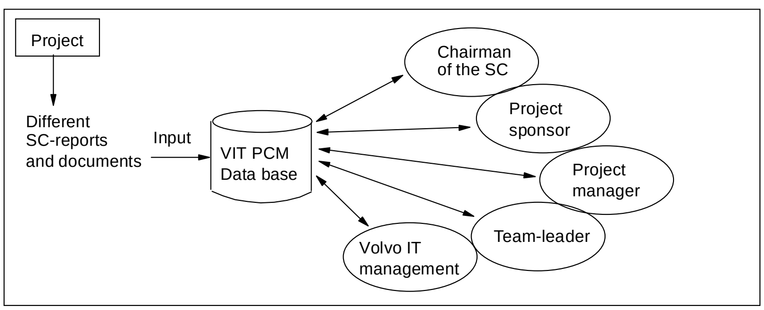

Figure 18. Input and output from the VIT PCM monitoring database

Figure 13 and 15 contain several smaller figures. These smaller figures are named 1, 2, 3, etc. which can be seen in the upper right corner in figure 13 and 15. When referring to these smaller figures later in the text, it will be made as follows: When referring to the small figure 2 in figure 13 the author will write **Figure 13.2**, meaning the small figure with number 2 in the upper right corner in figure 13.

8 Analysis

When analysing the material there are two criteria that are to be reached (mentioned in *3. Aims and objectives*). Firstly one must see if one can identify the critical information processing subsystems in the application. Secondly, Miller's (1995) critical information processing subsystems must also take into consideration such information flows that are significant in the application. This means that one must be able to identify (transform) Miller's (1995) critical information processing subsystems on the project management process, as discussed in the chapter *7. Material*. The critical information-processing subsystems that is to be identified are input transducer, internal transducer, channel and net, timer, decoder, associator, memory, decider, encoder and output transducer (Miller, 1995). The two critical subsystems that handle both information and matter/energy are the reproducer and the boundary (Miller, 1995). These are also to be identified. All in all there are twelve critical information-processing subsystems to be identified.

8.1 Is the project management group a living system?

The first thing to do is to see if the project management group that is studied can be considered a living system. This is important because the critical information processing subsystem by Miller (1995) is only applicable on living systems.

Firstly let us see if the group that is studied can be modelled as a system, and secondly, let us see if the group that is studied is also a living system according to Miller (1995).

A system is something that consists of elements that have something in common with each other (a relation in some form), and the elements should interact with each other in some form (Flood & Carson, 1993). The project management group has several members (elements) with the common duty of managing a project. They also interact with each other (via messages, reports, documents, etc). The studied group thus consists of related elements with interactions between them.

A system is also seen as something that can not be divided into its separate elements and yet still be considered as a system. This means that the system is seen as a whole (Ackoff, 1981). The project management group can be divided into its separate parts and each person in the group can work for himself, which they often do most of the time, but when new information is to be discussed they summon for a meeting and process this information together. The group is constituted from the beginning for the soul purpose of producing some specific outcome. This means that people need to work together in order to co-ordinate the work and their different skills in an effective way. The mere fact that it can be difficult to replace members of the group in an advanced stage of the project management process also emphasises the necessity of keeping the group together. The group can thus not be separated into its separate parts and still be considered as project management group. The group can thus be seen as a whole. All of the criteria for the group to be a system seem to be fulfilled. Since the group is made up of human beings and all of the critical subsystems reside in human beings, the group is also a living system. *Let us now look on the subsystems with their related processes, and see if they are to be found in the applied situation.*

8.2 Identification of the critical subsystems

Here the critical information processing subsystems in the application will be identified.

8.2.1 The boundary subsystem

Definition. The boundary is the subsystem at the perimeter of a system that holds together the components which make up the system, protects them from environmental stresses, and excludes or permits entry to various sorts of matter-energy and information (Miller, 1995).

Description of the boundary subsystem: The boundary has three roles according to Miller (1995): First, it constitutes a barrier to flows of matter-energy and information in and out of the system. Secondly, it filters certain sorts of matter-energy and information, selectively permitting some to pass in or out but not others. And third, it maintains a steady-state differential between the interior of the system and its environment.

Boundaries at the level of groups (and above) have special structural characteristics, which derive from the physical separateness and independent mobility of their component organisations (Miller, 1995). The living boundary subsystems at the level of the group (and above) are frequently supplemented by artifacts such as rooms, buildings, fences, walls or other structures (Miller, 1995).

It can also be the various apparatus that enable the flow of matter-energy and information through these buildings (e-mail, phones, fax machines, etc.). The information that is to enter or leave the system must do so, according to Miller (1995), via the boundary and one of two other subsystems, the input transducer or the output transducer (more about these transducer subsystems later in the chapter). A boundary may also be a person who decide if information is to enter or leave the group in the first place (Miller, 1995).

The boundary subsystem in the application. The project management group studied is located at the Volvo IT premises in Skövde. All of the Volvo IT premises is guarded by security officers. The meetings are located in meeting rooms and they use e-mail, phones and fax-machines to communicate with each other. The project management group itself is located in a room where they sit together (allowing face-to-face communication).

Hence the project management group has a boundary made up of the building they reside in and the artefacts they use to communicate with the environment, this is in line with Millers (1995) criteria's for a boundary subsystem. But the boundary is also made up of the members in the group.

The information that enters or leaves the group is either approved or disapproved to do so by the chairman of the SC or the other members of the SC (not necessarily always in that order). So the decisions about what information that enters or leaves the group is constituted by the group members. The group members thus function as the boundary, which also is in line with Millers (1995) criteria for a boundary. The PCM model can contribute to these decisions made by the group members, via its normative role (the PCM model describes the normative way to work when managing projects at Volvo IT).

The group also has a special VIT PCM monitoring database, see Figure 20, that protects the different written documents and report that the group produces or receives (the database belongs to the artefactual part of the boundary). This database also functions as a shelter (a boundary) for the group (or rather the work made by the group).

All this together constitutes the barrier and filtering process that enables information to pass in and out from the group. This process of controlling the flow of information in and out from the system also upholds the steady-state differential between the group and the surroundings.

Since the identified boundary in the application comply with the structure of internal boundary subsystem given by Miller (1995) it seems that the project management group possess the boundary subsystem as specified by Miller (1995).

8.2.2 The reproducer subsystem

Definition. The reproducer is the subsystem which is capable of giving rise to other systems similar to the one it is in (Miller, 1995).

Description of the reproducer subsystem. The reproducer is the subsystem, which function as a reproducer of the system (Miller, 1995). The reproducer gives rice to systems of the same type as the one that the reproducer is located in (Miller, 1995). But some systems have reproducers that allow giving rise exactly the same system, cloning, (Miller, 1995). The reproduction system located at human beings allows for new human beings to be born. The child is not an exact copy of its parents, but it is of the same type. The groups that have the ability to reproduce also reproduce a group of the same type, an exact copy of the group can never be produced.

The reproducer subsystem in the application. A project management group per see does normally not reproduce itself into a new project management group. The group is constituted at the beginning of a new project. Once the project is finished and implemented, the group is dissolved. The group can be reunited (reborn) again when it is decided to start a new project, but the group (system) does not normally make the decision. That decision is made by the manager in head of the department, which receives the request for a new information system from a customer. This is in line with the Miller (1995, pp 519) where he says that human groups do not reproduce in the sense that humans do. New groups arise as a result of processes within the organisation, which are their suprasystems.

Nevertheless there may exist situations that make the project management group to reproduce itself. One such situation may be if a decider in the group would leave the group for some reason (the decider may get sick, resign, etc.). Let us say that it is the chairman of the SC that leaves the group. Now the group must find a new decider. A decider of such a dignity (the chairman of the SC is almost always the head of the department) almost brings with him new changes to the group that may affect the constitution and the way the group work. If the group is to undergo big changes due to the change of chairman, one can say that it is a new group (a new system). In such cases one can say that the group have a reproducer function.

Also in smaller projects (under a specified amount of time and cost) the head of the department may himself decide to start a project (and hence also start the birth of a new project management group). But being a system and not having a reproducer is not always menacing for the system. The reproducer is in fact one of the few subsystems that a system does not have to posses in order to be a system (Merker 1985, Backlund 2000). The system can instead be independent on other systems for its reproduction. It can be parasitic (the group is reborn due to malfunctions or errors in other systems) or it can be symbiotic (the group can rise again due to partnership with other groups).

Even if Miller (1995) mean that human groups do not reproduce themselves, we have fund two examples in the studied application when the project management group can reproduce itself (the situation when the chairman left the group and when the time and cost for a project is small enough to let the head of the department to make the decision himself to start a project). The group thus have a reproducer function even if it normally seldom come into use. The more normal way for the project management group to be reproduced is when orders to do so comes from a reproducer located in a suprasystem.

8.2.3 The input transducer subsystem

Definition. The input transducer is the sensory subsystem which brings markers bearing information into the system, changing them to other matter-energy forms suitable for transmission within it (Miller, 1995).

Description of the input transducer subsystem. This subsystem brings the markers bearing the information into the system. A marker is something that can carry with it information. A file or a piece of paper with scribbles on it is examples of markers. They both carry the information thus the information cannot travel from one point in space (the sender) to another (the receiver). The information thus needs something to carry it from the sender to the receiver and the marker does this.

Living components of the input transducer are found at least some of the time in almost all sorts of groups (Miller, 1995). The input transducer of groups can be dispersed in various ways. A messenger who is a component of the supra system sometimes may enter the group to give information. This is an example of a part of the input transducer subsystem upwardly dispersed (Miller, 1995). Another example is when a member of the group takes information from the outside of the boundary and brings it inside the system. The input transducer is now inwardly dispersed. In modern times artefacts often serve as input transducers to groups (Miller, 1995).

The input transducer subsystem in the application. In the project manager group, the input transducer can be any of the group members. They all know what information is significant for (or are related to) the project managing process and thus they know what information to bring in to the group. This is an example of the living components that almost always can be found in a system that function as input transducers, according to Miller (1995).

Let’s follow an example that allows us to see how the members in the group function as input transducers: lets say that we follow the project management process from the very start of a project. First the customer takes contact with the department manager and discusses the need for a new information system. The department manager now comes in contact with the initial information for the first time. The department manager brings the information with him into the department and discusses the request for the new information system with the project sponsor. If a decision is made to start a project the department manager creates a steering committee. He has now brought the information into the system (the project management group). The department manager (which by now is the chairman of the SC) have functioned as the internal transducer, as specified by Miller (1995), and brought the first information into the project management group, se Figure 14.1 and Figure 14.2. When the chairman later on receives an OK on the preliminary report from the customer, he brings the approved preliminary report into the system again, se Figure 14.3. He has now functioned, again, as the input transducer. When the project sponsor receive the processed business agreement (or an OK on the business agreement) he brings it into the system. Now the project sponsor has functioned as the internal transducer, as specified by Miller (1995), se Figure 14.3 and Figure 15. Later on in the project, the project manager awaits information from the customer on the approval of the final report. When he receives this information he brings it into the SC for a discussion of the result. The project manager has now functioned as the input transducers, as specified by Miller (1995), se Figure 16.5. The project sponsor again functions as the input transducer when he receives and brings into the system the answer (or maybe the approval) on the white book, se Figure 16.6.

The computerised information system with is software programs (e-mail functionality) and peripheral hardware connected to it (fax machines, etc), and the telephone system also allow taking information into the group. Thus the artefacts mentioned also serve as input transducers.

Since the identified input transducers in the application comply with the structure of input transducers given by Miller (1995) it seems that the project management group possess the input transducer subsystem as specified by Miller (1995).

8.2.4 The internal transducer subsystem

Definition. The internal transducer is the sensory subsystem which receives, from subsystems or components within the system, markers bearing information about significant alterations in those subsystems or components, changing them to other matter-energy forms of a sort which can be transmitted within it (Miller, 1995).

Description of the internal transducer subsystem. Not all information originates from outside the system. Some of it enters the information channels from within the system itself. This is done through the internal transducer subsystem (Merker, 1985). The internal transducer is an information handling subsystem that receives information from subsystems or components within the system and transduces it further. This information is about changes in the system, or about changes in components in the system, that is significant in one way or another. This information is then transformed into forms that are readily usable by the system (a change or alteration of the transmitting markers may have to be necessary).

