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Leo Tapani Taskinen

Measuring Change Management in Manufacturing Processes

A Measurement Method for Simulation-Game-Based Process Development

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Leo Tapani Taskinen

VTT Industrial Systems

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Abstract

The aim of this research is to find an answer to the research problem, which is *"How can change management be measured in order to help manufacturing companies develop their manufacturing processes?"* To solve the research problem, a constructive action research method is applied. The proposed solution to the research problem, i.e., a change management measurement system, is developed based on principles found in project management literature, process change management literature, performance measurement literature, three consultant surveys, and three case projects. Two of these three case projects applied simulation games as developmental tool, while one applied computer simulation. The proposed change management measurement system is evaluated through these three case projects, and thereafter both practised and further elaborated through two new case projects. The two new case projects are compared for gaining more sophisticated understanding of emerging patterns, and improvement suggestions for simulation-game-based change process utilising the change management measurement system are brought forward. Finally, the results are discussed, and the research and its contribution are evaluated through the quality criteria developed for this research.

The measures in the change management measurement system are classified into two types: the first type gauges change project management itself, and the second assesses the outcomes of the change project, i.e., the improvements gained in manufacturing operations. Both of these types are measured in three dimensions: human resources, processes and technology, which are further divided into effectiveness and efficiency. Effectiveness is defined as the external, strategic performance: "doing the right thing," where strategically correct processes are developed, and strategically sound targets are pursued.

Effectiveness includes adaptability. Efficiency is defined as the internal, operational performance: "doing it right," reaching the objectives of the change project economically and ideally with the best possible input/output. Consequently, the change management measurement system forms 12 measurement dimensions out of which six dimensions measure change project management itself and the other six dimensions measure changes in the manufacturing operations.

The proposed change management measurement process suggest that particular attention should be paid to measurement and consequent timely reactions in the early phases of the project. Reactions to early feedback enable rapid learning and a successful project trajectory can be achieved already in the early phases of the project. Thereafter, through continuous measurement and consequent timely reactions, a successful project trajectory can be maintained until the project end.

The case results suggest that there is a need for balanced change management measurement where both the change project management and the manufacturing operations management are measured. The balanced measurement improves the systematics and coherence of the change process; thus also the change management capability of the organisation is enhanced. In addition, it is proposed that the measurement system should flexibly allow customised measures for all the project steps. Furthermore, the research results support the idea that one key factor for success is how well the project management team uses the available measurement system, i.e. how well the measurement related tasks are performed. In change management capability improvement the measurement of human resource subject matters is fundamental to success, and it is proposed that in future research cycles, particular attention should be paid to development of measures concerning psychological, behavioural and teamwork subject matters.

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Otaniemi, September 2002
Tapani Taskinen

Contents

Glossary

Change management
is defined in this research as management which characteristically aims at performance improvements through innovations.

CMMF — Change management measurement framework, defines measurement dimensions for change management in manufacturing processes.

CMMS — Change management measurement system, includes CMMF and defines individual measures for measurement dimensions in CMMF.

CMMP — Change management measurement process that utilises CMMS.

Effectiveness — is defined in this research as doing strategically "the right thing", reflects quality and adaptability, and how well customer expectations are met according to the given corporate strategy.

Efficiency — is defined in this research as "doing it right" with best possible or optimal input/out; reflects internal performance and productivity, and how well resources are utilised.

MSCP — stands for the measured simulation-game-based change process.

Performance measurement
is the process of quantifying the efficiency and effectiveness of action (Neely et al., 1995).

Performance measure
is used to quantify the efficiency and/or effectiveness of an action (Neely et al., 1995).

Performance measurement system

is the set of performance mesures used to quantify both the efficiency and effectiveness of actions (Neely et al., 1995).

PMT stands for project management team

Project The ISO 10006:1997 (E) standard defines a project as a unique process consisting of a set of co-ordinated and controlled activities with start and finish dates, undertaken to achieve an objective conforming to specific requirements, including the constraints of time, costs and resources. The Standards Committee of the Project Management Institute (Duncan, 1996) defines a project as a temporary endeavour undertaken to create a unique product or service.

Project management

according to ISO 10006:1997 (E) standard includes the planning, organising, monitoring and controlling of all aspects of the project in a continuous process to achieve its objectives. The processes and objectives of quality management (ISO 8402) apply to all project management processes. Project management according to Kerzner (1998) involves both project planning and monitoring. Project planning includes definition of work requirements, quantity & quality of work, and resources needed; project monitoring includes tracking progress, comparing actual outcome to predicted outcome, analysing impact and making adjustments.

Process according to Melan (1993) a process is defined as a bounded group of interrelated work activities providing an output of greater value than the inputs by means of one or more transformations. Hammer and Champy (1993) define a business process as a collection of activities that takes one or more kinds of inputs and creates an output that is of value to customer. In this research, the business process under development is **the manufacturing process** and is defined according to Davenport (1993) as a structured, measured set of activities designed to produce a specified output for a particular customer.

Process management

The idea of process management is to optimise the performance of business processes instead of business functions. According to Melan (1993) process management is a concept that focuses on the flow of work independent of whether this work is a product or service, and independent of the organisation.

Process change management

is defined in this research as management which characteristically aims at performance improvements in manufacturing process through innovations.

Reengineering

According to Hammer and Champy (1993) reengineering is defined as "the fundamental rethinking and radical redesign of business processes to achieve dramatic improvements in critical, contemporary measures of performance, such as cost, quality, service, and speed".

Simulation

According to Greenblat (1988, p. 14) a simulation is an operating model of central features or elements of a real or proposed system, process, or environment. Banks (1998, p. 3) says that a simulation is an imitation of the operation of a real-world process or system over time. Saunders (1998, p. 9) defines simulation as a working representation of reality; it may be an abstracted, simplified or accelerated model of the process.

Simulation game

In simulation games, the rules and constraints are based on modelled reality. Roles, goals, actions, consequences and connections simulate the real or proposed system or process. A simulation game can be either generic or tailored: a generic simulation game can be utilised in any organisation while a tailored one is planned uniquely on a case by case basis (Riis et al. 1995, Piispanen et al., 1998).

1. Introduction

1.1 Background

According to Vollmann (1996) today's industrial revolution is characterised by a massive explosion of information and a technological quantum leap, with consequent increases in the power and flexibility of manufacturing technology, processes and organisation (see also Salminen, 2000). It can be seen that the level of competition is increasingly shifting from the effective management of operations to the efficient and effective management of change (c.f. Smeds, 1996a; 1996b), i.e., enterprises have to continuously change and develop their performance in order to survive. Consequently, in addition to being efficient and effective in their current processes, companies have to continuously develop their capabilities for change management.

1.2 Research question and objectives

The focus of this research is on change management in the development of manufacturing processes when pursuing radical development targets, e.g., to halve manufacturing throughput times and work-in-process inventories. In engineering-intensive enterprises manufacturing development projects tend to be costly and time-consuming, and their implementation is often problematic. The difficulty of business process improvement efforts is brought forward by several authors (e.g., Moss Kanter, 1983; Harrington, 1991; Davenport, 1993; Hannus, 1994; Smeds, 1994; Carr and Johansson, 1995; Kotter, 1995, 1996; Katzenbach, 1996 and Carnall, 1999). For example, Hammer and Champy (1993) estimate that 50–70% of business process re-engineering (BPR) projects fail or do not achieve the dramatic results they intended. Thus, it is justified to ask how the performance of manufacturing process development projects could be improved? An answer to this question could be measurement. The importance of measurement for improvement is strongly stressed in literature (Rummler and Brache, 1990; Harrington, 1991; Brown, 1996; Kaplan and Norton, 1996; Laakso, 1997; Carnall, 1999; Scheur, 2000).

Consequently, to meet the challenge of manufacturing process improvement when applying tailored simulation games as developmental tool, the research question, and objectives of this thesis are stated as follows:

1. Research question

How can change management be measured in order to help manufacturing companies develop their manufacturing processes when applying tailored simulation games as a developmental tool?

2. Objectives of the research:

Two primary objectives for this research are derived from the research question. The first objective is practical in its nature and it is

to develop and to test a measurement system for the development of discrete manufacturing processes, when applying tailored simulation games as a developmental tool.

The second, theoretical objective is

to enhance knowledge on measurement of change management in simulation-game-based manufacturing process development.

1.3 Scope of the research

The research is conducted in an empirical setting limited by the following four situational factors:

1. Industry type:
    - The case enterprises are industrial manufacturing companies
    - The number of employees working in the case factories varies between 120 and 300.
2. Type of manufacturing process under development:
    - Material flows and products are discrete
    - Manufacturing stages include both manual and automated work phases.

3. Type of intended change:

- All the case projects have radical improvement targets, e.g., to halve manufacturing throughput times and work-in-process inventories. The targets are based on given corporate strategy.

4. Applied change tool:

- Tailored simulation gaming (see Sections 4.4 and Chapter 5) is used as a change management tool in the case projects D and F developing the change management measurement framework and in the case projects G and H testing and elaborating the framework into a change management measurement method. Tailored computer simulation is used as a primary developmental tool in the case project E developing the change management measurement framework.

1.4 Structure of the research

This thesis consists of an introduction and three main parts divided into chapters as put forward in Tables 1.4-1 and 1.4-2. In Part I, the chapters concerning theory connection and practical relevance are brought forward and synthesised and the change management measurement system to solve the research problem is constructed. In Part II, the constructed change management measurement system is tested and elaborated in practice. Finally in Part III, the research is concluded as the results are discussed and the contribution to the existing knowledge is given.

Table 1.4-1. The structure of the thesis.

Introduction

Chapter 1 introduces the field of research and defines the research question, objective, hypothesis and problem area.

Chapter 2 introduces the research method together with the requirements for research quality.

Part I Developing the change management measurement system

Part I-A Theory connection

Chapter 3 reviews the literature in the field of project management.

Chapter 4 reviews the literature in the field of process change management together with the related issues of change measurement. Aspects of organisational learning, knowledge management and team work are included.

Chapter 5 introduces the applied change management methodology.

Chapter 6 reviews the literature on performance measurement

Part I-B Practical relevance

Chapter 7 brings forward the state of the art in change management according to the consultant surveys A, B, and C.

Chapter 8 introduces Case projects D, E, and F. Experiences with these three manufacturing process development projects are discussed.

Part I-C Construction

Chapter 9 carries out the construction of change management measurement system and evaluates it in the case projects D, E and F afterwards.

Table 1.4-2. The structure of the thesis.

Part II Testing and elaborating the change management measurement system in practice

Chapter 10 tests and develops the change management measurement system further through case project G.

Chapter 11 tests and develops the change management measurement system further through case project H

Chapter 12 compares case projects G and H in order to find emerging patterns.

Chapter 13 gives suggestions for the measured simulation-game-based change process.

Part III Summary, discussion and conclusions

Chapter 14 gives a summary of the research problem and method.

Chapter 15 discusses the developed change management measurement framework, system and the measured simulation-game-based change process. Suggestions for future research are also given.

Chapter 16 evaluates the research through the quality criteria introduced in Chapter 2.

Chapter 17 concludes the research.

2. Research method

This research is based on a constructive research approach that includes a literature review, comparative consultant survey and an action research in five manufacturing development projects. The choice of the research method is based on two facts (Taskinen and Smeds, 1998b):

- The need of the case companies to efficiently improve their manufacturing processes
- The need of the researcher to help case companies in their manufacturing development projects, that is, to do consultative research work.

According to Gummesson (1991) the challenges, when conducting consultative research work, i.e., action research work, are 1) pre-understanding; 2) access to reality; 3) understanding; and 4) quality or the validity of the research. On the other hand, Kasanen et al. (1991, 1993) presents cornerstones of constructive research as adequate link to the theory, relevance of the research problem, and the pragmatic and epistemological utility of the construct. The elements of constructive research are presented in Figure 2-1.

Kasanen et al. (1991, 1993) state the six phases of constructive research as follows: 1) Find a practically relevant problem which also has research potential; 2) Obtain a general and comprehensive understanding of the topic; 3) Innovate, i.e., solve the research problem by building a new construct; 4) Test the construct in practice; 5) Show the theoretical connections and the research contribution of the solution concept; 6) Examine the scope of applicability of the solution.

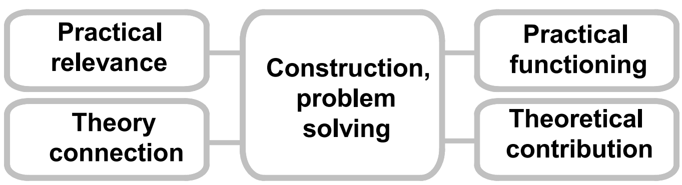


Figure 2-1. Elements of constructive research (Kasanen et al., 1993).

Kaplan (1998) proposes an innovation action research approach for creation of new management theory and practice. The basic structure for innovation action research is brought forward by the research cycle shown in Figure 2-2. However, it should be noted that the process is not as orderly and sequential as shown in Figure 2-2, but that there are multiple feedback loops and cycles. In innovation action research the scholar starts at the bottom of the cycle (the Base Case in Figure 2-2), by observing and documenting that the existing management practice is deficient, limited and can be improved. At this point, the initial innovations to overcome the limitations can be identified, and consequently further developed as the research proceeds. The second step is to teach and and speak about deficiences and limitations in current practice. The third step is to write articles and books. The fourth step is to test the new concept in practice through initial implementation after which the second loop around the innovation action research cycle starts. Thereafter the research proceeds until advanced implementations. Results from innovation action research projects are for example the development of activity-based costing and the balanced score card (Kaplan, 1998).

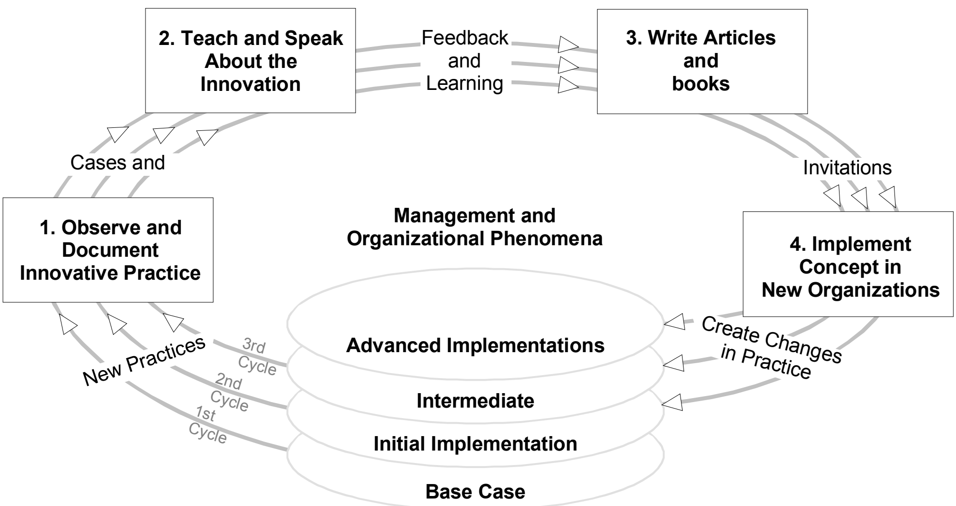


Figure 2-2. Innovation action research cycle (Kaplan, 1998).

The innovation action research approach by Kaplan (1998) and the action reasearch approaches presented by Kasanen et al. (1991, 1993) and Gummesson (1991) are basically hermeneutical knowledge creation processes, where the researcher acts as an active change agent in companies, helping to create a new management concept, practice and theory which did not exist before.

Kasanen et al. (1991, 1993) use the classification by Neilimo and Näsi (1980) in locating a constructive research approach among the established management accounting research approaches according to the two axes, theoretical-empirical and descriptive-normative, as shown in Figure 2-3. Also Olkkonen (1993) argues that a constructive research approach fits well when developing new managerial constructions.

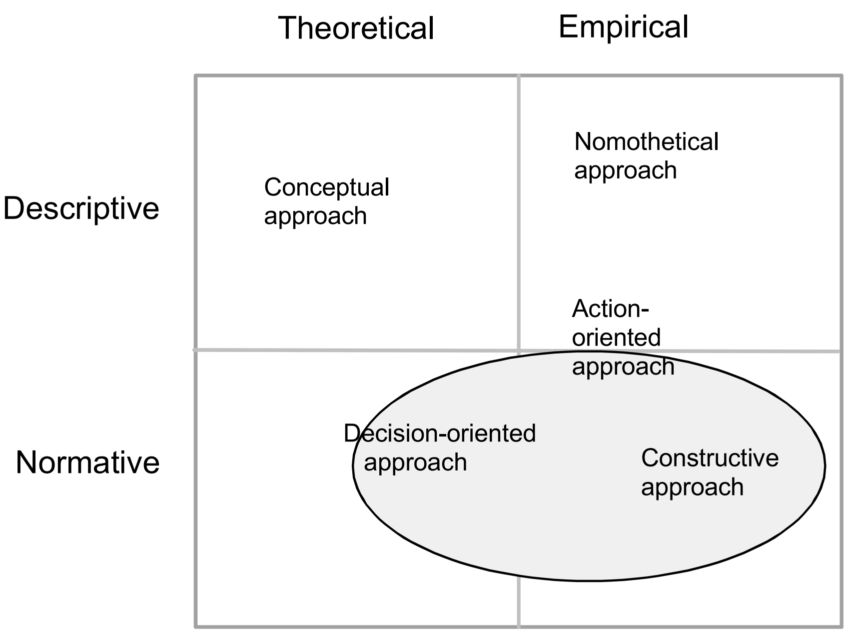


Figure 2-3. The location of the constructive approach in the established accounting research approaches (Kasanen et al., 1991, 1993).

Kasanen et al. (1991, 1993) explain the framework in Figure 2-3 as follows. The **conceptual approach** produces new knowledge primarily through the method of reasoning. The **nomothetical approach** is closely linked to the modernist (positivist) research tradition. The underlying explanatory model is causal and attempts are made to state findings in the form of general laws. The **decision oriented approach** is grounded in assumptions similar to nomothetical one, but there is a difference in the fundamental nature of the research, which in this case is normative, i.e., the results are meant to help management in running the firm. The **action oriented approach** brings the human being into the focus. The explanatory model is often teleological and the historical backround of the phenomena studied is examined carefully. **The constructive approach** takes a position in the typology, as shown by the drawn ellipse in Figure 2-3, i.e., in the normative and for the most part in the empirical area.

2.1 Pre-understanding

According to Gummesson (1991) pre-understanding is a combination of the researcher's own and other's experiences at the start of a research project or consulting assignment.

The research question of this thesis, its relevance and theory foundation are based on pre-understanding which comes from:

- The author’s two previous business process development projects where he was working as an in-house Project Manager and where simulation games were used as a development tool. The company, where these projects took place, can be described as an engineering workshop with two separate product lines. Both of these product lines had their own sales, design and manufacturing departments while purchase department was common for both of the product lines. Annual turnover of the company was about 20 M Euros. The first project (Taskinen, 1996) was more successful in terms of process improvement compared to the second project, which was performed later in the other product line and with different employees. During these two projects the need to improve simulation-game-based manufacturing process development emerged. The author started to ask what could be done better, and particularly, how the performance of the simulation-game-based manufacturing process development projects could be improved.
- The author’s experiences in development projects D, E and F (Chapter 8).
- Discussions with collaborating researchers.
- Interviews. Top managers of three global consulting companies A, B and C were interviewed to find out the state of the art in measurement of change management (Chapter 7).

- Literature. Several writers have argued that measurement is important for improvement (Rummler and Brache, 1990; Harrington, 1991; Brown, 1996; Kaplan and Norton, 1996; Laakso, 1997: Carnall, 1999; Scheur, 2000). However, no research reports concerning the measurement of simulation-game-based manufacturing process development projects could be found in literature. Even though tailored simulation games had been applied in several manufacturing system development and innovation projects in Finland since 1988. (Haho, 1988; Ahlbäck and Haho in Jahnukainen and Vepsäläinen, 1992; Savukoski et al., 1995; Piltonen et al., 1995; Smeds, 1994, 1996a, 1996b and 1997).

Thus, it can be proposed that both practical and theoretical viewpoints support the relevance of the subject matter. Consequently, based on pre-understanding, the research question of this study could be stated as follows:

"How can change management be measured in order to help manufacturing companies develop their manufacturing processes, when applying tailored simulation games as a developmental tool?"

2.2 Access to reality

According to Gummesson (1991) access to reality refers to the ability to get close to the object of study, to really be able to find out what is happening and to find empirical, real-world data and information concerning the object of study. If the access to reality fails, the collected data is not correct and consequent data analysis may lead to wrong conclusions. Thus, the researcher's ability to get close to the object of study is critical, and it influences data collection and data analysis decisions (see also Frankfort-Nachmias and Nachmias, 1996). Four types of access are needed (Gummesson, 1991): 1) access to money in order to finance the research project; 2) access to system, i.e., research object or the organisation to be studied; 3) access to individuals in the system; and 4) access of the system and its individuals to the researcher/consultant. In order to get proper access to the object of this study, i.e., to change management in the manufacturing processes, when applying tailored simulation games as a developmental tool, constructive action research (Rapoport, 1970; Gummesson, 1991; Kasanen et al. 1991 and 1993; Olkkonen, 1993; Kaplan, 1998) approach in case companies is applied as a research method.

According to Gummesson (1991) action research is known as the reseachers' participation in the process examined with active intervention. In this research, the researcher participated with active intervention in five manufacturing development projects. In the case projects D, F, G and H the intervention method applied and facilitated by the researcher was based on tailored simulation games, while in the case project E only tailored computer simulation was used. The data collection methods applied by the researcher were direct observations, project diaries, interviews, and questionnaires.

2.3 Understanding, innovation, and testing the construct in practice

Understanding and innovation develops according to the hermeneutic spiral, where each stage of research provides a new level of understanding that is turned to pre-understanding in the next research cycle (Susman and Evered 1978, Gummesson 1991, Kaplan, 1998). In this research, the development of the construct evolves according to the spiral shown in Figure 2.3-1. In Sections 2.3.2–2.3.5 the used research method is explained, i.e. what work was done as the research evolved.

Figure 2.3-1. Evolution of the research according to the hermeneutic spiral.

2.3.1 Practical relevance

2.3.1.1 Preliminary case projects D, E and F

This research started with action research projects in the case factories D, E and F. The aims of these projects were to improve the manufacturing processes of these case factories and to provide pre-understanding for this research. The projects were documented by the project diaries. Case projects D and E took place primarily between June and November 1997, while case project F was performed mainly between November 1997 and March 1998. In the beginning, the research question was approached by asking how to improve the performance of simulation-game-based change projects when developing manufacturing processes. The measurement idea emerged in early 1998 as it was thought that one way for improvement could be measurement. This led to an enquiry into the state-of the art in measuring change management, for which consultant surveys were performed.

2.3.1.2 Consultant surveys

The consultant surveys were performed in the spring of 1998. The purpose was to find out the main principles according to which change management was measured in practice. Top managers of four internationally well-known consulting companies were interviewed by the researcher, as it was believed that they represent the state of the art in measurement of change management. In the end only three of the four interviews contributed sufficiently to be included in the research.

The processes of extracting data, information and know-how during these interviews can be described as follows: At the beginning of each interview the author introduced his research topic and asked two questions [c.f. Taskinen and Smeds, 1998a]: How do you measure change management, and how should measurement methods in change management projects be further developed? Thereafter the author took down notes and recorded the interviews on audiotape. Each of these three interviews lasted approximately one hour.

2.3.2 Theory connection

Based on both the case projects D, E and F and the consultant surveys A, B and C, it could be said that the research question is relevant from a practical point of view and that there is a need to obtain a general and more comprehensive understanding of it from the literature. It was found that the measurement of change management is somewhat new as a research topic, and that there is no literature that could directly provide a solution to the research question. Therefore, the following areas of the literature were examined in order to extract the necessary theoretical building blocks: project management literature; process change management literature including issues such as process innovation, organisational learning, knowledge management, tailored simulation games and contingencies and variables in change projects; literature concerning the simulation based change management methodology applied in the case projects; and performance measurement literature including frameworks for performance measurement, guidelines for building measures, and measurement questionnaires together with data analysis.

2.3.3 Construction

In order to answer to the research question, a change management measurement framework, abbreviated CMMF, was synthesised from the results of consultant surveys A, B, C; practical case projects D, E, F; and the literature research. The change management measurement system, abbreviated CMMS, was then developed by proposing measurement questions for each of the measurement dimensions in the framework, and a measurement questionnaire was formulated. Next, the change management measurement system was tested by applying the questionnaire for subsequent evaluation of the case projects D, E, and F. The purpose was not to design highly sophisticated measurement questions but to get early feedback from the use of the developed change management measurement ideas. As the results supported the construct validity, that is, the questionnaire clearly differentiated between well and poorly managed projects, there was a need to continue the research by using, elaborating and testing the CMMS in real change management and change management measurement processes.

2.3.4 Practical functioning

The CMMS was tested and elaborated further in two new case projects G and H. Firstly, based on CMMS, a revision of needed measures was selected, determined and linked to the simulation-game-based change management process by the researcher (facilitator), project managers and production managers of case projects G and H. Secondly, these measures and the new ones that emerged during the projects were used, further elaborated and tested in practice in Cases G and H.

Case projects G and H were compared in order to perform a cross-case search for finding emerging patterns. According to Eisenhardt (1989) this tactic forces the researcher to look for subtle similarities and differences between cases, and can lead to more sophisticated understanding. Finally, improvement suggestions for using CMMS in future projects were given as the measured simulation-game-based change process was proposed.

2.3.5 Theoretical contribution

The theoretical contribution of this research is discussed in Part III. First, the research is summarised and the developed novel constructs, i.e. the change management measurement framework and system, and the measured simulation-game-based change process, are reflected in the theory. Second, the research is assessed through the quality criteria, which are developed for this research in Chapter 2.5. Finally, conclusions are drawn.

2.4 Role of the researcher

In the first phase of the project, i.e., from June 1997 to June 1998 (see Figure 2.3-1), the author of this dissertation worked as an external change agent in the case projects D, E and F. He designed and facilitated the simulation games in the case projects D and F, according to the simulation-game-based change process described in Chapter 5. The researcher's role in the case project E was somewhat different because computer simulation was applied in the change process instead of the simulation game (see Chapter 5). The case project E was co-ordinated in general by the author, but the computer simulation model of the manufacturing process to be developed was prepared by a simulation software specialist, who was also responsible for presenting the results of different computer runs in simulation seminars, where the results were discussed together with the personnel of case project E.

The author documented projects D, E and F by writing the project diaries based on observations and data collected from the personnel of the case projects D, E and F (Chapter 8).

Moreover, the literature research was done by the author as was the consultant surveys A, B and C (Chapter 7), after which the author constructed and evaluated the first versions of the change management measurement framework and system. Discussions and co-operation with collaborating researchers were helpful in this phase.

The role of the author in the second phase of the research, i.e., from July 1998 to March 1999, was firstly to elaborate the change management measurement system in a way that it is applicable in practice throughout the simulation-game-based development process described in Chapter 5. Consequently, the author prepared the first versions of the measurement questionnaires to be applied in the case projects G and H. Secondly, in the beginning of the projects G and H, the researcher discussed with the project management team members about the change management measurement system and improvement suggestions for the proposed measurement questionnaires were made. Thereafter, the author worked as an external change agent facilitating the project measurements as well as the simulation-game-based change processes in the case projects G and H described in Chapters 10 and 11.

In the third phase of the research, i.e., from April 1999 and thereafter, the planned changes were implemented in the case projects G and H. The role of the author as a change agent was over in this phase. However, the author followed the implementations in Cases G and H, and conducted post-project interviews with the Project Managers of Cases G and H, and Production Manager of Case H, to evaluate the change management measurement experiences. Thereafter, the author concluded this dissertation.

2.5 Quality of the research

According to Reason and Bradbury (2001) every action research is its own piece of art and articulates its own standarts. This mindset fits well also for constructive (innovative) action research aiming at managerial constructions. Therefore, the quality criteria for this research is developed in this chapter through examining the quality criteria presented by Kasanen et al. (1991, 1993), Gummesson (1991), Kaplan (1998), Thomas and Tymon (1982), Eden and Huxham (1996) and Reason and Bradbury (2001).

Kasanen et al. (1991, 1993), Gummesson (1991) and Kaplan (1998) have approached the quality issue more from the viewpoint of constructive action research than Thomas and Tymon (1982) and Eden and Huxham (1996) who have assumed a more general approach for qualifying management action research. Additionally, in order to complement the quality criteria presented in management action research context, the general criteria for action research by Reason and Bradbury (2001) are brought forward. Finally, the quality criteria for this research are concluded.

2.5.1 Quality criteria by Kasanen et al. (1991, 1993)

According to Kasanen et al. (1991, 1993) the two primary quality criteria of constructive research work are pragmatic and epistemological utility.

A successful constructive research in which an **innovative solution** to a real world problem is produced, its specific **usability** and **theoretical connections** are demostrated and its **potential for more general adequacy** is examined, is according to Kasanen et al. (1991, 1993) apt to fulfil the most significant general characteristics of science, i.e., **objectivity, criticalness, autonomy,** and **progressiveness** (see Figure 2.5.1-1). Moreover, Kasanen et al. (1991, 1993) argue that the requirements typical of the applied sciences, i.e., **relevance, simplicity and easiness of operation** are satisfied in a successful constructive research through the pragmatic starting point of the problem and through making certain that the constructed solution works. In other words, practical usability is the major characteristic that shows the truthfulness of a managerial construction. Generalisation of the results may be approached by considering what are the more general features becoming visible in the construction. It can be proposed that epistemological utility of a constructive research becomes evident through generalising the results.

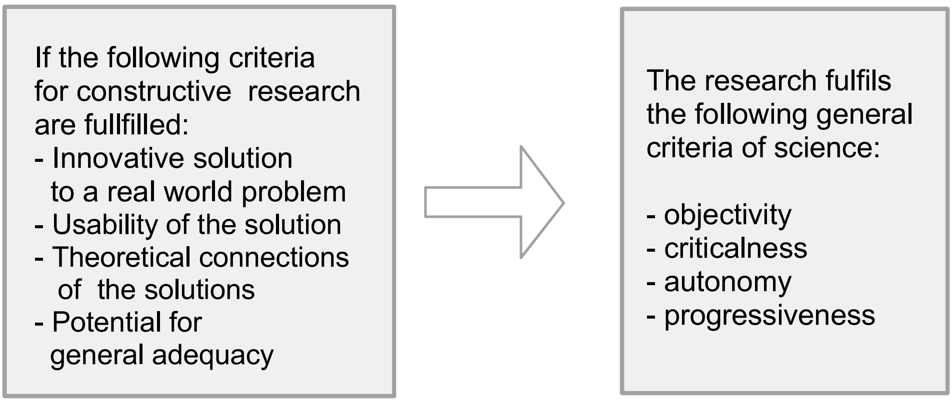


Figure 2.5.1-1. The criteria according to which a successful constructive research fulfils the general criteria of science.

Furthermore, Kasanen et al. (1991, 1993) state that a managerial construction is like a product competing in the market of solutions, and that the pragmatic utility of a developed construct can be validated through so called weak, semi-strong and strong market tests (see Table 2.5.1-1). The criterion for weak market test is that a manager responsible for the financial results of his or her business unit has been willing to apply the construct in his or her decision-making. The weak market test itself is relatively strict, i.e., only a few tentative constructions are able to pass it. The criterion for the semi-strong market test is that the construct has been widely adopted by companies. The criterion for the strong market test is that business results improve after practising the construct, and that the results are better compared to similar business units which do not apply the construct.

It is noteworthy that it is quite likely that a solution or construct which works in one firm is useful in several other similar firms, i.e., grounds for generalising results of a constructive research differ radically from an attempt to make statistical inferences from a small sample (Kasanen et al., 1991, 1993). Semi-strong and strong market tests require analysis of a substantial amount of implementation data from those companies applying the construct.

Table 2.5.1-1. Criteria for weak, semi-strong and strong market tests.

Test → **Criteria** ↓	Weak market test	Semi-strong market test	Strong market test
Has any manager responsible for financial results of his or her business unit been willing to apply the construction in his or her actual decision making?	Yes	Yes	Yes
Has the construction been widely adopted by the companies?	No	Yes	Yes
Has substantial amount of implementation data been analysed?	No	Yes	Yes
Have the business units applying the construction produced systematically better financial results than those which are not using it?	No	No	Yes

2.5.2 Quality criteria by Thomas and Tymon (1982)

Thomas and Tymon (1982) state that the practical relevance or usefulness of research must be assessed by using the practitioner (i.e., customer) as a frame of reference. The components of practical relevance according to Thomas and Tymon (1982) are as follows:

1. **Descriptive relevance**, which refers to the accuracy of research findings in capturing phenomena encountered by the practitioner in his or her organisational setting.
2. **Goal relevance**, which refers to the correspondence of outcome (or dependent) variables in a theory to the things the practitioner wishes to influence.
3. **Operational validity**, which concerns the ability of the practitioner to implement action implications of a theory by manipulating its causal (or independent) variables.

4. **Nonobviousness**, which refers to the degree to which a theory meets or exceeds the complexity of common sense theory already used by a practitioner.
5. **Timeliness** concerns the requirement that a theory be available to practioners in time to use it to deal with problems.

2.5.3 Quality criteria by Eden and Huxham (1996)

Eden and Huxham (1996) present 12 contentions to justify an action research project as quality research. The contentions cover generality and theory generation, the type of theory development appropriate to action research, the pragmatic focus of action research, designing action research and validity of action research. The first six contentions assess the outcomes of the action research and the further six contentions assess the characteristics of action research process. The 12 contentions are as follows:

1. Action research must have some **implications beyond those required for action or generation of knowledge in the domain of the project**. It must be possible to envisage talking about the theories developed in relation to other situations. Thus it must be clear that results could inform other contexts, at least in the sense of suggesting areas for consideration.
2. As well as being usable in everyday life action research demands **an explicit concern with theory**. This theory will be formed from the characterisation or conceptualisation of the particular experience in ways that are intended to be meaningful to others.
3. If generality drawn from action research is to be expressed through the design of tools, techniques, models and methods this, alone, is not enough - **the basis for their design must be explicit, and shown to be related to the theory**.
4. Action research will generate **emergent theory** through application in practice.
5. **Theory building**, as a result of action research **will be incremental**, moving from the particular to the general in small steps.

6. What is important in action research is not a (false) dichotomy between prescription and description, but a recognition that **description will become prescription** (even if implicitly so). Thus, the presenters of action research should be clear about expecting the customer to take from it and present with a form and style appropriate to this aim.
7. **A high degree of methodology and orderliness** is required in reflecting on, and holding to, the emerging research content of each episode of involvement in the organisation.
8. For action research, **the process of exploration** (rather than collection) of the data, in detecting emergent theories, must be either replicable or demonstrable through argument or analysis.
9. Adhering to the eight contentions above is a necessary but not sufficient condition for the validity of action research.
10. In order to justify the use of action research rather than other approaches, the reflection, and **data collection process** – and hence the emergent theories – **should be focused on the aspects that cannot be captured easily by other approaches**. This in turn suggests that having the knowledge about and skills to apply the methodology and analysis procedures for **collecting and exploring rich data** is essential.
11. In action research, the **opportunities for triangulation** that do not offer themselves with other methods, should be exploited fully and reported, i.e., triangulation should be used as a dialectical device which powerfully facilitates the incremental development of theory.
12. **The history and context for the intervention** must be taken as critical to interpretation of the likely range of validity and applicability of the results.

2.5.4 Quality criteria by Gummesson (1991)

Gummesson (1991) identifies the following quality criteria for case study research:

1. A research project should be conducted in a manner that allows the **readers** to draw their own conclusions.

2. The researcher should present his/her **paradigm**, i.e., the researcher's pre-understanding, the values of the system under analysis, theories and models that govern the project together with the reasons for the choice of these theories.
3. The research should possess **credibility**, i.e, correct data and interpretation supported by data, honest presentation of alternative interpretations and contradictory data.
4. The researcher should have adequate **access** to the process under study
5. A statement should be made regarding the **validity** of the research, i.e., to whom the results apply, does other research confirm the findings, do the results bear out the theories and models available in the literature
6. The research should make a **contribution**, i.e., be of value to the client and scientific community,
7. The **research process** should be dynamic, i.e., the researcher learns continuously by communicating impressions, hypothesis and so forth to those involved and other researchers, research should be creative.
8. The researcher should have **commitment and integrity**, i.e., be deeply involved in the project but at the same time retain a distance.
9. As an **individual**, the researcher should satisfy requirements such as pre-understanding through study and personal experience, candor and honesty.

2.5.5 Quality concerns by Kaplan (1998)

According to Kaplan (1998), it is a complex issue to evaluate satisfactorily, whether a new proposed managerial concept is a good, value-creating idea for organisations. The following concerns influencing the quality of innovation action research is put forward by Kaplan (1998):

1. The researcher has become an advocate for the approach and can benefit financially through consulting relationships with companies and consulting firms, plus fees for speaking appearances. However, the intimate association with the concept and its implementation causes the action researcher to lose neutrality and be a less-than credible source for independent evaluation.

Thus, **the problem of independence and objectivity for the action researcher remains**. There is a tension between the knowledge the action researcher has of the phenomenon for evaluation purposes versus the advocacy position of the action researcher.

2. The primary purpose of the initial publications representing an early stage of concept development, (during the first loop in the innovation action research cycle), is to provide opportunities for the researcher to gain feedback from academics and managers. However, independent scholars outside the implementation process may wish to assess the value and impact of the developed concept early in the knowledge creation process, thus, **there is a possibility that the early evaluation assessments are misleading**.

3. Finding of limited impact from a new idea may confound the inherent structural concerns of the construct with poor implementation experiences. Thus, the faithful implementation process of the solution concept is needed in order to guarantee that the new system provides valid signals for management action. In addition, **the process of applying the new concept may be critical**, i.e., how well the implementing company uses its new management tool. Thus, implementation failures of even valid concepts can arise from the following three sources:

   a. Implementing the concept prematurily when the concept has yet to progress

   b. Poor management of the project that develops the new system

   c. Managers fail or refuse to act based on signals from their new system

   These three sources (a, b and c) make it difficult for passive, distant observers to evaluate the new approach.

4. **Detailed studies of both successes and failures** are needed to learn about gaps either in theory or in the implementation process.

5. **Informal evaluations** can be performed through interactions with executives in the classroom and public seminars, through listening to managers' experiences, and through in-depth knowledge which comes from personal involvement in implementations.

6. **Publications must contain sufficient detail and precision** so that others can independently develop and validate the ideas.

7. **The concept has severe limitations if it continually requires the active involvement of the action researchers for each implementation**. Thus, the concept should be deliverable by people other than the original proponents, who have been well trained both in the concept and the effective implementation.

2.5.6 Quality criteria by Reason and Bradbury (2001)

Reason and Bradbury (2001) suggest the following criteria for improving the quality of the action research:

1. **Quality as relational praxis**:
   - Is the action research group set up for maximal participation?
   - Are the opportunities used to allow the personnel of the case organisation to feel free to be fully involved?
2. **Quality as reflexive-practical outcome**:
   - Research should be for the participant's own benefit, not to get an answer to questions posed by scientific criteria.
   - Are participants able to say "that was useful – I am using what I learned!"
3. **Quality through conceptual-theoretical integrity**:
   - Theory-building should be anchored in people's experience.
   - Does the new theory allow us to look anew at the world, or to re-conceive taken-for-granted conceptual categories that are oppressive or no longer helpful?
4. **Quality through methodological appropriateness**
5. **Quality as engaging in significant work**:
   - Is the research worthy of attention?
   - Did we choose a worthy subject for our efforts?
6. **Quality as emergent inquiry towards enduring consequence**:

- Action research in its all forms is a long-term, evolutionary, emergent form of enquiry that should proceed towards a new and enduring infrastructure.

2.5.7 Conclusions – quality criteria for this research

Based on the quality criteria presented by Kasanen et al. (1991, 1993), Gummesson (1991), Kaplan (1998), Thomas and Tymon (1982), Eden and Huxham (1996) and Reason and Bradbury (2001) the following quality criteria are adopted for the assessment of this research:

1. The first quality criterion of pragmatic concern questions, whether an **innovative solution to a real world problem** has been produced (Kasanen et al., 1991, 1993). This viewpoint is supported by the nonobviousness criterion brought forward by Thomas and Tymon (1982), engaging-in-significant-work criterion by Reason and Bradbury (2001) and the idea of creative research by Gummesson (1991). Also, Kaplan (1998) argues that action research should concern real world problems and be innovative. Consequently, the first quality assessment question for this research is as follows: Has this research produced an innovative solution to a real world problem? Innovative solution is defined here as a new managerial construct that is applied in practice.
2. The first quality criterion is backed up by the second quality criterion, that is, **evaluation of the practical usability of the developed solution concept through weak, semi-strong and strong market test** (Kasanen et al., 1991, 1993). The criteria for the market tests are put forward in Table 2.5.1-1. The criteria of practical usability in market tests are supported by the value-to-the-client mindset by Gummesson (1991) and Kaplan (1998). Also, the descriptive relevance, goal-relevance, operational-validity and timeliness concerns criteria by Thomas and Tymon (1982), and the relational praxis and reflexive-practical outcome quality criteria by Reason and Bradbury (2001) are embedded, or at least implicitly taken into account, in the market tests by Kasanen et al. (1991, 1993). In addition, Eden and Huxham (1996) support this criterion by stating that action research should be usable in everyday life. In this context, the quality concern of Kaplan is relevant, i.e., how well the implementing company uses its new management tool.

3. The third quality choice point examines **validity and generalisation of the results**, through the following questions:

   - Has the theoretical connection of the solution been demonstrated (Kasanen et al., 1991, 1993; Eden and Huxham, 1996)?
   - Have opportunities for triangulation been exploited and reported (Eden and Huxham, 1996)?
   - To whom do the results apply? What is the potential for general adequacy and what are the more general features emerging in the construction (Kasanen et al., 1991, 1993; Gummesson, 1991, Eden and Huxham, 1996)?
   - Does other research confirm the findings, do the results bear out the theories and models available in literature (Gummesson, 1991)
   - Does the new theory allow us to look anew at the world (Reason and Bradbury, 2001), i.e., does this research add to existing knowledge?