Any group members or subgroup is a component of the internal transducer that receives from other members and conveys to the group information about the group task, about group interactions, or about the internal states as they interact, including their feelings about group processes (Miller, 1995). Miller (1995) clearly states that any member of a group function as an internal transducer.

The internal transducer subsystem in the application. It is about sensing and managing the internal states in the group. In the project management group under study, the team-leader has the special responsibility of being the internal transducer. He thus has a formal role of being an internal transducer. The team-leader is the sub-manager for the whole development team. His responsibility is to permit time off, he co-ordinates the resources in the development team and he is the manager working closest with the personnel on a day-to-day basis. He is to report to the head-manager of the development team about people having time off, holiday charts, the progress of the work made in the department etc. Since he also is a member of all SC-teams he can easily report the different internal states to the other members of the SC.

But other members of the SC also have the role of an internal transducer. There is in fact both informal and formal ways to function as an internal transducer. The informal way is when members of the SC reports to each other in ways and on occasions not specified by the PCM model. The internal transducer process either do not have to follow a hierarchical path for the transmitting process (which is not necessary either according to Miller, 1995).

The more formal way of being an internal transducer is when reports etc., that is constituted by the PCM-model, is expected to be sent between members of the SC. Say that the SC awaits a result report from the project manager that is to be discussed at an SC meeting, see Figure 16.3 and Figure 16.4. In this case the project manager is an internal transducer that is to report about the progress of his development team (the state in which the construction of the information system is). Another example is when the project manager has written the white book and is to report the contents of the report to the SC, in order for the SC to decide on the open and closure of the gate G5, see Figure 16.6.

A living system can remain as a living system only if its subsystems and components report their current states and their needs, so that feedback signals can co-ordinate their processes with those of the whole system (Miller, 1995). By discussing and reporting the internal states of each of the SC members with other SC members (either formally on SC meetings or informally via e-mail, phone or small meetings) each of the SC members can act as internal transducers, and most of the time they also do so.

The markers used for transmitting this information to and through the different members in the group is formal reports (described in the PCM model) and informal reports (not mentioned in the PCM model). The informal markers can also be e-mail, phone-calls and small spur-of-the-moment meetings. I prefer to call them informal and formal transducer and the markers bearing the information are likewise called informal and formal markers.

Since the identified internal transducers in the application comply with the structure of internal transducers given by Miller (1995) it seems that the project management group possess the internal transducer subsystem as specified by Miller (1995).

8.2.5 The channel and net subsystem

Definition. The subsystem called Channel and net is composed of a single route in physical space, or multiple interconnected routes, by which markers bearing information are transmitted to all parts of the system (Miller, 1995).

Description of the channel and net subsystem. Channels may intersect at nodes and they may be interconnected to form nets. The net conveys markers bearing information. Also each group member is a part of the group channel and net subsystem, although when the group is not meeting, when a members is absent, or when the group process or the research design requires it, some or all of the channels may not be in use (Miller, 1995). There are thus two different kinds of channel and net subsystems. The one manufactured by human beings, the artificial channel and net, and the channel and net made up of the members in the team.

The channel and net subsystem in the application. Let us first see if we can identify the artificial channel and net subsystem, and later see if we can identify the channel and net made up of members in the group.

The artificial channel and net at Volvo IT where the project management group studied resides may be several things. It can be the system of distributed computers (clients) linked together by the server system that allow distribution of reports and e-mail messages between the members of the SC. It can also be the phone system allowing communication through the telephones. Fax-machines, copy-machines and printers also allow communication between the group but in a more indirect way. The expression “in a more indirect way” is used because the reports or charters must first be printed out from the machine before they can be handed over to the recipient for discussion. Using the computers or phones allow a more direct “face-to-face” communication. Nevertheless, the fax-machines, copy-machines and the printers are integrated parts of the distributed client/server system at Volvo IT, thus it is also an integrated part of the channel and net subsystem.

Much of the information is also transmitted via the internal web application, the Intranet. Volvo IT has a computerised, well extended, network with possibilities for the members of the SC group to send and receive information to and from each other in both space and time. All SC teams also have access to a special VIT PCM homepage. Here one can find support for how to conduct the project management process according to PCM, templates for different reports, etc. Information about changes and updates of the PCM process is also stated here. All SC groups also have access to a special VIT PCM monitoring database retrievable from the PCM homepage. Via this database members of the SC can follow the progress of the project they are to manage. The project manager, chairman of the SC and the project sponsor publish some of their reports there. Here one can also find logs describing the progress of the project.

The members in the project management group also function as a channel and net subsystem. They hold meetings where they communicate with each other and thus pass on information from one person to the other. They meet on coffee breaks and lunches where they discuss work related issues. Speech carried over the auditory band, gestures carried over the visual band and touching are different channels used when members of the group meet.

Since the identified channel and net in the application comply with the structure of the channel and net subsystem given by Miller (1995) it seems that the project management group possess the channel and net subsystem as specified by Miller (1995).

8.2.6 The timer subsystem

Definition. The timer subsystem is a subsystem which Miller did not incorporate into LST until 1990. It was first introduced in the article The Timer in Behavioral Science (Miller, 1990). The timer is the subsystem which function as the co-ordinator of time in the system (Miller, 1990).

Description of the timer subsystem. The timer transmits to the decider subsystem information about time-related states of other subsystems, components or processes within the system (Miller, 1995). The timer, according to Miller (1995), also co-ordinates the decider of the system to deciders of subsystems in time (if they exist).

In order for a system to keep track of its multiple processes and functions that work within the system, and to co-ordinate them with each other in time, some kind of functionality for this must exist inside the system. This functionality is realised by the timer. The timer is the subsystem which keeps track of when different processes start and stop. The timer also keeps track of when different stages in these processes occur (when they should occur and when they actually do so). This allow subsystems to know when to trigger the next process to start, when to stop processes and to keep track of deviations from predetermined stages the processes go through, that is if this deviations is time related in some way.

The timer subsystem in the application. In the project management group the timer is made up of three things. First, the PCM model functions as a timer in some stages of a project. Secondly, the SC meetings also function as a timer subsystem. Finally, the members in the system also function as timer subsystems.

In the project management group the timer is constituted mainly by the PCM-model. In the PCM-model there are gates (G-1, G0, G1, G2, G3, G4 and G5) that one must pass in order to go on to the next phase in the project. It is the members in the SC that together make the decision of opening or closing the gates, but it is the PCM model that says when and on what basis these decisions is to be taken.

The SC meetings that do not decide on closing or opening gates may also function as a timer. At these SC meetings the progress of the project is discussed and decisions may be made that function as regulating the following stages of the project in time.

The members constitute the third timer function in the project management group themselves. Individuals in the group carry out these timer processes so these timer processes are smaller than the timer processes carried out by the SC. All of the SC members in some way or another have to keep track of processes in time and co-ordinate them with each other, thus they all function as timer subsystems.

Since the identified timers in the application comply with the structure of the timer subsystem given by Miller (1990) it seems that the project management group possess the timer subsystem as specified by Miller (1990).

8.2.7 The decoder subsystem

Definition. The subsystem which alters the code of information input to it from the input transducer or internal transducer into a “private” code that can be used internally by the system (Miller, 1995).

Description of the decoder subsystem. When a group forms, its members usually begin to use a common language after a while (Miller, 1995). If all members do not speak the same language, one of the first discussions is about the selection of a common language to use in the group. If some members do not know the language, others must translate for them until they learn it (Miller, 1995). When a group has interacted over a period of time, the common interests and experiences lead to the development of a private language. This language may have quite a technical jargon or another convenient ways to express ideas, etc (Miller, 1995). The group has developed a “private code” that are efficient for the purposes of the group.

A group employs its decoder subsystem when it receives information from either outside the system or within the system that is coded in such a way that it is difficult to understand by the members in the group. According to Miller (1995), the information is coded either in a different code from the code used inside the group, or there may be distortions in other ways that make the information difficult to understand by the members inside the system. But if the information entering the group is in the same code as the code used within the group, the decoder subsystem need not be employed.

A groups decoder may be local, limited to one component, or it may be laterally dispersed to several members in the group (Miller, 1995).

The decoder subsystem in the application. The components of the decoder subsystem in the studied project management group are mainly of two kind, the artefacts the members in the group use to read and receive reports etc., and the members of the group.

The artefactual part of the decoder is the software programs that can alter the messages and reports that the members of the group receive while using their computers. If information from outside the boundary of the group is sent to the group and the form of the information that the internal transducers bring into the group is not usable by the group, the software programs can alter the code. Example; the manager of purchasing sends a report to the project sponsor originally written in a word processing program the project sponsor do not have. The project sponsor may have software that is compatible with the one the manager of purchasing is using, thus allowing alternation of the original code into code readable by the project sponsor. Usually all of the people employed at Volvo IT use the same kind of software to communicate with each other so this is normally not a problem, but if the sender is someone outside Volvo (an external customer outside Volvo) this problem may occur.

As mentioned earlier, a group's decoder may be local, limited to one component, or it may be laterally dispersed to several members in the group (Miller, 1995). In the project management group the decoder is in fact laterally dispersed between the members. The software programs earlier mentioned is located on servers which are located in one particular room at Volvo IT, thus the software may be seen as located centrally and not laterally dispersed, but the software is laterally dispersed on each client (PC) that the members in the group use (via the computerised network). The conclusion may thus be that the software functioning as decoder is laterally dispersed in the group.

The project members also function as decoders, and they are also laterally dispersed. The members of the group may sometimes not even be located in the same premises for periods of time, but they still belong to the group.

The members of the group are the part of decoder subsystem that does most of the decoding. They are all decoders since they all uphold a contact with the environment and bring information into the group. Since each member of the group is a specialists in a different area and thus receive information not readily understandable by the other members, and since some of this information is to be presented to the other members, the information they present to the others must be decoded to enable a proper understanding by all members.

Since the identified decoders in the application comply with the structure of the decoder subsystem given by Miller (1990) it seems that the project management group possess the decoder subsystem as specified by Miller (1990).

8.2.8 The associator subsystem

Definition. The subsystem which carries out the first stage of the learning process, forming enduring associations among items of information in the system (Miller, 1995).

Description of the associator subsystem. At the level of group and above, the association of items of information must be done by one or more organism components. In a group it is always a laterally dispersed process (Miller, 1995).

Other possible arrangements, according to Miller (1995), are for a subgroup to master a particular skill or for the group to divide a task requiring association so that each member take responsibility for a part.

Although different assignments of tasks in the associator are observed in the same group under different conditions, the subsystem usually includes all group members at some time, perhaps aided by computers (Miller, 1995).

The associator subsystem in the application. The associator subsystem in the project management group is mainly made up of the members of the group. All of the members in the group function on different occasions as associators. This is because delegating all of the associating related processes upon one person would be too much work for one person to handle and some associations would most certainly be lost or distorted. Each of the members in the group is a specialist in some area and the one in the group most familiar with associating processes related to his area of profession is most likely to make the best and most enduring associations. An example of an associating process in the project management group is when the project manager learns new ways of controlling the development process of the information system.

Laterally dispersing the associating processes among the members is the most efficient way for the associating subsystem to be constellated in the project management group. Each of the project management members takes responsibility of learning what is new in his area of responsibility.

As mentioned above, Miller (1995) means that dividing a task requiring association among the members of the group is also a possible arrangement for making endurable and efficient associations. This is also made in the project management group if the association to process is of such a nature that a division of labour between the members is possible.

In the project management group there are not so many associations made by the aid of computers.

Since the identified associators in the application comply with the structure of the associator subsystem given by Miller (1990) it seems that the project management group possess the associator subsystem as specified by Miller (1990).

8.2.9 The memory subsystem

Definition. The subsystem which carries out the second stage of the learning process, storing various sorts of information in the system for different periods of time (Miller, 1995).

Description of the memory subsystem. This subsystem is usually laterally dispersed to all group members, each of whom stores information in his own nervous system (Miller, 1995). In most groups, therefore, there is no group memory as such. In some cases, however, particular members of the group may have the responsibility for keeping records or storing particular sorts of information (Miller, 1995). Thus, groups and higher higher-level systems may disperse the remembering (memory) to all individual persons in the system, or the group may delegate the remembering responsibility to a single member in the group (Miller, 1995). Notes, written minutes, photographs, books, tape recordings, computers, etc., and other various sorts of artefacts augment the memory subsystem in different sorts of groups (Miller, 1995).