4. The fourth quality criterion evaluates **the quality of the action research process** with the following questions:

   - Has this research followed a high degree of methodology and orderliness in reflecting on, and holding to, the emerging research content of each episode of involvement in the organisation (Eden and Huxham, 1996; Reason and Bradbury, 2001)? It can be proposed that this question takes into account also the criterion of credibility by Gummesson (1991), the criterion of emergent theory through application in practice by Eden and Huxham (1996). In addition, the criteria concerning data collection and data exploration by Eden and Huxham can be suggested to be embedded in this quality assessment question. It may also be proposed that the detailed studies of both successes and failures quality concern by Kaplan (1998) is taken into account in this criterion.
   - Has the construct been informally evaluated during its implementation (Kaplan, 1998)?
   - Have opportunities been utilised to get feedback from managers and academics through speaking about the innovation and writing articles (Kaplan, 1998)? It can be proposed that this criterion takes into account also the dynamic research process-criterion brought forward by

Gummesson (1991), and the criterion of incremental theory building by Eden and Huxham (1996). In this context, the quality concern of Kaplan (1998) can be relevant, i.e., there is a possibility that early evaluation assessments by scholars outside the implementation process are misleading.

5. The fifth quality criterion evaluates **the characteristic of the action researcher**. According to Kaplan (1998) the problem of independence and objectivity for the action researcher remains, i.e., there is tension between the knowledge the action researcher has about the phenomenon for evaluation purposes, versus the advocacy position of the action researcher for the developed approach. Independence and objectivity are difficult to evaluate while the action researcher is deeply involved in the project and at the same time he or she should retain a certain distance. Thus, the researcher should possess characteristics such as commitment and integrity, pre-understanding, candour and honesty (Gummesson, 1991).

6. The sixth quality criterion evaluates **the value of the results to the scientific community, contribution to increased knowledge and enduring consequence** (Gummesson, 1991; Reason and Bradbury, 2001). The first five quality criteria are necessary but not sufficient for satisfactory scientific contribution, therefore the following two interlinked criteria should be evaluated:

   - Does this dissertation contain sufficient detail and precision so that others can independently develop and validate the ideas (Kaplan, 1998; Gummesson, 1991; Kasanen et al., 1991 and 1993; Eden and Huxham, 1996; Reason and Bradbury, 2001)?

   - The concept has severe limitations if it continually requires active involvement of the action researchers for each implementation (Kaplan, 1998). This criteria can also be understood to be included in the criteria of the semi-strong and strong market tests by Kasanen et al. (1991, 1993) if the construct is evaluated in contexts of other companies and facilitators than in the original case research. Thus, the quality question is formulated as follows: Is the solution concept deliverable by people other than the original proponent, i.e., the author of this thesis?

Tabular comparisons of the quality criteria found in literature and the criteria adopted for this research are summarised in Tables 2.5.7-1 and 2.5.7-2. The areas of contribution by Kasanen (1991, 1993), Thomas and Tymon (1992), and Eden and Huxham (1996) are shown in Table 2.5.7-1 while Table 2.5.7-2 describes the contribution areas by Gummesson (1991), Kaplan (1998), and Reason and Bradbury (2001).

Table 2.5.7-1. Quality criteria for this research and comparison to literature.

	1	2	3	4	5	6
Quality criteria for this research ==>	**Innovative solution**	**Practical usability, market tests**	**Validity, Generality**	**Action research process**	**Action researcher**	**Value, contribution, consequence**
Kasanen (1991, 1993):	x	x	x	x		x
1 Weak market test		x				
2 Semi strong market test		x				
3 Strong market test		x	x			x
Thomas and Tymon (1992):	x	x	x			
1 Descriptive relevance		x	x			
2 Goal relevance		x				
3 Operational validity		x	x			
4 Nonobviousness	x					
5 Timeliness		x				
Eden and Huxham (1996):		x	x	x		x
1 Implications beyond the project						x
2 An explicit concern with theory, meaningful to others		x	x			
3 Theory connection in generalisation			x			
4 Emergent theory through application in practice				x		
5 Incremental theory building				x		
6 Description will become prescription						x
7 A high degree of methodology and orderliness				x		
8 The process of exploration				x		
9 Validity of action research						
10 Reflection and data collection process				x		
11 Triangulation			x			
12 History and context for the intervention			x			

Table 2.5.7-2. Quality criteria for this research and comparison to literature.

Quality criteria for this research ==>	1 Innovative solution	2 Market tests	3 Validity, Generality	4 Action research process	5 Action researcher	6 Value, contribution, consequence
Gummesson (1991):	x	x	x	x	x	x
1 Allow readers to draw their own conclusions						x
2 The researcher's preunderstanding					x	
3 Credibility				x		
4 Adequate access to the process under study		x				
5 Validity			x			
6 Contribution to the client and scientific community	x					
7 Dynamic research process				x		
8 Commitment and integrity					x	
9 Requirements for the researcher					x	
Kaplan (1998):	x	x	x	x	x	x
1 Independence and objectivity of the researcher					x	
2 Early evaluations				x		
3 The process of applying the new concept		x				
4 Detailed studies of both successes and failures			x	x		
5 Informal evaluations				x		
6 Publications must contain sufficient detail and precision						x
7 The concept should be deliverable by people other than the original proponent						x
Reason and Bradbury (2001):	x	x	x	x		x
1 Relational praxis		x				
2 Reflexive-practical outcome		x				
3 Conceptual-theoretical intregrity	x		x			
4 Methodological appropriateness				x		
5 Engaging in significangt work		x				
6 Emergent inquiry towards enduring consequence						x

The adopted quality criteria for this research are used to manage the research process according to hermeneutic spiral where each stage of the research provides a level of understanding that is turned to pre-understanding in the next research stage. Thus, it can be stated that the adopted quality criteria are applied more implicitly during the research process and explicitly in the final stage of the research as put forward in Chapter 16.

PART I DEVELOPING THE CHANGE MANAGEMENT MEASUREMENT SYSTEM

In this part of the research, the theory connection and practical relevance of the research problem are brought forward, and synthesised and the change management measurement system to solve the research problem is constructed.

PART I-A THEORY CONNECTION

3. Project management

The empirical case studies in this research are change projects. The purpose of this chapter is to define a project, and project management in general, and to put forward issues on successful project management processes and knowledge areas. The principles of project management are applicable to management of change projects as well.

3.1 Definitions of concepts

The ISO 10006:1997 (E) standard defines **a project** as a unique process consisting of a set of co-ordinated and controlled activities with start and finish dates, undertaken to achieve an objective conforming to specific requirements, including the constraints of time, costs and resources.

The Standards Committee of Project Management Institute (Duncan, 1996) defines **a project** as a temporary endeavour undertaken to create a unique product or service.

Project management according to the ISO 10006:1997 (E) standard includes the planning, organising, monitoring and controlling of all aspects of a project in a continuous process to achieve its objectives. The processes and objectives of quality management (ISO 8402) apply to all project management processes.

Project management according to Kerzner (1998) involves both project planning and monitoring. Project planning includes definition of work requirements, quantity and quality of work, and resources needed; project monitoring includes tracking progress, comparing actual outcome to predicted outcome, analysing impact and making adjustments.

3.2 Characteristics of successful project management

Kerzner (1998) defines successful project management as having achieved the project objectives:

- Within allocated time period and the budgeted cost; and at a proper performance level
- While utilising the assigned resources effectively and efficiently
- With acceptance by the customer/user; and when you can use the customer's name as a reference
- With minimum or mutually agreed scope changes
- Without disturbing the main workflow of the organisation.

A successful project does not necessarily mean that the company as a whole is successful in its project management endeavours. Consequently, to be excellent in project management means having a continuous stream of successfully managed projects. Thus, a strong and visible corporate commitment to project management must exist (Kerzner, 1998). Moreover, successful project management is strongly dependent on a good daily working relationship between the project manager and those line managers who directly assign resources to projects; and the ability of functional employees to report vertically to their line manager at the same time that they report horizontally to one or more project managers (Kerzner, 1998).

Basically Kerzner (1998) identifies three key roles which are vital for the project's success: Project manager's role, Line manager' role, and Executive's role. The project manager is responsible for co-ordinating and integrating activities. He needs strong communicative and interpersonal skills and must become familiar with the operations of each line organisation and the technology being used. He also identifies the requirements and constraints of the project. Project managers may have increasing responsibility but little authority. Consequently, they are forced to negotiate with upper-level management and functional management for the control of company resources. The line manager's responsibility is to provide sufficient resources to accomplish the project, and to take part in the definition of the technical criteria and how the task will be done. Senior management's responsibility is to provide sponsorship, that is, behind-the-scenes assistance, advice and encouragement to project personnel.

The key knowledge areas or essential processes in project management according to Kerzner (1998) are 1. Systems thinking; 2. Organising and staffing the project team; 3. Time management; 4. Conflicts management; 5. Pricing, estimating and cost control; 6. Scheduling techniques; 7. Risk management; 8. Learning; 9. Performance measurement; 10. Predicting project success; and 11. Working with executives.

Verganti et al. (1998) emphasises the importance of early and continuous feedback which enables rapid learning in product development project context. A similar idea is brought forward by Thomke and Fujimoto (1998) who define a concept called front-loading as a strategy that seeks to reduce development time and costs by identifying and solving design problems as early as possible. Consequently, also from the viewpoint of this research, it could be advantageous if the problems were identified and solved as early as possible.

According to Wheelwright and Clark (1992) an outstanding development organisation requires a coherent architecture and process that is well understood, highly capable, and in control. They argue that too often development is done without an effective process and almost everything is implicit and subject to change within a project, even though a detailed framework of development would have a powerful impact on performance. Wheelwright and Clark (1992) suggest a six-element framework for project management as shown in Figure 3.2-1.

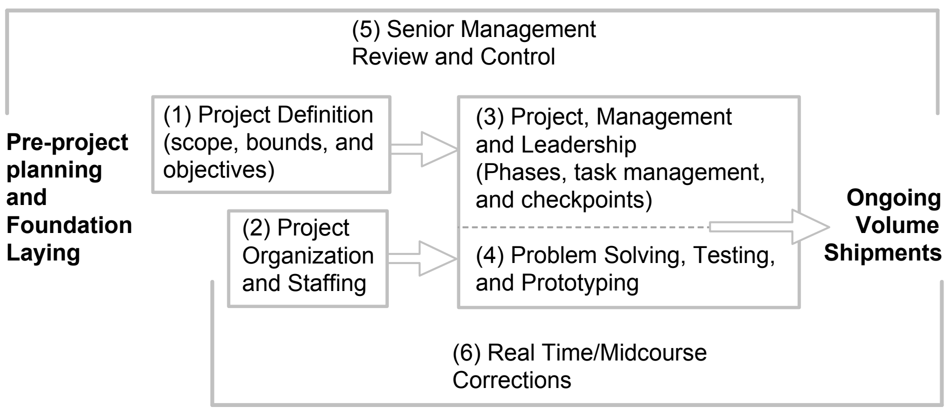


Figure 3.2-1. Basic elements of a project management framework according to Wheelwright and Clark (1992, p. 135).

The six basic elements in the framework are like the components of a product. In order to work well, a product, i.e., a development process needs components that function effectively and fit well together in order to create a coherent system. This system must be well matched to the development challenges it faces. These six elements in the framework of Wheelwright and Clark (1992) are explained as follows:

1. **Project definition includes** activities such as initial concept development, defining and scoping the project, internal and external preliminary input, selling the project to senior management and the entire organisation. Output of this phase is generally the official authorisation of the project.
2. **Project organisation and staffing**, this dimension defines who will work on the project and how they will organise to accomplish the work; which are physical locations, reporting relationships, the nature of individual responsibilities and support groups; which are the special training and hiring needs.
3. **Project management and leadership** includes nature and role of project leaders; establishing expectations for project roles and responsibilities; the way in which project tasks are sequenced, monitored and managed; checkpoints and milestones to signal completion of each phase.
4. **Problem solving, testing and prototyping** is closely interwined with management and leadership issues, however the focus is on the way in which individual work steps are conducted and the means by which the knowledge required to solve problems is developed
5. **Senior management review and control** element deals with senior management's role and interaction with the project team; reviews and evaluations; incentives and motivation
6. **Real time/midcourse corrections** element deals with measurement and evaluation of project status; rescheduling, resequencing, redefining the remaining tasks; and balance between early conflict resolution and subsequent adaptability.

Duncan (1996) describes project management knowledge and practice in terms of the following nine component processes: 1. Project integration management, i.e., project planning, plan execution and overall change controll; 2. Project scope management; 3. Project time management; 4. Project cost management; 5. Project quality management; 6. Human resource management; 7. Project communications management; 8. Project risk management; and 9. Project procurement management.

LaRoche (1998) introduces a "guerilla-like learning approach" for project management by suggesting the following four-step process for projects:

1. Identify impediments. The critical elements that are inhibiting project success.
2. Set priorities. Prioritise the top two or three impediments.
3. Create solution by using "learning intervention". The team can collaboratively work through the following process:
   - Research – gain a degree of expertise on the impediment;
   - Sharing – the group shares its experiences. The objective is to confirm that the group's impediment evaluation is accurate;
   - Tools – working tools are introduced or created to help solve the specific impasse;
   - Actions – the group's course of actions that ensures the success of the project. It describes what is to be done, by whom and when.
4. Check Progress. Evaluate what is working well and how it can be improved. The team must continue to monitor progress, while continued adjustments keep the team on track.

According to the survey of Belassi and Tukel (1996), the most important project success factors were ranked in the following order by 19 manufacturing companies: 1 Availability of resources; 2. Top management support; 3. Preliminary estimates; 4. Project manager's performance; 5. Client consultation. According to Salminen (2000), the three critical factors enhancing a change project's success are active local leadership, a high degree of participation with real decision-making power, and systematic motivation-based project control.

3.3 Conclusions

The point that is particularly essential from the viewpoint of this research is that in order to achieve a successful project, there is a need for a coherent development process that is well understood, highly capable, and in control (Wheelwright and Clark, 1992). This development process must be well matched to the development challenges it faces. Development time and costs can be reduced by identifying and solving problems as early as possible in the project (Verganti et al., 1998; Thomke and Fujimoto, 1998). In addition, the three vital roles according to Kerzner (1998) – Project Manager and team, Line Manager, and Executive – for project success together with the five success factors according to Belassi and Tukel (1996) and the three succces factors by Salminen (2000) should be taken into account in development projects.

The essential project management processes and knowledge areas found in five approaches examined (Wheelwright and Clark, 1992; Duncan, 1996, ISO1006:1997(E); Kerzner, 1998; LaRoche, 1998) are synthesised and classified under the following four categories (see Table 3.3-1):

1. **Strategy and direction setting related processes and knowledge areas**: consists of tasks as pre-project planning, foundation laying, project planning, setting priorities and identifying impediments, plan execution and overall change control.
2. **Human resources related processes and knowledge areas**: this category includes issues concerning project organisation, staffing the project team, communication management and learning.
3. **Time, cost, quality and control related processses and knowledge areas**: comprises controlling, monitoring, predicting and measuring the project performance in terms of time, cost and quality.
4. **Technology related processes and knowledge areas**: includes the technological issues and possibilities that can be applied as an aid in project management and in testing and prototyping the new solutions.

These processes and knowledge areas are taken into account when developing the change management measurement framework and system in Part I-C of this dissertation. It should be noted that these four categories are interlinked and thus have influences on each other.

Table 3.3-1. Essential processes and knowledge areas to be taken into account in project management.

Management process element Author	**Strategy and direction setting processes and knowledge areas**	**Human resources related processes and knowledge areas**	**Time, cost, quality and control related processes and knowledge areas**	**Technology related processes and knowledge areas**
Wheelwright and Clark, 1992	Pre-project planning and foundation laying, project definition	Project organization and staffing, leadership – role of project leaders and senior management	Senior management review and control, checkpoint management, real time/midcourse corrections	Testing and prototyping
Duncan, 1996, pmbok guide	Project integration management, i.e., project planning, plan execution and overall change control	Human resource management, Communications management	Scope, time, cost and quality management	-
ISO1006:1997 (E)	Stategic process, interdependency management processes	Personnel and communication related processes	Scope, time, cost, resource, purchase and risk related processes	-
Kerzner, 1998	Project planning and monitoring, Systems thinking	Organising and staffing the project team, management of conflicts, learning, working with executives	Time management, pricing estimating and cost control, predicting project success, performance measurement, risk management	Project management softwares
LaRoche, 1998	Set priorities, identify impediments	Create solution by using learning intervention	Check progress	-
Belassi and Tukel, 1996	Top management support, factors related to external environment, Client consultation	Factors related to project manager and team members, factors related to organisation	Preliminary estimates, availability of resources	-
Salminen, 2000	Active local leadership	A high degree of participation with real decision power	Systematic motivation-based project control	-
Verganti et al. 1998; Thomke and Fujimoto, 1998	Front loading, early identification of problems	Rapid learning	Early feedback	-

4. Process change management

This research aims at the improvement of project management that concerns manufacturing process development. Thus, it is necessary to review process change management related literature. Section 4.1 defines what is a process, process management, process change management and classifies process based improvement methods. Section 4.2 introduces change management frameworks for process innovation. Section 4.3 concerns organisational learning, knowledge management and teamwork. Section 4.4 approaches simulation gaming as a tool for change management while Section 4.5 puts forward contingencies and variables in change projects. Conclusions are drawn in Section 4.6.

4.1 Definition of concepts

Different authors have provided definitions for a business process. For example, Melan (1993) defines **a process** as a bounded group of interrelated work activities providing an output of greater value than the inputs by means of one or more transformations. Hammer and Champy (1993) define a business process as a collection of activities that takes one or more kinds of inputs and creates an output that is of value to the customer. In this research, the business process under development is **the manufacturing process** and is defined according to Davenport (1993) as a structured, measured set of activities designed to produce a specified output for a particular customer.

Harrington (1991, p. 114) defines five characteristics of business processes as follows:

- Flow. The methods for transforming input into output.
- Effectiveness. How well customer expectations are met.
- Efficiency. How well resources are used to produce an output.
- Cycle time. The time taken for the transformation from input to final output.
- Cost. The expense of the entire process.

The idea of **process management** is to optimise the performance of business processes instead of business functions. According to Melan (1993) process management is a concept that focuses on the flow of work independent of whether this work is a product or service, and independent of the organisation.

The focus in this dissertation is management of change, intended to improve the manufacturing process, but what does change management stand for? An approach attempting to define change management comes from literature concerning process management, i.e., mainly re-engineering, and organisational change. According to this literature (Moss Kanter, 1983; Harrington, 1991; Hammer and Champy, 1993; Davenport, 1993; Hannus, 1994; Smeds, 1994; Kotter, 1995, 1996; Vollmann, 1996; Katzenbach, 1996; Carnall, 1999), improvements or changes in business processes can be achieved through innovation that does not only concern the mere technology or the process chain itself, but necessitates individual and organisational change. Change is people intensive and requires people to learn new behaviours and skills. In this context, innovation refers to the process of bringing any new, problem solving idea into use - application and implementation are central to this definition (Moss Kanter, 1983, p. 20–21). Hannus (1994) argues that change management consists of tasks needed for organising and co-ordinating the change project including identification of negative resistance and changing it to positive development systematically during the whole change project. Consequently, in this research **process change management** is defined as

management which characteristically aims at performance improvements in the manufacturing process through innovations.

Davenport (1993) categorises various process-based operational improvement methods in terms of the relationship between the level of change and the context or frequency of the application as seen in Figure 4.1-1.

Vollmann (1996) categorises development approaches as brought forward in Figure 4.1-2. Transformation happens when the scope of change is broad and the time frame for achieving the change is long. Turnaround is speedy change on a broad scope, which may require downsizing. When change is relatively narrow in scope as in this research, fast reengineering or slow continuous improvement may be appropriate.

Context / Outcome	Project / One-Time	Continuous Improvement / Ongoing
Incremental Improvement	Activity value analysis Overhead value analysis Process value analysis	Total quality management Business process improvement Activity-based
Radical Innovation	Process innovation (reengineering, business process redesign)	Not meaningful

Figure 4.1-1. Approaches to business process improvement (Davenport, 1993).

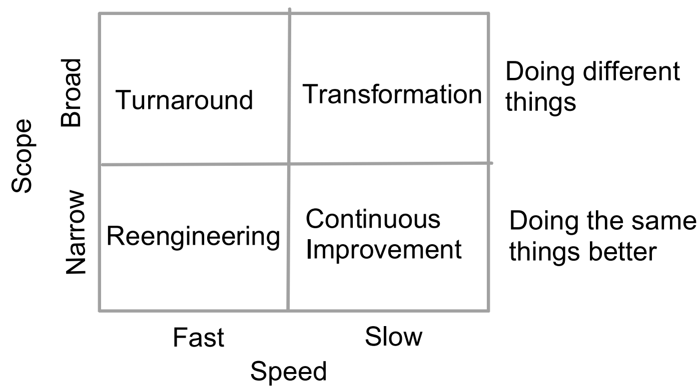


Figure 4.1-2. Dimensions of change programs (Vollmann, 1996).

In the case projects (D, E, F, G, H) of this research, the improvement approach is that of process innovation (reengineering). The intention in the case projects is to achieve radical business improvements. Hammer and Champy (1993) define reengineering as "the fundamental rethinking and radical redesign of business processes to achieve dramatic improvements in critical, contemporary measures of performance, such as cost, quality, service, and speed". In the following section, six frameworks for process innovation are examined.

4.2 Process change management frameworks

A number of authors have presented generic frameworks for business process innovation, e.g. Harrington (1991), Davenport (1993), Smeds (1994), Hannus (1994), Kotter (1995), Rummler and Brache (1995) and Vollmann (1996), (see synthesis in Table 4.2-1). For this research, the framework of Smeds (1994) is of special interest because it is presented in the context of a simulation game development tool. According to Smeds (1994), a generic framework, as shown in left side of Figure 4.2-1, can be used to manage innovative change in business processes. The right side of Figure 4.2-1 depicts possible tasks and methods for different phases.

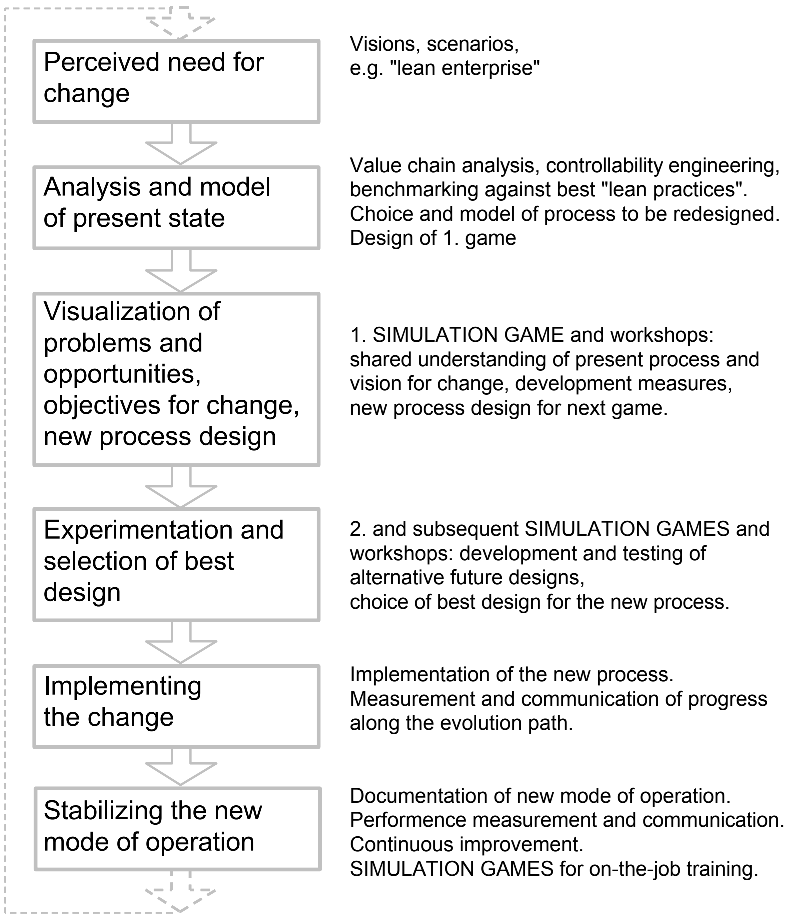


Figure 4.2-1. A Framework for business process development using simulation games (Smeds, 1994, p. 74).

Harrington (1991) provides the five phases of business process improvement as follows: 1. Organising for Improvement; 2. Understanding the Process; 3. Streamlining, possibilities for automation should be considered at this phase; 4. Measurement and Control, and 5. Continuous Improvement. According to this approach, the executive improvement team sets the initial development goals and gives the task to the process improvement team (PIT) which defines milestones according to the five phases and makes a detailed plan for 90 days. The detailed 90-day plan is then revised every 30 days and 30 more days are added. Furthermore, PIT members work on the project for about 160 hours each during the first two months, after which their commitment drops 10% per month during the following year.

The framework of Davenport (1993, p. 25) has also five phases: 1. Identifying processes for innovation; 2. Identifying change levers; 3. Developing process visions; 4. Understanding existing processes; 5. Designing and prototyping the new process. In this approach four criteria that guide change process selection are identified: 1. Strategy; 2. Process Health; 3. Process Qualification, i.e., the process has a committed sponsor, and 4. Manageable Project Scope. Davenport sees that human resources and technology are important levers of change. Once the process to be improved is selected, the approach is to set goals and visions, model and understand the process, analyse the model, generate an improved model of the process; prototype and implement the improvements in reality; and finally do post implementation assessment.

Kotter (1995) suggests the following eight phases for change projects, each of which also functions as a milestone: 1. Establishing a sense of urgency; 2. Forming a powerful guiding coalition; 3. Creating a vision; 4. Communicating the vision; 5. Empowering the others to act on the vision; 6. Planning for and creating short-term wins; 7. Consolidating improvements and producing still more change, and 8. Institutionalising new approaches.

Rummler and Brache (1995) present the following five phases for process improvement: 1. Performance improvement planning; 2. Project definition, 3. Process analysis and design, whose outcome is a high level plan for implementation; 4. Implementation, and 5. Process management.

Hannus (1994) presents a model for core process redesign called PROPER (Core **Pro**cess Redesign for High **Per**formance). Figure 4.2-2 describes more precisely the structure of a development project according to the PROPER model.

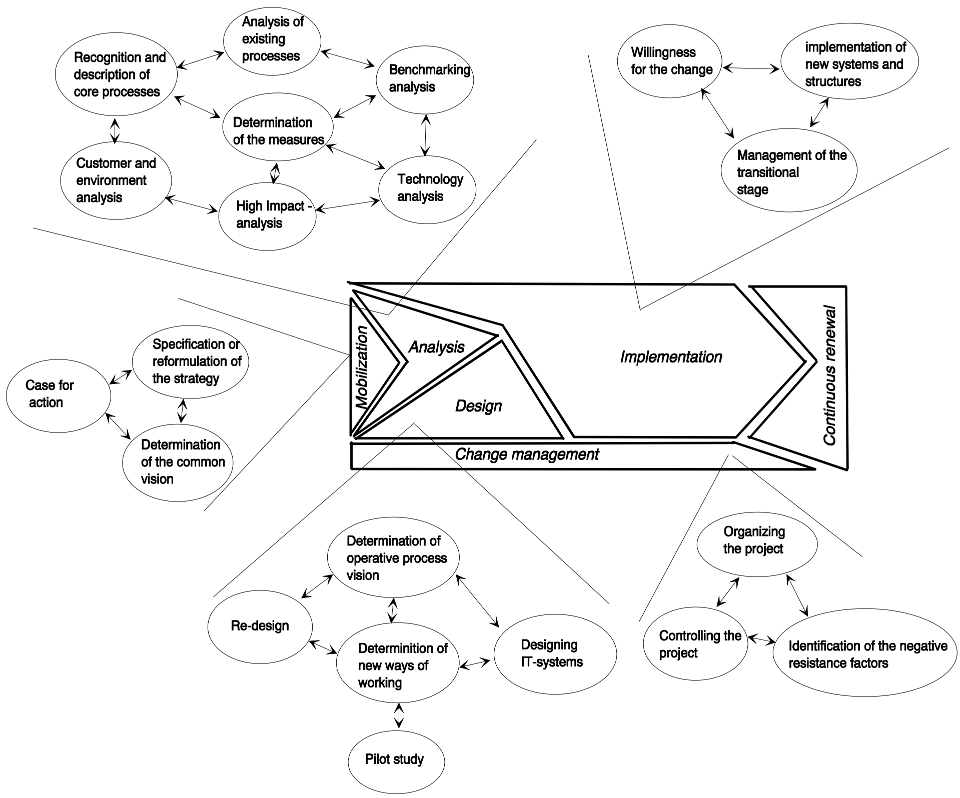


Figure 4.2-2. The structure of a development project according to the PROPER model (Hannus, 1994).

The first phase is **mobilisation**. The task is to plan and start the development project. The essential things are to find reasons for the change (case for action) and to determine the common vision. Also the formulation of company strategy is to be made or reformulated in this phase. Objectives of the **analysis** phase are to specify performance goals and measures, identify and model core processes, to prioritise, evaluate and innovate new ways of working, and to perform benchmarking.

The design phase has the following objectives:

- to determine the operative process vision
- redesign the processes
- design the information technology systems
- conduct a pilot study concerning new ways of working.

The implementation phase determines whether the project will succeed or not. Turning negative resistance into positive development is also one of the important tasks in this phase. The implementation phase consist of the following tasks:

- to achieve willingness for the change: know-how, values, culture, and motivation
- to implement new structures and systems: *structure* – organisation, steering systems, measures; *processes* – information and material flows; *technology* – information and communication systems
- to manage the transitional stage: giving up old ways of working and starting to utilise new ones.

Change management consists of those tasks that are needed for organising and co-ordinating, the project. Identifying negative resistance and changing it to positive development is to be handled systematically during the whole project. Furthermore, teams that will realise the change have to be formed. Normally, the following teams are needed:

1. **Control team** (steering group) determines the goals according to the company strategy. This team takes care that there are enough resources and that the goals are achieved. The leader of this team (sponsor) is normally a senior executive or the chief executive.
2. **Core team.** This is the change team of the whole project. The leader of the core team is normally a process owner and also a member of the steering group. Members of this team collect the results of the analysis, determine the process vision and manage the implementation phase.

3. **Project teams** concentrate on implementation tasks normally linked to sub-processes. The leaders of the project teams belong to the core team and are the owners of sub-processes.

Continuous renewal accompanies the project.

All process change management frameworks presented above support the following issues, which are central for this research:

- Coherent development approach (coincides with Wheelwright and Clark (1992), Chapter 3),
- Human resource intensive requiring much communication, motivation and both individual and organisational learning,
- Five generic development phases (with the execption of the framework of Kotter (1995) which does not explicitly comprise understanding and analysis phase):

1. Strategic issues and direction setting phase;
2. Understanding and analysis phase;
3. Design phase;
4. Implementation phase;
5. Stabilising the new approach and continuous improvement phase.

Consequently, it can be argued that a sound change management process should comprise at least the five above-mentioned generic development phases (see also Table 4.2-1). The core ideas of these five phases are concluded as follows: The **strategic issues and direction setting phase** guarantees that the project and its objectives are aligned with the corporate strategy. In this first phase, the processes to be developed are identified, improvement visions created and the change project is planned and organised. (Hannus, 1994; Harrington, 1991; Davenport, 1993; Smeds, 1994; Kotter, 1995, Rummler and Brache, 1995, Vollmann, 1996). In the **understanding and analysis phase**, the current processes are modelled and understood by the project personnel (Hannus, 1994; Harrington, 1991; Davenport, 1993; Smeds, 1994; Rummler and Brache, 1995).

Table 4.2-1. The central phases of different business process development approaches.

Process phases → *Author ↓*	**Strategic issues and direction setting**	**Understanding and analysis**	**Design**	**Implementation**	**Stabilising the new approach, continuous improvement**
Harrington (1991)	Organizing for improvement	Understanding the process	Streamlining	Streamlining, Measurement and Control	Continuous improvement, Measurement and Control
Davenport (1993)	Identifying processes for innovation, identifying change levers, developing process visions	Understanding existing processes	Designing and prototyping the new process	Implementing the process and associated systems	Post implementation assessment, measurement
Hannus (1994)	Mobilization, change management	Analysis	Design	Implementation	Continuous renewal
Smeds (1994)	Percieved need for change	Analysis and model of the present state, visulisation of problems and opportunities, objectives for change	Experimentation and selecting the new process design	Implementing the change, measurement and communi-cation of progress	Stabilising the new mode of operation, performance measurement
Kotter (1995)	Establishing a sense of ugrency, forming a powerful guiding coalition, creating and communicating vision, empowering others to act on the vision	In the model Kotter (1995) understanding and analysis are not explictly expressed	Planning and creating short term wins	Consolidating improvements and producing still more change	Institutionalizing new approaches
Rummler and Brache (1995)	Performance improvement planning, project definition	Process analysis and design	Process analysis and design	Implementation	Process management

Latest at this phase, the processess to be innovated are prioritised and performance goals and measures specified. The weakness of the model of Kotter (1995) is that it does not explicitly contain the understanding and analysis phase (see Table 4.2-1). In the **design phase**, the improved process model is generated and tested through simulation game (Smeds, 1994) or prototyped in practice (Harrington, 1991; Davenport, 1993; Hannus, 1994; Kotter, 1995), and a high level plan for implementation is developed (Rummler and Brache, 1995). In the **implementation phase**, the new process improvement ideas are fully implemented in practice and the results are measured. **Stabilising the new approach and continuous improvement phase** follows. (Harrington, 1991; Davenport, 1993; Hannus, 1994; Smeds, 1994; Kotter, 1995, Rummler and Brache, 1995).

4.3 Change from viewpoint of organisational learning, knowledge management and teamwork

4.3.1 Organisational learning

Prusak (1996) has stated that the only thing that gives an organisation a competitive edge is what it knows, how it uses what it knows, and how fast it can know something new. According to Senge (1990) the ability to learn faster than competitors may be the only sustainable competitive advantage. He states that **a learning organisation** is a place where people are continually discovering how they create and change their reality – a learning organisation is continually expanding its capacity to create its future. Carnall (1999) argues that if only individuals learn, then when people leave an organisation the learning they have acquired goes with them. In organisational learning, learning is reflected in changing procedures, patterns of behaviour and evolving cultures. Without learning companies as well as individuals only repeat old practices and nothing is improved (Garvin, 1993). Consequently, learning is an essential component of change.

Garvin (1993) defines that **a learning organisation** is skilled at creating, acquiring and transferring knowledge, and at modifying its behaviour to reflect new knowledge and insight. Furthermore, an organisation can not be classified as a learning organisation if only the potential for improvement exists without accompanying changes in the way that work gets done. According to Garvin (1993) it is essential to define a learning organisation in a way that it is actionable and easy to apply. Secondly, clear management guidelines for practice with operational advice is needed. Third question is measurement: how to assess the organisation's rate and level of learning. There are five main activities in which a learning organisation is skilled (Garvin, 1993): systematic problem solving, experimentation with new approaches, learning from own experience and past history, learning from the experience and best practices of others, and transferring knowledge quickly and efficiently throughout the organisation.

Senge (1990) suggests five components to be essential in building learning organisations. These five learning disciplines which form an ensemble are as follows:

1. Systems thinking, i.e., a discipline for seeing wholes, fundamental characteristic of complex human systems is that cause and effect are not necessarily close in time and space; this component integrates the other disciplines.
2. Personal mastery, i.e., commitment and capacity to lifelong learning,
3. Mental models, i.e., deeply ingrained assumptions and generalisations that influence our behaviour; these internal pictures should be unearthed and made open to the influence of others.
4. Building shared vision, i.e., a shared picture of future to be created.
5. Team learning, the purpose is that the intelligence of team exceeds the intelligence of individuals in the team. In addition, individuals in a team are learning more rapidly than could occur otherwise (see also Katzenbach and Smith, 1993).

Mohrman and Cummings (1989) define action learning in organisational development context as a process where "organisational members try out new behaviors, processes, and structures; assess them and make necessary modifications". Action learning happens in cycles and includes four major activities as follows:

1. Taking action to implement and/or modify a design, i.e., trying out new behaviours, structures and processes.
2. Collecting pertinent information on progress:
   - design features, e.g., participants' perceptions of how well the design is being implemented;
   - design outcomes, e.g., specific performance measures such as costs, productivity and human measures as absenteeism, commitment and work satisfaction;
   - situational forces that can affect the success of new design including technological, environmental and personal dimensions.
3. Diagnosing progress, i.e., analysing the data collected in a previous stage to discover whether the implementation is progressing as intended and whether modifications are necessary.
4. Planning to modify the design and/or implementation process, i.e., to make specific plans to adjust the design and the change program to achieve the desired results.

According to Mohrman and Cummings (1989) the higest form of learning is deutero learning, i.e., learning how to learn. Strategy and the task environment of the company form the basis for the development and organisational learning.

Argyris and Schön (1978) speak about single-loop learning, double-loop learning and deutero-learning, i.e., learning how to carry out single-loop and double-loop learning. In single-loop learning new knowledge is applied to improve the quality and efficiency of existing operations while double-loop learning leads to new practices and innovation in organisation. Deutero learning is organisational when it is embedded in maps and and images which guide organisational decision, control and instruction. Argyris and Schön (1978) define a scheme for theory of action in organisational learning context: in situation S, if you want to achieve consequence C, under assumptions a...n, do A.

4.3.2 Knowledge management

According to Nonaka and Takeuchi (1995), the organisational knowledge creation process is strategically important for a company and the capacity of double-loop learning is built into a knowledge-creating organisation. They argue that organisational learning develops in a dynamic knowledge conversion process between the individual and the organisation, and between tacit and explicit knowledge as shown in Figure 4.3.1-1.

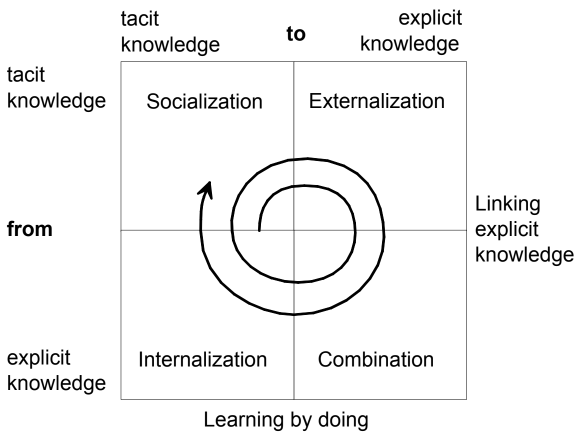


Figure 4.3.1-1. Four modes of knowledge conversion and the knowledge spiral (Nonaka and Takeuchi 1995, pp. 71–72).

According to Davenport et al. (1998), knowledge is information combined with experience, context, interpretation, and reflection. It is a high-value form of information that is ready to be applied to decisions and actions. In addition, they have identified four types of objectives for knowledge management projects as follows (Davenport et al., 1998): /1/. Create knowledge repositories for both explicit and tacit knowledge; /2/. Improve knowledge access; /3/. Enhance the knowledge environment, i.e., improve knowledge creation, transfer and use; /4/. Manage knowledge as an asset.

Successful knowledge management projects are characterised by the following factors (Davenport et al., 1998):

- Link to economic performance
- Technical and organisational infrastructure

- Standard, flexible knowledge structure in order to extract knowledge
- Knowledge-friendly culture which highly values learning
- Clear purpose and language
- Change in motivational practices, e.g., increasing motivation to create, share and use knowledge
- Multiple channels in knowledge transfer
- Senior management support.

Allee (1997) defines knowledge as experience or information that can be communicated and shared. When a company continuously adapts and changes, **core knowledge competencies** and **core performance capabilities** are combined and recombined into new configurations. Allee (1997) explains core performance capabilities as processes and functions that are generic to the success of many enterprises. On the other hand, core knowledge competencies are those domains of expertise – knowledge and technical knowledge – that are unique to a particular type of business and form the content or subject matter of the enterprise. The ability to reconfigure competencies and capabilities quickly and efficiently is critical for flexible and rapid response to changes in markets, resources and business environment. – A lot of learning takes place in order to build a knowledge competency. Allee (1997) argues that the value chain is really a knowledge chain, where expertise and know-how is input into a product or service at every link of the value chain.

4.3.3 Team work

Several writers have addressed the team as an useful, or even critical, organisational component that may improve productivity of an organisation (Senge, 1990; Katzenbach and Smith, 1993 and 1999; Katzenbach, 1996; Aaltonen et al., 1996; Biech, 2001). It is also argued that the intelligence of team can exceed the intelligence of individuals in the team and that individuals in a team are learning more rapidly than could occur otherwise (Senge, 1990). Consequently, it can be proposed that organisational learning and knowledge management are intimately linked with team performance. The characteristics of a team are put forward in the following.

Katzenbach and Smith (1999) define a team as a small number of people with complementary skills who are committed to a common purpose, performance goals, and a working approach for which they hold themselves mutually accountable. According to Biech (2001) a team is a group of people who are mutually dependent on one another to achieve a common goal. The characteristics, or building blocks, of a high performance team are as follows (Biech, 2001):

- **Clear goals**; **defined roles**; open and clear **communication,** and **effective decision making**. These characteristics are the foundation and they should be strong and be in place early.
- **Balanced participation,** this ensures that everyone on the team is fully involved; **valued diversity**, i.e., participants are valued for the unique contributions that they bring to the team; **managed conflicts**: teams can benefit of the conflict they experience, i.e, conflict forces team to communicate differences, seek common goals, and gain consensus. In addition, conflict may allow team members to express their emotions, preventing feelings about unresolved issues from becoming obstacles to the team's progress.
- **Positive atmosphere**, i.e, a team must have a climate of trust and openness**;** **co-operative relationships**, i.e., team members should know that they need one other's skills, knowledge, and expertise to produce something together that they could not do as well alone.
- **Participative leadership**, this is the only building block that can be removed without disturbing the rest. This means that leaders share the responsibility and the glory, are supportive and fair, create a climate of trust and openness and are good coaches and teachers. In most productive teams, it is difficult to identify a leader during a casual observation. In general, leadership may shift at various times.

Consequently, it can be stated that the application of a team, which has the previously mentioned team characteristics (Senge, 1990; Katzenbach, 1996; Biech, 2001) greatly improves success possibilities of a project. In context of this research, it is particularly noteworthy that team performance development can be seen as an integral part of simulation-game-based change management (Aaltonen et al., 1996; Smeds, 1994, 1997; Riis et al., 1998; Taskinen and

Smeds, 1999b; and Smeds et al., 2000a). In Section 4.4, tailored simulation games are expanded on as a balanced change management method.