The memory subsystem in the application. In the studied project manager group, the memory subsystem is dispersed between the members in the group, the filing system in their computers and notebooks (the memory subsystem is laterally dispersed, as according to Miller, 1995). Also the VIT PCM monitoring database function as a component of the memory subsystem.

The members in the group have different responsibilities and work with different things (different skills) so each of the members have somewhat different memories that they must keep track of (laterally dispersed memory). Example: the team-leader has to keep track of the state of the resources in the development team, i.e. which person work in what team and which hardware and software resources are used by different teams, etc. The project manager must keep track of all the different processes in the design and development stage of the project, etc. This means that the different members have the responsibility of keeping record of and storing information concerning their area of responsibility. This is in line with Miller (1995).

They keep all this in the memory subsystem by writing notes, writing reports, filling in checklists, etc. (they use these different scaffoldings as aids for remembering). The computer and its hard drive are used as a memory subsystem. But they also keep massive amounts of information in their head.

The VIT PCM monitoring database also functions as a component of the memory subsystems for the members of the SC group. The database allows the different members in the group to retreive reports, documents, checklists, etc. when needed. The project member writes document log and document status for every report they produce. This enables the members to look into the PCM monitoring database and study the log and status of each individual report. Example; the project manager fills in the log and status of the result report on a regular basis (or when something unexpected happens). This enable for, say the team-leader, to follow the progress of the project in between the SC meetings that the project manager summon for.

Since the identified memories in the application comply with the structure of the memory subsystem given by Miller (1990) it seems that the project management group possess the memory subsystem as specified by Miller (1990).

8.2.10 The decider subsystem

Definition. The decider is the executive subsystem which receives inputs from all other subsystems and transmits to them information outputs that control the entire system (Miller, 1995).

Description of the decider subsystem. The decider of a group, according to Miller (1995), may be in a single component organism, which is often the case in work groups or authoritarian family groups. It may include certain members for one type of decision and other members for another type, or it may include the whole group in a democratic process (Miller, 1995). A single group often uses different deciders in different circumstances (Miller, 1995).

The decider is the only essential critical subsystem, and it cannot be symbiotically dispersed to any other system (Miller, 1995). The fact that the decider subsystem is the only essential subsystem is not the same as saying that it is the only subsystem that must recide in a system, in order for the system to be a living system. A system with the decider as the sole constituent element is not a living system, it is not a system at all (Miller, 1995). But there can not be a system without a decider. This is essential.

The decider subsystem in the application. In the project management group all of the members are deciders. But they have different authorities to make decisions and different areas in which they make decisions. This is in line with Miller (1995).

The chairman of the SC has the main responsibility that the requested and signed for information system has all the functionality and quality as specified in the business agreement. This also means that the chairman of the SC is the one in the group with the highest degree of authority.

The team-leader has the responsibility of handling the allocation and distribution of the resources in the project. He is the sole decider of who and what material should be assigned to which project.

The project sponsor is responsible of handling the funds for the project. He does not decide if the project should be accepted or discarded based on the economical status of the project, this is something for the chairman of the SC to decide, but he can grant or decline requests for funds.

The project manager has the responsibility to manufacture the system. He has the authority to decide over smaller changes in the information system, without first discussing it with the SC. He does not have the authority to make big alternations in the design and functionality of the system without first consulting the customer and maybe other members of the SC team which have the authority to make decisions like this. This is due to different things. A big alternation of the project may increase the cost for the system. In cases like this the project manager must discuss it with the project manager. If the big alternation of the system demands more resources it must be discussed with the team-leader, etc.

The PCM model, which guide the members of the team in their work function in some stages as supporting for how to manage the processes. The PCM model is not only a guiding method for how to conduct a project management process. It is also mandatory to use thus it also function as guiding for how to make decisions. The PCM model states under what circumstances one is allowed to open or close a gate. The PCM model also entails checklists, etc. which must be used during the project. But the PCM model do not itself transform information into decisions, like the members in the group does, thus it is not a decider in the sense that Miller (1995) mean.

The term echelon is not mentioned in this section and this is because groups do not have echelons, according to Miller (1995). Echelons only reside in living systems above the level of groups (i.e. organisations, societies, supranational systems).

Since the identified deciders in the application comply with the structure of the decider subsystem given by Miller (1990) it seems that the project management group possess the decider subsystem as specified by Miller (1990). This is except for the slight controversy statement that the PCM model has a determinative function and thus functions as a decider in the group. As discussed earlier, Miller (1995) clearly takes a stand against the PCM model as a decider.

8.2.11 The encoder subsystem

Definition. The subsystem which alters the code of information input to it from other information processing subsystems, from a “private” code used internally by the system into a “public” code which can be interpreted by other systems in its environment (Miller, 1995).

Description of the encoder subsystem. A single-component organism, or all members together may constitute this subsystem (Miller, 1995). Sometimes translation into a language foreign to group members or into some sort of code is done by the encoder (Miller, 1995).

Miller’s (1995) description of the structure of the encoder subsystem is scantily worded. He does not say much more about the structure of the encoder subsystem than mentioned above. Nevertheless, due to the uncomplicated and straightforward essence of the encoder subsystem it is fairly easy to identify the subsystem in the application. But since the structural description of the encoder is so scarce there is only little room for a discussion of the structure of the encoder subsystem. The encoder must therefore mainly be identified based on the processes it conducts, more than its structure.

The encoder subsystem in the application. In the applied situation each of the members in the project management group function as encoder. The chairman of the SC encodes the information that he is to put outside the group in order for the information to be easily comprehended by people outside the group. Since the chairman of the SC also is the head of the department in which the SC resides, he may ask another members in the group to encode the information. This may be due to shortage of time (the manager of the department may be busy) or he uses his authority to do so based on other premises. It is common that the team-leader sometimes functions as a form of secretary and aids the chairman of the SC with the contacts outside the group (since his schedule is not as busy as the chairman's is and since the chairman is often out of the office).

The team-leader has an overall responsibility to keep a close contact with the customers during projects and when inquires are made of smaller changes to existing information systems that the department has developed. He must thus often function as an encoder and make sure that the information that leaves the group is easy to understand.

The project manager has the responsibility to uphold a close contact with the manager of purchasing (the customer) and the overall manager of the project on the customer side. He initiates and receives request for information that he put outside the group to the above mentioned professions. He must thus also encode the information into an easily understandable form so the manager of purchasing and the overall manager understand the message he conveys.

The project sponsor must when he is talking about funding and costs with the buyer of the system do it in such a way that is easily understandable. If the project sponsor discusses this with the economically responsible on the customer side, the work done on the encoding process is smaller since the project sponsor and the economically responsible on the customer side speaks the same "language" (they have the same profession). But when the project sponsor discusses economical issues with someone else on the customer side (or anyone outside the group) that does not have the same knowledge in this profession, more work must be made on the encoding process.

If the internal code and the external code (or languages) is the same, the encoder subsystem is not used. This is usually the case if, say, the project manager in the group and the overall project manager on the customer side discusses a topic in which both of them have the same degree of knowledge.

Another situation when the encoder process always must be in process is if people in the project manager group discusses (or leave reports) to customer that speaks another language. If the customer is a French company, talking Swedish is not an option. If the corporate language in both companies is the same, say English, then it is sufficient to encode the information leaving the group into English.

Since the identified encoders in the application comply with the structure of the encoder subsystem given by Miller (1990) it seems that the project management group possess the encoder subsystem as specified by Miller (1990). The processes the encoder subsystem does in the application also function as identifying for the subsystem.

8.2.12 The output transducer subsystem

Definition. The subsystem which puts out markers bearing information from the system, changing markers within the system into other energy-matter forms which can be transmitted over channels in the systems environment (Miller, 1995).

Description of the output transducer subsystem. At the level of the group or above this process is usually downwardly dispersed to one or more individual (Miller, 1995). But it is not unusual for encoder and output transducer components of groups to be the same (Miller, 1995). It is also common that a part of the encoder perform output transducing processes as well (Miller, 1995). A manager may not only write a statement (encoding process) that is to be transported to the outside of the boundary of the group. It is also common that he also put the letter on the mailbox (output transducer process). But is does not have to be this way, the encoder and output transducer may also be different members of the group.

Output transducers of groups may be head of departments whom report on activities in his department, secretaries mailing letters, representatives of working groups who report to echelons above them on employee satisfactions or demands, etc.

The output transducer subsystem in the application. In the project management group each of the members has the function as an output transducer on different occasions. Most of the time the output transducer is also the encoder (Miller, 1995), but there are moments when this is not the fact. An example of this is when the team-leader is ordered by the chairman of the SC to make sure that someone outside the group receives a document or a report that the chairman of the SC has written. The team-leader thus functions as the output transducer even though he has not written the materiel to be outwardly transduced (he has not encoded the material), see Figure 14.2. On other occasions the team-leader function both as the encoder and output transducer. This is when he himself has encoded the information that he transduces to the outside of the group. The project sponsor also has the responsibility and authority to communicate with people outside the group and hence also function as an output transducer, see Figure 14.3, Figure 16.6. This is the same for the project manager. He also transduces output from the group during the process of developing the information system. He often talks directly with the overall project manager on the customer side or the manager of purchasing during the project.

All of the members in the project management group are human beings and thus also living systems. All of the members have the authority of interacting with members of other systems (the customer system, higher-level Volvo Information Technology systems, technical support systems, etc.) if this is necessary for the conducting of their work. They also have the responsibility to inform other systems related to their work if the systems are affected of the work they do (changes in the signed for information system, changes of delivery dates, problems that may affect the development, etc.).

Since the identified output transducers in the application comply with the structure of the output transducer subsystem given by Miller (1990) it seems that the project management group possess the output transducer subsystem as specified by Miller (1990).

8.3 A normative evaluation of the critical subsystems according to LST and the corresponding subsystems in the application

The similarities and differences between the critical information processing subsystems, as Miller (1995) defined them, and their correspondences in the application is here to be discussed.

As previously discussed all of the twelve critical information processing subsystems could be identified to exist in the project management group. Often the number of group components is smaller than the number of critical subsystems in the group (Miller, 1995). The fact that groups can have fewer components than they have subsystems is one reason for the prominence in group theory of the concept of “role”, a term for the process typically carried out by a subsystem or components (Miller, 1995). If a group should have as many members as there are critical subsystems, all groups would have to entail twenty members (or more) in order to survive. In reality it is not so, there exist of course groups with a number of members fewer than twenty. As a member of a group, one might get assigned the functionality of being more than one critical subsystem thus a group with only a few group members may entail all the critical subsystems.

Another important aspect of groups is that they are not always assembled, and yet according to Miller (1995), they remain group. Even when they are assembled all members are not always present. Not every cousin gets to every family reunion, and yet they are members of their family (the group).

One important aspect to discuss before the normative analysis of the subsystems start, is that for some subsystems there is a lack of a clear description of the processes that the different subsystems conduct. For some subsystems at the group level Miller (1995) really does not mention any clear defined processes at all. There are also moments when defining a difference between structure and process is difficult due to the inherent similarity between the two. This mean that some of the processes of the subsystems can not be analysed in such a way as would have been preferred.

8.3.1 The Boundary Subsystem

The boundary processes according to Miller (1995). The boundary subsystem carry three processes, according to Miller (1995), all separated but still related. First, it constitutes a barrier to flows of matter-energy and information in and out of the system. Secondly, it filters certain sorts of matter-energy and information, selectively permitting some to pass in or out but not others. And third, it maintains a steady-state differential between the interior of the system and its environment.

The boundary processes in the application. Lets see if the boundary subsystem identified in the application (the identification is described under *8.2.1 The boundary subsystem* for a description of the identification of the boundary in the application) function in the same way as stipulated by Miller (1995). The project management group is located in a building, which only clarified persons is permitted to enter. The group thus have a physical boundary (walls, doors, passes, etc.) that shelters it from its surroundings and hinders an unwonted matter-energy flow to enter the group. The group also has a non-physical boundary. The deciders and input transducers (members of the SC) constitute this boundary that allow hindering of unwanted information to enter the group. This means that the first of the three processes that a boundary subsystem carries out, according to Miller (1995), also is carried out by the boundary in the application.