4.3.4 Conclusions

The approaches for learning, knowledge management and teamwork brought forward in this section of the thesis are concluded under the following process elements (see Table 4.3.1-1):

1. Strategy, vision, goals and objectives

2. Systematic learning, knowledge management and team process

3. Learning climate and knowledge environment.

Strategy, vision, goals and objectives of a company form the basis for organisational learning and organisational knowledge creation, both of which are strategically important for the success of a company (Nonaka and Takeuchi, 1995). Senior management support for knowledge management endeavours is an important success factor (Davenport et al., 1998) together with clear management guidelines for practising learning organisation (Garvin, 1993). The strategy, task environment and shared vision of a company work as a basis and motivate organisational learning (Mohrman and Cummings, 1989; Senge, 1990) which is needed when developing knowledge competencies (Allee, 1997). A common goal is an important requirement for effective teamwork (Katzenbach, 1996; Aaltonen et al., 1996; Biech, 2001).

Systematic learning, knowledge management and team process is needed in order to make an organisation and its members learn and perform effectively and efficiently (Argyris and Schön, 1978; Mohrman and Cummings, 1989; Senge, 1990; Garvin, 1993; Nonaka and Takeuchi, 1995; Katzenbach, 1996; Aaltonen et al., 1996; Biech 2001). The challenge is to get the organisation into a state of double loop learning that leads to new practices and innovation (Argyris and Schön, 1978; Mohrman and Cummings, 1989; Senge, 1990). The ability to reconfigure core knowledge competencies and core performance capabilities quickly and efficiently is critical for rapid responses to changes in business

Table 4.3.1-1. The central process elements in organisational learning, knowledge management and teamwork.

Process element ==>r	**Strategy, vision and objectives**	**Systematic learning, knowledge management and team processes**	**Learning climate and knowledge environment**
Author			
Argyris and Schön (1978)	In situation S, if you want to achieve consequence C, under assumptions a...n, do A	Single loop learning and double loop learning, deutero learning	Maps and images for guiding organisational decision, control and instruction
Mohrman and Cummings (1989)	Strategy and task environment form the basis for the development	1. Take action to implement or modify 2. Collect information on progress 3. Diagnose the progress 4. Planning to modify the design and/or implementation process; Deutero learning, i.e., learning how to learn	Open communication, motivation
Senge (1990)	Building shared vision	Systems thinking, adaptive and generative learning	Team learning, Mental models that influence on behaviour, Personal mastery: Commitment and capacity to lifelong learning
Garvin (1993)	Define learning organisation, management guidelines for practice	Assessment of organisation's rate and level of learning, Systematic problem solving, Experimentation with new approaches, Learning from own experience and past history, Learning from the experience and best practices of others	Transfering knowledge quickly and efficiently throughout the organisation
Nonaka and Takeuchi (1995)	Organisational knowledge creation is strategically important for a company	Knowledge spiral: Socialisation, Externalisation, Combination, Internalisation	The capacity of double loop learning is built into the knowledge creating organisation
Davenport et al. (1998)	Clear purpose and language, Senior management support	Manage knowledge as an asset, link to economic performance; enhance knowledge environment: improve knowledge creation, transfer and use; create knowledge repositories for explicit and tacit knowledge	Knowledge friendly culture, motivation to create, share and use knowledge, Technical and organisational infrastructure, multiple channels in knowledge transfer, standard, flexible knowledge structure in order to extract knowledge from
Allee (1997)	Core knowledge competencies, Core performance capabilities	Ability to reconfigure core knowledge competencies and core performance capabilities quickly and efficiently	Climate of trust and openness
Biech (2001)	Clear goals	Balanced participation, effective decision making, managed conflicts, participative leadership	Defined roles, open and clear communication, positive atmosphere, co-operative relationships, valued diversity

environment (Allee, 1997). Consequently, knowledge should be managed as an asset (Davenport, 1998). According to teamwork literature (Katzenbach and Smith, 1993; Katzenbach, 1996; Aaltonen et al., 1996; Biech, 2001) a well functioning team can perform far better than individuals alone, thus it can be proposed that systematic team processes can be advantageous. The idea of systematic learning, knowledge management and team process is analogous to ideas brought forward in Chapter 3 and Section 4.3 where it was respectively argued that systematic project processes and change management processes are needed in order to get good results in change endeavours.

Learning climate and knowledge environment are elements that should facilitate learning, knowledge creation and teamwork. Open and clear communication, positive atmosphere, and motivation to create, share and use knowledge are needed together with supporting technical and organisational infrastructure (Mohrman and Cummings, 1989; Allee, 1997; Davenport et al., 1998; Biech, 2001). Maps, images and mental models in an organisation should promote double loop learning and co-operative relationships (Argyris and Schön, 1978; Senge, 1990; Nonaka and Takeuchi, 1995; Biech, 2001).

4.4 Tailored simulation gaming as a change management method

The purpose of this section is to clarify principles of simulation games and principles according to which tailored simulation games facilitate process development projects, organisational learning and knowledge creation and team performance. Application of simulation games in manufacturing system development and innovation have been reported in Finland since 1988, e.g., Haho (1988); Ahlbäck and Haho in Jahnukainen and Vepsäläinen. (1992); Savukoski et al. (1995); Piltonen et al. (1995); Smeds (1994, 1996a, 1996b and 1997); Taskinen (1996). According to Smeds (1996a), games have been used in Finland not only for production system development but also for the administrative application areas, e.g., Ruohomäki and Vartiainen (1992, 1994); Pankakoski et al. (1994); Piispanen, (1995) and Piispanen et al. (1998).

4.4.1 Definition of concepts

A number of authors have provided definitions of simulation. For example, according to Greenblat (1988, p. 14) **a simulation** is an operating model of central features or elements of a real or proposed system, process, or environment. Banks (1998, p. 3) says that **a simulation** is an imitation of the operation of a real-world process or system over time. Saunders (1998, p. 9) defines **simulation** as a working representation of reality; it may be an abstracted, simplified or accelerated model of the process.

In **games**, playing proceeds based on the choices and decisions of persons playing the game. The following features can be found in games (Greenblat, 1988; Ruohomäki and Vartiainen, 1992, Saunders, 1995): players have roles, players have objectives to strive for, there are rules and constraints for actions, players have actions to perform, actions have consequences (positive and negative) for players and for the systems, the game is a contest bound by skill or luck.

The relations of simulation object (system to be simulated); model of the system, i.e., process charts plus alpha-numeric data; and imitation of the system are represented in Figure 4.4.1-1. The static model is constructed from the data gathered from the simulation object. Furthermore, an operative model or an imitation is constructed based on the essential parts of the model and the simulation object. Smeds et al. (2000b) group process models into four categories as follows:

1. Conceptual: process charts and maps
2. Computational: discrete event numerical simulation models
3. Visual: visualisation of conceptual and computational models
4. Social: facilitated, systematic discussion of the process with the business process people; process roles, tacit and explicit knowledge of each participant are important modelling parameters.

In **simulation games,** the rules and constraints are based on modelled reality. Roles, goals, actions, consequences and connections are simulating the real or proposed system or process. A simulation game can be either general or tailored:

a general simulation game can be utilised in any organisation while a tailored one is planned uniquely for each case (Riis et al. 1995, Piispanen et al., 1998). In this research tailored simulation games are utilised in the case projects.

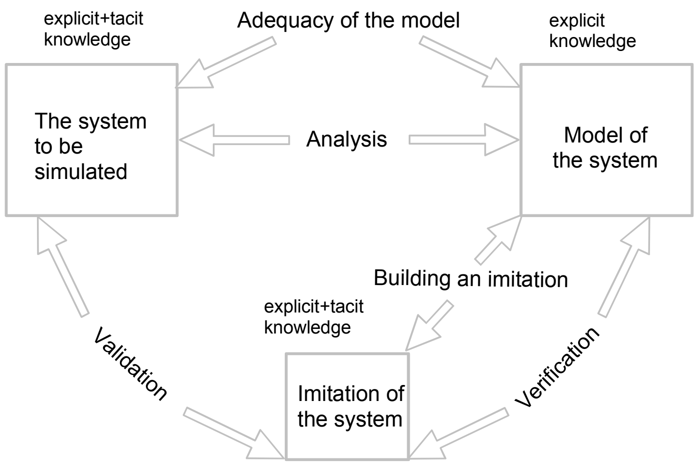


Figure 4.4.1-1. Development phases of a simulation game (modified from Vartiainen et al., 1990).

Riis et al. (1995) provide a classification of the games according to the two dimensional map shown in Figure 4.4.1-2. The first dimension in the map is pedagogic purpose and the second dimension is number of pre-defined jobs. Pedagogic purpose can vary between awareness, understanding and practical know-how while the number of pre-defined jobs can vary between single decision maker, decision center and multifunctional interplay. The simulation game applied in this research, and brought forward in Chapter 5, falls into multi-functional interplay category as shown in Figure 4.4.1-2.

Additional criteria for classifying the games are as follows (Riis et al. 1995): computer based or manual, target group, the degree of competition between parallel teams, the extent to which rules and underlying models may be changed, the extent to which the rules are known to the players, and the advancement of time.

Smeds (1998) classifies enterprise simulation models according to the nature of the system to be simulated, and tools used in the simulation as brought forward in Figure 4.4.1-3. For example, material flows in production systems can be considered as technical subsystems of an enterprise and simulated with computer supported mathematical models. On the other hand, simulation models of enterprises as social (or socio-technical) systems should incorporate the interaction of human beings through brainstorming and games (manually) or applying computer supported virtual reality. The simulation game method brought forward in Chapter 5 and applied in this research falls into the grey shaded area of the typology as shown in Figure 4.4.1-3.

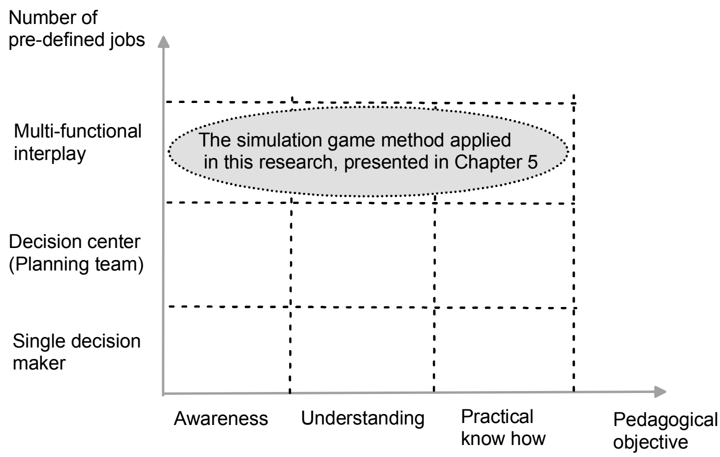


Figure 4.4.1-2. Two-dimensional map according to which games can be classified (Riis et al. 1995, p. 8).

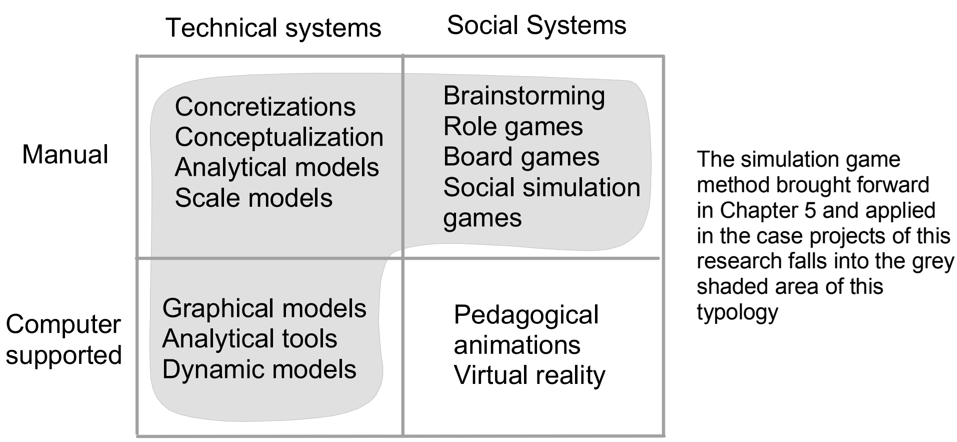


Figure 4.4.1-3. Different simulation models (Smeds, 1998).

The difference between a social simulation game and a computer simulation method is basically that in a simulation game, there is always an active group of people (decision center) playing different roles to run the game. For computer simulations this is not necessary, as the simulation software specialist (single decision-maker) designs the model after the data collection phase and runs the model with different parameters. The outputs of different runs are then discussed and compared in computer simulation seminars (decision center) (Taskinen and Smeds, 1999).

4.4.2 Applying tailored simulation games in change management

A development project based on tailored simulation gaming is a balanced and holistic approach since all the three central aspects of reality: human resources, processes and technology, are taken into account. Tailored simulation games can be applied in all the three phases of development: understanding present system, prototyping new system and training to operate new system. One way is to use tailored simulation games in evolutionary change projects where the specific goals evolve from one simulation to the next (Smeds 1994, Smeds et al. 2000a). Primary goals and phases when developing business processes are following (Ruohomäki and Vartiainen, 1992; Ruohomäki, 1994, Riis et al., 1998):

1. In the beginning of the development project: to create understanding about the need of change, to understand the system and to critically analyse the business process and ways of working;
2. Testing of development visions: prototyping new system, i.e., to try and test new ways of working, to foresee coming changes in organisation, resources and working methods;
3. Training to operate new system and education of personnel.

In particular, tailored simulation gaming facilitates empowerment and learning during the change project. Through participation, a common understanding, motivation and commitment in change is created, more viable ideas are developed and finally the organisation is able to implement the planned changes in reality, c.f. Smeds (1994, 1997) and Riis et al. (1998). From an organisational learning point of view, gaming supports both single and double loop learning depending on development targets. Gaming can also facilitate an active job experience, i.e., combination of high decision latitude and high psychological demand as defined by Karasek and Theorell (1990). In addition, simulation games support all four modes of knowledge conversion and the knowledge spiral by Nonaka and Takeuchi (1995, pp. 71–72), where tacit knowledge is involved (see Figure 4.3.1-1), c.f. Smeds (1997):

- Socialisation: the individual, tacit knowledge is shared through the joint game experience;
- Externalisation: tacit knowledge is made explicit through conceptualisation and dialogue in the game and in the debriefings;
- Combination: different bodies of explicit knowledge are combined into a new design partly already during the game and especially in debriefings or design teams after the game;
- Internalisation: alternative designs are experimented within games; learning by doing and adopting the new way of working; converting explicit knowledge back to tacit individual knowledge. Internalisation happens already during the game and continues thereafter in the everyday work.

The following three success factors suggested by Riis et al. (1995) should be taken into account when applying simulation games:

1. Define the pedagogical and learning context for the game
2. Define the subject area and the objectives of the game
3. Identify the constraints on applying a game.

Consequently, it can be said that development projects based on tailored simulation games are likely to be successful in terms of understanding the system, prototyping the new system and training to operate the new system. However, it should be noted that, in real life, plans do not always materialise because of contingencies or unestimated changes in the business or project environment.

4.5 Contingencies and variables in change projects

In a broad sense, everything in a change project can be variable or under contingency. Basically contingencies and variables can be classified into external and internal. The external ones are variables in the company's and project's environment, e.g., norms, standards and institutional arrangements in society, existing technologies, prevailing organisational "paradigms" and rules of competition (Smeds, 1994). The internal ones are variables within the organisation, project organisation and psychosocial work environment. From the perspective of this research the internal variables are in focus.

According to Smeds (1994), four organisational variables for innovation and learning can be categorised as follows:

1. Task:	*Contents, inherent rewards, degree of autonomy*
2. Formal organisation:	*Division and co-ordination of tasks, management and reward systems, parallel structures for innovation*
3. Informal organisation:	*Informal arrangements, management practices, and interpersonal relationships*
4. Individual:	*Knowledge and skills, needs, values, creativity, power/responsibilities, champion characteristics.*

Smeds (1994) argues that these organisational variables should be taken into account when managing organisational change toward a lean enterprise. Furthermore, Smeds (1994) states that the tailored simulation game is a tool that takes these variables into account when pursuing lean process ideas. In addition, the company's current project portfolio (Smeds, 2001), if there is one, can be understood as variable, i.e., a factor that can have influence on the change project performance. An aggregate project plan would help, for example, in prioritizing the projects and identifying the resource needs. In this context, it is worth mentioning that Hamel (2000) speaks about innovation portfolio that includes a portfolio of ideas, a portfolio of experiments and a portfolio of ventures.

Mohrman and Cummings (1989, p. 52) contrast **traditional organisations** and **innovative organisations** according to six major organisational design elements as shown in Table 4.5-1: 1. Task/Technology; 2. People; 3. Human Resource Systems; 4. Structure; and 5. Organisational values and norms. Both kinds of organisations can be high performing, depending on the strategy and task environment.

T*able 4.5-1. Traditional organisations versus innovative organisations (Mohrman and Cummings, 1989).*

Design components	**Traditional organisations**	**Innovative organisations**
Task/Technology	Routine; highly certain	Complex, uncertain
People	Moderate to low learning needs; narrow skills	High learning needs; multi-skilled
Information/Decision systems	Centralised; closed	Dispersed; open
Human resource systems	Standardised selection; routine training; job-based pay; narrow, repetitive jobs	Realistic job previews, continuous training; skill and performance-based pay; enriched jobs and self regulating teams
Structure	Tall, rigid hierarchies; functional departments	Flat, flexible hierarchies; self-contained businesses
Organisational values and norms	Promote compliance and routine behaviours	Promote involvement, innovation, and co-operation

Karasek and Thorell (1990) present a psychosocial work experience model, where the variables are psychological demand and decision latitude. Decision latitude combines the breadth of skills the workers can use on the job and their authority over decision making. In the model (see Figure 4.5-1) four different kinds of psychosocial work experiences are described: high-strain jobs, active jobs, low-strain jobs and passive jobs. The most adverse reactions of strain, e.g. fatigue, anxiety, depression and physical illness, occur when the psychological demands are high and worker's decision latitude in the task is low; the lower right corner of Figure 4.5-1. On the contrary, highest levels of performance but without negative psychological strain can be achieved when workers feel a large measure of control and freedom to use all available skills; the upper right corner of Figure 4.5-1. The low-strain job category, in the upper left corner of Figure 4.5-1, describes the situation where psychological strain and risk of illness are low because there are relatively few challenges to begin with, and the decision latitude allows the individual to respond to each challenge optimally. In passive jobs, in the lower left corner of Figure 4.5-1, both decision latitude and psychological demand are low, which may lead to gradual loss of skills, lack of job challenges, restrictions preventing workers from improving their work, and loss of work motivation. Thus, optimally, the personnel should experience high decision latitude and high psychological demand in their daily work. Also change projects could be optimal for the personnel, if high decision latitude and high psychological demand are experienced.

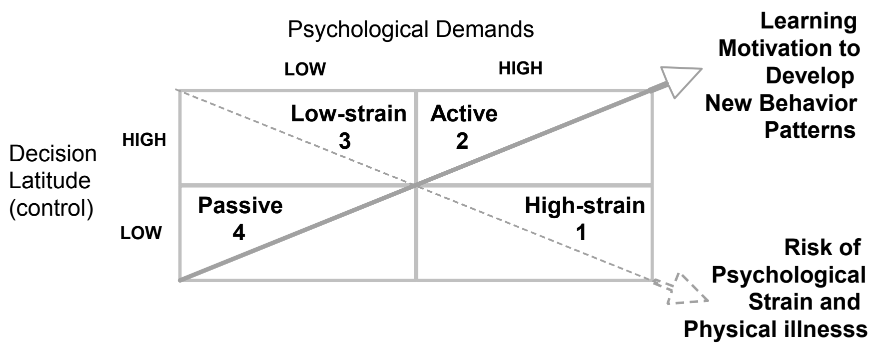


Figure 4.5-1. Psychological demand/decision latitude model (Karasek and Thorell, 1990, p. 32).

Antonovsky (1985) defines a variable called sense of coherence as follows: "The sense of coherence is a global orientation that expresses the extent to which one has a pervasive, enduring though dynamic feeling of confidence that one's internal and external environments are predictable and that there is a high probability that things will work out as well as can reasonably be expected". According to Antonovsky (1985) the person with a strong sense of coherence is quite able to see reality, to judge the likelihood of desired outcomes in view of the countervailing forces operative in all of life, while a person with a weaker sense of coherence will tend to anticipate that things are likely to go wrong.

4.6 Conclusions

Strategy, vision and objectives of a company form the basis for development projects, which aim at process innovation comprising organisational learning organisational knowledge creation, and teamwork issues. Consequently, it needs to be verified that the development project of the manufacturing process is aligned with the corporate strategy, and fits into the project portfolio of the company. Thereafter, improvement visions can be created and the change project can be planned and organised.

Systematic development, organisational learning and teamwork processes are needed as a change management tool in order to achieve successful project performance and make an organisation and its members learn effectively and efficiently (Argyris and Schön, 1978; Mohrman and Cummings, 1989; Senge, 1990; Garvin, 1993; Nonaka and Takeuchi, 1995; Katzenbach, 1996; Biech, 2001). The challenge is to get the organisation into a state of double loop learning that leads to new practices and innovation (Argyris and Schön, 1978; Mohrman and Cummings, 1989; Senge, 1990). A sound development process should comprise at least the following five development phases: 1. Strategic issues and direction setting; 2. Understanding and analysis; 3. Design; 4. Implementation; and 5. Stabilising the new approach and continuous improvement. Moreover, contingencies and organisational variables in change projects should be taken into account in development process. Tailored simulation games when applied are tools that facilitates systematic process development, organisational learning, teamwork, take into account contingencies and organisational variables in an organisation, and support all four modes of knowledge conversion and the knowledge spiral by Nonaka and Takeuchi (1995). In additon to human resources, technology is an important leverage of change (Harrington, 1991; Davenport, 1993; Hannus, 1994). Moreover, the company should have a project portfolio (Hamel, 2000; Smeds, 2001) in order to help in prioritizing the projects of the company and identifying the resource needs.

Learning climate and knowledge environment of a company are elements, which can facilitate learning, knowledge creation and teamwork. Open and clear communication and motivation to create, share and use knowledge are needed together with supporting technical and organisational infrastructure (Mohrman and Cummings, 1989; Allee, 1997, Davenport et al., 1998, Katzenbach, 1996; Biech, 2001). Maps, images and mental models in an organisation should promote teamwork and particularly double loop learning (Argyris and Schön, 1978; Senge, 1990, Nonaka and Takeuchi, 1995; Katzenbach, 1996; Biech, 2001).

5. The simulation-game-based change process

The simulation-game-based change process applied in the case projects D, F, G and H is described in Figure 5-1. The simulation application is principally based on the research by Piltonen et al. 1995; Torvinen, 1995; Savukoski et al., 1995 and Taskinen, 1996. In case project E, only computer simulation was applied instead of simulation game.

The simulation-game-based change process is well suited to the improvement of production management and the enhancement of process knowledge (Piltonen et al. 1995; Torvinen, 1995; Savukoski, 1995, Taskinen, 1996; Taskinen and Smeds, 1999b). The change management measurement system developed in this thesis is integrated into this simulation based change management method.

The applied change process and the role of the researcher as facilitator in this change process are as follows:

Step 1 can be understood as a kick-off for the whole change project. In Step 1, the process to be developed is selected, and both development objectives and the scope of the game are defined. The facilitator or designer of the game, i.e., the researcher, together with the representatives of the company, e.g. Manufacturing Manager and Project Managers, form a project management team and plan the whole change project. At this point the necessary resources are reserved, milestones are set and tasks to be performed are agreed upon collaboratively by the facilitator and the company representatives.

In **Step 2**, the Project Manager of the company organises manufacturing process data collection in the company according to the instructions of the game facilitator. The information about

- the real customer orders,
- products, product structures,
- capacity of machines and workers,
- cycle times,

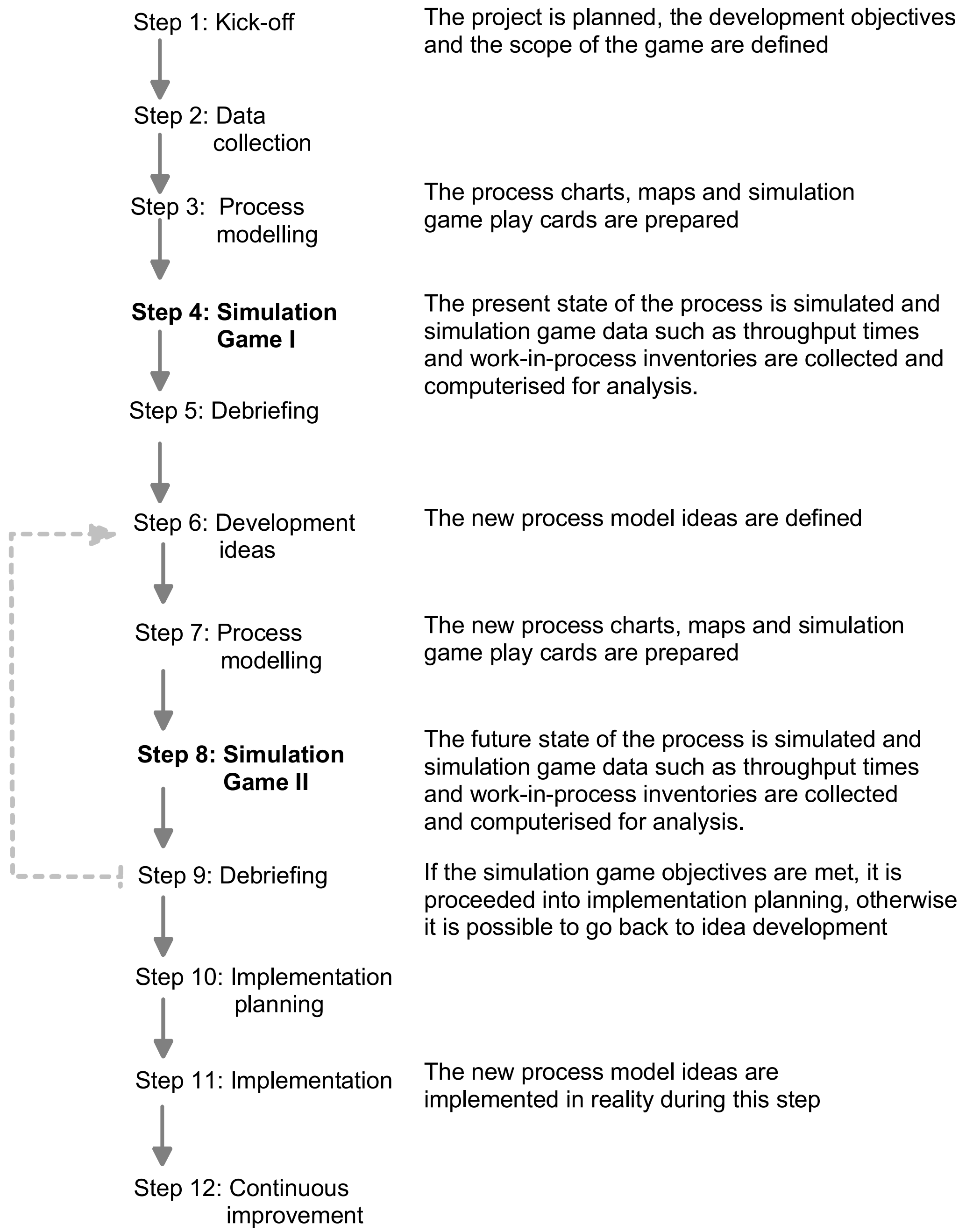


Figure 5-1. The applied change process.

- failure percentages,
- costs,
- production flows,
- bottlenecks and problems,
- layouts, ways of working and production control principles

are collected from a definite period of operation. The principal source of data is the company's enterprise resource planning system (ERP-system) and the people working in the process. At this step the change project personnel is nominated and informed. In addition, the personnel of the whole factory or business unit is informed that a manufacturing process development project has been started.

In **Step 3**, the game facilitator prepares process charts and maps as well as simulation game play cards, based on the data collected in Step 2. The information that is considered essential in the simulation game is printed on the cards, representing material and information transfer in the process. The desks in the simulation game room are arranged according to the real process flow and layout. In addition, conceptual process models, i.e., process flowcharts and layouts are shown on the wall of the simulation game room.

In **Step 4**, the game facilitator gives the simulation game intructions and the simulation game can start. The simulated process is loaded by sending cards representing customer orders from the starting point of the process. Consequently, after some time the material and information flows should reflect the real manufacturing process. The play cards represent the real, historical actions, resource needs and cycle times for actual products, orders and customers. The players of the game selected in Step 2 are simulating the resources in the process, and the simulation game clock synchronises the usage of these resources. The simulation game clock is programmed so that it is possible to simulate several days, weeks or even months during one day. Simulation game data such as throughput times and work-in-process inventories are collected into a computer for analysis purposes during the simulation, and a simulation game diary is written for a debriefing meeting that takes place in Step 5. Process roles, and the tacit and explicit knowledge of each participant are important parameters and taken into account through discussion during the simulation game.

In **Step 5**, the simulation game is validated in a debriefing meeting. The results achieved in the simulation game are compared to real life data. The change project personnel have the possibility to discuss the simulation game results, compare them to the real life outcomes they know by experience, and give new problem solving ideas. If it can be concluded that the simulation game reflected the real process situation well enough, the project proceeds to the idea generation phase in Step 6.

In **Step 6**, the game facilitator facilitates a new idea generation or brainstorming meeting. At this point simulation game results and real problems are discussed once more by the change project personnel. New improvement and problem solving ideas are generated and collected.

In **Step 7**, the game facilitator prepares the conceptual process flow chart, map and simulation game model according to the new improvement ideas developed in Step 6. The information that is considered essential in the new simulation game is printed on game cards representing material and information transfer in the new process. The desks in the simulation game room are arranged according to the improved layout.

In **Step 8**, the game facilitator gives the new simulation game intructions to the change project personnel and the simulation game can start. Thereafter, the development ideas are tested by playing the simulation game. All the necessary simulation data is collected for analysis purposes and a simulation game diary is written.

In **Step 9**, the simulation game results are analysed, discussed and validated in a debriefing meeting conducted by the game facilitator and the project management team. The results achieved in the simulation game are compared to the results in the first game and development objectives set in the beginning of the project. The change project personnel have the opportunity to discuss the simulation game results, and to compare them to respective values in real life. If it can be concluded that the simulation game objectives are satisfactorily met, implementation planning takes place in Step 10, and simulation game intervention is over. If the simulation game objectives are not satisfactorily met, it is possible to go back to idea development in Step 6.

In **Step 10**, the game facilitator and other project management team members prepare plans for implementation of improvement ideas tested in Step 8 and validated in Step 9.

In **Step 11**, the new tested and validated improvement ideas are implemented in reality by the project personnel and other personnel working in the process.

In **Step 12**, it is checked at appropriate intervals, how well development objectives are met in reality. Continuous improvement follows.

6. Measurement of change management

" If you cannot measure it, you can not control it. If you cannot control it, you can not manage it. If you cannot manage it, you can not improve it. It is as simple as that." (Harrington, 1991)

Several writers have stressed the importance of measuring the change process (e.g., Rummler and Brache, 1995; Harrington, 1991; Brown, 1996; Kaplan and Norton, 1996; Laakso, 1997; Kezbom et al., 1989; Carnall, 1999; Olve et al., 1999). Measurement is important for improvement because measurement focuses attention on essential factors, shows how resources are used, assists in goal setting and in monitoring both trends and progress, provides input for analysing root causes and sources of errors, identifies opportunities for improvement and provides means of knowing whether you are winning or losing (Harrington, 1991). In this context, it is noteworthy to mention that already as early as 1924–1927, it was found at the Hawthorne Works of the Western Electric Company (Illinois, USA) that mere increased attention to workers from management promoted improvements in productivity (Scheur, 2000, p. 58; see also Mayo, 1933). Consequently, the measurement of change management could promote improvements in project performance even through mere increased attention.

6.1 Guidelines for building performance measures

According to Kezbom et al. (1989), the process of controlling project work can be depicted as represented in Figure 6.1-1. When controlling project work there must be a feedback system that enables the project team and/or an individual to react to the measurement data and correct problems (Kezbom et al., 1989; Harrington, 1991; Laakso, 1997). Kezbom et al. (1989) suggest the following guidelines for performance measurement:

- Do not collect data that you are not going to analyse, determine the minimum information requirements, trivia should never be measured.
- Controls must be appropriate to the size and and complexity of the activities being measured, the control system must provide reports on a timely basis so

that corrective action can be taken before deviations from plans become serious.

- Measurement systems should be congruent with the events being measured, controls should be useful, usable and simply to employ.
- Measure and compare results to predetermined standarts.
- Operationalize control system, measurement data should be available to those members of the project team who need it and are capable of taking corrective action.

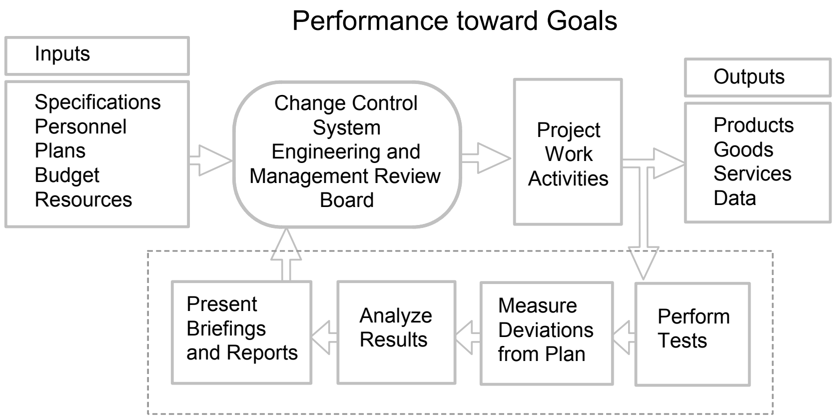


Figure 6.1-1. The process of controlling project work (Kezbom et al., 1989, p. 142).

Harrington (1991) argues that there is a need to develop three major process measurements. These measurements are effectiveness, efficiency and adaptability:

- Effectiveness. How well customer expectations are met;
- Efficiency. How well resources are used to produce an output;
- Adaptability. The flexibility of the process to handle future, changing customer expectations and today's requests.

On the other hand, according to Carnall (1999) efficiency comprises achieving existing objectives with acceptable use of resources while effectiveness means efficiency plus adaptability. Thus, the effective organisation is both efficient and able to modify its goals as circumstances change. According to Carnall (1999) it is important to avoid narrow measures of effectiveness, because it can be misleading. What is needed is a broad assessment approach combining both quantitative and qualitative measures.

Frankfort-Nachmias and Nachmias (1996) define that measurement is a procedure in which numerals (numbers or other symbols) are assigned to empirical properties (variables) according to rules.

Neely et al. (1995) argue that performance measurement is the process of quantifying action, where measurement is the process of quantification and action leads to performance. The following three definitions are given by them:

- "**Performance measurement** can be defined as the process of quantifying the efficiency and effectiveness of action".
- "**A performance measure** can be defined as a metric used to quantify the efficiency and/or effectiveness of an action".
- "**A performance measurement system** can be defined as the set of metrics used to quantify both the efficiency and effectiveness of actions".

Neely et al. (1995) define effectiveness to be a measure of the extent to which customer requirements are met, while efficiency is a measure how economically the firm's resources are utilised. Furthermore they argue that performance measure systems can be examined at three different levels: the individual performance measures, the set of performance measures, i.e., performance measurement system, and the relationship between the performance measurement system and the environment in which it operates.

According to Brown (1996) measures should be linked to the factors needed for success and be based on the needs of customers, shareholders, and other stakeholders. The building of measures in an organisation should start at the top and flow down to all levels of employees. When the environment and the strategy changes, measures should be changed and adjusted accordingly. Brown (1996) argues that measurement of the vital few key variables is better than measurement of the trivial many and that multiple indices can be combined into a single index to give a better overall assessment of performance. Measures should be a mix of past, present, and future to ensure that the organisation is concerned with all three perspectives. Moreover, the target values for the measures should be based on research rather that arbitrary numbers. Olve et al. (1999) argue that measurement must be an easy, uncomplicated process and measures should be unambiguous and sufficiently cover the aspects included in strategies and critical success factors. Measures used in different perspectives should be clearly connected and useful for setting realistic goals.

Laakso (1997) has concluded that the main principles for any performance evaluation system are effectiveness, efficiency and adaptability (c.f. Harrington, 1991). Laakso (1997) has also brought forward a general framework for establishing performance measures. The framework incorporates the following components:

1) **Company wide objectives:** measures should be derived and aligned with company wide objectives.
2) **Situational characteristics:** local reality should not be ignored; current problems, process maturity and work force attitudes have a strong impact on the development of measures.
3) **Battery of measures:** a structured catalogue of reasonable measures to support the selection of feasible measures for a particular problem and process situation.
4) **Implementation of measures** for a business process through analysis, development and installation phases. In the analysis phase, the objectives for measures are defined and the stakeholders needed to develop measures activated. The development phase includes the analysis of cause and effect relationships, selection of measures and further refinement of selected measures. The battery of measures is utilised at this point and each involved work group must have a capability to influence on measure selection and development. The installation phase comprises design of reporting formats and both documentation of measurement principles and procedures. Documentation and visualisation assure that all the involved stakeholders will understand measures correctly.

Moreover, Laakso (1997, p. 94) suggests the following eleven points to be taken into account during the design and implementation of new measures:

1. The role of measures in self-management, empowerment and learning should be understood.
2. Employees should be allowed to include measures of their own that have an understandable meaning for their daily work.
3. A measure should be clearly defined, precise, objective and have explicit purpose.
4. There must be emphasis on the visualisation of the measurement trends.
5. There is a danger that measures tend to reflect the organisation chart and as a result isolate different functions instead of uniting them into business processes.
6. Measures must be explicitly linked to the strategies and goals of the business.
7. Performance measures should relate to specific, stretching, but achievable goals.
8. One should distinguish between measurements that are imposed by other stakeholders (e.g., tax authorities) and those that should help controlling and improving operations.
9. Measures must serve a clear purpose to be used actively to manage operations, otherwise measurement is a non value adding activity.
10. Measures that do not lead to action, or that foster dysfunctional behaviour, represent waste and must be removed.
11. Measures and measurement systems must be continuously maintained, and the dynamics of a measurement system must be managed in order to provide timely and accurate information.

6.2 Frameworks for performance measurement

6.2.1 Performance measures for project managers and personnel by Kerzner (1998)

Kerzner (1998, p. 428–430) suggests that organisations in general should measure their project managers and project personnel through a framework comprising the primary measures, secondary measures and additional considerations as brought forward in Table 6.2.1-1. Project managers are assessed primarily on how long it took to organise the team, whether the project is moving along according to agreed schedules and budgets, and how they meet goals and objectives set by their superiors. Project personnel are assessed

Table 6.2.1-1. Performance measures for project managers and personnel (Kerzner, 1998).

Primary measures:		**Measures for project managers**	**Measures for project personnel**
	1	Success in leading the project toward pre-established global objectives, e.g., milestones, target costs and quality	Success in directing the agreed-on task toward completion, e.g., technical implementation, milestones
	2	Project manager's success and effectiveness in overall project direction and leadership, e.g., objectives, reporting	Effectiveness as a team member or team leader, e.g., building effective task team, participation and involvement
Secondary measures:	**1**	Ability to utilise organisational resources	Success in performing functional tasks in addition to project work
	2	Ability to build effective project team	Administrative support services
	3	Project planning and plan implementation	New business development
	4	Customer/client satisfaction	Professional development
	5	Participation in business management	
Additional considerations:	**1**	Difficulty of tasks involved	Difficulty of task involved
	2	Scope of the project	Managerial responsibilities
	3	Changing work environment	Multi-project involvement

primarily on their ability to direct the implementation of a specific project subsystem, for example, technical implementation as measured against requirements, quality, schedules and cost targets; and team performance as measured by ability to build an effective task group and integrate among various functions. It can be proposed that these generic project measurement ideas could be applicable and adaptable also in the change projects.

6.2.2 The three levels of performance by Rummler and Brache (1995)

The measurement framework of Rummler and Brache (1995) is comprised of organisation, process and job/performer levels together with three performance needs of goals, design and management. The framework results in nine performance variables, which can be measured. The framework is put forward in Figure 6.2.2-1. In the framework, measures in different levels should be soundly aligned with each other, i.e., job/performer level measures should support process level measures and furthermore process level measures should support organisational measures. The management measures should guarantee effectiveness of design and goal variables. Design measures should guarantee the efficiency of design so that organisation, process and job/performer level goals can be efficiently met.

Figure 6.2.2-1. The nine performance variables (Rummler and Brache, 1995).

	The three performance needs			
		Goals	**Design**	**Management**
The three levels of performance	**Organisational level**	*Organisation goals*	*Organisation design*	*Organisation management*
	Process level	*Process goals*	*Process design*	*Process management*
	Job/Performer level	*Job goals*	*Job design*	*Job management*

6.2.3 Balanced scorecard by Kaplan and Norton (1996)

The balanced scorecard (Kaplan and Norton, 1996), abbreviated BSC, is a measurement framework for measuring business strategy and translating it into operational terms. It emphasises financial and non-financial measurements derived from the mission and strategy of the business unit. In this framework, the objectives, measures, targets and initiatives are specified from the points of view of the customer, financial, internal business process, learning and growth. BSC should translate the business unit's mission and strategy into tangible objectives and measures.

The balanced scorecard complements financial measures of past performance with measures of the drivers of future performance. It has greatest impact when it is deployed to drive organisational change. The planning process enables the organisation to quantify the long run outcomes, identify mechanisms and provide resources for achieving those outcomes, and establish short-term milestones for the financial and non-financial measures on the scorecard. The strategic learning framework embedded in BSC is seen to be the most innovative and most important aspect of the entire scorecard management process. The emphasis on cause and effect introduces dynamic systems thinking. It helps individuals in various parts of the organisation to understand how their role influences others and the entire organisation. Every measure selected for a Balanced Scorecard should be an element in a chain of cause-and-effect relationships that communicates the meaning of the business unit's strategy to the organisation. Ultimately, the causal paths from all the measures should be linked to long-run financial objectives. An ideal strategic business unit (SBU) for a Balanced Scorecard conducts activities across an entire value chain and has a well-defined strategy. Once a Balanced Scorecard has been developed for an SBU, it becomes the basis for Balanced Scorecards for departments and functional business units within the SBU.

6.2.4 Four levers of control by Simons (1995)

Simons (1995) introduces four levers of control that can be used for strategy renewal and for harnessing the creativity of employees. The four levers of control are as follows:

1. Diagnostic control systems ensure that goals are being achieved efficiently and effectively, measuring against plan to guarantee the predictable achievement of goals
2. Beliefs systems communicate core values, empower and encourages individuals to search for new opportunities
3. Boundary systems establish the rules and identify actions that employees must avoid
4. Interactive control systems are the formal information systems that involve managers personally in face-to-face meetings in the decisions of subordinates, focusing on constantly changing information that is considered potentially strategic.

It can be proposed that from these four levers of control only the diagnostic and interactive control systems represent clearly two different types of control. Beliefs systems and boundary systems represent issues to be measured and controlled through diagnostic and interactive control systems.

6.3 Measurement questionnaires and data analysis

The purpose of this section is to introduce some principles concerning measurement questionnaire construction and data analysis. This is a relevant issue, as the measurement questionnaire is the main measurement instrument in this research. However, it needs to be acknowledged that the objective in this research is not to design highly sophisticated measurement questionnaires and questions, but rather the first prototypes for testing the new measurement ideas developed in this research.

The foundation of a questionnaire is the question, and most questions can be classified as either factual or relating to subjective experience (Frankfort-Nachmias and Nachmias, 1996). Factual questions are designed to elicit objective information from the respondents, while subjective experience involves the respondents' beliefs, attitudes, feelings and opinions. Furthermore, the following three types of question structures can be identified: closed-ended questions, open-ended questions and contingency questions.

For measurement of subjective experiences such as attitudes, a common format for questions is the rating scale (Henerson et al., 1982; Frankfort-Nachmias and Nachmias, 1996). For example, the rating scale is used when asking respondents to make a judgement in terms of sets of ordered categories, such as “strongly agree, agree, neither agree nor disagree, disagree, strongly disagree”.

The four principal levels of measurement that can be applied with the measurement questions are nominal, ordinal, interval and ratio (Valkonen, 1981; Frankfort-Nachmias and Nachmias, 1996). The mathematical and statistical operations that can be performed on a given set of numbers are dependent on the level of measurement attained. Statistics at nominal level include for example the mode, and measures of qualitative variation. The ordinal level allows operations that do not alter the order of properties. For example, the central tendency of ordinal numbers can be described through the median and basically the mean is not allowed. For the interval level and ratio level, all descriptive and inferential statistics are applicable. However, Valkonen (1981) argues that the ordinal level of measurements can be processed mathematically and statistically as interval level measurements without causing major errors.

In this research, sophisticated statistical operations are not essential from the viewpoint of attitude measurement, as the measurement objects are basically only the project management team and the project participants. The answers of all respondents can easily be collected from questionnaires onto a sheet for examination. Thus, the answers of every single participant can easily be checked, discussed and analysed by the facilitator and project management team. However, calculation of the core tendency of the responses could be useful for summarising the measurements for communication purposes.

According to Frankfort-Nachmias and Nachmias (1996) and Henerson et al. (1982), indexes can be constructed by combing two or more variables, which are employed as indicators, i.e. questions in the questionnaire. Basically, an index is a more credible measure of an attitude than only a single question. An index can be built for example as follows: a set of five questions for measurement of an attitude is constructed, and thereafter answered by a group of respondents. The response scores are assigned to each of the questions according to the scale: Strongly agree = 5; Agree = 4; Neither = 3; Disagree = 2; and Strongly disagree = 1. A respondent who answers 5 to all five statements will get a total score of

25, indicating that the attitude of the person is strongly as stated in the questions, and if the person gets a total score of five his/her attitude is strongly opposite.

A group average (mean) of ordinal level measurements can be calculated to determine the core tendency of a group of respondents. By averaging group scores on a set of attitude questions (Henerson et al., 1982) the data can be summarised and reduced to facilitate plotting, display and interpretation. According to Henerson et al. (1982), there is one easily recognised situation in which the group average score may be misleading and should not be used; this is when the responses pile up at two ends of the continuum, i.e. people's opinions are polarised. An average would fail to reflect this polarisation, and would mislead the audience.

6.4 Conclusions

The two measurement principles of **effectiveness and efficiency** are argued to be the elements of a sound measurement system (Harrington, 1991; Neely, 1995; Rummler and Brache, 1995; Simons, 1995; Laakso, 1997; Carnall, 1999). Effectiveness is defined as a measure of the extent to which the strategically right things have been done, or how well customer expectations are met. Effectiveness includes adaptability and flexibility to change the strategy according to changing circumstances, so that the wanted effectiveness level can be maintained (Carnall, 1999). Efficiency is defined as a measure on how economically resoures are utilised, or how to do "things right" with best possible input/output ratio.

Diagnostic and interactive controls should be applied to ensure that the goals are being achieved effectively and efficiently (Simons, 1995). In this research, in the change project management context, diagnostic control is defined as a measurement diagnosis done by the project management team or individuals responsible for measurement. Interactive control involves both the project management team and project personnel for face-to-face meetings in decision making based on measurement data.

The guidelines for building measures for projects (Kezbom, 1989; Harrington, 1991; Brown, 1996; Laakso, 1997; Olve et al., 1999; Carnall, 1999) are brought forward in Tables 6.3-1 and 6.3-2 according to the three interrelated categories as follows: content and subject matter of measures, performance measurement system and performance measurement. **A performance measure** was defined as a metric used to quantify the efficiency and effectiveness of action (Neely et al., 1995). Moreover, measures can be classified by their nature into quantitative, qualitative, financial and non-financial measures (Harrington, 1991; Neely et al., 1995; Kaplan and Norton, 1996; Carnal, 1999). **A performance measurement system** was defined as the set of metrics used to quantify the efficiency and effectiveness of action and **performance measurement** was defined as the process of quantifying the efficiency and effectiveness of action (Neely et al., 1995). Consequently, performance measurement applies performance measurement system consisting of individual measures in order to quantify both the efficiency and effectiveness of action. Principles and suggestions concerning performance measurement are as follows:

- Measure clearly what is essential for success. Measurement should be an easy process and measures congruent with the events being measured. Do not collect data that you are not going to analyse, otherwise measurement is non-value adding activity (Kezbom et al. 1989; Brown, 1996; Laakso, 1997; Olve et al., 1999).
- Measures should be based on company wide objectives, and adjusted as environment and strategy changes (Brown, 1996; Laakso, 1997).
- Measurement data should be available on a timely basis to those who need it so that corrective action can be taken before deviations from plans become serious (Kezbom et al., 1989; Harrington, 1991).
- The values and empowerment of project personnel, the rules to be followed, the actions to be avoided, learning, systems thinking and customer satisfaction should be taken into account when designing measures (Rummler and Brache, 1995; Kaplan and Norton, 1996; Simons, 1995; Kerzner, 1998).
- Measure past, present, future and compare the results to predetermined standards (Brown, 1996).
- Each involved work group must have a capability to influence measure selection and development (Laakso, 1997). A battery of measures, i.e., a structured catalogue of reasonable measures should be available to support the selection of feasible measures for a particular problem and process situation. Documentation and visualisation assures that all the involved stakeholders will understand measures and measurements correctly (Laakso, 1997).

Table 6.3-1. The guidelines for measures, measurement system and measurement process.

	Content and subject matter of measures	**Features of performance measurement system**	**Features of performance measurement process**
Kezbom et al. (1989)	Do not collect data that you are not going to analyse, i.e., determine the minimun information requirements, trivia should never be measured	Controls must be appropriate to the size and complexity of the activities being measured, the control system must provide reports on a timely basis so that corrective action can be taken before deviations from plans become serious, measurement systems should be congruent with the events being measured, controls should be useful, usable and simply to employ	Measure and compare results to predetermined standards, operationalize control system, measurement data should be available to those members of the project team who need it and are capable of taking corrective action
Harrington (1991)	Effectiveness, efficiency and adaptability	Measures enable process improvement team to understand what the goals are	Feedback system enables an individual to react to the measurement data and correct problems
Simons (1995)	Effectiveness, efficiency, core values, empowerment, actions to be avoided	Diagnostic control, beliefs system, boundary system, interactive control system	Focus on constantly changing information that is considered potentially strategic
Rummler and Brache (1995)	Effectiveness and efficiency	Three levels of performance: job, process, organisation; and three performance needs: goal, design, management	Monitoring, controlling and improving performance at all three levels
Brown (1996)	Measure the vital few key variables, measure past, present and future, multiple indices can be combined into a single index to give better overall assessment of performance	Link measures to success factors, measures should be based around the needs of key stakeholders, measures should start at the top and flow down to all levels in the organisation, measures need to have targets that are based on research rather than arbitrary numbers	Measures should be adjusted as environment and strategy changes

Table 6.3-2. The guidelines for measures, measurement system and measurement process

	Content and subject matter of measures	Features of performance measurement system	Features of performance measurement process
Kaplan and Norton (1996)	Financial and non-financial measures	Four inter-linked viewpoints: customer, financial, internal business process, learning and growth; integrates measures derived from strategy	Translates business strategy into operational terms, measurement promotes systems thinking
Laakso (1997)	Effectiveness, efficiency and adaptability, measures must serve a clear purpose to be used actively to manage operations, measures should be clearly defined	Measures should be derived and aligned with company-wide objectives, situational characteristics should not be ignored, battery of measures, i.e., a structured catalogue to support the selection of feasible measures	Implementation of measures For a business process through analysis, development, and installation phases, visualisation of measurement trends, the role of measures in self management
Olve et al. (1999)	Measures should sufficently cover the aspects included in strategies and critical success factors	Measures should be unambiguous, measures used in different perspectives should be clearly connected, measures should be useful for setting realistic goals	Measurement must be an easy, uncomplicated process.
Carnall (1999)	Effectiveness measures, i.e., efficiency plus adaptability; efficiency measures	Broad approach to assessment, i.e., combination of quantitative and qualitative measures	Monitoring effectiveness

The measurement questionnaires are to be used as measurement instruments in this research. However, the objective here is not to design highly sophisticated questionnaires and questions but only prototypes for testing the potential measurement ideas. The foundation of a questionnaire is a question that can be either factual or relating to subjective experience. A common format for measurement of subjective experiences such as attitudes is the rating scale. Question structures can be divided into three types: closed-ended, open-ended and contingency. An index can be constructed by combining two or more questions measuring the same subject matter or attitude, and the core tendency of a group of respondents can be summarised by averaging group scores on a set of questions.

PART I-B PRACTICAL RELEVANCE

7. Consultant survey

Managing Directors from three global consulting companies were interviewed by the author of this dissertation. The purpose was to find out and define the state of the art in measuring change management projects. In the following sections, the results from the interviews are described.

7.1 Consulting Company A

For Consulting Company A, measurement of change management is an evaluation process where all the subjects under change should be tracked. Objectives are discussed and agreed upon within a team. What kinds of know-how or experts are needed? What are the success factors in the change project? In particular, the willingness to change and perseverance in development are evaluated at the beginning of the project. When the objectives are clear and the present situation is known, it can be seen whether the development project is advancing in the right direction. In addition, milestones are followed: if the milestone is not met as planned, modification is needed. Usually a new course is taken and the project team pursues the next milestone. Basically, change projects are measured against objectives and milestones. Sometimes actions to be taken can be used as measurements: whether actions are taken or not is thus checked.

Operational measures such as quality, throughput times, punctual deliveries or same day deliveries, service level, creativity, stakes in personnel training, use of information technology, investments in information technology, are used. These measures normally monitor the manufacturing situation on a monthly or quarterly basis. In the case of change projects, however, the reactions should be faster, which requires that the operational measures should be checked on a weekly basis in order to get timely feedback. The final results or impacts of change actions are not necessarily seen immediately but later on, after one year or several years.

A future development area in measuring change project management is the area of creativity. For example, the following issues can be measured: the use of creativity, the ability to create and the climate for innovation.

7.2 Consulting Company B

According to the business measurement framework of Consulting Company B, business strategy is measured by business results (see Table 7.2-1): a popular tool for this is the balanced scorecard. Furthermore, the competitive factors stemming from business strategy are measured from three points of view: human resources (behaviour), processes, and technology (information systems).

The first level change management measures are business advantages and benefits achieved in the large company-wide change projects. The second level is the process level, where process results such as throughput time and quality are measured by comparing the results to the previously set objectives. The third level is to measure change in behaviour. Changes in behaviour are measured by asking how people see, perceive and verify changes in themselves, in their work environment, in their colleagues, managers and subordinates. The following three phases can be identified when behaviour is measured:

1. Understanding phase: a person understands the new ways of working and what is happening.
2. Evaluation phase: a person tries the new ways of working and evaluates their applicability.
3. Acceptance phase: a person has accepted the new ways of working and starts to put them into practice.

Through these behavioural measurements, management can see that 90% of employees understand what is going on, for example, or that 85% of employees have accepted the new ways of working. The central factors in change management are the participation of management, participation of personnel, development project portfolio, change monitoring and navigation.

Consulting Company B has also used a questionnaire-based Change Journey Assessment Profile, to detect and measure whether the change is successful or not. The profile contains questions about the commitment of management, commitment of personnel, communication, sponsorship and common vision. Also, questions about behaviour patterns and feelings, and about the appropriate directions of development can be asked. The profile questions are developed for each change project separately, and answered by different organisational groups.

Table 7.2-1. Business measurement framework for Consulting Company B.

	Competitive factor	**Human resources**	**Processes**	**Technology**	**Business result measures**
	Capabilities	M_{HR1}	M_{PR1}	M_{T1}	E.g.:
Vision and business strategy	Know-how	M_{HR2}	M_{PR2}	M_{T2}	Net profit
	Operational excellence	M_{HR3}	M_{PR3}	M_{T3}	Return on capital
	Customer relations	M_{HR4}	M_{PR4}	M_{T4}	Stock
	...	...	...	...	Quotation
	CFn	M_{HRn}	M_{PRn}	M_{Tn}	etc.

Visioning should not occur in the traditional sequence, vision-plan-implement, but instead through a spiral path as shown in Figure 7.2-1. According to this framework, it is management's job to create the first version of the process vision. Feedback should then be sought from team leaders and workers, whereby the vision evolves. This method ensures that process visioning is based on reality.

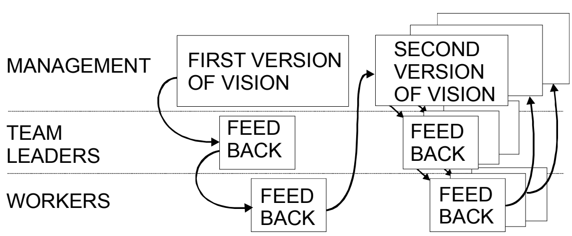


Figure 7.2-1. Visioning framework for process development applied in Consulting Company B.

7.3 Consulting Company C

In Consulting Company C, one of the main measures in the area of change management is the willingness to change, or its opposite, the resistance to change within an organisation. In this measure, personnel are classified into nine groups according to their willingness to change. Group number one is the most willing to change, while group nine is the most resistant. It is of special importance to identify members of group nine. Normally the largest part of an organisation belongs to groups four to six. The grouping is accomplished by interviews, questionnaires and tests, which evaluate the capabilities, motivation and potential of personnel.

The three key points of change management in Consulting Company C are as follows:

1. Common vision, strategy alignment and fulfilment of objectives;
2. Preconditions and critical success factors: readiness for the change, understanding its necessity and motivation, use of resources, commitment of management, commitment of personnel, and desire of owners; and
3. Operative measures, as simple as possible.

7.4 Conclusions

Managing Directors from three global consulting companies A, B and C were interviewed to define what consulting companies are measuring in change projects. The central results of these interviews from the view point of this research, i.e., what to measure in change projects, are synthesised and categorised below and in Table 7.4-1 according to measures for manufacturing process, project as process, human resources and technology. These four measurement dimensions are taken into account when developing and testing the change management measurement system in Parts II and III of this dissertation.

The suggested **measures for manufacturing process** were quality, throughput times, punctual deliveries, service level and business advantages. The measures should be as simple as possible.

Table 7.4-1. Change management measures in consulting companies A, B and C.

Measurement Dimensions =>	**Measures for operational prcocess, i.e., manufacturing process**	**Measures for project as process**	**Measures for human resources**	**Measures for technology**
Consulting Company A	Operational measures: e.g., quality, throughput times, punctual deliveries, service level etc.	Fulfilment of objectives, achievement of milestones, actions to be taken	The climate for innovation, use of creativity and ability to create, stakes in personnel training, perseverance in development, willingness to change, know-how	Use of information technology and investments in information technology
Consulting Company B	Operational process measures: e.g., quality, throughput times, business advantages, etc.	Fulfilment of objectives, achievement of milestones, common vision, strategy alignment	Change in behaviour: understanding, evaluation and acceptance phases; Participation and commitment of management and personnel; communication, sponsorship, feelings	Technology, information systems
Consulting Company C	Operational process measures as simple as possible	Vision, strategy, fulfilment of objectives, use of resources	Willingness to change, resistance to change, understanding the necessity of change, motivation, commitment of management and personnel, desire of owners	–

The proposed **measures for project as process** were fulfilment of objectives, achievement of milestones, actions to be taken, existence of common vision, strategy alignment, and use of resources.

The following **measures for human resources** were brought forward: climate for innovation, use of creativity and ability to create, stakes in personnel training, perseverance in development, willingness to change and resistance to change, know-how; change in behaviour: understanding, evaluation and acceptance phases; participation and commitment of management and personnel, commitment of management and personnel, communication, sponsorship, feelings, understanding the necessity of change, motivation, and desire of owners.

The suggested **measures for technology** concerned principally information systems, e.g., the use of information technology and investments in information technology.

8. Preliminary case projects

Three preliminary case projects D, E and F are described in this chapter. The purpose of these projects is to provide relevant and practical requirements for the development of change management measurement construct. In all these case projects D, E, and F, the steps of the change process are similar to the change process described in Chapter 5 and in Figure 5-1.

8.1 Case project D

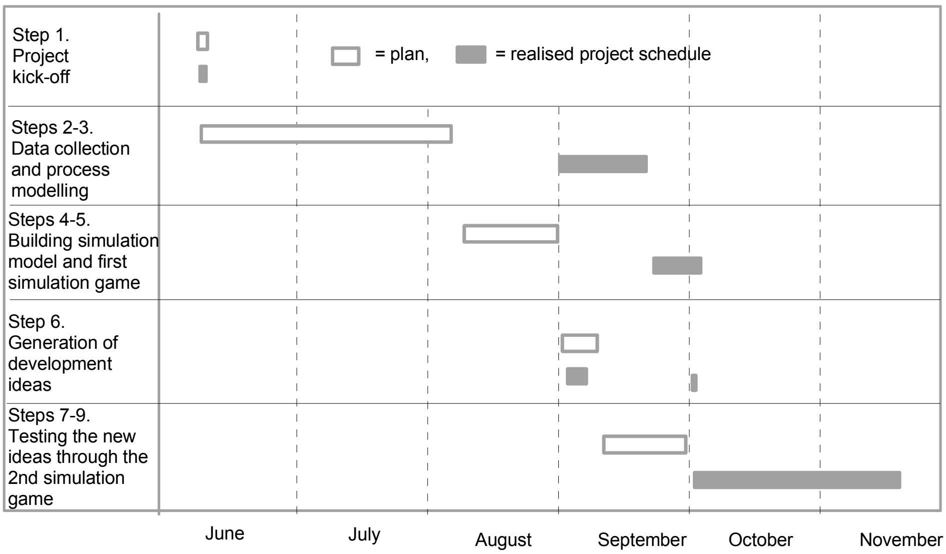
Case Factory D provides manufacturing services for the electronics industry. The main products include circuit boards. The business volume is growing 30–50% annually and the material flow is growing in proportion. Sixty new employees were hired and new machines were acquired during the first half of 1997. The total number of personnel in the factory was 220 when the project started.

The plan, objectives and data needs for process modelling and simulation game were defined at the project kick-off. The objectives of the change project were set as follows: 1. To double the volume of production; 2. to cut manufacturing throughput times by 50%; 3. to halve the work-in-process inventory (WIP); 4. to identify bottlenecks in production, and 5. to commit the employees to the project.

The project started with a delay due to a lack of time and resources for data collection and for the preliminary preparation in the company. After the Project Manager was nominated, the data collection and process-modelling tasks could be carried out. The main improvement idea, which arose during the project, was that three customer-oriented manufacturing cells (teams) should be made as opposed to one big line. In this context it should also be considered, whether pull-type production control could be utilised. These development ideas were thought to be the keys to facilitate production control, improve teamwork, speed up manufacturing throughput time and decrease WIP. One product group comprising 35% of the whole production volume was selected as the target group for development. Only if improvement ideas worked in this pilot product group could the other two manufacturing cells be successfully organised according to the same principle.

The production data was gathered and simulation game seminars arranged according to the realised project schedule as shown in Table 8.1-1. From Table 8.1-1 it can be seen that the realised project schedule is clearly lagging behind the plan. A detailed description of the planned project schedule, realised project schedule and invested work hours in Case D is presented in Appendix A on page A1 (Table A-1).

Table 8.1-1. Planned and realised project schedules.



Two debriefing and discussion meetings were held after the second simulation game on November 10 and 20. In addition to numerical simulation game results concerning throughput times and work-in-process inventories, the respective numerical results of computer simulation runs were shown to the change project personnel. The results of both simulations showed that the objectives set at the beginning of the project could be achieved in reality.

An attempt to measure simulation game intervention was done through a survey after the second simulation game, i.e., after Step 5 in Table 8.1-1. The experiences of the players (17 persons) in Case D were examined by a questionnaire that was modified from research done by Ruohomäki (1994). A similar questionnaire has been used by Taskinen (1996) in manufacturing process development context. Originally Ruohomäki (1994) developed her questionnaire in context of simulation-game-based administrative process development. However, it can be proposed that the questionnaire by Ruohomäki (1994) is modifiable, due to its general nature, for assessment of human resource subject matters of the simulation game intervention in manufacturing process context. Example questions in the questionnaire are shown in Appendix C on pages C9–C12. The method for processing measurement data is explained in Appendix G.

The objective of this measurement was to get feedback and find out how the simulation game supported the manufacturing process development project. Basically the questions in the questionnaire were multiple choice with a scale of one to five, e.g. 1 = strongly disagree, 2 = disagree, 3 = neither disagree nor agree, 4 = agree, 5 = strongly agree. The survey covered the following topics T_t ($t = 1...10$):

1. Reality of the simulation game
2. Information given before the simulation game
3. Objectives of the simulation game
4. Communication and group work
5. Learning
6. Starting to practice new working methods
7. Testing and planning the new working method
8. Feelings after simulation game days
9. Practical arrangements
10. Economical evaluation.

The results based on answers to the multiple choice questions in the survey are concluded and summarised in Figure 8.1-1 where the scale 1–5 can be interpreted as follows: 1 = very poor performance, 2 = poor performance, 3 = average performance, 4 = good performance, 5 = very good performance. From Figure 8.1-1 it can be seen that according to the group averages the change project personnel in the case project D experienced the simulation game positively. The results were discussed with the project participants in a debriefing meeting following the second simulation game.

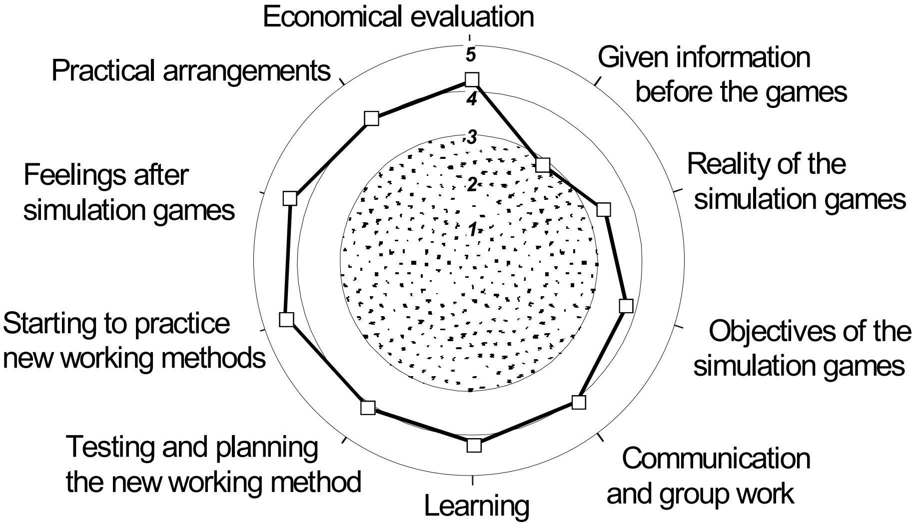


Figure 8.1-1. Experiences of simulation game players in case project D.

The milestones for implementation were planned as follows:

- new pull production control ideas with throughput time and WIP measures in use during February 1998;
- formation of manufacturing cells and layout changes after having new manufacturing space in June 1998.

The results in Figure 8.1-1 support the findings of Piltonen et al. (1995) and Haho (in Ruohomäki and Vartiainen, 1992) in the sense that the manufacturing simulation games are well suited for the development of manufacturing processes and that a simulation game facilitates and improves learning during the manufacturing process development project. In addition, Forssén and Haho (2001) have reported the positive experiences and influences of 88 simulation games on business process development projects. Noteworthy is that these 88 simulation games fall into the manual simulation model category according to the typology in Figure 4.4.1-2 while the simulation game method applied in this research uses also computer for analysis of process parameters. Positive simulation game experiences are also reported in the context of administrative process development (Ruohomäki, 1994; Piispanen, 1995). These simulation games for administrative process development fall also into the manual simulation model category according to the typology brought forward in Figure 4.4.1-2.

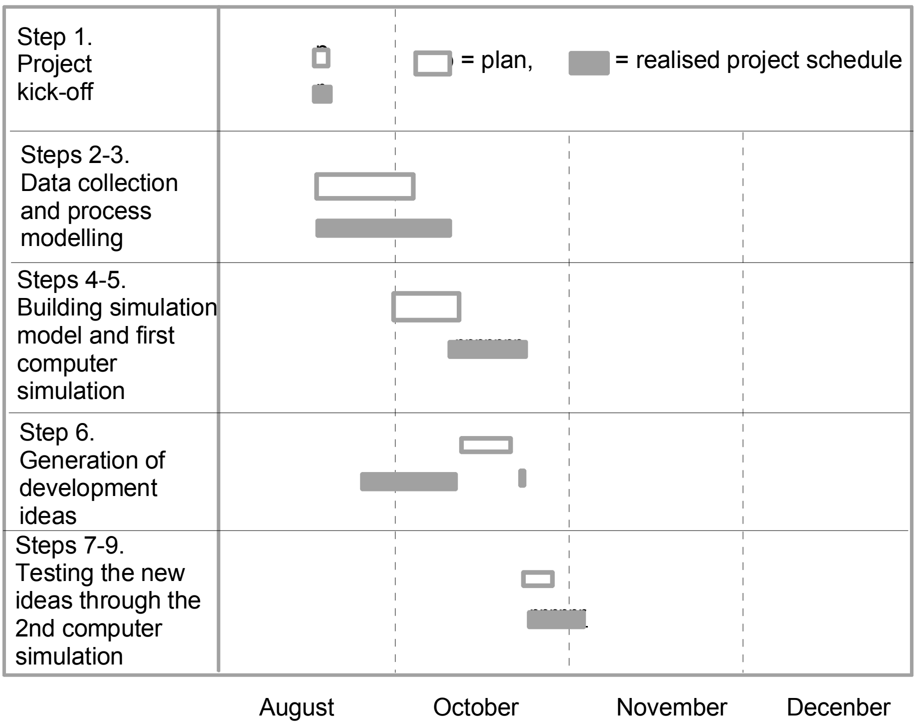
8.2 Case project E

Case Factory E is also a supplier in the electronics industry, but the products are mainly made of sheet metal. Its business volume is increasing. The company had about 140 employees when the project started in August 1997. The change objectives were formulated at the beginning of the project together with the production manager and managing director as follows: (1) to halve the manufacturing throughput time; (2) to halve the WIP inventory; (3) to increase production volume about 10–20% annually; (4) to increase the flexibility of production, and (5) to prepare for a maximum volume increase which may be 50% of today's volume over the next year.

Table 8.2-1 shows the planned and realised project schedule. More detailed descriptions of the planned and realised project schedule and invested work hours are brought forward in Appendix A. The project proceeded according to plan with one exception. Because of the other duties of the Project Manager, the data collection task had to be restricted to certain product groups. During the idea generation and development meeting, it was decided to simulate how pull control would work in a specific product group cell layout, and to compare the new control principle to the present one in computer simulation seminars.

The group including the Project Manager (Method Designer), Production Manager, Manufacturing Manager, Production Scheduler, Material Purchaser, Manager responsible for subcontractors and Programmer for the flexible manufacturing system joined the simulation seminars. After the first simulation seminar, the model was improved, and after the second simulation seminar the new layout and production control method were accepted by the participants. However (as can be seen from Appendix A, page A2), there has been no blue-collar employee participation in the project and even in Step 5 there was no participative simulation game, and the results were only discussed with managers.

Table 8.2-1. Planned and realised project schedules in Case E.



The project was planned further in a debriefing meeting in January, 1998 and the new milestones were set as follows:

- committing workers to the change by a simulation game during May 1998;
- start of layout changes June 12 , 1998 and
- improvements in use on October 15, 1998.

However, Case Factory E bought a new enterprise resource planning system (ERP-system) at the end of April 1998. This decision was not co-ordinated with the ongoing change project. This implies that the company did not have a clear change project portfolio (c.f. Smeds, 2001). The ERP-system implementation project started immediately and the manufacturing development project was temporarily terminated and postponed. In addition, there were a few changes in personnel.

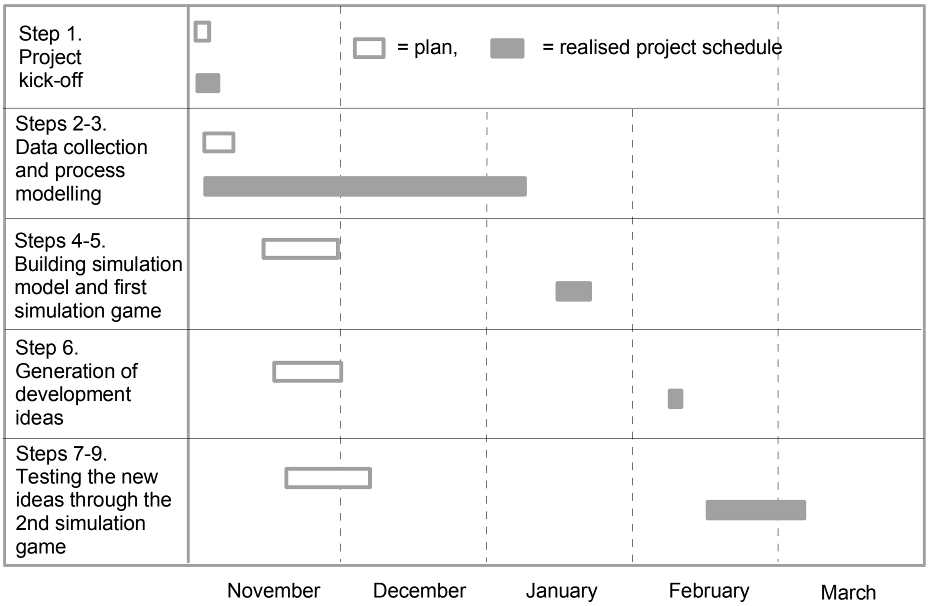
8.3 Case project F

Case Factory F is an engineering workshop. The volume of business is not expected to increase, but new models of products are introduced regularly due to intense competition. Personnel numbered 240 in November 1997. Table 8.3-1 shows the planned and realised project schedules. A more detailed description of the planned and realised project schedules together with the invested work hours is brought forward in Appendix A on page A3. The project objectives were set at the kick-off meetings as follows: (1) to halve the WIP inventory; (2) to reduce throughput time in the A-processes by 40% and in the B-processes by 20%; (3) to commit the employees to the project, and (4) to improve productivity by 10% within 2 years.

After the project started it was soon found that the Project Manager and other employees (foremen and representatives from five manufacturing functions) were overloaded by the implementation task of a new enterprise resource planning system: consequently, the original project plan was too tight and data collection and modelling work were delayed. For this reason, the first simulation game seminar was used for model building and for collecting manufacturing data. The second simulation game seminar then revealed the problems of the present manufacturing system. The biggest problem was in synchronisation, i.e.; different manufacturing functions were manufacturing the parts punctually but for different end products.

The improvement idea generation meeting concluded that the pull principle instead of the push principle in production could be the solution, and the new principle was tested in the simulation game seminar on 12 March, 1998. The results of the simulation showed that the pull principle synchronises the production, and that layout changes would also make the manufacturing and production control easier. A benchmarking visit to see a pull production control system in reality was arranged. Ten hours (one working day) were used for the visit and two hours for the discussion afterwards with the Project Manager, and the Production Manager and eight workers. The implementation of improvements was set to start in September 1998.

Table 8.3-1. Planned and realised project schedules in Case F.



8.4 Conclusions

All the case projects D, E and F had challenging development objectives and they utilised the change process presented in Figure 5-1 in Chapter 5. In Case D an attempt to measure simulation game intervention in change project was done through a questionnaire after the second simulation game round – the measurement experience was positive and the good simulation game results encouraged the project personnel to proceed into implementation.

Based on experiences in case projects D, E and F it could be proposed that the following areas should be taken into account in change management construct development:

- **Human resources side in general**: e.g., information, communication, motivation, learning and commitment.
- **Project as a process**: e.g., quality of planning, none of the cases prepared a budget for the project, all the projects were delayed compared to the project plan.

- **Corporate strategy alignment of the project**: Not one of the top managers in the case projects D, E and F had discussions with the project personnel about strategy alignment of the change project and its relative priority in the project portfolio of the company when the manufacturing development project started.

These three above-mentioned problem areas are taken into account in change management measurement system development in Part I-C. The discussion concerning Cases D, E and F will be continued in Part I-C in Section 9.6 where a more thorough analysis is provided through testing the first version of the change management measurement framework and system.

PART I-C CONSTRUCTION

9. The system for change management measurement

9.1 The synthesised measurement dimensions

By synthesising Chapters 3 to 8 in Part I-A and I-B, the five measurement dimensions for change management can be conluded. The dimensions are as follows:

1. Corporate strategy basis
2. Development process
3. Operational process, i.e., manufacturing process in this research
4. Human resources
5. Technology.

Table 9.1-1 summarises how Chapters 3 to 8 contribute to each of these five measurement dimensions.

Table 9.1-1. The five measurement dimensions synthesised from literature review, consultant survey and case projects D, E and F.

The synthesised measurement dimensions from Chapters 3–8 → **Chapters 3–8 ↓**	**Strategy basis** for the project	Coherent and capable **development process,** i.e., suggestion to measure the project as a process, includes time, cost, quality and control related issues	Operational process, i.e., **manufacturing process** including time, cost, quality and control related issues	**Human resources** related issues	**Technology** related issues
Principles of successful project management (Chapter 3)	Strategy and direction setting processes	Need for a coherent, capable and well understood development process; time, cost quality and control related processes	Monitoring and analysing the impact of the project	Human resources related processes	Technology related processes
Principles of process change management (Chapter 4)	Clear strategy basis	Systematic development, organisational learning and teamwork process, e.g., tailored simulation-game-based change process	Manufacturing process is a structured, measured set of activities to produce a specific output for a particular customer	Learning climate and knowledge environment	Technology as lever of change
The simulation-game-based change management methodology applied in case projects (Chapter 5)	Tailored simulation game suits well to the improvement of production management	Simulation-game-based change management process	Manufacturing process is the system to be simulated, i.e., the relevant information concerning the products and the process is collected	Tacit and explicit knowledge are important modelling parameters	Simulation game related technology
Principles concerning measurement of change project management (Chapter 6)	Measuring effectiveness, measures must be linked to the strategies and goals	Measuring effectiveness and efficiency, systems thinking, the process of controlling project work: diagnostic controls, financial measures	Measure the process, effectiveness and efficiency of the process, if you cannot measure the process you cannot manage it	Measures for learning, project managers & personnel, interactive controls, non-financial measures	Effectiveness and efficiency of technology
Consultant surveys A, B and C (Chapter 7)	Measures for the project as a process	Measures for the project as a process	Measures for operational process	Measures for human resources	Measures for technology
Case projects D, E and F (Chapter 8)	Strategy alignment	Measures for project as a process	Operational measures related to objectives	Measures for human resources	Manufacturing technology

9.2 The two measurement principles – effectiveness and efficiency

In Chapter 6, effectiveness and efficiency were defined to be the main principles for any measurement system (Harrington, 1991; Neely et al., 1995; Rummler and Brache, 1995; Simons, 1995; Laakso, 1997; Carnall, 1999). Consequently, these two measurement principles are to be included in the change management measurement framework. Effectiveness was defined as the ability to meet customer expectations, i.e., in change management context to do strategically "the right things" (Taskinen and Smeds, 2000). Effectiveness includes adaptability, i.e., flexibility to change the strategy according to changing circumstances so that the wanted effectiveness level can be maintained. Efficiency was defined as a measure of how economically resources are utilised, i.e., to do "things right", or a measure of how good is the input/output ratio of a process or an activity.

Table 9.2-1. Definitions of effectiveness and efficiency.

Effectiveness	– Doing strategically the right thing, reflects quality and adaptability, and how well customer expectations are met according to the given corporate strategy
Efficiency	– Doing it right with best possible or optimal input/out; reflects internal performance and productivity, and how well resources are utilised

9.3 The change management measurement framework

In order to achieve an understandable, clear and usable change management measurement framework, the change project itself and its object, i.e., manufacturing operations, are examined separately. In Figure 9.3-1 it is brought forward how change management includes these two proposed main measurement dimensions. These two proposed main measurement dimensions are logically interlinked as the development project has influence on the manufacturing operations through development efforts, and manufacturing operations have influence on the change project through the development challenge and feedback.

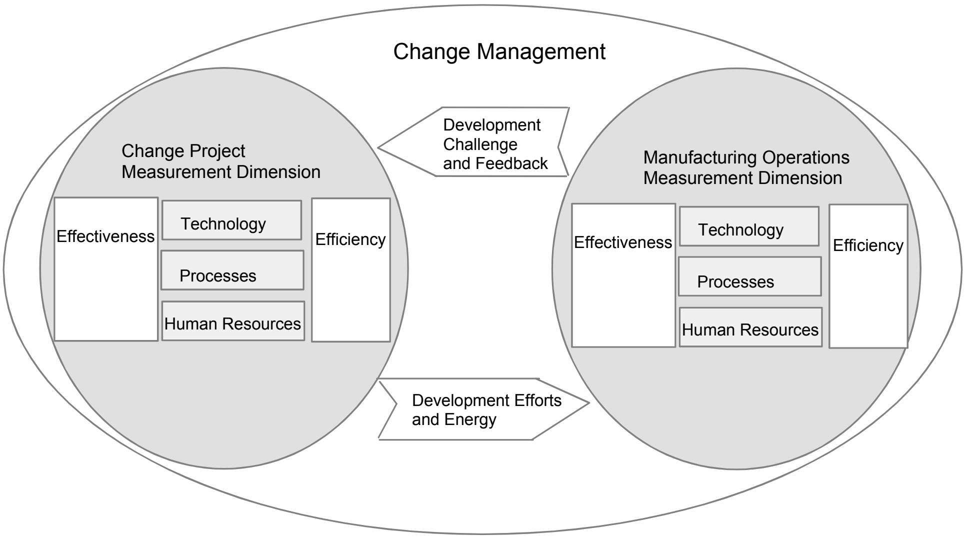


Figure 9.3-1. The two interlinked main measurement dimensions of change management.

Consequently, the two generic main measurement dimensions for the change management measurement framework are

- *development project dimension, i.e.,* ***change project dimension*** *in this research; and*
- *system to be developed dimension, i.e.,* ***manufacturing operations dimension*** *in this research.*

The change management measurement framework, or CMMF, can now be concluded by combining and synthesising these two main measurement dimensions with the five measurement dimensions brought forward in Section 9.1 and with the two measurement principles of effectiveness and efficiency as brought forward in Section 9.2. In Table 9.3-1, it is brought forward the twelve dimensional measurement framework and how it takes into account all the central issues found in the literature, consultant surveys A, B, C and case projects D, E and F as synthesised in Section 9.1. In CMMF (Table 9.3-1) it is basically assumed that change project management and manufacturing operations management are among the competitive factors that have risen from business strategy. The synthesised measurement dimensions in CMMF are reasoned and explained as follows.

The change project management measurement dimension is firstly divided, based on Section 9.1, into the three sub-measurement dimensions of project process, human resources, and technology. Secondly, these three dimensions are further divided according to the two measurement principles of effectiveness and efficiency explained in Section 9.2. Thus, the six measurement dimensions for the change project are as follows:

1. Effectiveness of human resources
2. Efficiency of human resources
3. Effectiveness of project process
4. Efficiency of project process
5. Effectiveness of project technology
6. Efficiency of project technology.

The manufacturing operations management measurement dimension is also firstly divided, based on Section 9.1, into the three sub-measurement dimensions of manufacturing process, human resources, and technology. Secondly, these three measurement dimensions are further divided according to the two measurement principles of effectiveness and efficiency explained in Section 9.2. Thus, the six measurement dimensions for the manufacturing operations management are as follows:

1. Effectiveness of human resources
2. Efficiency of human resources
3. Effectiveness of operational process
4. Efficiency of operational process
5. Effectiveness of technology
6. Efficiency of technology.

Consequently, it can be concluded that a twelve dimensional framework has been constructed for measurement of change management in manufacturing processes. The proposals for the measures of change project management and manufacturing operations management are given in Sections 9.4 and 9.5.

Table 9.3-1. The twelve dimensional framework for measuring change management.