The second process carried out by the boundary, according to Miller (1995), the filtering of certain sorts of matter-energy and information, selectively permitting some to pass in or out but not others, are also present in the boundary subsystem in the application. This is due to the fact that the different members in the group know what information is significant to bring in or out from the group, and thus filters the unwanted information from the wanted information. In the same way they know what matter-energy is significant to bring in and out from the system.

Since the group has both a physical boundary (walls, doors, passes) and a non-physical boundary (the knowledge among the members in the group of what matter-energy and information is relevant to bring out or in to the group), the boundary subsystem in the application also fulfils the third process that a boundary shall do, according to Miller (1995). That is, maintaining of a steady-state differential between the interior of the system and its environment.

The application seems to have processes that are specified by the boundary subsystem given by Miller (1995). The processes conducted by the boundary subsystem in the application are in line with the processes of the boundary subsystem given by Miller (1995), and hence it seems reasonable that the project management group possess a boundary subsystem.

8.3.2 The Reproducer Subsystem

The reproducer processes according to Miller (1995). At the group level, or higher, the reproducer subsystem may be founders, committees that draft constitutions, or charter conventions. These mentioned may create and implement explicit or implicit templates, which program the reproduction of the entire system (Miller, 1995).

The reproducer process in the application. The reproducer subsystem is realised by the head manager of the department at which the study was conducted (see 8.2.2 The reproducer subsystem for a description of the identification of the reproducer in the application). According to Miller (1995) the reproducer subsystem in groups, or higher-level systems, may be founders, committees that draft constitutions, or charter conventions. These may create and implement explicit or implicit templates, which program the reproduction of the entire system. In the application the chairman of the SC and the project management together process a business agreement that the customer (via the manager of purchasing) signs. This business agreement is the basis for the composition of the SC. If the information system to be built is of a very technical nature, then maybe a technician from a technical department must be a member of the SC. If the system to be built is to manage business activities, a project manager with experience from developing such systems is chosen to be a SC member. And if the system to be built is to manage production activities, a project manager with experience from developing production systems is chosen to be a SC member.

It is the type of information system that is agreed upon to be built, that in some way governs the composition of the SC. This means that a charter (based upon the business agreement) or a constitution (there may be rules of whom is normally to be members of the SC) function as templates for the programming of a reproduction of a project management group.

This is in line with the reproducer processes, according to Miller (1995) thus it means that the reproducer subsystem in the application function as specified by Miller (1995).

8.3.3 The Input Transducer Subsystem

The input transducer processes according to Miller (1995). There are mainly four processes carried out by the input transducer subsystem in the group constellation (Miller, 1995):

1) *Input-output transducer functions.* Input transducers of groups may affect input to the group in various ways. Examples of this are: If the signal is to weak for the transducer to receive, if there is noise in the channel, if the input transducer is overloaded or when the transducer is imperfect due to inattention or sleepiness.
2) *Channel capacity.* The channel capacity of groups may be raised by increasing the number of input transducers or by selecting the best input transducers in the group.
3) *Lag.* Lag is when the information entering the system in some way is delayed. It may be due to overload in the channels or because the information is of a complex structure. Lags of input speed may also occur if the input transducer is a single person.
4) *Accessory functions.* Various living components and non-living artefacts protect, conduct, concentrate, analyse, amplify, diminish, distort, or add noise to input signals to groups.

The input transducer processes in the application. In the application the input transducers are mainly of two kinds, artefacts or the members in the group (see 8.2.3 The input transducer subsystem for a description of the identification of the input transducer in the application).

Each of the members in the project management group may function as input transducers (conduct the process of bringing information into the group). When doing so they may come across situations when they receive signals that is too weak (reports that is lacking information), noise in the channel (reports may be sent to another department than expected). The members of the SC functioning as input transducer for the moment may be tired or over worked and this may cause malfunction in the input transducing process. All of these scenarios are situations that may appear in the input transducer process in the project management group. This is in line with what is mentioned in 1) Input-output transducer functions.

If the input of information into the project management group is not functioning properly, the chairman of the SC may delegate the task of bringing certain information into the group onto more than one person. This way he increases the channel capacity. But normally the most competent members in each field of the SC take in information relevant to their area of expertise into the group. This is the most common way to ensure that the proper information enters the group. The selection of the most competent input transducer in order to increase the amount of input is in line with what is mentioned in 2) *Channel capacity.*

Through the use of more than one member of the SC as input transducer, the risk of overload on the input transducer subsystem is scattered throught the different input transducers. By letting the most competent members in each field of the SC take in information relevant to their area of expertise into the group, complex information structures is delegated to the one most likely to handle the information best. This is the way normal way for the SC to handle the problem with lag, mentioned in 3) Lag.

The project management group also uses artefacts as input transducers. A computerised information system distributed in a network allow information to be taken into the SC via e-mail, sharing of disk space, etc. This is an example of an accessory function, mentioned in 4) *Accessory functions.* Software programs allow analysing of information, amplifying some material, concentrating various information, etc.

Thus, in the application the different members of the SC and some of the artefacts they use are the sensory subsystem in the group, which function as the input transducers. The members in the group, and some of the artefacts they use, bring markers bearing information into the system, and changes them (if necessary) to other matter-energy forms suitable for transmission within the system.

The application seems to have processes that are specified by the input transducer subsystem given by Miller (1995). The processes conducted by the input transducer subsystem in the application are in line with the processes of the input transducer subsystem given by Miller (1995), and hence it seems reasonable that the project management group possess an input transducer subsystem.

8.3.4 The internal transducer subsystem

The internal transducer processes according to Miller (1995). Any group member is, according to Miller (1995), a component of the internal transducer subsystem. The direct face-to-face contacts of groups provide a much better opportunity for easy internal transducing than occurs in systems at higher levels (Miller, 1995). They receive from the other members information that they convey to the group decider. This is information about the groups tasks, interactions and internal states as they interact (Miller, 1995).

The internal transducer also senses changes going on in the group. Groups learn about their internal states by reports from members specially designated to be internal transducers (Miller, 1995). The group may also sense these changes of the internal states from all of the members directly, each reporting changes in himself (Miller, 1995).

The internal transducers send, according to Miller (1995), information to the decider about the internal state of the system in which they are a part. They may also send information to higher echelons of their subsystem without transmitting it to the next higher level of system.

The internal transducer subsystem have a very important role, since, according to Miller (1995), a living system can only remain as a system if its subsystems and components report their current states and affairs. This enables feedback signals to co-ordinate their processes and actions with those of the total system (Miller, 1995).

The internal transducer processes in the application. In the application all of the members in the SC report changes of states in their area of profession to others in the group through reports, e-mail, or orally (see *8.2.4 The internal transducer subsystem* for a description of the identification of the internal transducer in the application). This is crucial since the members in a group must communicate with each other in order to get the job done (Miller, 1995). The person in the group, which has a more designated role of being an internal transducer, is the team-leader. One of his duties is to keep track of changes in his department and report them to the chairman of the SC, project sponsor, project manager or whom ever it may concern (he thus has a sensing functionality). He keeps track of people on leave, whom are working in what project, resources in the different project development teams, etc. This means that he must communicate about what state the different development teams are to the head of the department (which also is the chairman of the SC in every SC-team). He also communicates these states to others in the department whom is concerned. The team-leader may also transform the markers carrying the information before passing it further (if necessary). The team-leader thus processes internal information in the application.

But as mentioned earlier, all of the other members in the SC also function as internal transducers. They report to the team-leader (or to others in the group) about the progress of their work. So their exists an interchangeable communication between the members in the group (they also processes internal information).

The internal transducer is the subsystem responsible for communicating the internal state in the system. The internal transducer thus senses the state of the system in which it resides, according to Miller (1995). The different members in the project management group all communicate with the team-leader of the state of their work. They also communicate this to other members in the group, which is affected in some way. The team-leader has a designated, more formal, role as an internal transducer. He function as a “spider in the middle of a web”, sensing the overall state of the department, but also the states of the different development teams (he is always a member in every SC-team, and thus involved in the work of every development team). He then reports the progresses (the states) of every development team to the manager of the department.

This means that all of the members in the group function as an internal transducer, in some way or another. When comparing the processes that the internal transducer subsystem does according to Miller (1995) and the processes that the internal transducer subsystems does in the application one can see that the internal transducer processes in the application is in line with the input transducer processes, specified by Miller (1995). The application seems to have processes that are specified by the internal transducer subsystem given by Miller (1995).

8.3.5 The channel and net subsystem

The channel and net processes according to Miller (1995). The process that the channel and net subsystem does, is, according to Miller (1995), to allow the sending of information from a sender to a recipient. This means that the markers carrying the information travels along the channels in a net. These channels intersect at nodes and the nodes are interconnected to form a net (Miller, 1995). The channels in the net compose a route in physical space and on this route markers bearing information are transmitted to all parts of the system (Miller, 1995).

This channel and net may be composed of a computerised network made up of computers, fax-machines, wires, switches, etc., (an artefact made by man) but members of groups may also form a net allowing information to travel from sender to receiver (Miller, 1995).

The channel and net processes in the application. In the application the members of the project management group send information to and from each other via e-mail, telephones or fax machines. The members in the SC also facilitate a channel and net subsystem through face-to-face communication (see *8.2.5 The channel and net subsystem* for a description of the identification of the channel and net in the application).

According to Miller (1995) routes and nodes in a physical net constitute the channel and net subsystem, allowing transmission of information through the net (the information is carried by markers), to and through the various members or components of the system. The project management group uses a computerised network, composed of nodes (computers, fax machines, etc.) and routes (electrical cords, switches) uniting the nodes, allowing the members of the group to communicate with each other. The use markers such as paper (fax machines, documents), digital files (documents, Intranet, other data), electrical currents (propagating the transmitting of the information in the computerised network), etc.

But the members also function as a channel and net subsystem. They have SC meetings and other smaller meetings where they convey information to each other. They inform each other orally at these meetings via transmission of information in the air. The marker is the air that allows the transmission of the information.

The processes carried out by the members in the SC and the processes carried out by the artefacts used by the group is in line with the channel and net processes, according to Miller (1995). The application seems to have processes that are specified by the channel and net subsystem given by Miller (1995).

8.3.6 The timer subsystem

The timer processes according to Miller (1990). The timer is the subsystem which function as the co-ordinator of time in the system (Miller, 1990). The process of the timer is to transmit to the decider subsystem information about time-related states of other subsystems and components or processes within the system. The timer process is also about co-ordinating the decider of the system to deciders of subsystems in time (if they exist).

The timer processes in the application. In the application the timer subsystem is of three kinds (see 8.2.6 The timer subsystem for a description of the identification of the timer in the application). First, the PCM model functions as a timer in some stages of a project. Secondly, the SC meetings also function as a timer subsystem. Finally, the members in the system also function as timer subsystems.

Let us first discuss the PCM model and its role as a timer. The PCM model is mandatory to use and follow when conducting projects at Volvo IT. In the model there exists checklists that specify when it is allowed to close a gate and open another. If the criterion's specified in the checklists are fulfilled, a gate can be closed and the project can go further to the next gate. These checklists, ant hence the PCM model) function as a timer deciding when in time the project is allowed to advance further.

Now let us look upon how the SC meetings function as a timer. In between the SC meetings where decisions are taken to open or close a gate, other decisions are made about weather to let the project advance to a new stage in the development process or not. This means that there exists SC meetings, beside those where decisions are made to open or close a gate, where one make decisions concerning progresses of the project, co-ordinate processes, etc. These meetings thus function as timers in the project.

The third timer related process in the project management group is constituted by the members themselves. Individuals in the group carry out these timer processes so these timer processes are smaller than the timer processes carried out by the SC. When the project manager manages the development of the information system, he keep track of what stage the development process is in. He initiates and realize the different stages the development process must go through and time co-ordinates them. The project sponsor, when communicating about the project, with the manager of purchasing and later on writes the business agreement, also time co-ordinates the processes he must go through. The team-leader, who is responsible for managing the resources in the different development teams must also co-ordinate the different resources in time. The chairman of the SC has the overall responsibility for all of the different projects, thus he must co-ordinate all of his meetings with the different project management groups, customers, etc. As one can see, all of the SC members in some way or another has to keep track of processes in time and co-ordinate them with each other, thus they all function as timer subsystems.