The synthesised measurement dimensions in Section 9.1 →		Strategy basis for the project, i.e., strategy alignment	Coherent & capable development process, to measure the project as a process including time, cost, quality and control related issues	Operational process, i.e., manufacturing process including time, cost, quality and control related issues	Human resource related issues	Technology related issues
***Measurement dimensions for change project management* ↓**						
Human Resource Measures	1. Effectiveness				X	
	2. Efficiency				X	
Process Measures	3. Effectiveness	X	X			
	4. Efficiency		X			
Technology Measures	5. Effectiveness					X
	6. Efficiency					X
***Measurement dimensions for the manufacturing operations management* ↓**						
Human Resource Measures	1. Effectiveness				X	
	2. Efficiency				X	
Process Measures	3. Effectiveness	X		X		
	4. Efficiency			X		
Technology Measures	5. Effectiveness					X
	6. Efficiency					X

9.4 The measures for change project management

In this section change project management measures for measuring effectiveness and efficiency of human resources, project process and project technology are suggested.

9.4.1 Effectiveness of human resources

A number of authors, (e.g. Harrington, 1991; Wheelwright and Clark, 1992; Davenport, 1993; Hammer and Champy, 1993; Belassi and Tukel, 1996) stress that senior management sponsorship and commitment, i.e., providing resources and support, rewards and offering opportunities for improvement, are essential factors in change. Communication of corporate strategy, vision, desire of owners and project objectives to project personnel and organisation are also important and closely related to sponsorship. Innovative climate reflects how organisations' norms and values favor change and help individuals to be creative (Moss Kanter, 1983; Davenport, 1993 and Consultant Survey in Chapter 7). Evaluation of the understanding of objectives, and communication can be defined to be strategically important because those involved must understand the change, its objectives and related matters (Harrington, 1991; Hammer and Champy, 1993; Hannus, 1994; Kotter, 1996; Carnall, 1999). Consequently, the first suggestions for effectiveness measures of human resources (HR) are as follows:

- top management sponsorship,
- communication of corporate strategy, vision and project objectives,
- desire of owners,
- innovative climate,
- evaluation of the understanding of objectives and communication in general.

9.4.2 Efficiency of human resources

Time is stressed as an important measurement factor by both project and process management literature (e.g., Stalk and Hout, 1990; Charney, 1991; Harrington, 1991; Wheelwright and Clark, 1992; Hammer and Champy, 1993; Davenport, 1993; Hannus, 1994; Kotter, 1996, Kerzner, 1998). The amount of invested time tells us how serious the development effort is and also reflects internal drivers such as motivation, commitment, involvement and empowerment.

Learning is necessary when developing new competencies and capabilities (Argyris and Schön, 1978; Senge, 1990; Prusak, 1996; Garvin, 1993; Nonaka and Tageuchi, 1995; Davenport et al., 1998; Allee, 1997). According to Karazek (1990) learning happens and motivation to develop new behaviour patterns exist at its best when both psychological demands (or development challenge) and decision latitude (or empowerment) are high. Learning in change can be thought to be an internal change factor reflecting productivity of the project.

Social skills, teamwork skills and educational skills are needed in order to achieve results efficiently (see e.g. Moss Kanter, 1983; Davenport, 1993; Kerzner, 1998; Carnall, 1999). Such skills are, for example, the facilitation techniques, which encourages the participation of all group members, e.g., social simulation games and brainstorming techniques. Sense of coherence (Antonovsky, 1985) could possibly be used as a self-assessment measure to evaluate the capability to judge the likelihood of desired outcomes. Capability in change can be assessed, e.g., based on previous change project experiencies, training and educational level of project personnel and management (Kerzner, 1998).

The following measures for efficiency of human resources are suggested:

- invested time of management and employees,
- motivation: willingness to change and its opposite resistance to change, perseverance in change,
- social skills, team work skills and educational skills,
- sense of coherence,
- capability and learning.

9.4.3 Effectiveness of project process

The change project has to fit soundly into the corporate strategy and overall project portfolio (Harrington, 1991; Wheelwright and Clark, 1992; Hammer and Champy, 1993; Davenport, 1993; Hannus, 1994; Kotter, 1996, Kerzner, 1998, Olve et al., 1999). Consequently, evaluation of strategy alignment of the project justifies the project.

Development organisation requires coherent architecture and process that is well understood, highly capable and in control (Wheelwright and Clark, 1992). It is argued that evaluation, selection and use of change management methods and creativity techniques are essential to project success.

Project planning is an important factor influencing project performance, i.e., in order to achieve efficient project performance project planning should be effective (Kerzner, 1998; Wheelwright and Clark, 1992). Thus, it is argued that the quality of project planning should be checked and critical success factors should be identified.

The first suggestions for effectiveness measures of the project process are concluded as follows:

- corporate strategy alignment of the project,
- quality of planning and identification of critical success factors,
- use of change management methods and creativity techniques.

9.4.4 Efficiency of project process

The first suggestions for efficiency measures of project process are the following (e.g., Harrington, 1991; Wheelwright and Clark, 1992; Kerzner, 1998):

- achievement of objectives compared to plan including milestones,
- timetables, budgets and project scope.

9.4.5 Effectiveness of project technology

It should be considered what kind of technologies and tools are needed and are available to help in the project management task. Both consultant survey and process management literature (Harrington, 1991; Hammer and Champy, 1993; Davenport, 1993; Hannus, 1994) argue that automation or information technology can play a critical role in enabling innovation in business processes. Kerzner (1998) states that there is a large array of software available for project managers to help in the management task and argues that most project management software packages offer at least the following features: planning, tracking, monitoring, reports, calendar, what-if analysis and multiproject analysis.

The first suggestion for effectiveness measure of technology is identification and selection of strategically right technologies and tools such as project management softwares, simulation games, computer simulations, computer-aided tools and information systems.

9.4.6 Efficiency of project technology

The first suggestion for efficiency measure of technology is cost efficient use of technology. It should be noted that process management literature (Harrington, 1991; Hammer and Champy, 1993; Davenport, 1993) warns that there is also a chance to misuse technology. Consequently, it shoud be evaluated that the selected tools are used in a way which helps in project management task and not vice versa. It is proposed that evaluation of skill level in using technology can be used as an efficiency measure of technology.

The first suggestions for efficiency measures of project technology are

- cost efficient use of technology, and
- it can be proposed that the evaluation of skill level in using the selected tools and need for training concerning the selected technology could reflect the efficiency of the current project technology.

9.5 The measures for manufacturing operations management

9.5.1 Effectiveness of human resources

Literature concerning organisational learning and knowledge management (e.g. Argyris and Schön, 1978; Senge, 1990; Prusak, 1996; Garvin, 1993; Nonaka and Tageuchi, 1995; Davenport et al., 1998; Allee, 1997) stresses the importance of education and learning which improve capabilities, competencies and skills.

Consequently, the first suggestions for effectiveness measures of human resources in manufacturing operations are

- capabilities, competencies and skills,
- education, operational expertise,
- customer awareness,
- process awareness and systems thinking.

9.5.2 Efficiency of human resources

The following efficiency measures for human resources in manufacturing are suggested (e.g. Stalk and Hout, 1990; Harrington, 1991; Charney, 1991).

- input/output measurements on human productivity,
- quality costs,
- flexibility and versatility.

9.5.3 Effectiveness of operational process

Strategy alignment and profitability of the process are the first suggestions for operational process effectiveness measures. These measures reflect the importance of the process and its impact on both the company and the company's customers (Harrington, 1991; Hammer and Champy, 1993; Davenport, 1993; Hannus, 1994; Kotter, 1996).

9.5.4 Efficiency of operational process

The first suggested efficiency measures concerning operational process efficiency are as follows (e.g. Stalk and Hout, 1990; Harrington, 1991; Wheelwright and Clark, 1992; Hammer and Champy, 1993; Davenport, 1993; Hannus, 1994):

- operational input/output measures,
- volume,
- lead time, flexibility,
- amount of work-in-process, and
- quality of produced products.

9.5.5 Effectiveness of operational technology

Consultant survey and process management literature (e.g. Harrington, 1991; Hammer and Champy, 1993; Davenport, 1993; Hannus, 1994) argue that the use of automation or information technology can play a critical role in business processes. The first suggestion for effectiveness measure of operational technology is the evaluation of technologies and tools needed in the operative process – for example, it can be asked if there exists an evaluation process for operational technology and what is the quality of that evaluation process in the company.

9.5.6 Efficiency of operational technology

Process management literature (e.g. Harrington, 1991; Hammer and Champy, 1993; Davenport, 1993) warns that there is a chance to misuse technology. Consequently, it should be evaluated that the technologies and tools are used efficiently. The first suggestions for efficiency measures of technology are cost/benefit measures, i.e., how cost efficient is the use of operational technology.

9.6 Testing the change management measurement system

The change management measurement system, or CMMS, was tested through case projects D, E and F afterwards by a questionnaire survey and examining data from project diaries. The respondents to the survey were project personnel, Project Manager and Production Manager in each case company D, E and F. The survey was conducted after the planned implementation phase, i.e., after Step 7 in Figure 5-1. The test results of CMMS are summarised in the comparative radar in Figure 9.6-1 as a relative comparison between the cases. The case projects D, E and F are introduced in Chapter 8.

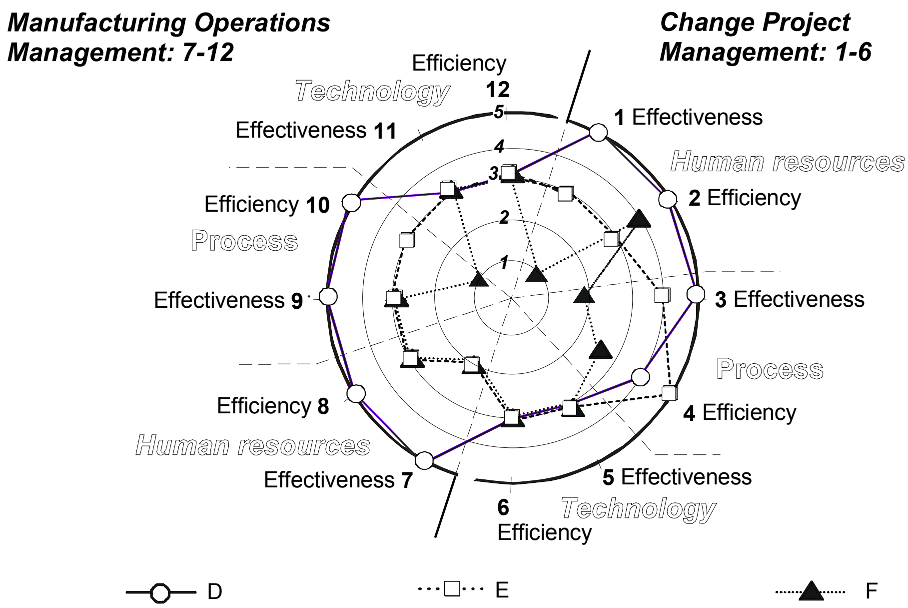


Figure 9.6-1. Comparative values of change management measurements after the end of the case projects D, E and F.

It can be seen from Figure 9.6-1 that Case D had the best overall change management performance while Case E was the second best and Case F came third. Analysis of the cases according to the twelve radar values is discussed in detail in the following two sections. Firstly, in Section 9.6.1, the applied measures for change project management are discussed; and secondly, in Section 9.6.2, the applied measures for manufacturing operations management are examined. The method applied for the processing of the research data is described in Appendix G. Values in Figure 9.6-1 are comparisons between the cases D, E, and F. Consequently, Figure 9.6-1 describes the order of performance of the cases D, E and F in each of the measurement dimensions. Basically, the scale in each measurement dimension in the radar is an ordinal scale from 1 to 5 and can be interpreted as follows: 1 = very poor performance, 2 = poor performance, 3 = average performance, 4 = good performance, and 5 = very good performance.

9.6.1 The measures for change project management

The questions used in the six measurement dimensions for change project management are described in this section as follows:

1. **Effectiveness of human resources** in the change projects was approached in the survey through the following questions:

   - Communication of strategic issues, visions and corporate objectives (scale: 1–5)
   - Evaluation of the understanding of project objectives and quality of communication during the change project (scale: 1–5)
   - Top management sponsorship (scale: 1–5) evaluated by project personnel, Project Manager and Production Manager
   - Innovative climate (scale: 1–5) evaluated by project personnel, Project Manager and Production Manager.

   The comparative measurement values for HR effectiveness of change project management in Figure 9.6-1 show clearly that the Case D has the highest score, followed by Case E and Case F.

2. **Efficiency of human resources** in the change project was approached in the survey through the questions that mapped:

   - employee motivation to change (scale 1–5), and
   - the amount of invested managerial and employee time [hours] (scale: 1–5).

It is obvious, that every project has a break-even point after which the increase in invested work hours (input) is not more beneficial to the project. In order to be able to plan and budget work hours the project management team needs experience. For example, Harrington (1991) suggests in process improvement context that each of the project improvement team members should work on the project about 160 hours during the first two months, after which their commitment drops 10% per month during the following year.

In Case D, the amount of invested managerial and employee time was 435 hours (5 points) while in Case E it was 139 hours (3 points), and in Case F 280 hours (4 points) although the change targets and objectives were of approximately similar in size. In addition, the shop floor workers were well motivated to change in Case D (5 points), in Case F to some degree (4 points) while in Case E there was no worker involvement (3 points). Thus, the comparative measurement values for HR efficiency of change project management in Figure 9.6-1 show that the Case D has the highest score, Case F has second best values while Case E comes third.

3. **Effectiveness of project process** was approached in the survey by asking evaluations from Project Manager and Production Manager concerning the following items:

   - Corporate strategy alignment of the project (scale: 1–5)
   - Quality of timetable and milestone determination (scale: 1–5)
   - Quality of budget and resource determination (scale: 1–5).

   The HR effectiveness measurement values in Figure 9.6-1 show that the Case D has the highest score and that Case E is close to Case D while Case F is clearly lagging.

   The temporal termination of the change project in Case E, because of the ERP-system investment, can be seen as a concrete outcome of poor process effectiveness in change process management.

4. **Efficiency of project process** was approached by comparing the project plan with the realised project schedules:

   In Case D, the project was lagging 51 days or 49% behind the original plan at the end of the last simulation phase (4 points). The best achievement of objectives compared to the plan in the last simulation phase was in Case E: the delay was only 13 days, or 20% of the planned calendar time (5 points). Case F had the poorest planning and the delay in the project plan was 98 days (337%) (2 points). In Case F it was difficult for the Project Manager to find time for data collection and therefore a group of employees was asked to help. This indicates poor planning and inefficiency from the process point of view, though it did increase the participation of employees in the project. Thus poor process efficiency had an improving effect on human resource efficiency measurements. The efficiency measurements of project process in Figure 9.6-1 shows that the Case E has the highest score and that Case D is close to Case E while Case F is lagging.

5. and 6. **Effectiveness and efficiency of project technology** in change projects were evaluated respectively as follows:

   - Effectiveness: The early identification of needed tools and know-how required in the change project? (Yes/No)
   - Efficiency: Evaluation of training needs concerning the use of tools and technology? (Yes/No)

   These measures need to be further developed. The answers did not differ between the case projects. Consequently, 3 points can be given for Cases D, E and F as the comparative measurement values as shown in Figure 9.6-1.

9.6.2 The measures for manufacturing operations

The measurement questions used in the six measurement dimensions for manufacturing operations management are described as follows.

1. **Effectiveness of human resources** in manufacturing operations was measured by asking the following questions:

- Do you use skill matrix? (Yes = 5, Partly = 3, No = 1)
- Do you monitor the personnel's understanding of operative process measures? (Yes = 5, Partly = 3, No = 1)

The combined measurement in Figure 9.6-1 shows that Case D has the highest score while cases E and F came second.

2. **Efficiency of human resources** in manufacturing operations was measured by observing during the projects how human productivity is gauged. In the case project D this subject matter was discussed (5 points) while cases E and F paid no attention to this question (3 points). Therefore Case D has the highest score while cases E and F come second.

3. **Effectiveness of manufacturing process** was measured by asking Project Managers and Production Managers questions as follows:

   - Was there corporate strategy alignment of the manufacturing process? (Yes, a core process = 5 / No, not a core process = 1)
   - Were the operational measures as stated in the change project objectives measured and followed systematically? (Yes = 5 / No = 1)

   In every case study it was concluded that manufacturing is strategically important. Operational process measurements as stated in the project objectives were measured and followed systematically only in Case D. Case D has the highest score while cases E and F come second.

4. **Efficiency of manufacturing process** was measured by checking the following process information six and twelve months after the second simulation phase:

   - Can changes in operations be seen? (Yes/No)
   - Work-in-process inventory decrease? (%)
   - Decrease in manufacturing throughput time? (%)
   - Production volume increase? (%)

Six months after the second simulation phase, i.e., after Step 9 in Figure 5-1, clear and concrete changes in efficiency measurements of operations could be detected only in Case D where a work-in-process inventory had decreased 40% and the decrease in throughput time was 46%. In addition, the increase in production volume was 30%. On the other hand, no changes were found in the efficiency measurements of the manufacturing process in Cases E and F. Twelve months after the second simulation phase, efficiency of operative manufacturing process was further improved in Case D compared to the situation at project kick-off: the work-in-process inventory had decreased 50% and the decrease in throughput time was 60%. In Case E, the planned layout changes were made and the WIP decrease was 30% while volume increased 15% compared to the situation at project kick-off. In Case F, major changes were not found in the operative process measurements twelve months after the second simulation (Step 5.3 in Fig. 5-1). On the other hand, a system for Continuous Improvement including a suggestion system was installed in Case F within six months after the second simulation game. Consequently, based on these changes in reality the comparative measurement values for the efficiency of manufacturing process was given as follows: Case D, 5 points; Case E, 3 points; and Case F, 1 point. See also Figure 9.6-1.

5. **Effectiveness of manufacturing technology** was measured by asking questions as follows:

   - Is there a process for the evaluation, selection and benchmarking of manufacturing technologies in the company? (Yes/No)
   - Is there a process for the evaluation of information technology? (Yes/No)

6. **Efficiency of manufacturing technology** was evaluated by asking the following questions:

   - Do you measure manufacturing technology's costs and benefits?
   - Amount of investments in manufacturing technology?
   - Do you measure information technology's costs and benefits?
   - Amount of investments in information technology?

The cases D, E and F were similar in effectiveness and efficiency of technology in manufacturing. All the case companies had a process for the evaluation, selection and benchmarking of manufacturing and information technologies. Costs/benefits and investments in manufacturing technology were discussed but no absolute values were collected. In addition, no attention was paid to costs/benefits and investments in information technology during the projects. Consequently, 3 points were given as comparative measurement values for all the case projects D, E and F as can be seen in Figure 9.6-1.

9.7 Conclusions

The analyses of the three case studies D, E and F indicate that the developed change management measurement system, abbreviated CMMS, differentiates successful and less successful change projects in manufacturing processes. In particular, when examining the case projects with CMMS afterwards, good values in change project measurements seem to correlate with the speed of improvement in reality as seen from the efficiency measurements of operational processes. In particular, this can be seen when comparing the performance of Case D to Cases E and F. Case D has the best overall change project management performance as well as the fastest improvements in reality. That is, after six months of the second simulation game, in Case D, work-in-process inventory had decreased 40% and throughput time 46%, and the increase in production volume was 30%. No changes were found in the efficiency measurements of the manufacturing process in Cases E and F six months after the second simulation phase (see Figure 9.6-1).

The sequence of cases D, E and F along both the change project management and operational excellence measures in Figure 9.6-1 is almost the same. The notable exceptions are:

- human resource efficiency of change projects between cases E and F, and
- process efficiency of change projects between cases D and E.

In human resource (HR) efficiency of change project Case F has higher value than Case E has while Case E is better in HR effectiveness. This means that human resources are used strategically better in Case E than in Case F while HR internal performance is higher in Case F. The problem in Case F is that time is used or wasted for non-strategic activities from the change project point of view. The same phenomenon can be seen when comparing effectiveness and efficiency of change processes of cases D and E. These exceptions show that it is important to concentrate on what is strategically essential and only then concentrate on internal efficiency.

Testing of CMMS is needed in such case projects, which apply CMMS as a tool from the very beginning of the project. Therefore, in Part II CMMS is applied and developed further in context of new case projects G and H.

PART II TESTING AND DEVELOPING THE CHANGE MANAGEMENT MEASUREMENT SYSTEM IN PRACTICE

The change management measurement system, abbreviated CMMS, was developed in Part I by constructing the change management measurement framework, abbreviated CMMF, and by defining the first sets of measures. CMMS was then tested in the case projects D, E and F. This testing was done after the case projects D, E and F as final evaluation. Consequently, CMMS needs to be developed, elaborated and tested further in real change management and change management measurement processes.

In Chapters 10 and 11, CMMS is tested and elaborated further in the case projects G and H. Firstly, based on CMMS, a revision of needed measures is selected, determined and linked to the simulation-game-based change management process by the researcher, i.e. the facilitator, project managers and production managers of the case projects G and H. Secondly, these measures and the new ones that emerged during the projects are used, further elaborated and tested in practice in the Cases G and H. All the twelve dimensions in CMMS were not measured on every measurement point because it was found that it is more practical to measure sub-dimensions (e.g., human resources dimension in change project management) at appropriate intervals and then take these submeasurements into account when assessing all the twelve dimensions in CMMS. This sub-measurement data and the measurement radars, in the case projects G and H, are processed, calculated, and summarised according to the principles brought forward in Appendix G. The twelve dimensions in CMMS, when measured, are evaluated and summarised mainly through discussion in the project management team meetings. Basically, the measurements are subjective self evaluations of the participants. The applied ranking scale from 1 to 5 can be interpreted as follows: 1 = very poor performance, 2 = poor performance, 3 = average performance, 4 = good performance, and 5 = very good performance.

In Chapter 12, the case projects G and H are compared in order to find emerging patterns. Finally, in Chapter 13, improvement suggestions for using CMMS in future projects are given as the measured simulation-game-based change process is proposed.

10. Practical functioning of the change management measurement system in case project G

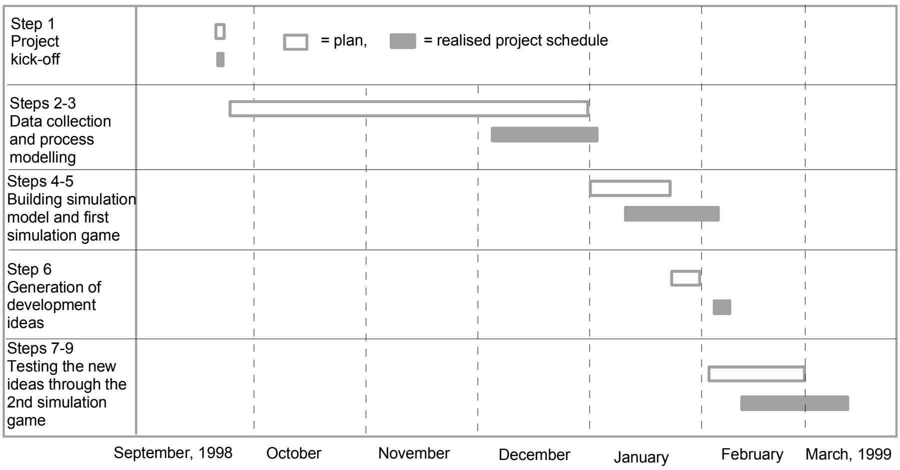
Case Factory G is a contract manufacturer for the electronics industry. The main products include circuit boards and business volume was estimated to grow 30–50% annually when the project started.

Case project G was performed in the same factory as case project D but the manufacturing process under development was different as well as employees working in the process. The Project Manager, Production Manager and Technical Director are the same persons in the case projects D and G. The total number of personnel in Factory G was 280 when the simulation game project started in September, 1998 and 300 in May 1999 when implementation was planned. The number of workers in the process under development was 120, which is 30 more than when beginning case project D. The following group of people from the factory took part in the project: Project Manager, Production Manager, Technical Director and a group of blue-collar employees. The original schedule, the first versions of change management measures, change objectives and data needs for process modelling were defined at the project kick-off. The planned schedule and the realised project schedule are presented in Table 10-1. A more detailed description of the planned schedule and the realised project schedule together with the used managerial and blue-collar employee hours are brought forward in Appendix B on page B1.

The objectives for the project were set as follows:

- to cut manufacturing throughput times by 50%;
- to halve the WIP inventory;
- to guarantee the volume increase of production;
- to identify bottlenecks in production;
- to commit the employees to the project and
- to measure and manage the change project.

Table 10-1.The planned and realised project schedule for the first and second simulation game rounds in Case G.



In the kick-off meeting the first versions of CMMS measures were selected and documented and a common understanding of central matters and measures in the project was achieved by the project management team, or PMT, i.e., Production Manager, Project Manager, a production supervisor and the researcher. Discussion about effectiveness and efficiency helped the PMT concentrate firstly on the strategic side and then on internal efficiency measures. In particular, the CMMS approach utilising measurement surveys was found to be practical because it facilitated discussion and the central aspects of change were pointed out and documented from the very beginning of the project. The measurement procedure during the project generally included that the measurements were analysed and thereafter the summarised results were shown to change project participants in the beginning of the next project meeting following the measurement. The measurement results were discussed and reactions were performed.

Measurement of all the twelve dimensions in CMMS was primarily meant for the use of project managers for self evaluation purposes while the sub-measurement dimensions were used to measure the performance of the whole project personnel. In Sections 10.1 to 10.7 it is described in more detail what was measured, i.e., how CMMS was applied, elaborated and tested in the case project G. The structure and content of Chapter 10 is arranged chronologically according to the change process as summarised in Figure 10-1 (a more detailed description of the structure is brought forward in Appendix E).

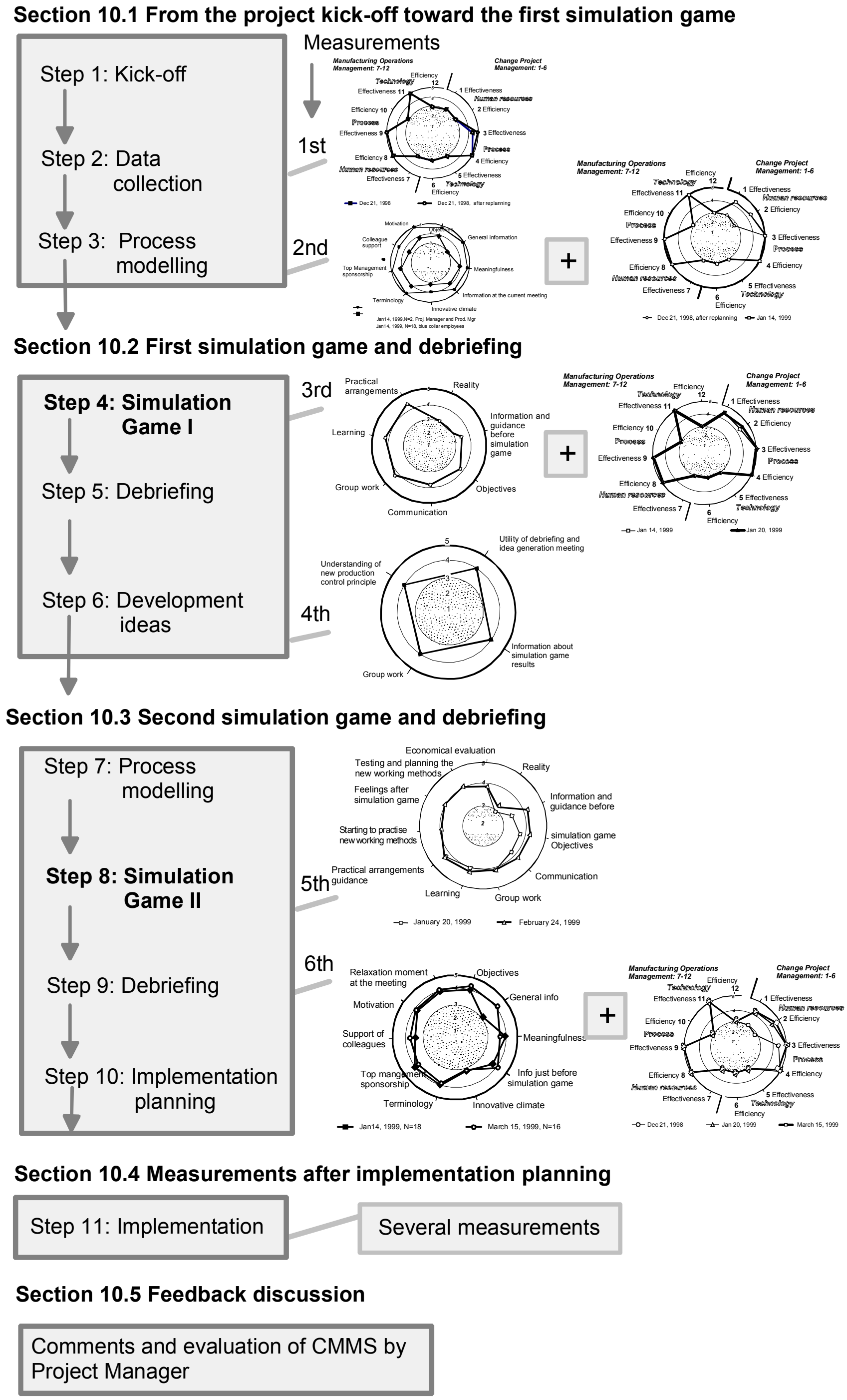


Figure 10-1. The structure of the case project G and Chapter 10.

10.1 From project kick-off toward first simulation game

The project proceeded according to the original plan from kick-off to the first measurement meeting which was held with the researcher, Production Manager, Project Manager and a blue-collar employee (a production supervisor). The supervisor was taken into the project management team because it was believed that he could give shop floor insights and thus could contribute to the development and refinement of measures in CMMS as well as communicate the change project to his colleagues.

In this first measurement meeting CMMS worked not only as a measure but also as a checklist of what should be measured when the project proceeds. In other words, CMMS helped the project management team to further develop and refine measures and measurement questionnaires which were applied to get documented feedback from project personnel during the project. Target values for the measurements were also set in this meeting.

The first measurement values according to CMMS (December 21, 1998) are summarised in the radar in Figure 10.1-1. This time, Process Effectiveness measurements of Change Project Management concerning planning and budgeting caused discussion, re-planning and budgeting until finally all three company representatives gave five out of five for planning and budgeting measurements. The measurement questions were primarily similar to measures used for evaluation of cases D, E and F in Section 9.6. The measurement questions applied are brought forward in Appendix C on pages C2–C4.

The second measurement occurred (January 14, 1999) after a meeting where information about the change project was given to participating blue-collar employees. The purpose was to measure only human resource related subject matters. The answers are summarised in Figure 10.1-2 and an example of the applied questionnaire is brought forward in Appendix C on pages C6–C8. The answers reveal that target values, i.e., four or higher, were achieved by blue-collar employees only in meaningfulness, top management sponsorship and understanding of terminology and objectives, but not in information, innovative climate, support of colleagues and motivation. The difference between the average scores given by the blue-collar employees (number of respondents 18) and both Project Manager and Production Manager is approximately one. This means that the level of understanding of the measured subject matters is different between these two organisational groups. Based on the measurements corrective actions were started. In particular, more information was given and results of the survey were discussed with all the change project participants.

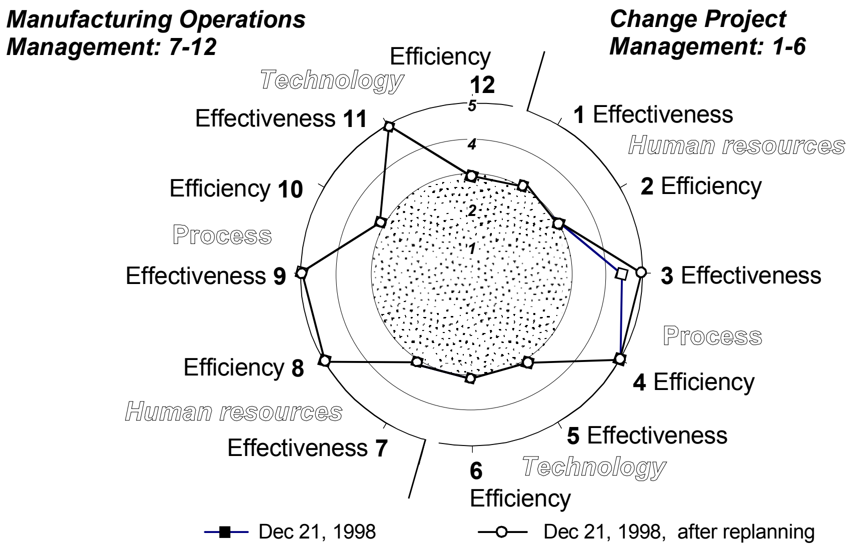


Figure 10.1-1. Summary of first measurements according to CMMS.

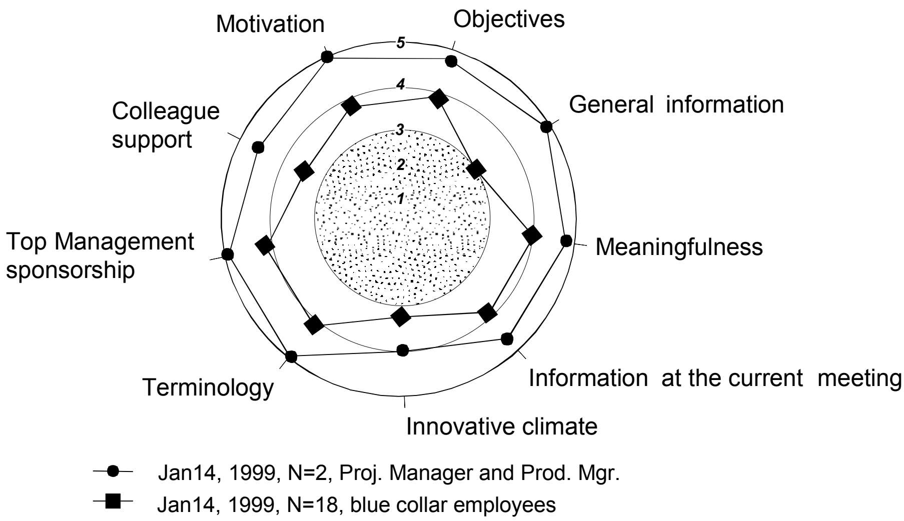


Figure 10.1-2. Measurement values concerning human resource related subject matters.

After this first information meeting PMT measured also all the twelve dimensions in CMMS. Summarised measurement values are shown in the radar in Figure 10.1-3 and the applied questions in the questionnaire are shown in Appendix C on pages C2–C4. The values in January 14, 1999 show improvements in Human Resource Effectiveness and Efficiency measurements of Change Project Management when compared to values in December 21, 1998. The improvement in Human Resource Effectiveness was due to increased top management support, and also due to measurement of innovative climate and project personnel's understanding of manufacturing terminology. Human Resource Efficiency improved due to increased work time investment, and due to measured communication, motivation and willingness to change.

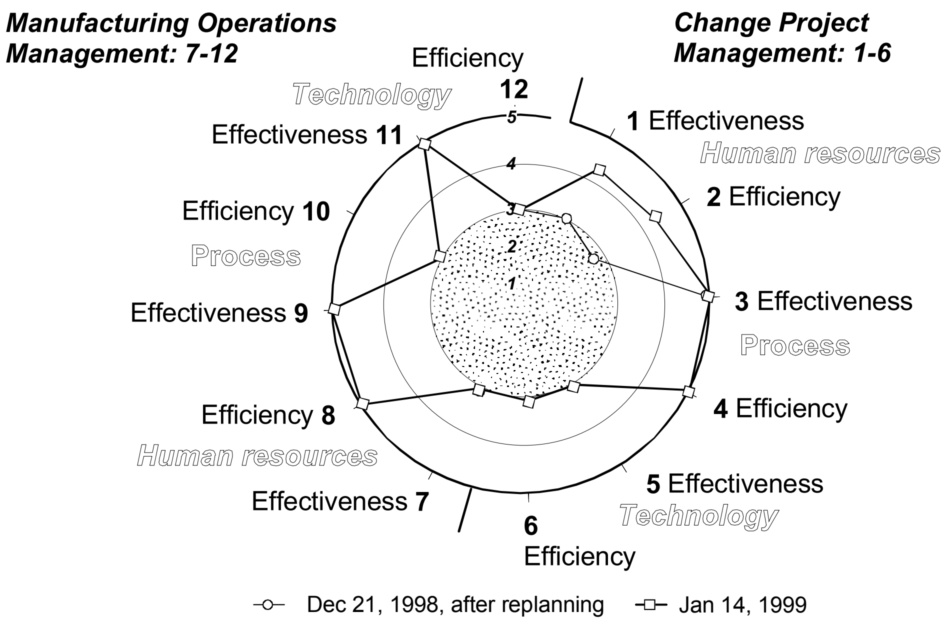


Figure 10.1-3. Summarised measurement values according to CMMS.

10.2 First simulation game and debriefing

The third measurement in the change project happened after the first simulation game. The topics concerning the simulation game were measured through a questionnaire survey. The answers helped the project management team to evaluate how blue-collar employees experienced the simulation game days. The summary in Figure 10.2-1 shows that simulation game worked almost as intended and revealed improvement needs in the following areas (number of respondents 18): reality of games, information, communication and objectives. Examples of the questions in the applied questionnaire are brought forward in Appendix C on pages C9-C10.

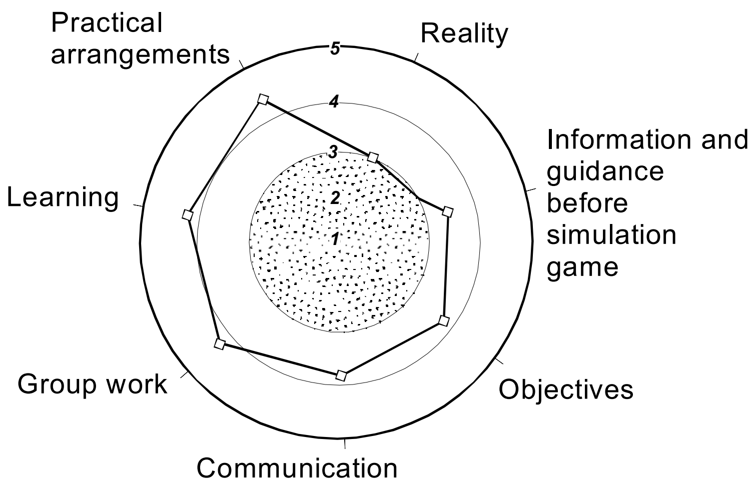


Figure 10.2-1. Summary of measurements concerning the first simulation game.

The measurement values according to the twelve dimensional CMMS were also checked after the first simulation game by PMT (January 20, 1999). The only change, compared to previous checking (i.e., in January 14, 1999), was in Human Resource Efficiency measurements of Change Project Management as seen in Figure 10.2-2. This change reflected basically the fact that blue-collar employees were involved in the project. The measurement questions in the applied questionnaire are brought forward in Appendix C on pages C2–C4.

The measurements concerning the first simulation game were discussed with the blue-collar employees in a feedback, debriefing and an idea generation meeting. The main improvement idea, which arose during the idea generation meeting, was that the company should consider whether pull-type production control could be utilised. In particular, this was the project management team's opinion because of the good results in the other manufacturing process where pull-type production control was applied one year earlier. The amount of new ideas generated in the debriefing and idea generation meeting was positive, indicating motivation and commitment of the change project personnel.

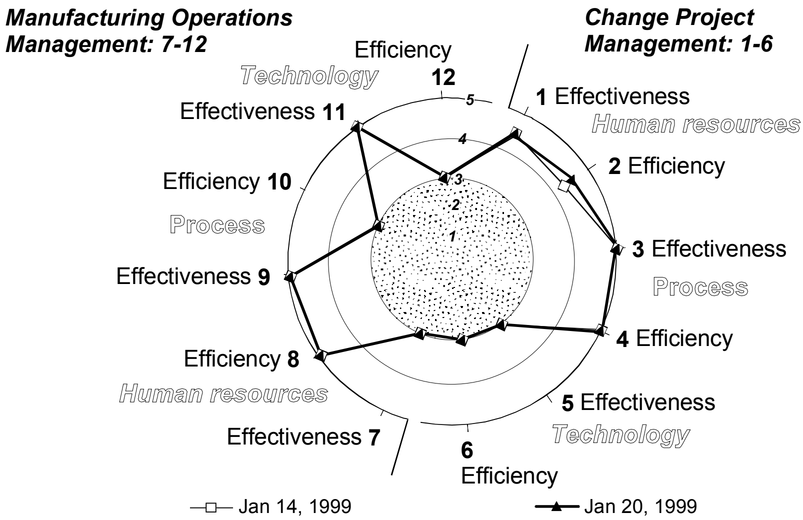


Figure 10.2-2. Summarised measurement values according to CMMS.

The fourth measurement happened in a andfeedback meeting that was arranged after the idea generation meeting. At that point, PMT applied human resource related measurement questions to find out how the change project personnel had experienced the previous idea generation meeting. Summarised answers of 17 respondents are brought forward in Figure 10.2-3. PMT could see from the answers that both of the meetings were experienced as meant. The questions in the applied measurement questionnaire are presented in Appendix C on page C13.

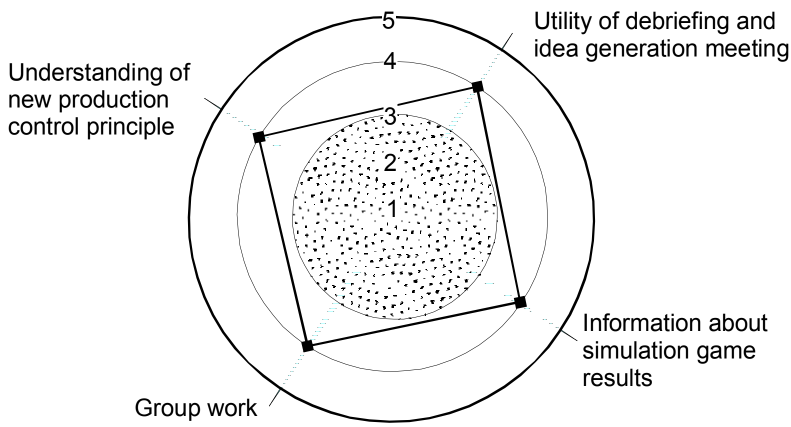


Figure 10.2-3. Summarised measurement values concerning idea generation and debriefing meetings.

10.3 Second simulation game and debriefing

The fifth measurement took place after the second simulation game, which was arranged for testing of development ideas. According to the measurements concerning the second simulation game, reality of the game, objectives, information, guidance and communication were experienced better than in the first game. This is obviously due both to the experienced learning curve in the first game and the special attention paid to by PMT. Thus, measurements showed to PMT that improvement efforts since the first simulation game had worked and that the game had worked very well. In Figure 10.3-1, the summary of measurements concerning the second simulation game (February 24, 1999; number of respondents = 17) are compared to answers concerning the first simulation game (January 20, 1999; number of respondents = 18). Examples of the questions in the applied questionnaire are shown in Appendix C on pages C9–C12.