The PCM model, the SC meetings and the different SC members function as timer subsystems on different occasions. Each of these time co-ordinates processes, and transmits to various decider subsystems information about time-related states of other subsystems and components or processes within the system, as stated by Miller (1995). The different timers also inform the chairman of the SC of the states of the processes going on in the group and thus time co-ordinates the chairman of the SC to other deciders in the group.

The timer related processes in the application are similar to the timer processes given by Miller (1995). The application seems to have processes that are specified by the timer subsystem given by Miller (1990).

8.3.7 The decoder subsystem

The decoder processes according to Miller (1990). The decoder is the subsystem which alters the code of information input to it through the input transducer or internal transducer into a “private” code that can be used internally by the system (Miller, 1995). Groups, both animal and human groups, co-ordinate their processes by exchange of coded signals. The input transducer and the internal transducer perform quite different processes than the decoder, according to Miller (1995). The input and internal transducing processes is not only about taking the information into the system (the input transducer) or transport the internal information inside the system (the internal transducer). It is also about changing the energy or material form of the markers bearing this information (one should bear in mind that this changing of matter-energy form of the markers is not always necessary). The decoder on the other hand alters the code in which the information appears. This is the sole purpose of the decoder.

A groups decoder may be local, limited to one component, or it may be laterally dispersed to several members or to all (Miller, 1995). A decoder may be artificial (artefacts) or members of the group (Miller, 1995).

The decoder processes in the application. The decoders in the studied project management group are mainly of two kinds (see *8.2.7 The decoder subsystem* for a description of the identification of the decoder in the application). First there are the artefacts the members in the group uses in order to read and receive reports etc. and secondly there are the members of the group.

The artefactual part of the decoder subsystem is the software programs that can alter the messages and reports that the members of the group receive while using their computers. If information from outside the boundary of the group is sent to the group and the form of the information that the internal transducer brings into the group is not usable by the group, the software programs can alter the code. Example: the manager of purchasing sends a report to the project sponsor originally written in a word processing program the project sponsor do not have. The project sponsor may have software that is compatible with the one the manager of purchasing is using, thus allowing alternation of the original code into code readable by the project sponsor. Usually all of the people employed at Volvo IT use the same kind of software to communicate with each other so this is normally not a problem, but if the sender is someone outside Volvo (an external customer outside Volvo) this problem may occur.

The components of the decoder subsystem that do most of the decoding are the members of the group. When the different members either receive information from outside the boundaries or from inside the system, and is to present the information to the other members of the group, a transformation process of the received code is sometimes necessary.

This is due to the fact that the different members of the SC team are skilled on different things, and have different responsibility areas, and thus cannot be familiar with every bit of information that enters the system. Each of the SC members is skilled to process different information (in general) and thus have the responsibility to translate the information that is to be shared with others into a form understandable by the others.

Sometimes the information has to be decoded in order for the receiver to understand it himself. This may happen when the designated receiver of the information is not familiar with the information (or the way the information is presented). If this happens and the information is within the designated receiver's profession (and no one else's thus making it impossible to receive any help with deducing the material), he may have to start a decoding process with himself as the sole benefitter of the outcome. Example: the project manager receives information (a request for an alternation of the agreed upon design of the information system) from the head manager of the head project (in which the Volvo IT project is a sub-project) on the customer side. He experience difficulties with understanding what the head project manager means (either due to an unclear specification or an ambiguous request). So, the project manager either may want to spend some time, what the head manager really means, before returning with a request for further (or a more clearer) explanation on the subject, or he may go to the head manager directly for a further explanation. In the first case, the project manager decodes the received material himself and in the second case he receives help with the decoding process from outside the boundary. In the second case the decoding process is a two-part process between the project manager at Volvo IT and the head manager on the customer side. Since all of the members in the management group receive reports, either from outside the boundary or from inside the system, and on different occasions are to present the content in these reports to the other members in the group (or enhancing the level of comprehension on the subject for themselves) they are all decoders.

If the public form in which the information enters the system is the same as the private form used by the system, the process of decoding does not have to be carried out. But normally a decoding process in one form or another (either by artefacts or by members of the group) needs to be made to the information that enters the system. The material may also have to be reduced (redundant information), and not only be decoded into an understandable form by the decoder subsystem.

The application seems to have processes that are specified by the decoder subsystem given by Miller (1995). He states that the systems must have functionality for transforming both external and internal code understandable by the members of the group. The use of artefacts (as explained above) and the decoding processes that the members do on different occasions (as explained above) are in line with the decoding processes given by Miller (1995), and hence it seems reasonable that the project management group possess a decoder subsystem.

8.3.8 The associator subsystem

The associator processes according to Miller (1995). The subsystem which carries out the first stage of the learning process, forming enduring associations among items of information in the system (Miller, 1995). Successful groups, as they interact over time, associate in ways that are reinforced by feedback from past group actions that reduce strain (Miller, 1995). Miller (1995) means that associations synthesises a set of relationships among bounds so that, putting A into the system will elicit items B…N as outputs, each with its own probability, which will be grater than 0 and less than or equal to 1. A in this case is the original information entering the associator, and B…N is the new information leaving the associator. What Miller (1995) mean with this is that information that is putted into a system are always altered into another form. One can transform raw information into new knowledge and insights, only if this new information can be associated with previous knowledge and insights residing inside the system.

This means that the associator in the system must be familiar with the new data that enters the system, in order to transform the raw data into information (or else the associator must himself go through a learning process in order to understand the new data). This is also in line with what Miller (1995) says. Meaningful relationships must exist between the incoming data and the residing information data bank in order for new information to be born; i.e. associations must be possible.

The associator processes in the application. In the project management group (see *8.2.8 The associator subsystem* for a description of the identification of the associator in the application), all members have different (or similar in some extent) knowledge data banks about how to manage a project. This allows each and every one of them to function as associators (and an increasement of knowledge, through learning, about how to manage a project is made). The group as a system is also able to learn, but the speed of learning is slower than for the individual (Miller, 1995). This is due to the inherited inertia in systems composed of other systems (it takes time to spread new insights and knowledge throughout a group). This is also true for the studied project management group.

The project management group learns by modifying their structures and procedures with experience. Certain actions and structures are associated with reward more often than others, but the process may be slow, according to Miller, (1995). This is true also for the project management group since it takes time to see the impact of the work made by the group (not before the manufactured information system has been in use in the business for some time, the actual benefit of the system may bee noticed). After that feedback (new insights based on the success, or failure, of the information system) can go back into the group enhancing the knowledge in the group.

The application seems to have processes that are specified by the associator subsystem given by Miller (1995). Hence it seems reasonable that the processes conducted by the associator subsystem in the application function according to the processes conducted by the associator subsystem defined by Miller (1995). Miller (1995) states that the systems must have a functionality for transforming new data and information into a comprehensible form readily understandable by others in the group. Miller (1995) also states the group and its members must also have the functionality of being able to learn from old mistakes and previous actions. The project management group possess all of the above mentioned functionalities.

8.3.9 The memory subsystem

The memory processes according to Miller (1995). The memory subsystem is the subsystem which carries out the second stage of the learning process, storing various sorts of information in the system for different periods of time (Miller, 1995). This subsystem usually is, according to Miller (1995), laterally dispersed to all group members, each of whom stores information in his own nervous system. In most groups, therefore, there is no group memory as such (Miller, 1995). In some cases, however, particular members of the group may have some special responsibility of keeping records or storing special information (Miller, 1995).

Groups have, according to Miller (1995), an advantage over organisms in storing information, since they have available as many nervous systems as members in the group. This means that they are potentially able to store that many times as much information as the average members (Miller, 1995). In reality this is not the case since everyone in the group store some common information (Miller, 1995). The memories in the group may be realised by the members in the group, but also by artefacts used by the members in the group (Miller, 1995). According to Miller (1995), memory, recall and retrieval, traditionally have been considered to be stages that can occur after associating in the learning process. Miller (1995) also claims that association can only be demonstrated through memory, via recall and retrieval, but that they seem to be independent processes. The process of storing information involves three stages (Miller, 1995):

- Putting into storage markers bearing the information
- Maintaining them in storage over time and
- Retrieving from the storage the information on the same markers or read out onto others

Each of these stages will be addressed in a section below called The memory processes in the application. Some information to be stored comes from outside the system (environment or suprasystems) via the input transducer and associator subsystems. Some information to be stored also comes from within the system, via the internal transducer and the associator subsystems.

Groups and higher higher-level systems may disperse the remembering (memory) to all individual persons in the system, or the group may delegate the remembering responsibility to a single member in the group (Miller, 1995).

The memory processes in the application. In the studied project manager group (see *8.2.9 The memory subsystem* for a description of the identification of the memory in the application), the memory is dispersed between the members in the group and artefacts they use as aids for the memory. The VIT PCM monitoring database also functions as a memory.

The members in the group have different responsibilities and work with different things (different skills) so each of the members have somewhat different memories that they must keep track of. Example; the team-leader has to keep track of the state of the resources in the development team, which person work in what team and which hardware and software resources that are used by the different teams, etc. The project manager must keep track of all the different processes in the design and development stage of the project, etc.

They keep all this in memory by writing notes, writing reports, filling in checklists, etc. (they use different scaffolding as aids for remembering) but they also keep massive amounts of information in the head.

The VIT PCM monitoring database also functions as a memory for the members of the SC team and for the group as such. The database allows the different members in the group to retrieve reports, documents, checklists, etc. when needed. The project member writes document log and document status for every report they produce. This enables the members to look into the PCM monitoring database and study the log and status of each individual report. Example; the project manager fills in the log and status of the result report on a regular basis (or when something unexpected happens). This enable for, say, the team-leader to follow the progress of the project in between the SC meetings which the project manager summon for.

The memory of the group is dispersed among its members, but the group also has a database allowing storage of important documents, instructions, checklists, etc. The memory subsystem in the project manager group is hence composed of the members in the group, their memory supporting artefacts, and the VIT PCM monitoring database.

Mentioned earlier in the previous section called *The memory processes according to Miller (1995)*, the process of storing information involves three stages (Miller, 1995). Putting into storage markers bearing the information, maintaining them in storage over time and retrieving from the storage the information on the same markers or read out onto others. The members of the project management group put into storage markers bearing the information (they store reports, notes, digital files in computers and in the VIT PCM monitoring database, etc.). The members also maintain the information that is put into storage (they make sure that the information is up to date and deletes the information that is not). There may of course some delay in this process of updating information. This can be ascribed to the work load (may be too big for some members during some period of time) or to it may be due to pure neglect from the members. Finally, the members retrieve the information from storage when needed. Sometimes they change the markers bearing the information (a computerised file may be printed on paper, etc.) and sometimes they do not.

The application seems to have processes that are specified by the memory subsystem given by Miller (1995). Hence it seems reasonable that the processes conducted by the memory subsystem in the application function according to the processes conducted by the memory subsystem defined by Miller (1995).

8.3.10 The decider subsystem

The decider processes according to Miller (1995). The decider is the executive subsystem, which receives inputs from all other subsystems and transmits to them information outputs that control the entire system (Miller, 1995).

Every hierarchical system has a decider and the decider must have authority over the other members in the system. The decider controls the system in such a way that the system operates to fulfil the objectives specified for the system (Miller, 1995).

The decider of a group is often its leader (Miller, 1995). It can be a chairman, team-leader, etc. But the decider process can also be dispersed to all of the members in the group (Miller, 1995). The later would be a collective, since in a collective there should not be a sole decider. There may also be so that the members in the group decide over different tasks and processes (Miller, 1995).

The term echelon is not discussed in this section and this is because groups do not have echelons, according to Miller (1995). Echelons only reside in living systems above the level of groups (i.e. organisations, societies, supranational systems).