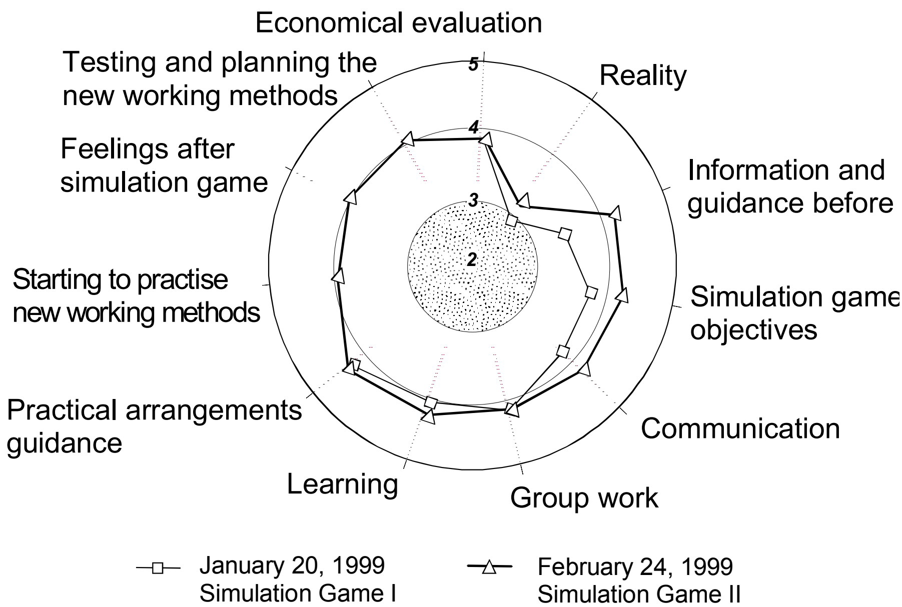


Figure 10.3-1. The summarised results concerning the first and second simulation games.

The sixth measurement point was when a feedback and debriefing meeting about the second simulation game was arranged. Also, the implementation plan was discussed and communicated to project personnel at this meeting. The simulation game phase of the project was at its end and PMT wanted to know how the project was performing. Consequently, human resource related subject matters were measured (March 15, 1999, number of respondents 16) and compared to previous measurements (January 14, 1999, number of respondents 18) as brought forward in Figure 10.3-2. PMT could conclude that a little improvement in measurement values had occured and that there are no big issues to be concerned about in the change project. In particular, scores in general information had improved compared to the previous measurements. Examples of the applied measurement questions is brought forward in Appendix C on pages C6–C8.

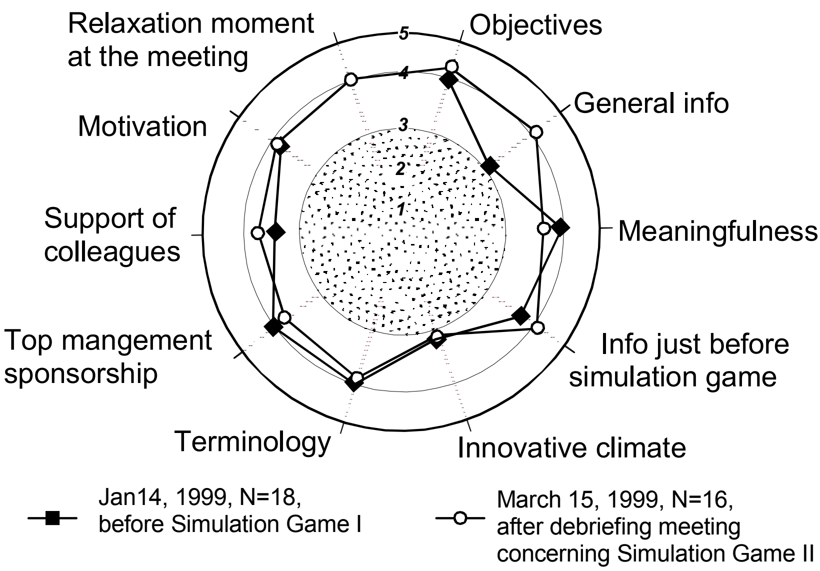


Figure 10.3-2. Summary of human resource measurements.

In this sixth measurement point, all the twelve dimensions in CMMS were also checked. In Figure 10.3-3, the summarised measurement values (March 15, 1999) are shown and compared to previous measurements (December 21, 1988 and January 20, 1999). The measurement questions are brought forward in Appendix C on pages C2–C4. From Figure 10.3-3 it can be seen that Human Resource Efficiency of Change Project Management has improved since the previous measurement checking. The improvement is mainly due to increased work time investment. On the contrary, Process Efficiency of Change Project

Management has slightly decreased because of a 15-day delay from the original plan.

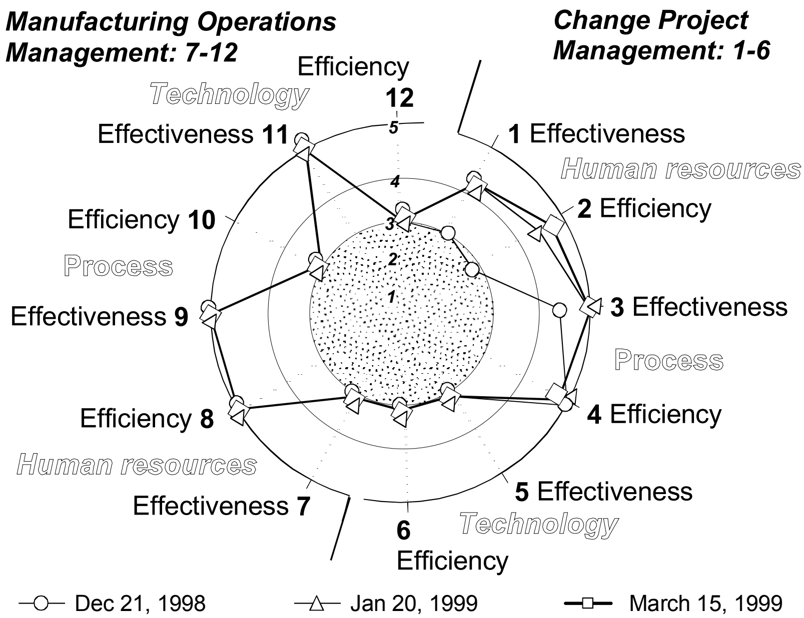


Figure 10.3-3. Summary of measurements according to CMMS.

The simulation game phase of the project was now over and no changes could yet be detected in the measurements of Manufacturing Operations Management. However, simulation game results showed that development targets set at the beginning of the project concerning efficiency measurements of Manufacturing Operations Management, i.e., reduction of work-in-process inventory and decrease in manufacturing throughput time, could be achieved in reality. Consequently, implementation planning was done according to new ideas tested in the second simulation game. The milestones and measures for implementation were planned as follows:

- implementation of new pull production control ideas with throughput time and WIP measures for selected products should start 22 days after the last debriefing meeting (March 15, 1999);
- all the primary changes should be implemented after summer holidays (by the end of August 1999);

- primary measures from this point were defined to be improvements in terms of manufacturing throughput time and work-in-process inventory. In addition, invested work hours were to be collected.

10.4 Measurements after implementation planning

After implementation planning Human Resource Efficiency of Change Project Management was monitored through the measurement of work hours. Between April and September 1999, 150 hours were used by Project Manager and 67 hours by the manufacturing personnel. In addition, manufacturing throughput times and work-in-process inventories were documented in order to judge the success of the whole project. In December 1999, it was concluded that the development objectives had been clearly achieved. In Table 10.4-1, it is described how manufacturing throughput time developed from the project kick-off on September 1998 to September 1999 and December 1999. The decrease in work-in-process inventory was also extremely good. However, the work-in-process statistics are not shown here because the collected data were not totally reliable due to changes in personnel responsible for the work-in-process data collection.

Table 10.4-1. The development of manufacturing throughput time in Case G.

	September 1998	September 1999	December 1999
	Throughput time [%]	Throughput time [%]	Throughput time [%]
Average through-put time [%] compared to the situation at project kick-off	100.0%	44%	29%

10.5 Feedback discussion

The researcher had a feedback discussion with Project Manager of Case G in September 1999. The purpose was to evaluate CMMS and its influence on the change project. Comments of Project Manager of Case G are summarised below:

1. The twelve dimensional CMMS approach worked well as a checklist and as a planning tool. In particular, it was good to go through and determine effectiveness and efficiency measures before starting the project.
2. CMMS helped in checking whether the realised project schedule is proceeding according to plan. If we had not used CMMS, we might have missed the necessary reactions and the project would have been delayed.
3. Technology measures in CMMS were not useful in this project but can be in some other projects.
4. The utility of CMMS was to see whether opinions of PMT members are the same, and are the PMT members capable of working together. CMMS helped and facilitated discussion and was necessary in our project.
5. Human resource measures during the project were concrete, good and helped PMT members, e.g., to see whether more efforts are needed in teaching terminology to the project personnel.
6. Measurements concerning the first simulation game gave feedback on what should be improved or done differently – at least reality was one improvement area. PMT got feedback on whether it was able to guide well enough and whether people learned new matters concerning the manufacturing process under development.
7. It was good that PMT applied the measures concerning the simulation games so that everybody had a better possibility to influence, give feedback, participate and point out if something goes or went awry.
8. Measurements concerning idea generation told the PMT whether the idea generation meeting was good and helped in development of future brainstorming sessions.
9. CMMS worked as a project management tool
10. Milestones were achieved and through the simulation game it was seen that development objectives concerning manufacturing throughput times and work-in-process inventories can be achieved in reality.
11. Afterwards it can be said that we should have measured change also during the implementation phase.

10.6 Summary

The challenging development objectives for the project in terms of manufacturing throughput times and work-in-process inventories together with the objectives concerning volume increase, bottleneck identification, motivation, project measurement and management were set at the beginning of the change project. In the kick-off meeting also the first versions of CMMS measures were selected, and documented and a common understanding about central matters and measures in project was reached by the project management team. The discussion about effectiveness and efficiency helped to PMT concentrate firstly on strategic side and then on internal efficiency measures. In particular, the CMMS approach utilising measurement surveys was found practical because it facilitated discussion and the central aspects of change were pointed out and documented from the very beginning of the project. The measurement results were taken into account and the project management team could conduct needed corrective actions. The measurement of all the twelve dimensions in CMMS was primarily meant for the use of project managers for self evaluation purposes while the sub-measurement dimensions were used to measure the performance of all project personnel. During the change project six separate change management measurement checks were performed.

The first measurements according to CMMS in the beginning phase caused improvement of the project plan and budgeting. The second measurement happened after a meeting where information about the change project was given for the first time to the participating blue-collar employees. The purpose was to measure only human resource related subject matter. The answers revealed that target values were achieved by blue-collar employees only in meaningfulness, top management sponsorship and understanding of terminology and objectives but not in information, innovative climate, support of colleagues and motivation. Also it should be noted that the difference between the average scores given by the blue-collar employees (number of respondents 18) and both Project Manager and Production Manager was approximately one. This meant that the level of understanding of the measured subject matters was different between these two organisational groups. Based on the measurements corrective actions were started. In particular, more information was given and results of the survey were discussed with all the change project participants. After this first information meeting PMT measured also all the twelve dimensions in CMMS. The results showed improvements when compared to previous measurements.

The third measurement in the change project happened just after the first simulation game. The answers helped the project management team to evaluate how blue-collar employees experienced the simulation game days. Basically, the first simulation game worked almost as intended and revealed improvement needs in the reality of the games, information, communication and objectives. The measurements concerning the first simulation game were discussed with the blue-collar employees in feedback, debriefing and idea generation meeting. The main improvement idea, which arose during the idea generation meeting, was that the company should consider whether pull-type production control could be utilised. The amount of new ideas generated in the debriefing and idea generation meeting was positive, indicating motivation and commitment of the change project personnel.

The fourth measurement happened in a feedback meeting that was arranged after the idea generation meeting. At that point, PMT applied human resource related measurement questions to find out how the change project personnel had experienced the previous idea generation meeting. From these measurements PMT could see that both of the meetings were experienced as intended.

The fifth measurement took place just after the second simulation game, which was arranged for testing of development ideas. According to the measurements concerning the second simulation game, reality of the game, objectives, information, guidance and communication were experienced better than in the first game. This was obviously due to both the experienced learning curve in the first game and the special attention paid to by PMT. Thus, measurements showed to PMT that improvement efforts since the first simulation game had worked and that the game had worked very well.

The sixth measurement point was when a feedback and debriefing meeting about the second simulation game was arranged. Implementation plan was discussed and communicated to project personnel at this meeting. The simulation game phase of the project was at its end and PMT wanted to know how the project was performing. Consequently, human resource related subject matters were measured. Finally, PMT could conclude that a little improvement in measurement values had occured and that there are no big issues to be worried about in the change project. In this sixth measurement point, all the twelve dimensions in CMMS were also checked. Particularly, Human Resource Efficiency of Change Project Management has improved since previous measurement checking. Improvement was mainly due to increased work time investment. On the contrary, Process Efficiency of Change Project Management was slightly decreased because of a 15-day delay in the original plan.

The simulation game phase of the project was finally over and no changes could yet be detected in the measurements of Manufacturing Operations Management. However, simulation game results showed that development targets concerning work-in-process inventory and manufacturing throughput times could be achieved in reality. Consequently, implementation planning was done according to new ideas tested in the second simulation game. Primary measures from this point were defined to be improvements in terms of manufacturing throughput time and work-in-process inventory. In addition, invested work hours were collected. After implementation, it was concluded that the development objectives had been clearly achieved.

Finally, the researcher had a feedback discussion with Project Manager of Case G in order to evaluate CMMS and its influence on the change project. According to his comments, the applied change management system was useful.

11. Practical functioning of the change management measurement system in the case project H

Case Factory H is also a supplier in the electronics industry, but the products are mainly made of sheet metal. The products, markets and manufacturing system of Case H are rather similar to Case E. Business volume is increasing and the factory had 120 employees when the project started (September 11, 1998). Number of workers in the process under the development was 60.

The definition of the change objectives, project plan, measures for the change and data needs for process modelling were started at the project kick-off. The objectives were set as follows:

(1) To shorten manufacturing throughput times down to 48 hours;

(2) to halve the WIP inventory;

(3) to double the volume of production;

(4) to identify bottlenecks in production, and

(5) to commit the employees to the project and

(6) to measure and to manage the change project.

The following group of people from Case Factory H took part in the project: Project Manager 1, Project Manager 2, deputy Project Manager 2, Production Manager, Managing Director and a group of blue-collar employees. In Case H, the project management team (PMT) included the researcher, Project Manager 1, Project Manager 2, deputy Project Manager 2, Production Manager and a production supervisor. The original plan and the realised project schedule are brought forward in Tables 11-1 and 11-2. More detailed description of the original plan and the realised project schedule together with the used managerial and blue-collar employee hours are shown in Appendix B on pages B2-B3. Originally PMT planned to arrange two simulation games, as the basic approach is according to the applied change management method, but in the end, the project ended up with three simulation games.

In Sections 11.1 to 11.10 it is described what was measured, i.e., how CMMS was applied, elaborated and tested in the case project H. The structure of Chapter 11 is arranged chronologically according to the realised change process as summarised in Figure 11-1 (a more detailed description of the structure is brought forward in Appendix F).

Table 11-1. The planned and realised project schedules for the first and second simulation game rounds in Case H.

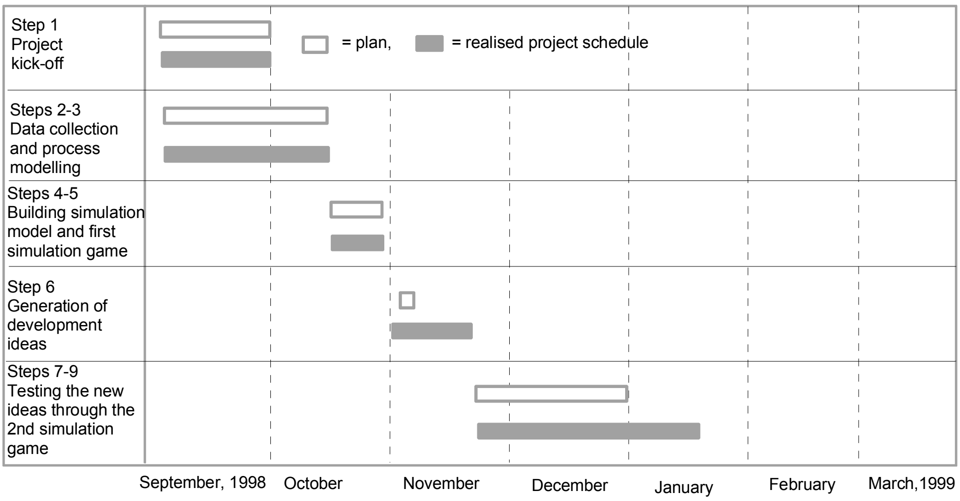
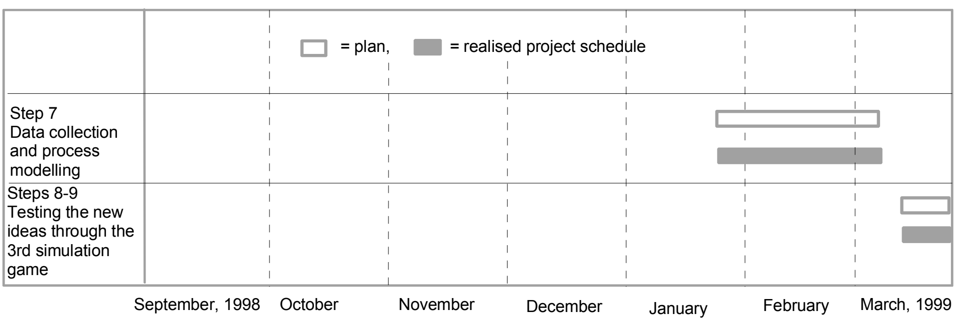


Table 11-2. The planned and realised project schedules for the third simulation game round in Case H.



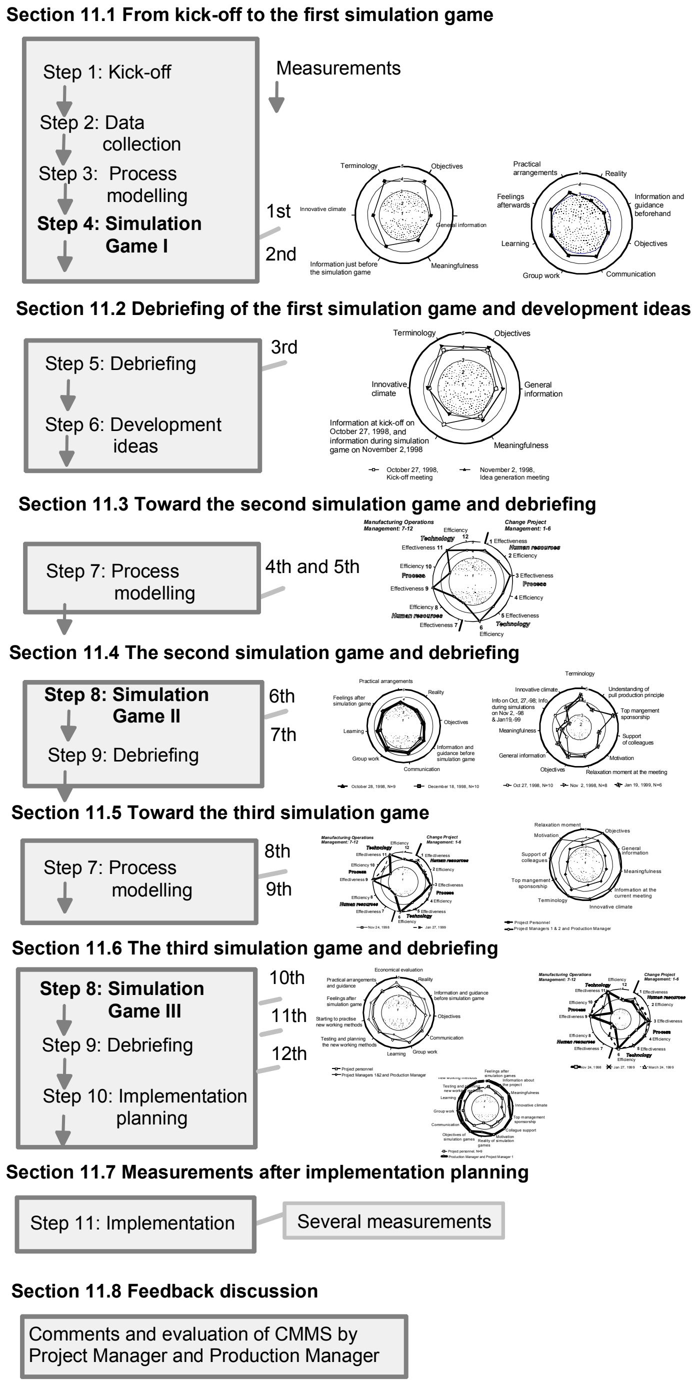


Figure 11-1. The structure of the case project H and Chapter 11.

11.1 From project kick-off to first simulation game

The project schedule is brought forward in Table 11-1 (see Appendix F for a more precise description). The project management team defined objectives for the project in the kick-off meeting after which the first change management measures for the project were defined according to the twelve dimensional CMMS. Information about the project for the project personnel was given the first time three weeks before the first simulation game. The information was repeated on the morning of the first simulation game day after which PMT measured human resources related subject matters as summarised in Figure 11.1-1 (number of respondents 10). The analysis of measurements showed that the development objectives were clear to almost all. It also showed which technological terms were still not understood by the participants. It was concluded that general information, meaningfulness and innovative climate could be improved. Examples of the measurement questions are brought forward in Appendix C on pages C6–C8.

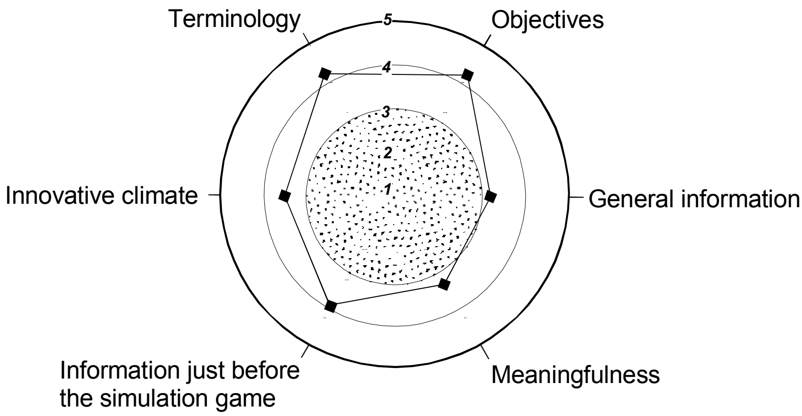


Figure 11.1-1. Summary concerning human resource measurements.

The second measurement concerning human resource related subject matters happened after the end of first simulation game. The measurements were first analysed in a project management team meeting. The results showed that there is need for improvement. All the average scores were below 4; and reality, information and objectives were below 3 as can be seen in Figure 11.1-2 (number of respondents 9). These measurements reflected the managerial discontinuity in the project, the Project Manager 1 was absent when the simulation game model was built up and played. It was concluded that PMT should pay more attention to game model building and to the quality of information meetings when the project proceeds. Examples of the applied measurement questions are brought forward in Appendix C on pages C9–C10.

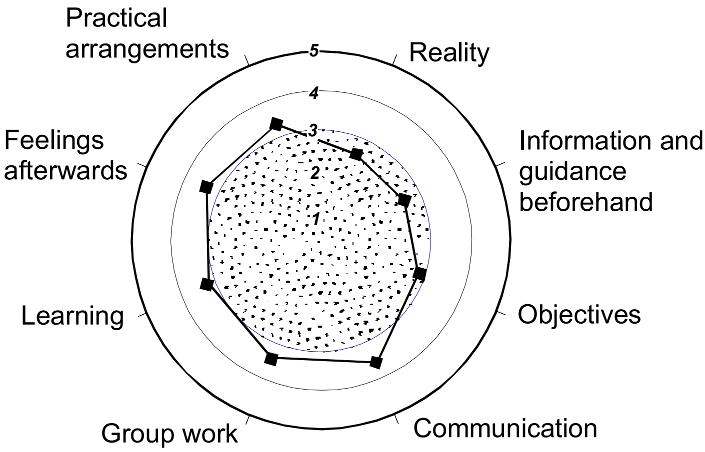


Figure 11.1-2. Summary of measurements concerning the first simulation game.

11.2 Debriefing of first simulation game and idea generation

An information, feedback, debriefing and idea generation meeting was held after the first simulation game. The company's strategy, project objectives, and visions as well as central terminology in production were told again to the project personnel at the beginning of the meeting, thereafter, during brain storming, plenty of development ideas were generated. This was thought to reflect the commitment of the personnel in the change project. After the idea generation meeting, human resource subject matters were measured (November 2, 1998, number of respondents 8). Examples of the measurement questions are shown in Appendix C on pages C6–C8. The measurements are summarised in Figure 11.2-1 and compared to previous measurements (October 27, 1998, number of respondents 10). The new results showed slight improvements in all dimensions with one exception. Namely, information at the kick-off for all project participants (October, 27) was experienced better compared to information during the first simulation game.

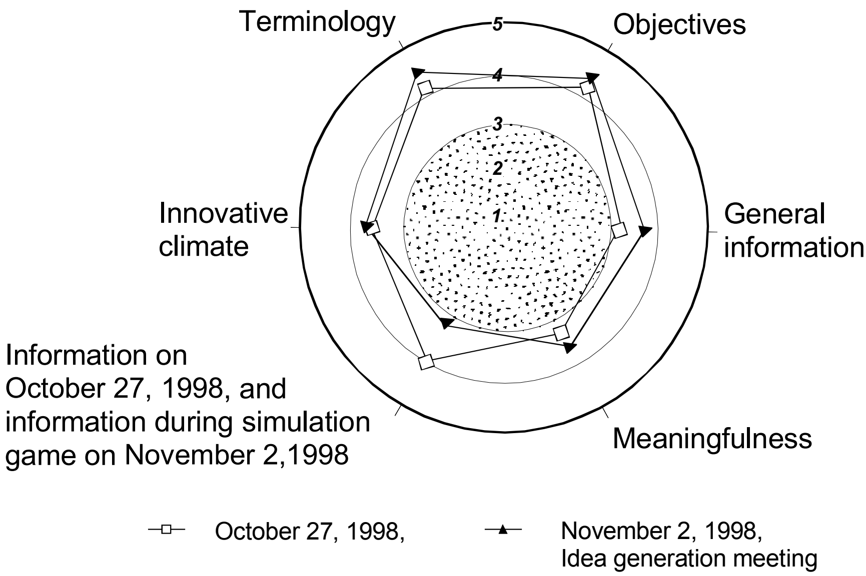


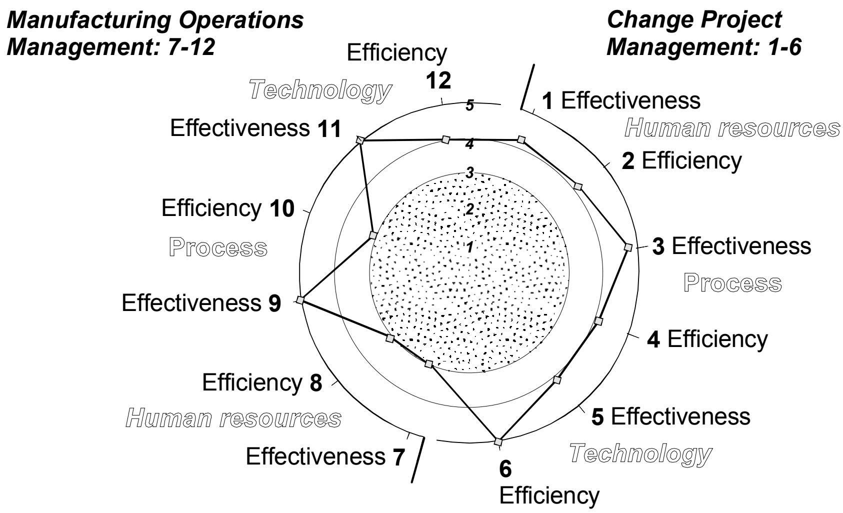
Figure 11.2-1. Summarised measurements at kick-off and idea generation meeting.

11.3 Toward second simulation game

The fourth change management measurement happened before the second simulation game when Process Effectiveness measurements of Change Project Management were monitored by Production Manager, Project Manager 1 and by the deputy to Project Manager 2. Both Production Manager and Project Manager 1 agreed that determination of budgets and resources could be improved. In addition, Project Manager 1 thought that the project objectives and milestones could be clearer. The results were discussed and appropriate corrective actions were taken, i.e., the project plan was refined. However, no attention was paid to improving the budget and determination of resources because it was believed that no formal budget and resource determinations are needed. The applied measurement questions are brought forward in Appendix C on page C5.

A fifth measurement was still taken before the second simulation game, at a PMT meeting where all aspects according to the twelve dimensional CMMS were monitored for the first time. The summary of measurements is shown in

Figure 11.3-1 and the applied measurement questions are brought forward in Appendix C on pages C2–C4. CMMS reminded and pointed out to the PMT that the central matters in change and worked not only as a checklist of what still should be measured, but also what should have been measured. Thus, previous measurement experiences were also discussed.



11.3-1. Summary of measurement values according to CMMS.

11.4 Second simulation game and debriefing

The second simulation game seminar started with information about objectives and about the new manufacturing system model, which was then simulated. The sixth measurement was conducted at the end of the simulation game seminar when experiences concerning the simulation game were evaluated through a questionnaire survey. The results showed that the game had worked better than the previous one, but that there was still a need for improvement. A summary of the measurements is brought forward in Figure 11.4-1. In this second simulation game on December 18, 1998, the number of respondents was 10 and in the first simulation game on October 28, 1998, the number of respondents was 9. Examples of the questions in the applied questionnaire is brought forward in Appendix C on pages C9–C11.

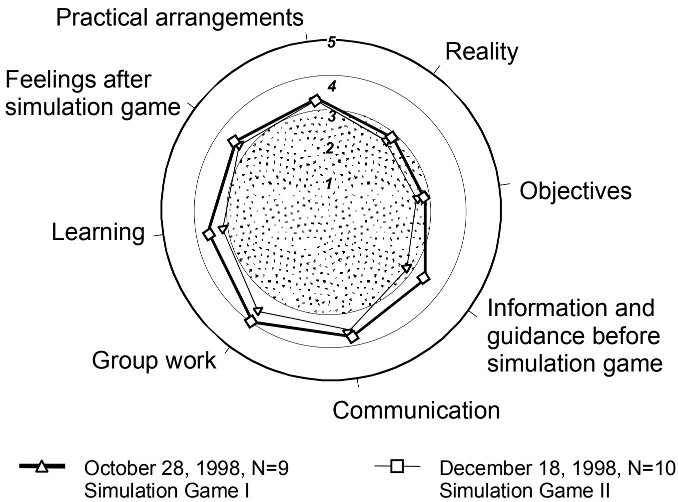


Figure 11.4-1. Summary of measurements concerning Simulation Game I and II.

The simulation model was new to every player and extra efforts were needed in achieving understanding on how the new model would work; this might have influenced the evaluations. The simulation game results were inspected and analysed first at a project management team meeting following the second simulation game. The results showed that throughput time could be improved 70% on average and that work-in-process inventory could be reduced 50% compared to reality. Finally, it was concluded that radical improvements could be achieved in reality if planned changes were realised. Basically, implementation planning could have been started.

The seventh measurement was in the debriefing and information meeting arranged for the change project personnel after the second simulation game. Human resource related measures were utilised to find out how well the project was performing. Summarised results are shown in Figure 11.4-2 together with the summary of previous measurements. In the debriefing meeting of the second simulation game (January 19, 1999) the number of respondents was 6 while in the debriefing meeting after the first simulation game (October 27, 1998) the number of respondents was 8, and in the information meeting (November 2, 1998) before the first simulation game, the number of respondents was 10. Thus, it should be noted that different radars in Figure 11.4-2 are brought forward mainly for obtaining a general perspective on how different measurements are related to each other. It is not meaningful to make very strict comparisons and conclusions based on comparisons in Figure 11.4-2. Particularly so, because the number of respondents was different during the measurements, and also because in the debriefing of the second simulation game new measurement questions were applied as can be seen on the right side of Figure 11.4-2. The examples of the measurement questions are brought forward in Appendix C on pages C6–C8. When attempting to construe the measurement results, it can be proposed that the answers showed that information during the debriefing of the second simulation game was evaluated a little worse than during the debriefing of the first game. This probably reflected the fact that the developed way of working was new to every player during the second game. On the other hand, understanding of objectives, manufacturing terminology, top management sponsorship (Managing Director was at the meeting) were quite good (see Figure 11.4-2). However, understanding of new production model and production control model, meaningfulness, and support of colleagues could have been better. In addition, it was argued that also motivational level should be better, even though the score was 4. Consequently it was decided to arrange a third simulation game with a new group of blue-collar employees and also with a product group. The objective was to get a larger number of personnel involvement and ensure that the new ideas were truly understood and that the new ideas would work with some other product groups as well.

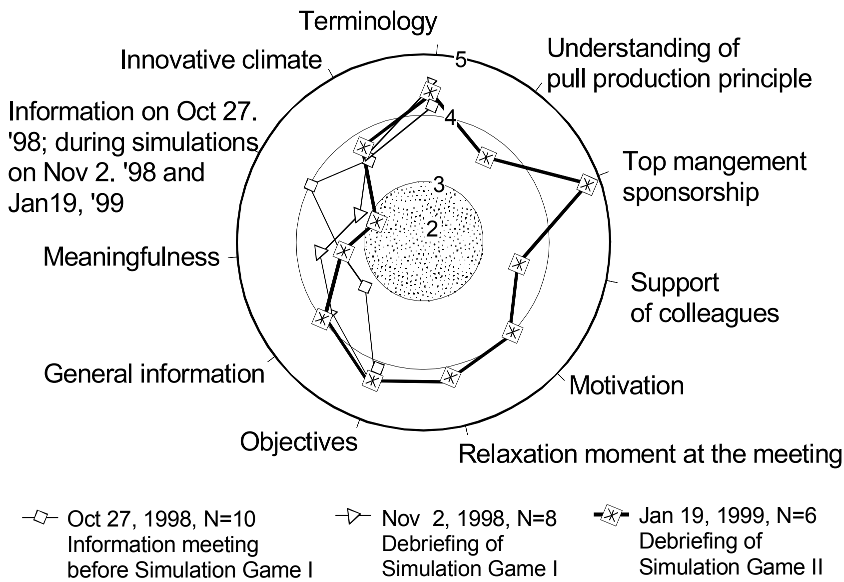


Figure 11.4-2. Summary of human resource related measurements.

11.5 Toward third simulation game

The eighth measurement was conducted at a project management team meeting (January 27, 1999) when all the twelve dimensions of CMMS were measured for the second time during the project. The summarised measurement values in this eighth measurement meeting (January 27, 1999) and comparison to previous measurements (November 19, 1998) are brought forward in Figure 11.5-1, where it can be seen that the new scores are even or higher compared to previous situation. The answers show that the change project was proceeding almost according to plan.

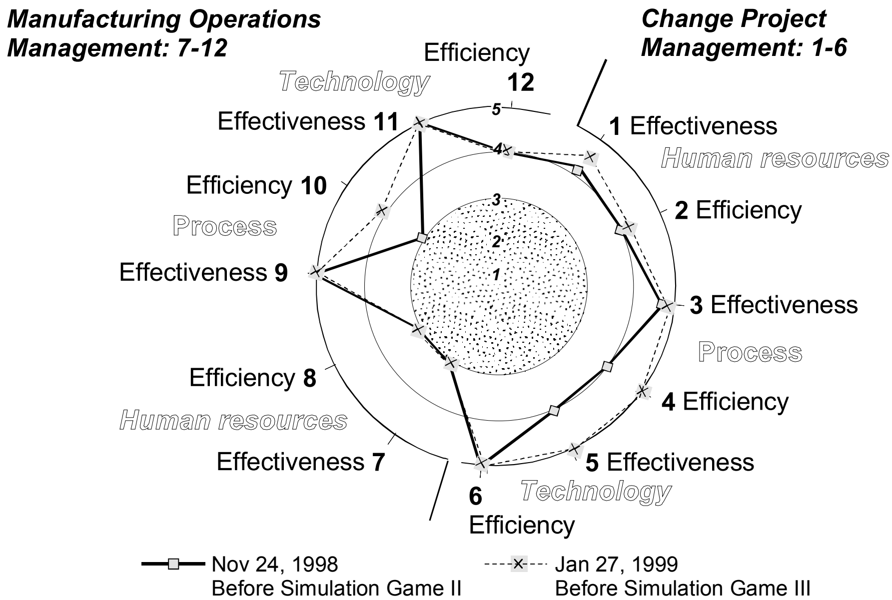


Figure 11.5-1. Summarised measurement values according to CMMS.

This eighth measurement caused two primary reactions that are noteworthy. Firstly, Process Efficiency of Manufacturing Operations Management, i.e., throughput times and work-in-process inventories, as stated in the change project objectives was not known clearly enough and not measured as was planned. Due to measurement, the detection and clarification of missing values were started. Secondly, the measurement concerning Process Effectiveness of Change Project Management set off a refinement of resource planning.

Consequently, the measurement results show that improvement has taken place in both main measurement dimensions: change project management measurement values and operational excellence measurement values. The applied measurement questions are brought forward in Appendix C on pages C2–C4.

The ninth measurement checking point was one day before the third simulation game when PMT informed the new change project participants, i.e., a new group of blue-collar employees, of the following matters: objectives and visions of the company, objectives of the project, manufacturing terminology, change management measurement viewpoint, motivation, project history, and both new production and production control principles. In addition, a one-hour simulation game exercise was performed. Finally, a human resource related measurement questionnaire was filled in by the change project personnel. Examples of the measurement questions are brought forward in Appendix C on pages C6–C8. The summarised measurement results are brought forward in Figure 11.5-2, where a big difference can be seen when comparing answers of blue-collar employees (number of respondents 10) to answers of Project Managers 1 and 20, and Production Manager (number of respondents 3). This indicates that managers and blue-collar workers have different views and a different level of understanding of the project.

The measurement results showed that project objectives were satisfactorily known as well as manufacturing terminology but top management sponsorship, information, innovative climate, meaningfulness and motivational level of the project personnel could have been better. It was concluded that Managing Director should be involved in the project – he finally took part after the third simulation game in a debriefing meeting (March 30, 1999). The third simulation game itself was believed to enhance innovative climate, information and motivation of the change project personnel.

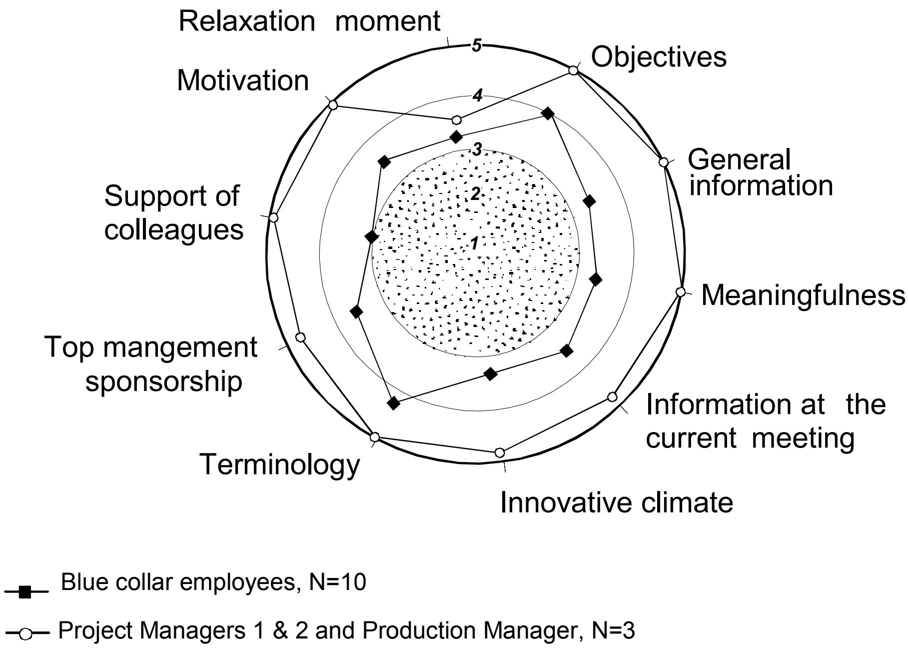


Figure 11.5-2. Summary of measurements one day before the third simulation game.

11.6 Third simulation game and debriefing

During the third simulation game it could be observed that project personnel started to become enthusiastic and understand the new production and production control principles. In the end of the third game the tenth change project management measurement concerning mainly human resource related matters was performed (March 18, 1999, number of blue-collar respondents 10, number of managerial respondents 3). The results brought out that the third simulation game had worked as meant or even a little better than previously was believed by PMT. The summarised results are shown in Figure 11.6-1 where it can be seen, in particular, that the difference between the answers of managers and blue-collar employees is smaller compared to the difference before the third game as shown in Figure 11.5-2. Examples of the measurement questions are brought forward in Appendix C on pages C9–C12.

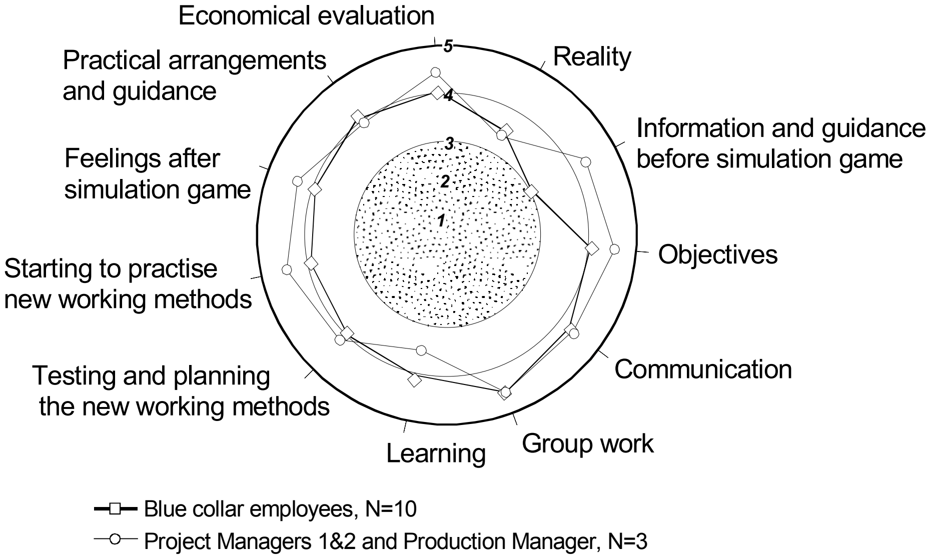


Figure 11.6-1. Summarised measurements concerning the third simulation game.

The eleventh change management measurement was after the third simulation game in a project management team meeting. The previous measurements were examined and all twelve dimensions in CMMS were measured by PMT for the third time during the project. The summary of measurements is brought forward in Figure 11.6-2. The applied measurement questions are brought forward in Appendix C on pages C2–C4.

Compared to the previous measurements changes have happened in five measurement dimensions. Firstly, the value concerning Human Resources Effectiveness of Change Project Management has fallen a little due to a decrease in top management sponsorship. Secondly, Human Resources Efficiency of Change Project Management has improved due to increased human resource involvement. Thirdly, Process Effectiveness of Change Project Management has improved due to improved planning concerning timetables, budgets and resources. Fourthly, Human Resource Effectiveness of Manufacturing Operations Management has developed because the blue-collar employees have been encouraged to learn multiple skills. Fifthly, Process Efficiency of Manufacturing Operations Management has improved because, eventually, it could be judged that the operational values concerning the development objectives were known and measured systematically.

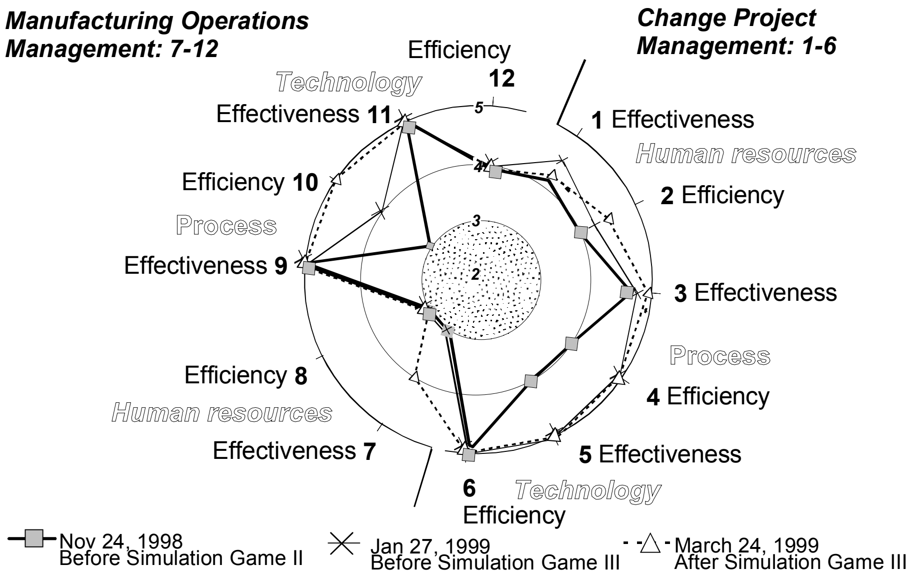


Figure 11.6-2. Summarised measurement values according to CMMS.

Based on measurements and observations during the last simulation game it could be concluded that the project was now proceeding as desired. Analysis of simulation game results supported the view that the development ideas should be implemented in reality. In particular, the results showed that manufacturing throughput time could be decreased 73% on average and that WIP inventory could be reduced 89% in reality while at the same time volume could be increased 49%. The Production Manager concluded that it is difficult to decide anything other than to proceed into implementation of planned changes.

The twelfth change management measurement took place in a debriefing meeting concerning the third simulation game (March 30, 1999). The measurement concerned human resource and simulation game related subject matters as summarised in Figure 11.6-3. Examples of the measurement questions are brought forward in Appendix C on pages C9–C12. The measurement results were analysed in the implementation planning meeting by PMT. The analysis showed that motivational level of blue-collar employees was acceptable but could be higher as well as the innovative climate. The blue-collar employees in the change project were relatively willing to begin practising new working methods. Top management sponsorship was experienced as satisfactory. Furthermore, in Figure 11.6-3 it is shown that there is again a big difference between the answers of the change project managers (number of respondents 2) and blue-collar employees (number of respondents 9).

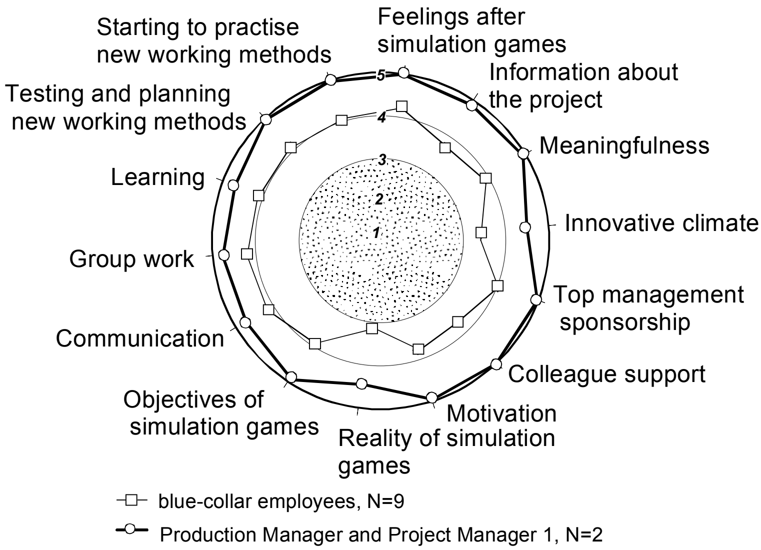


Figure 11.6-3. Summary of measurements concerning the third simulation game and its debriefing.

The implementation project was nominated as Team 2000 and it was decided to proceed according to the following steps:

1. Nomination of Project Manager, project management team, project group, and preparation of a detailed implementation plan (April 1999)
2. Information for the whole manufacturing personnel (May 1999)
3. Detailed implementation plan prepared (June 1999)
4. Implementation after summer holidays (Autumn 1999).

The objective was, from this point on, to concretise planned changes in reality. At this point, the simulation game intervention was over as well as active participation of the researcher as a change agent. However, the researcher continued to follow-up how the project was proceeding by having contact with PMT members on a monthly basis during the implementation phase.

11.7 Measurements after implementation planning

In October 1999, PMT wanted more information about the willingness to change among the members of the first new team, and a measurement survey was applied. The results showed that willingness to change was great. Invested work hours were not measured. The first new team, called Team 2000, started to operate fully according to a new production control principle in a new layout in the beginning of November 1999. Experiences were positive and encouraging in terms of manufacturing throughput time and work-in-process inventory as can be seen from Tables 11.7-1 and 11.7-2. Throughput time increase in December 1999 were due to customers cancelling orders. The other planned teams were scheduled to start after Team 2000 had been properly established.

Table 11.7-1. Comparison of manufacturing throughput times [%] per month between June (100%) and December 1999 (110%).

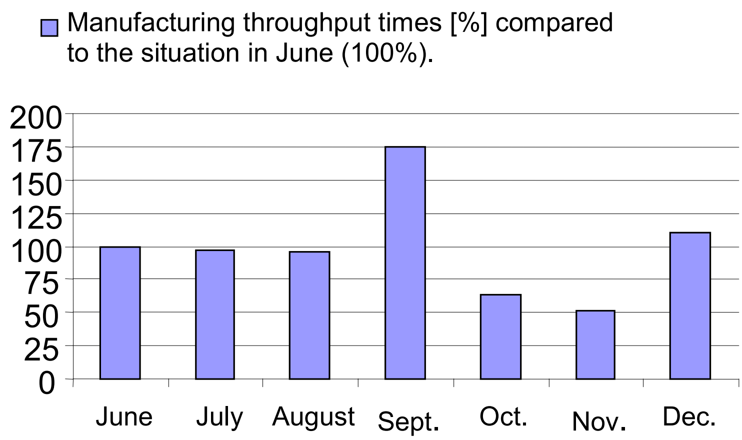
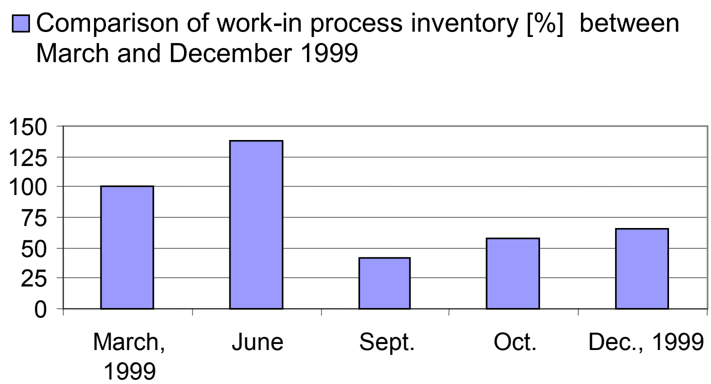


Table 11.7-2. Comparison of work-in-process inventory [%] between March (100%) and December 1999 (63%).



11.8 Feedback discussion

The researcher had a feedback discussion with Production Manager and Production Manager of Case H on December 22, 1999. The purpose was to evaluate and discuss the influence of CMMS on the project. The comments of Project Manager and Production Manager are summarised below:

1. It was useful to know how well manufacturing terminology was understood among project personnel. It helped us.
2. By measuring we could see that the values were not alarming.
3. Format of measurement questionnaires could be improved.
4. In reality, efforts are always needed to inform the project personnel.
5. We could have examined more carefully human resource related measurements.
6. Feedback information from simulation game sessions was essential.
7. Most of the measurement values were on the positive side, i.e., above 3, and we could proceed with the project.
8. The applied measurements and simulation games assisted in creating a positive attitude and helped in team formation.
9. It is good for the project management team to know whether the project is proceeding on the right path, measurements give something concrete about what the project personnel think.
10. Measures about how well the simulation game reflected reality could have been formulated differently or more broadly, e.g., we could have measured different aspects of reflected reality in games.
11. CMMS helped us to remember the important issues during the project.
12. We should have compared invested man-hours to budgeted man-hours but the problem was that we did not budget man-hours. On the other hand, it is a little bit difficult to record man-hours for the project because of other works to be performed. If we think of the project as an investment, this experience helps us to budget projects in future. If we did the same project now we would budget it properly.
13. Measurements related to simulation game technology could have been taken into technology measures in the twelve dimensional CMMS.
14. Human resource and simulation game related measures worked very well as a project sales tool for both the blue- and white-collar personnel in the last debriefing meeting, i.e., the results were not bad.
15. It would be a good idea to measure in future too, e.g. innovation climate etc.

11.9 Summary

Case Factory H is a supplier in the electronics industry, but the products are mainly made of sheet metal. The number of workers in the process under development was 60. The definition of the change objectives, project plan, measures for the change and data needs for process modelling were started at the project kick-off. The challenging objectives concerned manufacturing throughput times, work-in-process inventory, production volume, identification of process bottlenecks, commitment of the employees, measurement and management of the change project.

Project Manager 1, Project Manager 2, deputy to Project Manager 2, Production Manager, Managing Director, a group of blue-collar employees and the researcher took part in the project. The project management team included the researcher, Project Manager 1, Project Manager 2, deputy to Project Manager 2, Production Manager and a production supervisor. Originally, the project management team planned to arrange two simulation games, as the basic approach is according to the applied change management method, but finally the project ended up with three simulation games.

The project management team defined objectives for the project in the kick-off meeting after which the first change management measures for the project were defined according to the twelve dimensional CMMS. Information about the project for the project personnel was given the first time three weeks before the first simulation game. The information was repeated in the morning of the first simulation game day after which the project management team **measured for first time** human resources related subject matter. The analysis of measurements showed that the development objectives were clear almost to all and that some technological terms were still not understood by the project participants. It was concluded that general information, the meaningfulness and innovative climate could be better.

The second measurement concerning human resource related subject matters happened after the end of first simulation game. The measurements were firstly analysed in a project management team meeting. The results showed that there is need for improvement. The measurement values reflected the managerial discontinuity in project – Project Manager 1 was absent when the simulation game model was built up and played. It was concluded that PMT should pay more attention to game model building and to the quality of information meetings when the project proceeds.

An information, feedback, debriefing and idea generation meeting was held after the first simulation game. The company's strategy, project objectives, visions as well as central terminology in production were told again to the project personnel at the beginning of the meeting, thereafter, during brain storming, plenty of development ideas were generated. This was thought to reflect the commitment of the personnel to the change project. **The third measurement** happened after the idea generation meeting when human resource related subject matters were measured. The measurement values showed slight improvements since previous measurement.

The fourth change management measurement happened before the second simulation game when Process Effectiveness of Change Project Management was monitored by Production Manager, Project Manager 1 and by the deputy to Project Manager 2. Both Production Manager and Project Manager 1 agreed that determination of budgets and resources could be improved. In addition, Project Manager 1 thought that the project objectives and milestones could be clearer. The results were discussed and the project plan was refined. However, no attention was paid to improving the budget and determination of resources because it was believed that no formal budget and resource determinations are needed.

The fifth measurement happened still before the second simulation game, at a PMT meeting where all the aspects according to the twelve dimensional CMMS were monitored for the first time. CMMS reminded and pointed out to PMT the central matters in change and worked not only as a checklist of what still should be measured but also what should have been measured.

The second simulation game seminar started with information about objectives and about the new manufacturing system model, which was then simulated. **The sixth measurement** was conducted at the end of the simulation game seminar when experiences concerning the simulation game were evaluated through a questionnaire survey. The results showed that the game had worked better than the previous one, but that there is still need for improvement. The simulation model was new to every player and extra efforts were needed to achieve understanding of how the new model would work; this might have influenced the evaluations.

The simulation game results were inspected and analysed first at project management team meeting following the second simulation game. The results showed that throughput time could be improved 70% on average and that work-in-process inventory could be reduced 50% compared to reality. Finally, it was concluded that radical improvements could be achieved in reality if planned changes were realised.

The seventh measurement was in the debriefing and information meeting arranged for the change project personnel after the second simulation game. Human resource related measures were utilised to find out how well the project was performing. When attempting to construe the measurement results, it was proposed that the answers showed that information during the debriefing of the second simulation game was evaluated little worse than during the first game. This probably reflected the fact that the developed way of working was new to every player during the second game. On the other hand, understanding of objectives, manufacturing terminology, top management sponsorship were quite good. However, understanding of the new production model and production control model, meaningfulness, and support of colleagues could have been better. It was also argued that motivational level should be higher. Consequently, a third simulation game was decided to be arranged with a new group of blue-collar employees and also with a different product group than previously. The objective was to get more personnel involvement and to ensure that the new ideas were truly understood and that the new ideas would work with some other product groups as well.

The eighth measurement was conducted at a project management team meeting when all the twelve dimensions of CMMS were monitored for the second time during the change project. The answers showed that the change project was proceeding almost according to plan. This eighth measurement caused two primary reactions that are noteworthy. Firstly, Process Efficiency of Manufacturing Operations Management, i.e., throughput times and work-in-process inventories, as stated in the change project objectives was not known clearly enough and not measured as was planned. Due to measurement, the detection and clarification of missing values were started. Secondly, the measurement concerning Process Effectiveness of Change Project Management set off a refinement of resource planning. Consequently, the measurement results showed that improvement had taken place in both main measurement dimension.

The ninth measurement checking point was one day before the third simulation game when the project management team informed the new change project participants about objectives and visions of the company, objectives of the project, manufacturing terminology, change management measurement viewpoint, motivation, project history, and both new production and production control principles. In addition, a one-hour simulation game exercise was performed. Finally, a human resource related measurement questionnaire was filled in by the change project personnel. The measurement results showed that there is a big difference when comparing answers of blue-collar employees to answers of Project Managers 1 and 2 and Production Manager. This indicated that managers and blue-collar workers have different views and a different level of understanding about the project. However, the measurement results showed that the change project objectives were satisfactorily known as well as manufacturing terminology but top management sponsorship, information, innovative climate, meaningfulness and the motivational level of the project personnel could have been better.

During the third simulation game it could be observed that the project personnel started to be enthusiastic and understand the new production and production control principles. In the end of the third game **the tenth change project management measurement** concerning mainly human resource related matters was performed The results brought forward that the third simulation game had worked as meant or even a little better than previously was believed by PMT. **The eleventh change management measurement** was after the third simulation game in a project management team meeting. The previous measurements were examined and all the twelve dimensions in CMMS were measured by PMT for the third time during the project. Compared to the previous measurements changes have happened in five measurement dimensions. Firstly, the value concerning Human Resources Effectiveness of Change Project Management had fallen a little due to a decrease in top management sponsorship. Secondly, Human Resources Efficiency of Change Project Management has improved due to increased human resource involvement. Thirdly, Process Effectiveness of

Change Project Management has improved due to improved planning concerning timetables, budgets and resources. Fourthly, Human Resource Effectiveness of Manufacturing Operations Management has developed because the blue-collar employees have been encouraged to learn multiple skills. Fifthly, Process Efficiency of Manufacturing Operations Management has improved because, eventually, it could be judged that the Process Efficiency measures of Manufacturing Operations Management were known and measured systematically. Based on measurements and observations during the last simulation game it was concluded that the project was proceeding as desired. Analysis of simulation game results supported the view that the development ideas should be implemented in reality.

The twelfth change management measurement took place in a debriefing meeting concerning the third simulation game. The measurement concerned human resource and simulation game related subject matters. The analysis of measurements showed that the motivational level of blue-collar employees was acceptable but could be higher as well as the innovative climate. The blue-collar employees in the change project were relatively willing to start to practise new working methods. Top management sponsorship was experienced as satisfactory. Furthermore, there was again a big difference between the answers of the change project managers and blue-collar employees.

Finally, the researcher had a feedback discussion with Production Manager and Production Manager of Case H. The purpose was to evaluate and discuss the influence of CMMS on the project. Comments of Project Manager and Production Manager supported the usefulness of the applied change management measurement system.

12. Comparison of the case projects G and H

Case projects G and H are compared in this chapter in order to do a cross-case search for patterns. That is, to list similarities and differences between the case projects. According to Eisenhardt (1989) this tactic forces researchers to look for the subtle similarities and differences between cases and can lead to more sophisticated understanding. Cases G and H are compared according to the project organisation, objectives and according to the project performance in the different phases of the project. The comparison of project performance is done by examining phase by phase how CMMS was applied, and what was the influence of measurement and project activities on the projects. In particular, in order to find out the advisable measurement process, a comparison of how CMMS measurement checkpoints differed throughout the projects G and H. Thus, also the realised project trajectories are compared and discussed through project schedules and time observations.

The project organisations G and H and their development objectives are compared in Section 12.1, after which the project performances are compared in Sections 12.2–12.6 according to the project stages and measurement points as brought forward in Figure 12-1.

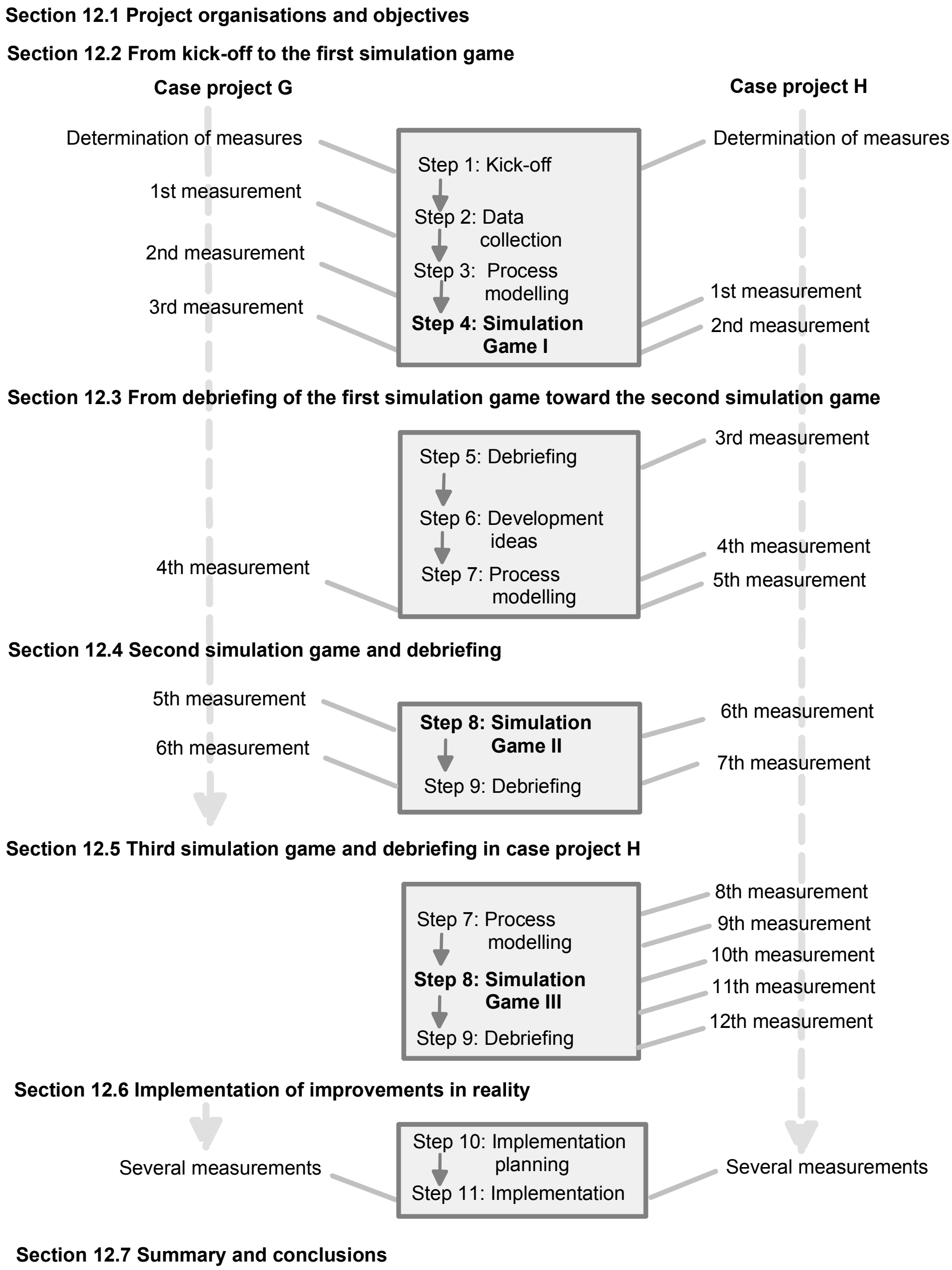


Figure 12-1. The structure of Chapter 12 is arranged chronologically according to the project stages.

12.1 Project organisations and objectives

Both Case Factories G and H provide manufacturing services for the electronics industry. The main products in Case G include circuit boards while in Case H the products are mainly made of sheet metal. Case Factory G employed 300 people while 120 people were employed in Case H. The number of people working in the manufacturing process under development was 120 in three shifts in Case G and 60 in one shift in Case H. Consequently, when thinking of number of the people on the day shift, the manufacturing processes in the case projects G and H are reasonably similar in size and in this sense meaningful comparisons can be made.

The case projects G and H are fairly similar according to the four organisation variables by Smeds (1994) for innovation and learning:

1) Task: Both of the project organisations are pursuing radical improvements in manufacturing processes with the same degree of autonomy, see objectives in Table 12.1-1.
2) Formal organisation: In both cases the Production Manager is superior to the nominated Project Manager who is the development engineer in the manufacturing organisation. The Production Manager reports to the management group.
3) Informal organisation: the project group in Case G is to some degree younger than in Case H, see age distribution in Table 12.1-2, no other meaningful differences in this sense could be found between Cases G and H.
4) Individual: From this viewpoint the case organisation G has an advantage over the case organisation H namely, the simulation-game-based change process had been experienced by the Project Manager and Production Manager of Case G (see Case D in paragraph 8.1) one year earlier while the change process was totally new to the Project Manager and Production Manager of Case H.

Table 12.1-1. Comparison of objectives between Case G and Case H.

Objectives of the project	Case G	Case H
Manufacturing throughput times	to reduce by 50%	down to 48 hours (i.e., to reduce a lot more than 50%)
Work-in-process inventory	to halve	to halve
Volume increase	to guarantee volume increase	to double the volume
To commit employees to the project	Yes	yes
Identify bottlenecks in production	Yes	yes
To measure and manage the change project	Yes	yes

Table 12.1-2. Age distribution of the project group in Case G and in Case H during the first two simulation games.

	Case G			Case H		
Age	Number of emloyees	Project Manager	Production Manager	Number of emloyees	Project Managers	Production Manager
18–25	2			2		
26–35	11	1	1	4	2	
36–45	2			1		
46–55	2			2		1
56–65				1		
$\sum$	17	1	1	10	2	1

When comparing the case projects G and H according to the psychological demand/decision latitude model by Karasek and Theorell (1990) it can be argued that in both cases psychological demands are high because of radical improvement objectives. In Section 4.4.2, it is brought forward that simulation gaming facilitates empowerment. Thus, it can be suggested that conditions for decision latitude in both of the case projects are reasonably similar because of simulation game intervention. In practice, an attempt to measure decision latitude was made through human resource related questionnaire surveys during the project (see e.g. Appendix C: page C7 question 9, and page C12 question 39).

No meaningful differences could be found when comparing cases G and H according to six major organisational design elements brought forward by Mohrman and Cummings (1989, p. 52). It can be proposed that both case organisations are somewhat more on the innovative side than on the traditional side and that both of the case organisations are striving to be more innovative than before.

12.2 From the project kick-off to the first simulation game

The first phases of the case projects G and H, i.e., from the kick-off to the first simulation game, are brought forward in Figure 12.2-1. The central events during the projects, related time observations concerning the schedule, measurement activities and invested work time in both of the case projects are shown in more detail in Tables D-1 and D-2 in Appendix D. The four main differences in measurement activities between the case projects G and H in the first project phases are as follows:

Firstly, the project objectives and the first versions of change management measures are determined in Case G at the project kick-off while in Case H the objectives are set at the project kick-off but the first change management measures are determined 19 days after the kick-off. In addition, target values for the measurements were set in the case project G but not in the case project H. Basically, the measures determined according to CMMS were the same in both of the case projects. Secondly, all the twelve dimensions in CMMS were measured three times in Case G but not a single time in Case H as can be seen in Figure 12.2-1. The first measurement caused replanning and budgeting in Case G. Thirdly, in Case H, Project Manager 1 is absent during the first simulation game and Project Manager 2 tries to replace him but experiences unplanned extra work in too short a period. Therefore advance preparations for the game in Case H are not as good as they could be and are not as good as in Case G where the same Project Manager is present during the first simulation game. Also, Case G has better scores compared to Case H in human resource related measurements in the first simulation game as summarised in Figure 12.2-1 (see also Figures 10.2-1 and 11.1-2). Fourthly, Case G has better employee involvement and top management sponsorship than Case H has. The number of employees involved is 18 in Case G and 9 in Case H. Case G had one-hour top management involvement while in Case H top management did not spend time with the project group.

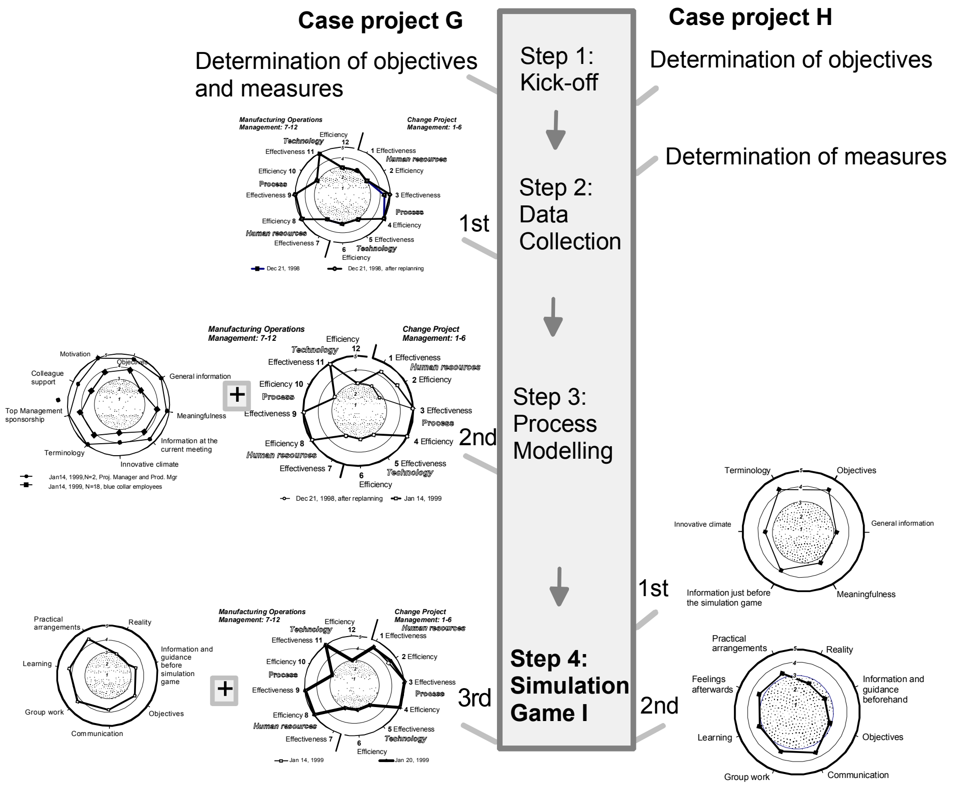


Figure 12.2-1. Measurements in the case projects G and H in the first project phases.

In addition, in these first project phases, the following three differences in project trajectories in terms of measurement checkpoints and time observations can be found between Cases G and H. Firstly, in Case G, the time span from the project kick-off to the first simulation game is **117 days**, that is, 55% of time until first the implementations in reality, while the respective time span in Case H is **47 days**, that is, 11% of calendar time until the first implementations in reality. Consequently, there was more time for data collection and for building a simulation model in Case G than in Case H. Secondly, the information for the change project personnel is given and human resource related measures applied four days before the first simulation games in Case G (2nd measurement concerning Case G in Figure 12.2-1) while in Case H the respective human resource related measures are not applied until the morning of the first simulation game (1st measurement concerning Case H in Figure 12.2-1). Thus, in Case G, PMT had time to react to the measurements before the first simulation game and give feedback to project personnel on a timely basis. In Case H, feedback is given later in the next debriefing meeting. Thirdly, the cumulative amount of invested working hours in Case G is **479** in the end of the first simulation game. That is, 52% of invested work hours until implementation planning. In Case H, the cumulative amount of invested working hours is **224** which is 27% of invested work hours until implementation planning. Consequently, it can be proposed that, in these first project phases, the project has been taken more seriously in terms of work time investment (Human Resource Efficiency measure of Change Project Management) in Case G than in Case H.

12.3 From debriefing of first simulation game toward the second simulation game

In both of the case projects, the results of the first simulation game and measurements were examined firstly by PMT after which the results were discussed by all the project participants in the debriefing and idea generation meeting. A summary of the measurements is brought forward in Figure 12.3-1. Plenty of development ideas were created in both of the case projects.

The five main differences in measurements between Cases G and H are as follows (the details are shown in Tables D-3 and D-4 in Appendix D). Firstly, the measures were applied only once in Case G while three measurements were performed in Case H. Secondly, more information is given in the debriefing meeting in Case H than in Case G because of previous feedback. That is, human resource related measurements concerning the first simulation game suggested that kind of reaction to PMT of Case H. Consequently, human resource related

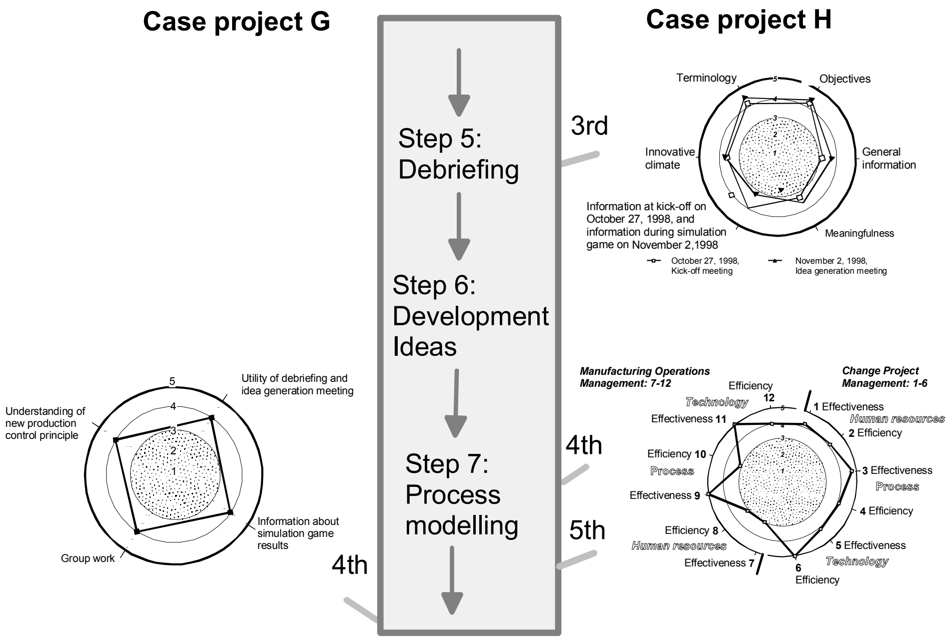


Figure 12.3-1. Summarised measurements between the first and second simulation games.

measures are applied again in Case H (3rd measurement) and results examined by PMT. The respective measurement was not necessary in Case G because the measurement values were acceptable already in the previous project phase. Thirdly, in Case H, Process Effectiveness of Change Project Management (primarily quality of planning) was measured in the project management meeting for the first time after the idea generation meeting (4th measurement). The result was project schedule refining but no attention was paid to improving budget and determination of resources. This measurement was not necessary in Case G at this phase of the project, because respective measurements together with necessary reactions were conducted earlier in Case G. Fourthly, five days after the measurement of Process Effectiveness of Change Project Management, all the twelve dimensions in CMMS were measured for the first time in Case H (Fig. 11.3-1). This measurement facilitated discussion concerning measures and thus helped PMT to improve measures to be applied. This measurement activity in Case H happened a lot later compared to Case G where all the twelve dimensions in CMMS, and in particular the Process Effectiveness of Change Project Management, had already been measured for the first time before the first simulation game. Consequently, Case G could react to measurements before the first simulation game. Fifthly, feedback about idea generation together with the information about the new manufacturing process model for the second simulation game is given to the project personnel of Case G one day before the second simulation game. After this meeting human resource related subject matters concerning the previous idea generation and current information were measured (4th measurement, see also Figure 10.2-3). In Case H, feedback about idea generation meeting and information about the new process model concerning the second simulation game was given in the morning just before the second simulation game started. However, this information meeting was not measured at all in Case H as it was done in Case G. Consequently, PMT and project personnel in Case G were better prepared for the second simulation game than PMT and project personnel in Case H.

The two main differences in the project trajectories in terms of measurement checkpoints and time observations can be identified. Firstly, in Case G, a debriefing and idea generation meeting is held 21 days after the first simulation game and 139 days after project kick-off. In other words, 63% of calendar days until the first implementations in reality has been spent at this point. In Case H, debriefing and idea generation meeting is held 5 days after the first simulation game and 52 days after project kick-off (i.e., 12% of calendar days until the first implementations in reality). The Project Manager in Case G worked 14 hours in this project phase while Project Manager in Case H worked 6 hours. Thus, the project management team of Case G had more time to prepare the debriefing meeting than project management team of Case H.

Secondly, the number of involved blue-collar employees is 18 in Case G and 8 in Case H. In this phase of the project, the invested working hours are 62 in Case G, and 27 in Case H, or 3.1 hours per person in Case G and 2.5 hours per person in Case H. The cumualtive invested working hours from the project kick-off are **541** in Case G, i.e., 58% of invested hours until implementation planning. In case H, the cumulative invested working hours from the project kick-off are **251**, i.e., 31% of all invested hours until implementation planning. Thus, the cumulative invested working hours in Case G are twice as much as in Case H. This indicates again, that the project has been taken more seriously in terms of work time investment in Case G when compared to Case H.

12.4 Second simulation game and debriefing

The three most meaningful differences and similarities between the cases G and H concerning measurement activities during the second simulation game and its debriefing can be identified (see Figure 12.4-1).

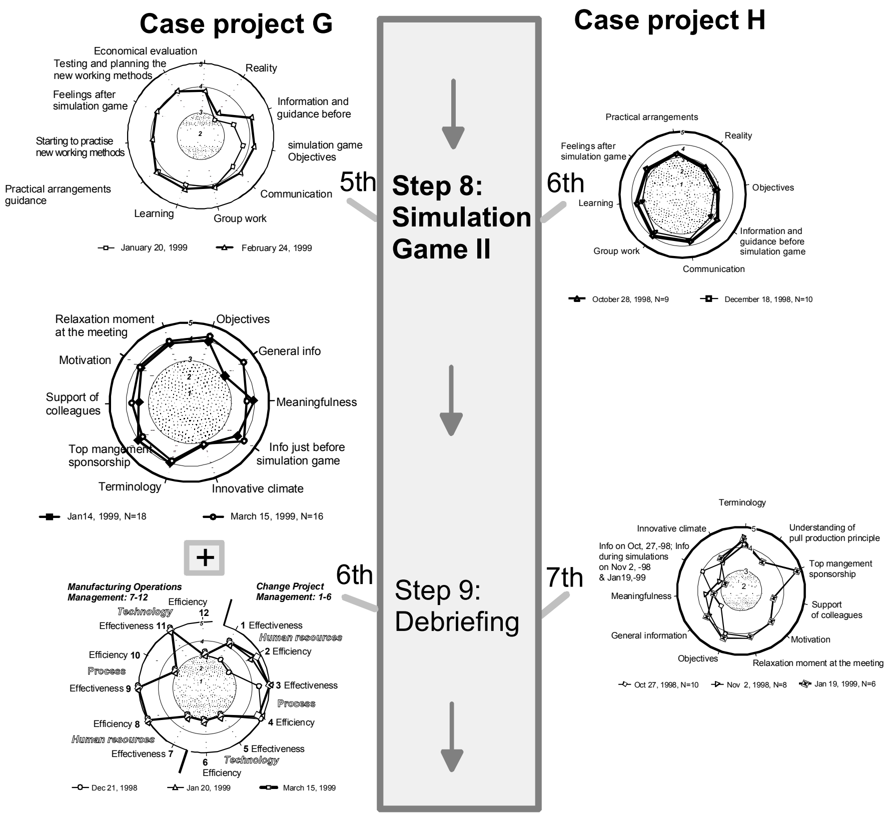


Figure 12.4-1. Summarised measurements in the second simulation game and debriefing.

Firstly, human resource related subject matters were measured after the second simulation game in both case projects G and H. The measurement results were then analysed in both of the case projects G and H at the project management meeting and later the results were presented to the other change project personnel in the feedback and debriefing meeting. Both of the case projects G and H had improved performance since the first simulation game but Case G (5th measurement) had better scores than Case H (6th measurement). Measurements for Case G are brought forward also in Figure 10.3-1 (average value of all the measurement dimensions is 4.1, N = 17) and for Case H in Figure 11.4-1 (average value of all the measurement dimensions is 3.4, N = 10). Thus, it is argued that the second simulation game worked better and was more successful in Case G than in Case H.

Secondly, after the feedback and debriefing meeting concerning the second simulation game, human resource related subject matters were measured in both case projects. Summarised answers in Figures 10.3-2 and 11.4-2 show that the average score of all the measurement dimensions is about the same (3.9) in Case G and Case H: the difference is that the number of respondents is 16 in Case G and only 6 in Case H. This reflects the fact that Case G had better human resource involvement and commitment to change.

Thirdly, in addition to debriefing, implementation planning was discussed and communicated to the change project personnel in Case G at this point. Although the simulation game results in Case H showed that development objectives are achievable in reality, PMT argued that understanding of new production model, motivational level, personnel involvement and support of colleagues among project personnel should and could be better. Consequently, it was decided to arrange a third simulation game in Case H.

The four main differences in the project trajectories in terms of measurement checkpoints and time observations can be identified. Firstly, in Case G, the second simulation game was played according to the new ideas after **14 days** after idea generation, or 154 days after the project kick-off, i.e., 73% of calendar days until the first implementations were spent. In Case H, the second simulation game was played **38 days** after idea generation, or days 98 after the project kick-off, i.e., 23% of calendar days until the first implementations were spent. Secondly, the number of involved blue-collar employees is 18 in Case G and 11 in Case H in this phase of the project. In Case G, the total amount of invested working hours in this project phase is **386**, i.e., 42% of all invested hours until implementation planning. In Case H, total amount of invested working hours in this project phase is **234**, i.e., 29% of all invested hours until implementation planning.

Thirdly, in this project phase, the invested working hours by Project Manager in Case G is 40 and 93 in Case H. One reason for this difference could be the fact that the Project Manager in Case H was absent in the first simulation game and now he had to work more. Fourthly, cumulative invested hours from the project kick-off are **927** in Case G, i.e., 100% of all invested hours until implementation planning. In Case H, all the invested hours from the project kick-off are **485**, i.e., 59% of all invested hours until implementation planning. Consequently, Case G has invested thus far, during the whole project, 1.9 times more working hours than Case H. Used calendar days from the project kick-off are 173 (82% of time until first implementations in reality) in Case G and 138 (33% of time until first implementations in reality) in Case H.

The outcomes in the end of this project phase are as follows:

- Case G has done implementation planning; and
- Case H is planning the third simulation game.

The detailed description of central events, measurement activities, time observations and work time investments of Cases G and H, in this project phase, are brought forward in Tables D-5 and D-6 in Appendix D.