The decider processes in the application. In the project management group there are several deciders, but they have different authorities (see *8.2.10 The decider subsystem* for a description of the identification of the decider in the application). In the application all of the members in the project management group function as components of the decider subsystem, but their decider functionality is coupled to their individual field of profession and area of responsibility in the management process.

The chairman of the SC has a different field of responsibility than, say, the team-leader. This means that the chairman of the SC decides on matters different than the team-leader. But all of the SC members are components of the decider subsystem. This comes from the fact that they all have responsibility areas, which give them the authority of making decisions. They are also expected to make decisions that function supportive for the progress of the project.

The structure of groups information processing network also affect its deciding processes (Miller, 1995). In the application the members in the SC work close together (they are all located in the same room and they have worked together for a long time). They have established a way of working together that is efficient, and there do not seem to exist any rivalries among the members. The foundation for saying that their work seems to be efficient and that there do not seem to be any rivalries among the members is based on what the members said in the interviews. There was a unity on this matter between the interviewees. They all seem to work together towards a common goal, securing the manufacturing of cost-effective, efficient and high quality information systems (this was also stated by the interviewees in the interviews). The project management group's information processing network seems to function as according to the pinwheel connected network (Miller, 1995, pp. 545).

The PCM model guides the members in their work. But the PCM model is not only a guiding method for how to conduct a project management process. It is also mandatory to use thus it also function as guiding for decisions in some stages. The PCM model is describing under what circumstances one is allowed to open or close a gate. The PCM model also entails checklists, etc. which must be used during the project. But the PCM model do not itself transform information into decisions, like the members in the group does, thus it is not a component of the decider subsystem. According to Miller (1995), the decider is a system itself (a subsystem), which the PCM model is not.

The criteria that a system (the project management group) must have a decider are fulfilled. There is also the possibility that the system may reside more than one decider, and in the studied group several components of the decider subsystem also exists. These deciders in the project management group also decide over different processes and functions (which they must if they are not to send conflicting orders inside the system). This way of conducting the various decider processes is also in line with Miller (1995).

The application seems to have processes that are specified by the decider subsystem given by Miller (1995). Hence it seems reasonable that the processes conducted by the decider subsystem in the application function according to the processes conducted by the decider subsystem defined by Miller (1995).

8.3.11 The encoder subsystem

The encoder processes according to Miller (1995). The encoder subsystem is the subsystem which, according to Miller (1995), alters the code of information input to it from other information processing subsystems, from a "private" code used internally by the system into a "public" code which can be interpreted by other systems in its environment.

Miller (1995) states that little research has been carried out on group encoding. This is also evident in Miller's (1995) description of the process conducted by the encoding subsystem, since Miller's (1995) description of the processes conducted by this subsystem is scantily worded. Nevertheless, the general description, made by Miller (1995) in chapter Two The Basic Consepts, of the process conducted by the encoder subsystem seem to function also for the group constellation.

The process of encoding is about transforming an "internal code" into an "external code" (Miller, 1995). There are two purposes why one needs to encode information (Miller, 1995). First, it is necessary to alter the information passing out from the boundary into the environment into a form that is easily understandable by the environment. Since the system putting out the information may use a technical jargon not understandable by the environment, the information must be altered into a form that uses the jargon of the environment. Otherwise the purpose of sending information to the environment, chairing knowledge and data, would get lost. Secondly, the final wording of a group report or statement may want to conceal the private language, the "internal code", used (Miller, 1995). This may be of security reasons.

The encoding process is very important since the information that leaves the system must not be interpreted in ways other than expected. If the information is improperly encoded, the information may also be improperly decoded by the receiving system.

In many systems (even in high-level systems) it is mostly common that the decider also is the encoder of the information that is to leave the system (Miller, 1995). This is also true for groups. If another system than the decider is to encode the information that is to leave the system, the information that is to be encoded must pass yet another subsystem before it is encoded. This other subsystem that is to encode the information may itself (due to difficulties of comprehending the information) in fact contribute to the possibility of producing poorly encoded information. There is often a possibility that the information leaving the system is poorly encoded, just as it often is a possibility that the incoming information is poorly decoded.

The encoder processes in the application. In the applied situation, (see 8.2.11 The encode subsystem for a description of the identification of the decider in the application), each of the members in the project management group may function as a components of the encoder subsystem (this is in line with the structure of an encoder subsystem according to Miller, 1995).

The chairman of the SC encodes the information that belongs to his area of responsibility and he put it outside the group in order for the information to be easily comprehended by people outside the group. This is in line with what is mentioned in the section The encoder processes according to Miller (1995). But since the chairman of the SC also is the head of the department in which the SC resides, he may ask another members in the group to encode the information (this task can be delegated, according to Miller, 1995). This may be due to shortage of time (the manager of the department may be busy) or he uses his authority to do so based on other premises. Neither of these two ways of encoding information is used more than the other. They are used just as frequently.

It is common that the team-leader sometimes function as a form of secretary and aids the chairman of the SC with the contacts outside the group (since his schedule is not as busy as the chairman’s is and since the chairman is often out of the office). The team-leader has an overall responsibility to keep a close contact with the customers during projects and when inquiries are made of smaller changes to existing information systems that the department has developed. He must thus often function as an encoder and make sure that the information that leaves the group is easy to understand.

The project manager has the responsibility to uphold a close contact with the manager of purchasing (the customer) and the overall manager of the project on the customer side. He initiates and receives request for information that he put outside the group to the above mentioned professions. He must thus also encode the information into an easily understandable form so the manager of purchasing and the overall manager understand the message he conveys.

The project sponsor must when he is talking about funding and costs with the buyer of the system do it in such a way that is easily understandable. If the project sponsor discusses this with the economically responsible on the customer side, the work done on the encoding process is smaller since the project sponsor and the economically responsible on the customer side speaks the same “language” (they have the same profession). But when the project sponsor discusses economical issues with someone else on the customer side (or anyone outside the group) that does not have the same knowledge in this profession, more work must be made on the encoding process.

If the internal code and the external code (or languages) is the same, the encoder subsystem is not used. This is usually the case if, say, the project manager in the group and the overall project manager on the customer side discusses a topic in a language (code) in which both of them have the same degree of knowledge.

Another situation when the encoder processes always must be in progress is if people in the project manager group discusses (or leave reports) to customer that speaks another language. If the customer is a French company, talking Swedish is not an option. If the corporate language in both companies is the same, say English, then it is sufficient to encode the information leaving the group into English.

The encoder subsystem in the project manager group is hence mainly composed of the members in the group. The application seems to have processes that are specified by the encoder subsystem given by Miller (1995). Hence it seems reasonable that the processes conducted by the encoder subsystem in the application function according to the processes conducted by the encoder subsystem defined by Miller (1995).

8.3.12 The output transducer subsystem

The output transducer processes according to Miller (1995). The output transducer subsystem is the subsystem which, according to Miller 81995), puts out markers bearing information from the system. The transducer subsystem also change markers within the system into other energy-matter forms which can be transmitted over channels in the systems environment (Miller, 1995).

Miller (1995) states that little research have been carried out on output transducing in groups. This is also evident in Miller’s (1995) description of the process conducted by the output transducer subsystem, since Miller’s (1995) description of the processes conducted by this subsystem is scantily worded. Nevertheless, the general description, made by Miller (1995) in chapter Two The Basic Consepts, of the process conducted by the output transducer subsystem seem to function also for the group constellation.

The output transducer processes in the application. In many organisations (and groups as well), an important proportion of the time and energy of department heads is taken up with output transducing (Miller, 1995). This is also true for the studied project management group (an example is the project manager, who complained about the amount of time and effort he must spend on writing reports (encoding) and transduce them outwardly. According to Miller (1995), it is most common of groups that the head of the department is also the output transducer, but all of the members in the group can also be output transducers. If the members have such a responsibility in their work assignments that puts demands on them to stay in contact with systems in the environment, and authority to do so, they must act as output transducers. It is also common for encoders and output transducer components of groups, according to Miller (1995), to be the same. According to Miller (1995) a part of the encoder subsystem can also perform output transducing as well (see *8.2.12 The output transducer subsystem* for a description of the identification of the output transducer in the application).

Earlier in this description it was mentioned that it is common that the head of the department most of the time function as the output transducer (specified by Miller, 1995). But there are occasions when he may delegate this task to others (the delegating of output transducing tasks is not in contradiction with Miller, 1995).

An example of this is when the team-leader is ordered by the chairman of the SC to make sure that someone outside the group receives a document or a report that the chairman of the SC has written. The team-leader thus functions as the output transducer even though he has not written the materiel to be outwardly transduced (he has not encoded the material), see Figure 14.2. On other occasions the team-leader functions both as the encoder and output transducer. This is when he himself has encoded the information that he transduces to the outside of the group.

The project sponsor also has the responsibility and authority to communicate with people outside the group and hence also function as an output transducer, see Figure 14.3, Figure 16.6. This is the same for the project manager. He also transduces output from the group during the process of developing the information system. He often talks directly with the overall project manager on the customer side or the manager of purchasing during the project.

All of the members in the project management group are human beings and thus also living systems (Miller, 1995). All of the members have the authority of interacting with members of other systems (the customer system, higher-level Volvo Information Technology systems, technical support systems, etc.) if this is necessary for the conducting of their work. They also have the responsibility to inform other systems related to their work if the systems are affected of the work they do (changes in the signed for information system, changes of delivery dates, problems that may affect the development, etc.). Since all of the members in the project management group are living systems and also, on some occasion, themselves bring information outside the group, they are all output transducers.

Finally, the computerised information system used by the group to send information into the environment (customers, etc.) may encode the markers bearing the information (this is also a form of encoding process), but the computerised information system also functions as output transducers as it sends the information further in the network and finally outside the boundary of the group. The output transducer subsystem in the project manager group is hence mainly composed of the members in the group and the computerised information system in the network.

The application seems to have processes that are specified by the output transducer subsystem given by Miller (1995). Hence it seems reasonable that the processes conducted by the output transducer subsystem in the application function according to the processes conducted by the output transducer subsystem defined by Miller (1995).

8.4 Summary of the analysis

All of the twelve critical subsystems stated by Miller (1995) that were focused on in this work could be identified in the application. The processes performed by the subsystems in the application also seemed to function as the processes stated by Miller (1995).

8.5 Problems concerning the flow of information in the application

In this work the subsystems of the project management group are identified and an analysis is made on whether these subsystems function according to the functionality Miller (1995) has specified.

In this work no investigation has been made on finding any possible problems in the application, concerning the flow of information. If this had been made, one should have looked if these problems could have been identified with the help of Millers (1995) LST. One should have analysed if one would find any help from LST in solving these problems.

This is an example of a future work that can be made and thus further investigate the appropriateness of using LST as a diagnostic tool for analysing information flows in groups.

For each of the subsystems LST point outs variables that represent processes that each subsystem conducts. These variables are useful as an aid for further identifying the processes that a subsystem under investigation normally should do. If there is a discrepancy between the actual process of a subsystem in the application and the normal process of that subsystem, as exemplified by these variables, one may have identified a malfunction in the process of the identified subsystems. Even though this work is not investigating abnormal situations and processes of the flow of information in the application, some discovering of information processing in the application that is malfunctioning, has been made. One of these will be addressed here followed by a short discussion on how LST may function as a diagnostic tool for solving the problem.

8.5.1 The problem

When interviewing the project manager he complained on the project charter that he received from the chairman of the SC, see figure 15. The project manager meant that the charter was not up to the standard that he expected it to be. He did not refer to the composition of the charter (what is to be written in the charter as according to the template) but rather how it was written. He meant that it lacked important information and this forced him to finish the project charter on his own. This in turn meant that he had to postpone the processing of the proposal for the solution see Figure 14.1. This meant that the opening of gate 1 on time was in danger. The solution was this: the project manager and the chairman of the SC decided to divide the roadmap G1-G2 into two separate roadmaps (in the PCM-model the term roadmap is used to denote the activities and the responsibilities between two gates).

The G1-G2 roadmap was now divided in 1) a part where the project manager could finish the project charter and 2) a part where he could work on the proposal for solution.

8.5.2 How malfunctions in the process of writing the charter can be identified with help from LST

When the chairman of the SC worked on the project charter he functioned as a component of the internal transducer subsystem (se *8.3.4 The internal transducer subsystem*) and transduced a charter to the project manager that was faulty or inaccurate. Miller (1995) has a variable covering this, *meaning of internal information which is transduced*. The chairman of the SC transduced information (a charter) to the project manager where the meaning and intent was not revealed.

The chairman of the SC also functioned as a component of the encoder subsystem (see *8.3.11 The encoder subsystem*) when working on the charter. Miller (1995) has several variables covering processes that affect the encoding of the signed business agreement into a project charter. The variables are written in italics followed by a text exemplifying how the chairman and his processes of writing the charter could be related to the variable.

Meaning of information which is encoded. The chairman did not manage to write down (explain) the intent of what the information system should be able to manage.

Percentage of information which is encoded. The chairman may have miscalculated how much of the information he initially received that should be passed on to the project manager via the project charter.

Threshold of the encoder. The chairman may have difficulties in explaining the functionality of the information system to the project manager, via the project charter, due to his own difficulties of understanding the functionality.

Distortion of the encoder. The chairman may be distorted by all the meetings he must attend to, e-mails that should be read, etc. this may affect the writing of the project charter.

Percentage of omissions in encoding. The chairman may have missed to include important information in the project charter, due to different circumstances.

Percentage of errors in encoding. The chairman may include errors in the project charter, due to different circumstances.

Lag in encoding. The chairman may have shortage of time and this may result in a project charter that can not be signed by the project manager in time.

Cost of encoding. The chairman may think that his time is more important than the project managers time and thus delegate the finishing of the project charter to the project manager.

The chairman of the SC has as a component the functionality of more subsystems during a project than these two mentioned above. This is showed in *8.2 Identification of the critical subsystems* and *8.3 A normative evaluation of the critical subsystems according to LST and the corresponding subsystems in the application.* But when writing the project charter he functions mainly as a component of the internal transducer and the encoder subsystems.

Any of these above mentioned variables, or several combined, may show the reason for why the project manager received a project charter, which he was not satisfied with. The project manager interviewed was fairly new as a project manager, which is something that may explain the problem (this may be contributing to the complaint he had on the project charter, he may have wanted more support from the charter than the charter normally contributes with).

These examples on variables concerning the process of the encoder and the internal transducer, given by Miller (1995), show processes one may find related to the component of these subsystems, the chairman of the SC, that can lead to a faulty and inaccurate project charter. These variables may thus function, identified by the faulty processes in subsystems, as normative for the processes that should occur. Identifying problems in information flows in project management processes and analysing these processes with the help of LST is an example of a future work that can be made. This could function as a further investigation of the appropriateness of using LST as a diagnostic tool for analysing information flows in groups, and hence also as an extension of this work.

9 Results

The identification part of the analysis showed that all of the subsystems could be identified in the application. The normative evaluation showed that the processes performed by the identified subsystems functioned as stated by Miller (1995). This means that there exists conformity in the processes conducted by the subsystems in the application and how they should function according to Miller 1995).

In chapter *3. Aims and objectives* three criteria were mentioned that had to be fulfilled as a measure of how well LST is appropriate to use as a tool for analysing management processes when developing information systems:

- It must be possible to identify the critical information processing subsystems in the applied business
- The critical information processing subsystems must take into consideration such information flows that are significant in the application
- The transformation of the critical information processing subsystems shall, when analysed, make contributions that would not have been possible if LST would not be applied

The first criterion was met in this work. It was possible to identify the critical information processing subsystems in the application. The second criterion was also met in this work. The critical information processing subsystems take into consideration significant flows of information in the application. The third criterion was also met in this work. The functionality of the processes of each critical subsystem described by Miller (1995) may, when analysed, further enhance the understanding of how the processes of the correlated subsystems in an applied situation should function. LST may thus function as a diagnostic tool, showing how processes should function in an applied situation in order for the system as a whole to function.

10 Discussion

10.1 Why do the subsystems of LST match the applied situation so well?

There were no apparent discrepancies between the processes of the subsystems in the application and the way they should function according to Miller (1995). There are several reasons why this is so:

The members of the SC are themselves living systems. Each of the members of the SC are themselves living systems. They belong to the level of organisms (not discussed in this work) and they are the organisms with the most advanced and most developed cognitive skills of all organisms. As individual systems they reside all in Millers (1995) twenty subsystems, of which only twelve are focused on in this work. This ability of each member of the SC to have all of the twenty subsystems, combined with the roles and responsibilities each member have, will result in performances that are in accordance with the subsystems as specified by Miller (1995).

The authorities and obligations of the members of the SC. As mentioned above all of the members of the SC had authorities and obligations that made them function as components (on different occasions) of the twelve subsystems discussed in this work.

The way of conducting the project management process. The way the project management process is conducted made it fairly easy to identify each member of the SC and what they did. It is the use of the PCM model (and the project management process it specifies) and the fact that the group actually followed the processes specified by the model when conducting their work that facilitated the mapping of the project management process. Knowing the project management process thoroughly made it easier to do the transformation into the critical subsystems.

The generality of LST. The generality of LST made it fairly easy to identify the subsystems in the project management group and their related processes. This is the strength of LST. Because its level of generality when describing the critical subsystems and related processes, it is fairly easy to map these to elements and processes in the applied situation.

The PCM model governs the processes made by the group members. In the applied situation the project management members where governed by the PCM model. They also followed this model in a fairly strict manner. This is due to two reasons. First, the PCM model is necessary to use in all project management processes at Volvo IT. Secondly, the members of the project management groups at Volvo IT in Skövde have chosen to follow the PCM model strictly (this was stated by the four interviewees who where members of the SC). The fact that the PCM model is necessary to use at project management processes is not the same as actually using and following it strictly when conducting project management. At Volvo IT in Gothenburg the project management groups do not use and follow the PCM model to the same extent as they do at Volvo IT in Skövde. The fact that they use and follow the PCM model in such a strict way at Volvo IT in Skövde may be one reason for why the work processes function so smoothly and without any major discrepancies from the processes described by Miller (1995). PCM obviously offer a tool for conducting project management processes that allow all of the processes connected to the critical subsystems by Miller (1995) to exist in the application.

The close physical relation between the SC members. All of the members in the project management group are located in the same building. Some sit close together in an office landscape, and others sit in offices in the near premises. This physical closeness enables a fast and easy way for the members to contact each other, allowing support and fast decisions to be made in an easy way. During several years there has not been any new recruiting of members to the project management groups. The members have thus worked together during a long time. This means that the members have developed a way of working together and a way of understanding each other that has proven to function very well.

10.2 Reflections on LST as a diagnostic tool

Millers (1995) Living Systems, is a highly normative work. Being a normative model means that one will find a description of how processes and functions *should work* in the best of worlds. Being a normative model also means that the descriptions given are on a general level, in fact all normative models make their descriptions on a general level. This level of generality differs to some degree between the different models. In Millers (1995) LST, the description of what systems are considered as living and how they are constituted is on a high level of generality.

However, since the LST is a normative theory described on a high level of generality, it does not mention anything about how to pinpoint or to identify specific flows, or pieces, of information in applied situations. Since the theory is general in its scope, it does not claim that it should be able to do so. Nevertheless, sometimes this is needed if one is to map the flow of information in an applied situation. It is not enough in such situations only to be able to identify the subsystems in the application and the processes they conduct on a general level, sometimes one wants to pinpoint exactly what the processes are, what they do and exactly what information they process. In situations like these one has to go further in the mapping process (beyond the scope of LST) and use other methods to penetrate the applied situation. Methods like interviews and observations are examples of such situations.

The goal for this work was to see if LST would be appropriate to use as a diagnostic tool for analysing the flow of information in project management processes, in this case when developing computerised information systems. Each of Millers (1995) critical information processing subsystems could be found in the applied situation, and each of them had processes that are specified by the critical information processing subsystem given by Miller (1995). This means that the transformation from the critical subsystems given by Miller (1995) to the applied situation could be considered successful. The critical information processing subsystems also take into consideration such flows of information that are significant in the application. When transforming the critical subsystems to the applied situation, and vice versa, contributions to the understanding of the applied situation can be made that would not have been possible if LST would not have been used.

Let us say that one is to map a system (that belongs to the living systems), it is not always easy to know how to start the mapping process i.e. what to look for. LST gives that support and when the subsystems are identified one can use the processes related to the subsystems in the theory as a means to see if the processes conducted by the subsystems in the application function as they should. LST also has variables connected to each subsystem that may function as mechanisms for controlling how the processes conducted by the subsystems in the applied situation function. This means that LST may be appropriate to use as a diagnostic tool for analysing (but also for mapping) project management processes.

An important thing to keep in mind is that Millers (1995) LST is quite a large theory to grasp before one can use it efficiently. The theory is not only large in terms of work Miller has put that into it, he worked on it for twenty years, but also in terms of its physical volume. The book Living Systems consists of some thousand pages thus it put some demands on the reader (researcher) who is to use it as a tool for mapping different systems and processes. The researcher who is to use it in this way must not necessarily know all about the theory, but he must be familiar with the parts in the theory that is affected by, or affects, the applied situation to be studied. Otherwise the reader will find it difficult to carry out the mapping process.

Using Millers (1995) living system as a tool for determining if a system is living is fairly easy, if the researcher is familiar with the theory that is, since the circumstances that must be fulfilled in order to be considered a living system is quite straight forward and easy to understand. It is also quite easy to identify the processes and elements in the applied situation that correspond to the rules in the theory that function as determinative if the studied area is a living system.

10.3 An alternative way to map processes specified by LST

An alternative way to map processes specified by LST is to let the mapping processes be more strictly guided by LST. This would give the investigator who is to conduct the mapping process a tool that helps to specify what to search for. By using the names of the critical subsystems as metaphors (using metaphors facilitates a conceptual understanding of the processes conducted by the subsystems), and knowing how these subsystems should function (as described by LST), it may be easier to identify the critical subsystems and the processes they conduct. The investigator must of course first confirm that the investigated system is a living system. LST may also give some help when putting together interview questions and questionnaires.

10.4 Reflections on the working process

When the project was performed no difficult problems were met, but parts of the process proved to be more difficult than others. First, the process of mapping the project management process at Volvo IT become more demanding than was first expected. With that I mean that more time and effort had to be put into the mapping process than was expected. The PCM model had to be mapped, and the actual project management process had to be mapped. Was the actual project management process in accordance to the project management process as specified by the PCM model? Were there any differences? This mapping process took a lot of time and effort to complete to a level of such detail that one could make the transformation to Millers (1995) critical information processing subsystems. One had to be sure that one did not loose any important aspect of the processes in the application that could have an impact on the transformation to Millers (1995) critical information processing subsystems. Secondly, identifying the reproducer subsystem and its related process in the application was not trivial.

If there had been more time for conducting this work, I would have enlarged the project with a more problem-based approach. I would have tried to map the possible problems in the application, concerning the flow of information and see if these problems could have been identified with the help of LST. I would have analysed if one could find any help from LST in solving these problems. Extending the project this way may have revealed discrepancies between the critical subsystems as defined by Miller (1995) and the subsystems identified in the applied situation. In this work any clear discrepancies were not found between the critical subsystems as defined by Miller (1995) and the subsystems identified in the applied situation. Extending the work to include the mapping of possible problems in the application could have revealed some discrepancies.

My experience from this work is that LST indeed may function as a diagnostic tool for mapping project management processes and also for analysing them. But one must be familiar with LST to some extent before the mapping or analysing process begins. Otherwise one must first study LST before one can conduct a good mapping or analysing process. It would have been desirable to have some kind of guiding instruction on how to study LST that one could read before the mapping and analysing process started. These guiding instructions should relate to different parts of LST based on what is to be mapped or analysed. This would have helped practitioners who are to use LST as a mapping and analysing tool. Otherwise they will most certainly find it too difficult and time consuming to study LST, and as a result possibly reject LST as a diagnostic tool for mapping and analysing different processes.

10.5 Strengths and weaknesses of this work

One of the strengths of this work is the approach of applying a systems theory in practice. In this work LST is applied to a real life situation. This have enabled the possibility to estimate how appropriate it would be to use LST as a diagnostic tool when analysing flows of information in group constellations. Finding ways to use LST in applied situations strengthen the theory. Another strength of this work is that the application is extensively described. This has enabled a proper identification of the critical subsystems and their related processes in the application.

A weakness of this work is that is does not include a problem-based oriented part. This could have exposed more clearly if there where some dissimilarities between the functionality of the subsystems in the application and the functionality of the subsystems according to Miller (1995). If more time had been assigned for this work, such a problem-based oriented part would have been incorporated in this work.

10.6 Future Work

A possible future work could be to study a project management process with a problem based approach. This would be about finding possible problems in the application, concerning the flow of information. If this is made, one can analyse if one can find any help from LST in solving these problems. Conducting the work this way may reveal distinct discrepancies between the critical subsystems as defined by Miller (1995) and the subsystems identified in the applied situation.

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Appendix A

Interview Questions.

Questions about the PCM-model

1. What is your role in a development project?
2. What are your authorities and responsibilities?
3. Can you shortly describe the process when managing the development of information systems here?
4. How important do you think that the PCM-model is for the projects that are driven here?
5. Do you think that the PCM-model is well pursued here?
    1. If not, what stages or parts of the model is followed partly or as a whole?
    2. Are these stages or parts modified in any way?
6. In what stages of the PCM-model are you involved?
7. Beside the mandatory roles (chairman, project leader, project sponsor, etc.) are other roles created not mentioned in the model?

Questions about the systems development method

1. Are the AU-model used for building the system?
2. If not, what method is used?
3. Are this method (or methods) mandatory in the projects, or is there a freedom to alternate between the methods or maybe mix parts of different methods?
    - I this is so, briefly explain these alternations or mixes between different methods.

Questions about the flow of information

1. What type of information do you get and in what stages in a project do you receive it?
2. Where does that information come from?
3. What do you do with that information? (What do you transform it into?)
4. To whom or where do you pass the new (transformed) information?
5. What information do you create yourselfe from the beginning and the pass on?
6. To whom do you send this information and what do you expect in return?

Questions of evaluating nature

1. How do you consider that the co-operation between different professions function here?
2. Is there anything you lack or think of as a problem when you participate in projects here?

3. I this is so, do you have a suggestion for a solution to the problem?
4. Finally, is there anything that you would like to share with you that would further enlighten the development processes that is occurring here?

Appendix B

Description of Documents

Note to the reader: The text in this section and the text in the section *7.3 Interviews and flow of information* complement each other. This means the documents (formal information) the respondents receive is described in this section, and the way they receive it is described under *7.3 Interviews and flow of information*. It is thus necessary to read this section before reading *7.3 Interviews and flow of information* in order for the reader to receive a good understanding of the flow of information in the application.

In this section a description of the documents mentioned will be made. *Since several of the members in the group that is mapped out come in contact with the same documents during a project, these documents will be described here instead of describing them under each of the interviewed respondents.*

The documents will be described (generally) since they form the basis for the information that is transferred between the different members in the project management group. Some of the documents that will be discussed later, the Steering Committee Plan, Project Charter, Final Report and White Book, are mandatory in every project at Volvo IT and some documents are not. To use these other documents or not is up to each project management group.

Under some of the headings in the different document's described here there is yet a number of headings describing the content of the document more detailed. But in order to uphold a moderately detailed description of the documents a decision was made to rule out these sub-headings (sub-headings are mentioned only when necessary). The headings described and/or mentioned give a detailed enough description of the content of information in these documents. Figure 8 show the different documents used in a by the project management group (Steering Committee).

PCM – Documents	
Steering Committe Plan	Mandatory
Project Charter	Mandatory
Final Report	Mandatory
White Book	Mandatory
Result Report	
Risk Management Plan	
Communication Plan	
Steering Committee Meeting Notice	
Steering Committee Meeting Minutes	
Change management Council Meeting Minutes	
Resonsibility Matrix	
Human Resource Agreement	
Resource Agreement	
Project Experiences Collection	

Figure 19. PCM-documents (PCM-Model, 2001)

Steering Committee Plan

The purpose of the steering committee plan is to describe the activities and preparations of the steering committee (SC). The steering committee plan has five major parts: *Gate Plan*, *Meetings*, *Communication*, *Quality Review Plan* and *Steering Committee Responsibilities*.

In the *Gate Plan* section one decides timing, decisions, responsibility and issues to consider before the meeting. This is done in the same way for each of the five gates, G0 to G4.

In the *Meetings* section one decides when and where to have the different SC and customer meetings.

In the *Communication*, *Quality Review Plan* and *Steering Committee Responsibilities* sections one decides how the communication between the SC members shall be conducted, a plan for reviewing the quality of the project and the responsibilities for the SC members respectively.

Project Charter

The purpose of the project charter is to provide the directions necessary for delivering the results stated in the assignment agreement. The project charter is the agreement between the project manager and the steering committee chairman. The project charter has three major parts*: Project Background*, *Directions for the Entire Project* and *Directions for the Roadmap from G1 to G4.*

In the *Project background* section, a description of the background for the project is made. This gives the project manager which is to receive this document a summary of why the project is to be done, what caused the birth of the project and so on.

In the *Directions for the Entire Project* section, a large amount of information that the project manager need is stated. The information covers: Business Value, Project Objectives (includes cost and time framework), Prerequisites for the Entire Project, Project Approach, General Project Plans, Principles and Plans Affecting the project Quality, Organisation, Staffing and Responsibilities and finally *Risk Assessment.*

In the *Directions for the Roadmap from G1 to G4* section, the following information is covered: Objectives from the roadmap from G1 to G4, Prerequisites from the Roadmap from G1 to G4, Approach for the Roadmap from G1 to G4, General Roadmap Plans from G1 to G4, Plans and Activities Affecting the Quality of the Roadmap from G1 to G4 and finally Roadmap Responsibilities and Staffing from G1 to G4.

Final Report

The purpose of the final report is to describe the final result compared to the results stated in the project charter. The final report ensures knowledge sharing by describing the experiences gained during the project. The final report has seven major parts: *Background and Preconditions, Summary, project Objectives, Results, Risks, Hand-over and Recommendations, Project Experiences.*

Background and preconditions is a short description of the background and the preconditions that forms the basis for the development and building of the computerised information system.

Summary is for the summation of the major parts of the background and preconditions.

Project objectives have three sub-headings, Final Result, Time and Cost. In each of these sub-headings one writes down the objectives that is to be reached, if the objectives is achieved and comments on the achievement.

Results have two sub-headings, Results Achieved and Results not Achieved. In Results Achieved one writes the results that is achieved and comment on that result. In Results not Achieved one writes the results not achieved and comments on the results that has not been achieved.

Risks have three sub-headings: Risks, Consequences, Occurred Y/N and Actions. One writes the risks that are connected with the project, the consequences that are related with that risk and if the consequence related to the risk has occurred. If that is so one also writes down the actions that has been taken to reduce the consequence of the risk. One can also write down risks that can be expected to happen in the future and the appropriate actions to be taken against the consequences.

Hand-over and Recommendations have two sub-headings: Hand-over and Recommendations. The Hand-over part contains of three parts, No., Description and Receiver. One writes the number of the hand-over, what is to be handed over and who the receiver is. The Recommendations part also contains three parts, No., Description and Recommended receiver. One writes the number of the recommendation, what is to be recommended over and who the recommended receiver is.

Project Experiences contains of two sub-headings: Positive Experiences and Negative Experiences. Each of these sub-headings contains three parts, No., Experience and Involved Parties. One is to describe under each of the two headings the number of the experience, the experience itself and the parties who was involved in the experience.

White Book

The purpose of the white book is to follow up the impact of the project results with focus on the business value and to ensure knowledge sharing based on business experiences. The white book contains three parts: Preconditions and Background, Summary and Business Value.

Background and preconditions is a short description of the background and the preconditions that forms the basis for the development and building of the computerised information system.

Summary is for the summation of the major parts of the background and preconditions.

Business Value contains two sub-headings, Contribution to Business Value and Fulfilment of Business value. Under Contributions to Business Value one is to write how the solution (the computerised information system) is meant to contribute to the value of the business. Under Fulfilment of Business Value one is to write if and how the solution (the computerised information system) has fulfilled the value of the business.

Result Report

The purpose of the result report is to describe the project results achieved during a roadmap and to give the steering committee a summary of the project before a gate meeting.

The Result Report contain five parts: Summary, Results, Deviations from the Project Charter, Gate <X> Preparation Checklist Status and Experiences.

Summary is a small an overall description of how the project has gone so far.

Results achieved are a description of results that is achieved and not achieved so far.

Deviations from the Project Charter describes two things, the deviation from the entire project and the deviations for the roadmap from x to y. The deviation from the entire project describes the new final result for the entire project, new project time and new project cost. The deviation for the roadmap from x to y describes the new roadmap final result, new roadmap time and new roadmap cost.

Gate <X> Preparation Checklist Status describes the checklist item for the gate in question and comments on that checklist item.

Experiences include both positive and negative experiences. One is to write down the exact experience and recommendations on that experience if one has any.

Risk Management Plan

The purpose of the risk management plan is to describe the risks that is associated with the project and how to manage those risks. The Risk Management Plan contains of three major parts: *Background, Project Risks* and *Overview of Project Risks.*

In the *Background* one describes the purpose with the risk management plan, risk handling (how to handle various risks) and various definitions on risks.

Under *Project Risks* one gives each risk a name and then describes the following: risk identifier, description, impact, area of impact, level of impact, probability, roadmap of impact, date of impact, driving forces, actions, action status, action results and finally status.

Overview of Project Risks is a matrix, which describes the probability of each risk. On the Y-axis is the level of impact and on the X-axis is the probability for the risk to occur. One uses colour in the matrix to display the seriousness of each risk. Green means no problem at this time, yellow means the risk needs to be monitored closely and red means that the risk has become a problem.

Communication Plan

The purpose of the Communication Plan is to achieve a change in terms of changing knowledge, attitudes and behaviour. The plan answers these questions. Which activities are needed to achieve the objectives? Which are the target groups? What is the key messages? Which are the most important channels considering the habits of the target group? How do we measure success or failure in communication activities with the objectives above? How much will communication activities cost and who is paying? The Communication Plan is included in the Project Charter.

Steering Committee Meeting Notice

Steering Committee Meeting Notice is simply a template that is used for writing notices of the meetings that the SC has.

Steering Committee Meeting Minutes

Steering Committee Meeting Minutes is simply a template that is used for writing down the occasions for the SC meetings.

Change Management Council Meetings Minutes

The Change Management Council, which is the responsibility of the Project Sponsor, handles all the changes in the project that makes the solution different from the solution specified in the project charter. Change Management Council Meeting Minutes is simply a template that is used for writing down the occasions or the change management council meetings.

Responsibility Matrix

The Responsibility Matrix is used for defining the responsibility of the different members of the development team. The matrix has three parts: Checkpoint/Activity, Responsible and Remarks. The checkpoint/activity defines the checkpoint or activity that a person is responsible for and the remarks is used to define the scope of the responsibility. The Responsibility Matrix is included in the Project Charter.

Human Resource Agreement

The purpose of the Human Resource Agreement is to define the ones who are to be members of the development team. This makes it possible for the project manager to allocate the human resources he need for the project and to be sure that no one else can make a claim on the human recourses he has contracted. The Human Resource Agreement has ten parts: name of the recourse, skill/expertise of the recourse, a description of the assignment, time for the recourse to work in the development team, special conditions which can affect the agreement, expected results from the recourse, the terms under this agreement can be terminated and finally overtime and free time for the recourse. The project manager, the line manager (the team-leader) and the employee (the recourse), signs the document. This contract is made with everyone of the allocated recourses.

Recourse Agreement

The purpose of the Recourse Agreement is to define and allocate the recourses that are needed to complete the project. We are now talking about machines, computers, databases, software, etc. The Recourse Agreement has five parts:
1) identification of the resources, 2) a description of the recourse, 3) the time when the resource is needed, 4) a description of the special conditions/circumstances for the resource which could affect the agreement and finally 5) a description of the terms which under this agreement can be terminated.

Project Experience Collection

The purpose of the Project Experience Collection is to make a collection of experiences made during the project. There are a total of nineteen questions that is to be answered. They are too many to be described, but they are spanning from questions about the functioning of the SC-team to how well PC's and printers where functioning.