12.5 Third simulation game, and debriefing in the case project H

The third simulation game was not needed in Case G but arranged in Case H with another product group and with a new group of blue-collar employees when compared to the first and second simulation games. Central events, measurement activities and invested working hours during this phase of the project are shown in Tables D7 and Table D8 in Appendix D. Based on experiences on the second and the third simulation game rounds implementation planning is started **217** days after the project kick-off in Case H (i.e., 51% of calendar time until the first implementations in reality) while in Case G it took **173** days (82% of calendar time until the first implementations in reality), in this sense Case G was 44 calendar days faster. At implementation planning phase, the difference in cumulative invested hours from the project kick-off between Cases G and H is 109 hours: **818** hours were spent in Case H and **927** hours in Case G.

A summary of measurement activities in Case H in this last project phase is brought forward in Figure 12.5-1. The measurements are not explained again here as the explanations can be found in Chapter 11.

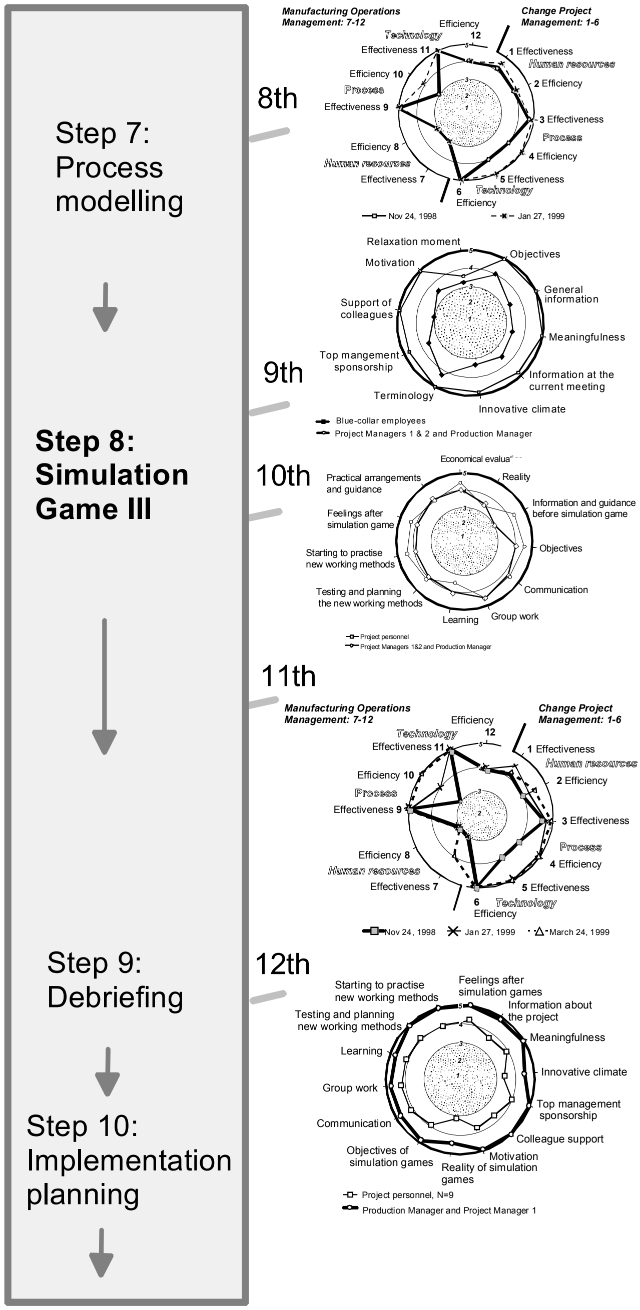


Figure 12.5-1. The summarised measurements in the last simulation game phases of Case H.

12.6 Implementation of improvements in reality

In Case G, the first implementations took place **211** days after project kick-off. In Case H, it took **422** days to get first changes implemented, see Table 12.6-1. In other words, Case G was twice as fast as Case H in first implementations in reality.

Table 12.6-1. Comparison of Cases G and H according to the time span from the project kick-off until the first implementations in reality.

	Case G	**Case H**
Central events during the project	**Days from the project kick-off**	**Days from the project kick-off**
First implementations in reality	211	422

12.7 Summary and conclusions

It is argued that the case projects G and H are reasonably similar in terms of organisation and objectives for meaningful comparisons despite the fact that Project Manager and Production Manager of Case G had experienced simulation-game-based change process one year earlier while in organisation of Case H has no previous experience. The application of CMMS was a new experience for both of the case organisations G and H.

In the first phase, i.e., from kick-off to the first simulation game, the most meaningful differences from change management point of view between Cases G and H are as follows:

1. In Case G, project performance is measured according to all of the twelve dimensions in CMMS and the consequent corrections to the project plan were done while in Case H respective measurements were conducted after debriefing of the first simulation game.
2. In Case G, human resource related measures were utilised after the first information meeting, and feedback was given to the project personnel before the first simulation game; while in Case H human resource related measures were applied in the morning of the first simulation game day and feedback was given until the debriefing meeting following the first simulation game.

3. Project Manager 1 of Case H is absent while Project Manager of Case G is not absent in the first simulation game.
4. The total amount of invested working hours from project kick-off to the first simulation game is **479** in Case G, i.e., 52% of invested hours until implementation planning. In Case H, the total amount of invested working hours in this first phase **224,** i.e., 27% of invested hours until implementation planning.

Consequently, it can be argued that in the first phase the case project G has had better and more timely change management performance compared to the case project H.

In both of the case projects G and H the results of the first simulation game were examined and new ideas generated in the debriefing meeting following the game. At this point, the difference was that Case G reported better measurement scores on human resource related subject matters concerning the first simulation game than Case H. Obviously this was due to better and more timely change management in the beginning of the project.

Information for the project personnel about the second simulation game is given one day in advance and measured in Case G while in Case H information is given just before the second simulation game and not measured immediately. Thus, PMT in Case H could not know clearly whether the information was understood or not before the second simulation game started. Later measurements concerning simulation game experiences revealed better scores in Case G than in Case H. After debriefing of the second simulation game implementation planning is started in Case G while Case H proceeds into third simulation game round. At this point, after 173 days from kick-off in Case G and 138 days from kick-off in Case H, and the total amount of invested work hours was **927** in Case G (100% of hours until implementation planning), and **485** in Case H (59% of hours until implementation planning).

During the third simulation round Case H improves change management performance according to measurements and finally proceeds into implementation planning. At this point, the total amount of invested work hours is **815** in Case H. The first implementations in reality were seen in Case H **422** days after the project kick-off while in Case G the first implementations could be seen **211** days after the project kick-off, i.e., Case G was twice as fast as Case H.

Based on comparisons of Cases G and H it can be suggested as a guideline that special attention should be paid to measurement and consequent timely reactions in the early phases of the project. In general, after every measurement there should be enough time for reactions before proceeding to the next project step.

13. The measured simulation-game-based change process

The emerging improvement ideas for CMMS based on Chapters 10-12 are concluded in this chapter and improvement suggestions for practising CMMS in the context of the simulation-game-based change management process are made. Thus, the outcome of this chapter is the measured simulation-game-based change process as brought forward in Figure 13-1. The measured simulation-game-based change process is a combination of the change process as described on the left side of Figure 13-1 and the change management measurement process, abbreviated CMMP, as described on the right side of the Figure 13-1.

The principal observation and development idea that emerged is that in the measured simulation-game-based change process the early phases should be performed with particular attention in order to achieve a successful project trajectory as soon as possible. In practice, the CMMS measures are selected and determined co-operatively by the facilitator and by the other project management team members in the beginning of the project. At this point a structured catalogue of previously tested and applied CMMS measures can be applied as an aid. Thereafter, the determined measures and possible emerging measures are applied in appropriate phases of the project. However, all the twelve measurement dimensions in CMMS are not monitored in every measurement point but only in those phases of the project where it is reasonable to check the overall project performance. In practice, the project management team members could consider what is the need for measurement in each project step, and whether measurement seems to be a value adding activity or not. Thus the PMT can conduct measurement activities in accordance with the emerging project situations. For example, if it is desirable, the PMT can combine the measurements from different phases of the project and draw a twelve-dimensional CMMS radar in order to get a clear picture from the overall project performance.

Optimally, the application of CMMS in the simulation-game-based change management process forms an ensemble where actions, measurements and reactions alternate. The emerged suggestions for the measured simulation-game-based change process (see Figure 13-1) are as follows:

Step 1. **Project kick-off:**

Includes planning, determination of objectives and change management measures according to all the twelve dimensions in CMMS. Close attention should be paid on this phase of the project in order to get a successful project trajectory from the very beginning. This idea is supported by the findings in the case projects G and H. Case G performed better than Case H in the first phases of the project and thereafter. Thus, it can be proposed that the success in the beginning helped Case G to achieve a successful project trajectory sooner compared to Case H. (see Section 12.7).

Step 2. Project management team meeting:

Includes measurement of all the twelve dimensions in CMMS. If measurement results imply that reactions or corrections should be made, it is highly recommended to do those reactions before proceeding to Step 3. This measurement was useful in the case project G and was omitted in the case project H.

Step 3. Project meeting:

In this meeting information about the project, terminology, and company objectives should be given to the project personnel. Measurement of human resource related subject matters concerning issues related to current information as understanding of objectives, terminology, meaningfulness and innovative climate is suggested. Feedback and corrections based on measurements, e.g., more information, should be made before the first simulation game. At this point project management team should also monitor all the twelve measurement dimensions in CMMS in order to make sure that the project is proceeding as desired. These suggested measures were performed at the right time in Case G due to which correct feedback was given and timely reactions done. Case H did not have time to react on timely basis to the respective measurements.

Step 4. Project meeting:

More information for the project personnel and feedback based on answers to previous measurements should be given and measured – as was done in Case G. In any case, an introduction to the first simulation game should be arranged, for example a short simulation game exercise, in order to make the start of the first simulation game day easier.

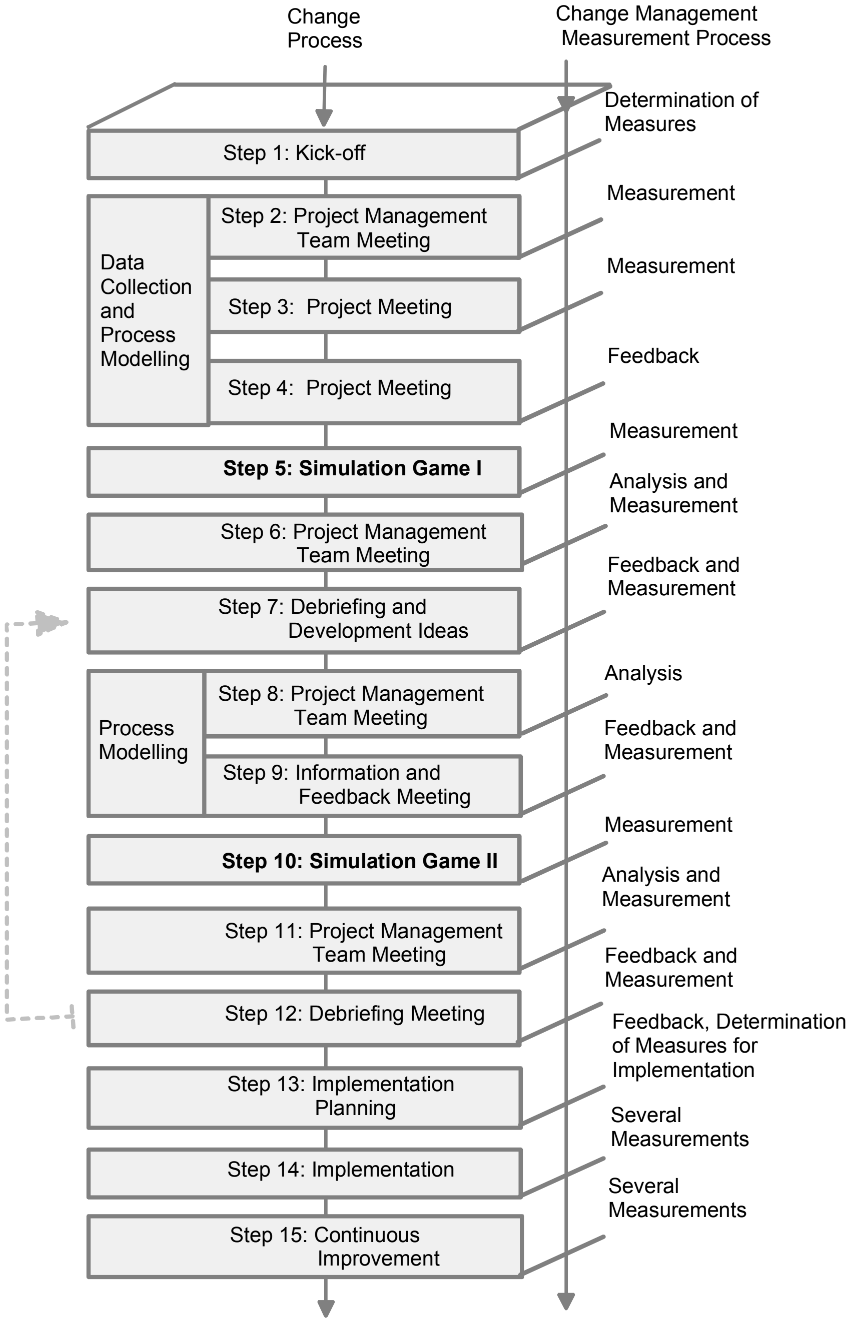


Figure 13-1. The measured simulation-game-based change process.

Step 5. **The first simulation game:**

The first simulation game day includes in the beginning a short repetition of previously given information, appropriate feedback based on previous human resource related measurements and repetition of game instructions before the actual game. The second simulation game day includes measurement of human resource related subject matters concerning the simulation game. Also emerging development ideas are asked, discussed and documented in this step. These measurements and actions helped later the project management teams of Cases G and H to evaluate the first simulation game.

Step 6. Project management team meeting:

Includes examination and analysis of previous measurements and simulation game results. In this step the project management team makes preparations for the next project meeting. In addition, if it seems reasonable, the PMT should monitor all the twelve measurement dimensions in CMMS in order to make sure that the project is proceeding as desired.

Step 7. Debriefing and idea generation meeting:

Includes debriefing of the first simulation game and brainstorming for development of improvement ideas. Feedback based on previous measurements concerning the human resource related subject matters in the simulation game is given in this step. The results of this step are new ideas about a possible solution on how the development objectives can be achieved in reality. It is suggested that human resource related subject matters concerning the current meeting should be measured in order to find out whether the meeting has worked as desired.

Step 8. Project management team meeting:

Includes examination and analysis of previous measurements and the results gained from the idea generation session. The project management team makes preparations for the next project meeting.

Step 9. Information and feedback meeting:

New development ideas together with the previous measurement results are discussed and communicated to the project personnel. In particular, it is discussed how the new development ideas will be taken into account in the second simulation game. Further ideas may also be asked at this point. Finally, it is suggested that human resource related subject matters concerning the current meeting should be measured in order to make sure that the meeting has worked as intended. In Case G, measurement assured that the project participants understand the new development ideas. This was not done in the case H.

Step 10. **The second simulation game**:

Before starting the actual simulation game a short repetition of previously given information should be given together with the appropriate feedback based on the previous project meeting and measurements. New game instructions should also be given before the game start. The second simulation game day includes measurement of human resource related subject matters concerning the simulation game experiences. In addition, further development ideas are discussed at this point. Both of the case projects G and H were measured as proposed.

Step 11. Project management team meeting:

Includes examination and analysis of the previous measurements together with the second simulation game results. The project management team makes preparations for the next project meeting, and drafts preliminary implementation plans if the project situation is mature enough. In this step, if it seems to be value-adding activity, PMT should also monitor all the twelve measurement dimensions in CMMS in order to make sure that the project is proceeding as desired.

Step 12. Debriefing meeting:

Includes debriefing of the second simulation game. The human resource related measurements concerning the second simulation game are discussed and feedback given. If the project situation is mature enough, preliminary implementation plans may be communicated to the project personnel as was done in the case project G. It is suggested that human resource related subject matters concerning the current meeting should be measured.

The result of this phase is principally the decision to proceed into implementation planning as in the case project G, or into the third simulation game round as in the case project H. In addition, if it is unclear how the whole project is performing, the project management team should also monitor all the twelve measurement dimensions in CMMS in order to make sure that the project is proceeding as planned.

Step 13. **Implementation planning**:

Includes feedback to project personnel based on measurements in the previous debriefing meeting. It is suggested that implementation planning together with determination of CMMS measures for implementation should be done at this step. This need emerged in both of the case projects G and H but was not systematically done. It can be proposed that the measures can be the same as applied in the previous phases of the project but also new measurement questions can be formulated. Lastly at this point, in addition to project personnel, other related personnel of the organisation should be strongly involved in the project. If necessary, additional simulation game round(s) may be arranged.

Step 14. Implementation of development ideas in reality

It can be recommended that the implementation phase of the project should be measured according to the principles in CMMS and according to the measures determined in Step 13. In particular, the focus of interest is on how well the objectives set in the project kick-off are met.

Step 15. Continuous improvement

It can be proposed that the developed and selected measures for manufacturing operations management are after the development project, at least partly, applicable for continuous measurement of manufacturing operations. According to emerging management needs new measures are developed and old obsolete ones discarded.

The measured simulation-game-based change process can be concluded to comprise at least the following characteristics and advantages compared to the mere simulation-game-based change process described in Chapter 5. Firstly, the preparation of the measures in the beginning of the project improves the quality of project planning. Secondly, measurement improves coherence of the project, and particularly enhances chances to achieve a successful project trajectory already in the early phases of the project. The third characteristic is that actions, measurements and reactions alternate. Thus, measurement enables the project management team to continuously improve the project performance. Fourthly, measurement improves communication, participation, and focuses the attention of the project personnel to the important factors in change.

PART III SUMMARY, DISCUSSION AND CONCLUSIONS

The last part of this research work begins by reviewing the research question, and objective, and by summarising the research. Followed by the developed change management measurement framework, system and the proposed measured simulation-game-based change process are discussed and future research topics are suggested. Thereafter the quality of this research is evaluated. Finally, conclusions are drawn. The structure of Part III can be seen in Table III-1.

Table III-1. The structure of Part III.

Chapter 14: Summary
Chapter 15: Discussion
Section 15.1: The change management measurement framework
Section 15.2: The change management measurement system
Section 15.3: The measures for change project management
Section 15.4: The measures for manufacturing process management
Section 15.5: The measured simulation-game-based change process
Section 15.6: The suggestions for future research
Chapter 16: Discussion through the quality criteria
Section 16.1: Innovative solution
Section 16.2: Pragmatic utility
Section 16.3: Validity, applicability and generality
Section 16.4: Action research process
Section 16.5: Action researcher
Section 16.6: Scientific contribution
Chapter 17: Conclusions

14. Summary

This research started with questioning *"how can change management be measured in order to help manufacturing companies develop their manufacturing processes when applying tailored simulation games as a developmental tool.*

Based on the research question the two research objectives were defined as follows:

First, pragmatic objective: "To develop and to test a measurement system for the development of discrete manufacturing processes, when applying tailored simulation games as a developmental tool."

Second, theoretical objective: "To enhance knowledge on measurement of change management in simulation-game-based manufacturing process development."

To solve the research question, and to meet the objectives the consultative (Gummesson, 1991) and constructive research methods (Kasanen et al., 1991 and 1993) and innovation action research approach (Kaplan, 1998) were combined as brought forward in Chapter 2. From the very beginning the research proceeded according to the principle of hermeneutic spiral (Gummesson, 1991) where research proceeds via a different level of pre-understanding to the next stages of understanding. The novel answers to the research question, i.e., change management measurement framework, abbreviated CMMF, and change management measurement system, abbreviated CMMS, were based on principles found in:

- project management literature in Chapter 3,
- process change management literature in Chapter 4,
- simulation game based change process literature in Chapter 5,
- performance measurement literature in Chapter 6,
- consultant survey in Chapter 7, and
- three preliminary case projects D, E and F in Chapter 8.

The constructed CMMS was then developed further by applying it for evaluation of the case projects D, E and F in Chapter 9. Thereafter, CMMS was practised, tested and further elaborated in context of the case projects G and H in Chapters 10–11. Finally, the application of CMMS in the case projects G and H were compared to gain a more sophisticated understanding about emerging patterns in Chapter 12. Improvement suggestions for change management measurement in the context of simulation-game-based change process were brought forward in Chapter 13. In the following Chapter 15, the change management measurement framework, the change management measurement system, and the measured simulation-game-based change process are discussed and reflected with theory, and future research issues are proposed. The quality of the research is discussed and evaluated in Chapter 16. Conclusions are presented in Chapter 17.

15. Discussion

15.1 The change management measurement framework

The synthesis of the developed change management measurement framework, abbreviated CMMF, is described in detail in Chapter 9.

According to Kasanen et al. (1991, 1993) practical usability, i.e., relevance, simplicity and easiness of operation are the major characteristics showing the truthfulness of a managerial construction. The idea of practical usability for managerial constructs is also supported by other authors (see e.g. Thomas and Tymon, 1982; Gummesson, 1991; Kaplan and Norton, 1996; Kaplan, 1998 and Reason and Bradbury 2001). Thus, the central principle guiding the development of CMMF was practical usability. In order to fulfil this practical usability criterion in the change management measurement framework, the change project itself and its outcomes were examined separately. Consequently, the main measurement dimensions for change management in CMMF were classified into two types of which the first type gauges change project management itself, and the second assesses the outcomes of the change project, i.e., the improvements gained in manufacturing operations. Furthermore, both of these main measurement dimensions were divided into three sub-measurement dimensions of human resources, processes and technology, which were further divided according to the principles of effectiveness and efficiency. Effectiveness was defined as the external, strategic performance: "doing the right thing," where strategically correct processes are developed, and strategically sound targets are pursued. Effectiveness includes adaptability. Efficiency was defined as the internal, operational performance: "doing it right," reaching the objectives of the change project economically and ideally with the best possible output. Consequently, CMMF forms 12 measurement dimensions out of which six dimensions gauge change project management itself and six other dimensions changes in manufacturing operations. These two proposed main measurement dimensions are logically interlinked as the development project has influence on the manufacturing operations. According to Kaplan and Norton (1996) a logical link between the measures was argued to be an important factor.

A factor that increases practical usability of the CMMF is visualisation. According to Laakso (1997) visualisation assures that all the involved stakeholders understand the measures and measurements correctly. For visualisation of CMMF, a 12 dimensional measurement radar was drawn, an example is brought forward in Figure 15.1-1 (a copy of Figure 10.1-1). In the radar, the scale of the dimensions is from 1 to 5: 1 = very poor performance, 2 = poor performance, 3 = average performance, 4 = good performance, 5 = very good performance. It can be proposed that the selected visualisation format is simple and easily understood. Radar type visualisation is also used by other authors. For example, performance measurement radars are brought forward by Camp (1995), Laakso (1997), Chapman and Hyland (1998) and Gieskes et al. (1999).

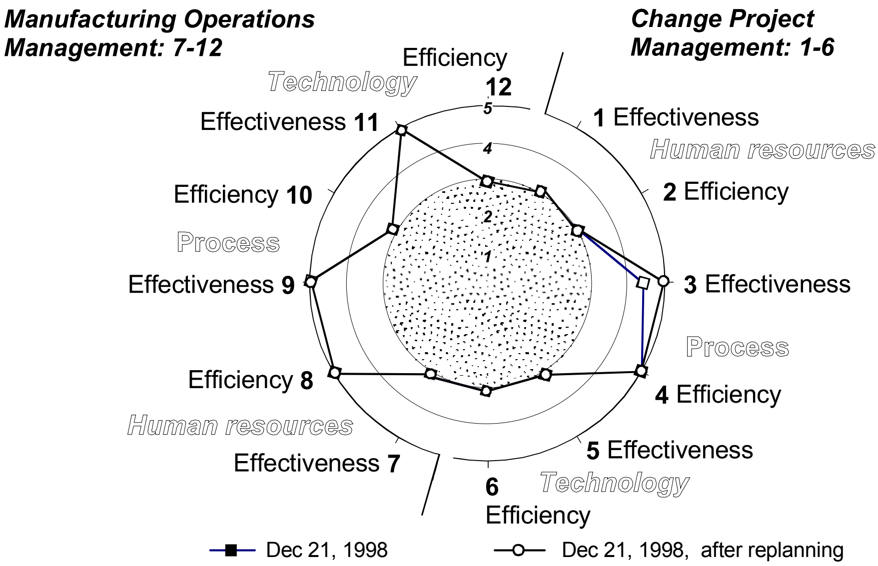


Figure 15.1-1. An example of 12 dimensional performance measurement radar according to CMMF.

After construction, CMMF was expanded into CMMS by formulating the measurement questions for the twelve measurement dimensions. Thereafter CMMS was practised in change projects G and H. Consequently, the discussion concerning CMMF continues further in the level of measurement dimensions, measures and measurement process as CMMS is discussed throughout Sections 15.2–15.5.

15.2 The change management measurement system

CMMS was tested through a questionnaire survey after three preliminary case projects D, E and F (Chapter 9). The respondents were the project personnel, Project Manager and Production Manager in each case company D, E, and F. The analysis of the survey results indicated that the developed measurement framework and system could explain differences between successful and less successful change projects in manufacturing processes. Good values in change project measurements seemed to correlate to the speed of improvement in reality. In particular, the human resource dimension of the framework was found to be essential. Furthermore, the results supported the idea that it is matter of importance to concentrate on what is strategically essential and only then concentrate on internal efficiency.

The CMMS was further elaborated in two phases. Firstly, the measures were determined and linked to the applied simulation-game-based change management method. Secondly, these measures were used, further elaborated and tested in practise in two case projects G and H after which these case projects were compared and improvement suggestions for using CMMS were given in Chapter 13. As a result, the measured simulation-game-based change process was proposed. In practice, when utilising the guidelines of CMMS, project management team members select and define measures first individually and then collaboratively together with the facilitator in the beginning of the project. Thereafter, the general guidelines of the measured simulation-game-based change process (Chapter 13) are followed, and the measures are adjusted and adapted according to the emerging circumstances during the course of the project. Consequently, it is possible that different project management teams end up with somewhat different sets of measures.

Relevance, simplicity, easiness of operation, practical usability and visualisation of measures were the pursued characteristics for the developed managerial construct. In conclusion it can be argued that these characteristics are prevalent in the change management measurement framework, system and process. In addition, typical to the change management measurement process is that measurements and reactions alternate, and that new measurement needs may arise when the change project proceeds.

Improvement suggestions for using the change management measurement system in practice were given in Chapter 13. The principal observation and development idea that emerged was that the utilisation of CMMS is a process where early phases should be performed with particular attention in order to achieve a successful project trajectory as soon as possible. In practice, CMMS measures are selected and determined collaboratively by the facilitator and the other project management team (PMT) members at the beginning of the project. Thereafter, PMT should still consider if there are emerging needs for measurement in each project step, and whether the measurement seems to be a value adding activity or not. Thus PMT can conduct measurement activities flexibly and in accordance with the emerging project situations. Monitoring of all the twelve measurement dimensions in CMMS is not needed in every measurement point in the project but only in those phases of the project where overall performance checking seem to be a value adding activity (see the suggested measures in each project phase in Chapter 13). Basically, PMT can combine the measurements from different phases of the project and check all the twelve dimensions in CMMS in order to get a clear picture of the overall project performance. It is suggested that the determined measures and possible emerging measures are applied in appropriate and mainly beforehand determined phases of the project, e.g., in the phases as proposed in Chapter 13.

15.3 The measures for change project management

The change project management measures, applied in the case projects G and H, for measuring effectiveness and efficiency of human resources, project process and technology, are evaluated and discussed in Sections 15.3.1–15.3.6.

15.3.1 Effectiveness of human resources

The suggestions for effectiveness measures of human resources (HR) were as follows:

- top management sponsorship,
- communication of corporate strategy, vision, and project objectives,

- desire of owners,
- innovative climate,
- evaluation of the understanding of objectives and communication in general.

According to experiences in the case projects G and H, these suggested measures worked. Top management **sponsorship** was discussed and evaluated in the project management meetings and thereafter the need for sponsorship was communicated to top managers. Sponsorship was also measured among the project personnel in the project meetings. **Communication** of corporate strategy, vision, desire of owners and project objectives was found to be essential. Measurements brought out in both of the case projects G and H that these issues are not easily understood. The project management team reacted to the measurements by giving more information to the project personnel. The measurement of **innovative climate** communicated to project personnel that not only new development ideas are needed but also creative atmosphere in project meetings would be good to achieve. In general, the measurement focused attention on important issues, brought out numerical values of the measured issues for evaluation and caused reactions leading to improvements. Particularly, the measurement experiences brought out the importance of communication and information related to these measurement subject matters. Through measurement the project management team could explicitly find out whether the project personnel had understood the given information.

Consequently, it is proposed that the findings in the case projects G and H bear out the measurement ideas found in the literature, and practised in the case projects as measures for Human Resource Effectiveness of Change Project Management, are valid (see e.g. Moss Kanter, 1983; Harrington, 1991; Wheelwright and Clark, 1992; Davenport, 1993; Hammer and Champy, 1993; Hannus, 1994; Kotter, 1996; Belassi and Tukel, 1996; Carnal et al., 1999).

15.3.2 Efficiency of human resources

The following measures for efficiency of human resources were proposed:

- invested time of management and employees,

- motivation: willingness to change and its opposite resistance to change, perseverance in change,
- team work skills, social skills, and educational skills,
- sense of coherence,
- learning and capability.

Time was stressed as an important measurement factor by both project and process management literature (e.g., Stalk and Hout, 1990; Charney, 1991; Harrington, 1991; Wheelwright and Clark, 1992; Hammer and Champy, 1993; Davenport, 1993; Hannus, 1994; Kotter, 1996, Kerzner, 1998). The amount of invested time was argued to tell us how serious the development effort is. In addition, it was argued that the invested time reflects internal drivers like motivation, commitment, involvement and empowerment. According to experiences in the case projects G and H, the measurement and management of invested work time was found to be important and it can be suggested that the amount of invested work hours should one factor to be measured in change projects. If only a little work time is invested by both project management and other project personnel, it is very likely that the desired results are not achieved as planned. Even if motivation is good but too little work time is invested in the project, the good results cannot be achieved. Comparison of the case projects G and H bore out this kind of reasoning. Particularly, the role of Project Manager and the amount of working hours and efforts he/she is investing seems to be meaningful.

Motivation of the project personnel and their willingness to change was measured through questionnaires by asking opinions of the participants about their personal support of the project and their willingness to start to practise the new ways of working. In case project G, the project management team concluded that the motivational level was acceptable throughout the project while in case project H, it was concluded after the second simulation game and before the third simulation game that there were improvement needs in motivational level. In both case projects, after the last simulation game it was concluded that the willingness of the project personnel in starting to practise the new ways of working was good.

Learning and capability of the project personnel was measured in case projects G and H through questionnaires. The answers to these questionnaires helped project management teams of both Cases G and H to assess the level and learning needs of the project personnel and to react accordingly. When comparing case projects G and H, it can be seen that changes in reality happened faster in case project G than in case Project H. In other words, learning and innovation concerning new ways of working was faster in the case project G than in the case project H. The results bear out the literature according to which it was proposed that learning should be measured when developing new competencies and capabilities (Argyris and Schön, 1978; Senge, 1990; Prusak, 1996; Garvin, 1993; Nonaka and Tageuchi, 1995; Davenport et al., 1998; Allee, 1997).

Teamwork skills, social skills and educational skills were argued to be necessary in order to achieve results efficiently (see e.g. Moss Kanter, 1983; Davenport, 1993; Kerzner, 1998; Carnall, 1999).

In case projects G and H, it was asked through measurement questionnaires about group work during the simulation game seminars. The questions concerned issues such as group size and composition, communication, discussion, and personal activity in the group. Also feedback on facilitation of the simulation games was asked. The group work and facilitation in both of the case projects G and H were evaluated positively by the project personnel. On the other hand, the given information in general and particularly information concerning objectives and visions of the current project as well as objectives and visions of the company were not easily assumed by the participants. This result could indicate that there were needs for improvement in educational skills of the project management team.

Sense of coherence (Antonovsky, 1985) was proposed to be used as self-assessment measure to evaluate the ability to judge the likelihood of desired outcomes. In the case projects G and H, it was asked through measurement questionnaires how the project personnel evaluated the likelihood of desired outcome before and after the simulation games. The project personnel in both case projects G and H evaluated after the second simulation game that the likelihood that the objectives set in the beginning of the project are more achievable in reality than they had thought before the simulation games. This was one indication that the projects were proceeding as wanted.

15.3.3 Effectiveness of project process

The effectiveness measures of the project process applied in the case projects G and H were as follows:

- corporate strategy alignment of the project,
- quality of planning, and
- identification of critical success factors.

According to the literature the change project has to fit soundly into the **corporate strategy** and overall project portfolio (Harrington, 1991; Wheelwright and Clark, 1992; Hammer and Champy, 1993; Davenport, 1993; Hannus, 1994; Kotter, 1996, Kerzner, 1998, Olve et al., 1999). This issue was discussed in project management team meetings from very beginning of the projects G and H. As a measurement result it was concluded that both projects are completely based on corporate strategy. This opinion never changed during the projects G and H. Therefore, it can be asked what was the utility of this measurement question after the kick-off meeting or was it non-value adding activity thereafter? This is not easy to answer, but it can be proposed that one utility could be that the question reminded the project management team members how important the project actually is. In addition, through the strategy alignment question it was formally checked that radical changes influencing on the project were not emerging in the business environment. The business impact of the project was discussed in this context as well.

The quality of project planning was argued to be an important factor influencing project performance (Kerzner, 1998; Wheelwright and Clark, 1992). In the case projects G and H, this issue was approached by asking how well timetables, milestones, budgets and critical success factors were determined. In both of the case projects G and H this measurement question set off refinement of the project plans. Thus, this measurement question was useful. In this context, an interesting incident happened in the case project H where the project management team had thought in the planning phase, i.e., when determining effectiveness measures of the project process, that budgeting is not needed in the project. However, this factor caused resource related problems later in the project. Afterwards the project management team in the case project H could conclude that, in future projects, budgeting of resources will be taken more seriously.

15.3.4 Efficiency of project process

The efficiency measures of the project process applied in the case projects G and H were achievement of objectives compared to plan including milestones, timetables, budgets and project scope (see e.g., Harrington, 1991; Wheelwright and Clark, 1992; Kerzner, 1998). In general, the follow-up of these parameters enabled and helped the project management teams to keep the projects on track and evaluate the performance of the project.

15.3.5 Effectiveness of project technology

The suggested measures for the effectiveness of project technology were identification and selection of strategically right technologies and tools such as project management softwares, simulation games, computer simulations, computer-aided tools and information systems.

In case projects G and H, the effectiveness of project technology was approached by asking whether or not the project management team had listed and identified the needed technological project tools and related know how. Obviously, this measurement question was not value adding for the PMT of case project G while they already felt that they had become familiar with the needed technological tools in a project two years earlier. The issue was discussed but the measurement did not cause any reactions. On the other hand, in the case project H, this measurement question caused reactions, i.e., the issue was discussed and the tools together with the needed know-how agreed. Thus, it is proposed that the utility of the applied measurement question is at its best at the beginning of the project. When the tools are agreed, this measurement question is not necessarily needed in the project.

15.3.6 Efficiency of project technology

There was a warning in the process management literature (Harrington, 1991; Hammer and Champy, 1993; Davenport, 1993) that there is a chance to misuse technology. Consequently, it was proposed that the selected technological tools should be evaluated in order to find out whether or not their use would help project managers in their tasks. Therefore, the following measurement questions assessing the efficiency of project technology were proposed and applied in the case projects G and H:

- Have you evaluated operational know-how concerning the use of needed tools?
- Is there a need for training concerning the needed tools?

This measurement question was not value adding for the PMT of the case project G as they already were familiar with the needed technological tools and knew how to utilise these tools. Thus, this measurement issue was only briefly discussed but no responses were taken. In the case project H, these two measurement question were discussed and answered. It was concluded that the basic level of operational know-how concerning the technological tools is high enough. Thus, it is proposed that the utility of these two measurement questions is at its best at the beginning of the project. Once the operational know-how is evaluated to be adequate, answering this measurement question seems to be non-value adding activity and thus not needed thereafter in the project. There is obvious need to develop these measurement questions into direction that could more directly measure cost/benefit ratios of the applied project technology.

15.4 The measures for manufacturing operations management

The measures for manufacturing operations management measurement tested in the case projects G and H are evaluated and discussed in Sections 15.4.1–15.4.6. It is proposed that these measures are to be formulated and applied not only for the development project purposes but also for continuous management and measurement of ongoing manufacturing operations.

15.4.1 Effectiveness of human resources

The literature concerning organisational learning and knowledge management (e.g. Argyris and Schön, 1978; Senge, 1990; Prusak, 1996; Garvin, 1993; Nonaka and Tageuchi, 1995; Davenport et al., 1998; Allee, 1997) stressed the importance of education and learning which improve capabilities, competencies and skills. This led to reasoning according to which the following measurement issues were proposed for evaluation of effectiveness of human resources:

- capabilities, competencies and skills,
- education, operational expertise,
- customer awareness,
- process awareness and systems thinking.

In the case projects G and H, the tested measurement questions assessing effectiveness of human resources in manufacturing were approached by formulating the following two basic questions:

- Do you encourage employees to learn multiple skills?
- Have you applied skill matrix?

In the case project G, when discussing these issues in the project management meetings, it was concluded throughout the simulation game project that the employees have not got enough encouragement for learning multiple skills and that the skill matrix was only partly done. Thus far they had not been able to allocate enough resources for this purpose. Consequently, the issue was taken under consideration in the simulation games where people could also play other roles than in reality.

In the case project H, a project for enhancing the skills of the employees had started almost simultaneously with this development project. Therefore, these issues were discussed during the simulation games where the employees could also play other roles than in reality.

In addition, a matter of interest, in both case projects G and H, was to evaluate how well the project personnel understand the applied manufacturing terminology and the whole manufacturing process. These subject matters were approached through measurement questionnaires. The utility was twofold: the project management team got feedback on what the level of understanding was and could focus the attention of employees on these essential subject matters.

15.4.2 Efficiency of human resources

In the case projects G and H, the following two questions were applied for efficiency assessment of human resources in manufacturing:

- Do you measure human productivity and how?
- How flexible is human work capacity %?

These measurement issues were already in use as normal practise in both case organisations G and H. During the project neither changes were desired nor could be detected in these parameters. The utility of this measurement question was that these issues were discussed and thereafter could better be taken into account in the simulation games as well as in idea generation meetings.

15.4.3 Effectiveness of operational process

Strategy alignment and profitability of the process were the first suggestions for operational process effectiveness measures. These measures reflect the importance of the process and its impact on both the company and the company's customers (Harrington, 1991; Hammer and Champy, 1993; Davenport, 1993; Hannus, 1994; Kotter, 1996). In case projects G and H, this measurement dimension was approached by asking what was the strategic meaning of the manufacturing process under development.

Thereafter, the question was discussed and evaluated. The project management teams in both case projects G and H concluded that the manufacturing process under development is the core process and thus its strategic meaning is vital.

The utility of the measurement question applied is best in the beginning of the project when the project is planned and motivated. Once answered and discussed, it is likely that the strategic meaning of the manufacturing process does not change during the project. Consequently, the applied measurement question is not a value adding activity after the planning phase. However, it is proposed in this context that the project management team should communicate to the project personnel throughout the project, i.e., in the project meetings and in the simulation games, how vital the process under development really is.

15.4.4 Efficiency of operational process

The suggested efficiency measures concerning operational process efficiency in CMMS were operational input/output measures, volume, lead time, flexibility, amount of work-in-process, and quality of produced products (see, e.g., Stalk and Hout, 1990; Harrington, 1991; Wheelwright and Clark, 1992; Hammer and Champy, 1993; Davenport, 1993; Hannus, 1994).

In case projects G and H, the central operational target values for the whole project set in the project kick-off were basically related to efficiency measures of operational process. Thus, this measurement category was important. In the case project G, the development targets related to this measurement dimension were

- to cut manufacturing throughput times by 50%;
- to halve the work-in-process inventory;
- to guarantee the volume increase of production;
- to identify bottlenecks in production;

and in the case project H, the targets were

- to shorten manufacturing throughput times down to 48 hours;
- to halve the work-in-process inventory;
- to double the volume of production; and
- to identify bottlenecks in production.

For measurement of these process parameters the following two measurement questions were applied in the case projects G and H:

- Are the existing values of the manufacturing process parameters stated in the objectives of the development project known and measured systematically?
- If no, when do you start measuring and when do you have those values?

In the case project G, the existing values of the manufacturing process parameters stated in the objectives of the development project were known and measured systematically as normal manufacturing practise. No extra reactions were needed in order to find out the answers for measurement questions. In the case project H, the situation was different. The values for the questioned process parameters were not known as well as was wanted in the beginning of the project. Therefore, a sub-project for building up a measurement system for tracking the values of these operational process parameters was started. Finally, just after the third simulation game round the measurement system was ready and in use.

During the implementation phase in the projects G and H, the changes in efficiency measures of the operational process were followed and compared to the development objectives set in the beginning of the project. Consequently, it is proposed that the measurement questions applied in the case projects G and H for tracking the efficiency of the operational processes were useful and relevant.

15.4.5 Effectiveness of operational technology

According to the consultant surveys A, B and C and process management literature (e.g., Harrington, 1991; Hammer and Champy, 1993; Davenport, 1993; Hannus, 1994) it was argued that the use of automation and information technology can play a critical role in business processes. Therefore, the evaluation of technologies and tools needed in the manufacturing process was proposed as the effectiveness measures of operational technology. In the case projects G and H, the measurement questions were formulated as follows:

- Is there a process for evaluation, selection and benchmarking of manufacturing technologies in the company?
- Is there a process for evaluation of information technology in the company?

These measurement issues were then discussed in the project management team meetings in the case projects G and H. Both companies did have a process for evaluation, selection and benchmarking of manufacturing technologies as well as for information technology. The utility of this measurement was that the discussion brought out that both manufacturing technology and information technology can play a critical role when improving manufacturing process performance. No other reactions but discussion was generated by this measurement. It was thought in both Cases G and H that the evaluation, selection and benchmarking of the manufacturing technology and information technology are not within the scope of the manufacturing development project. Thus, in the following measurement meetings, when checking all the 12 dimensions in CMMS, these measurement questions were only quickly reviewed. Based on experiences in the case projects G and H, the conclusion is that the utilisation of these two measurement questions for qualifying effectiveness of operational technology was a value adding activity only in the first measurement meeting, where all the 12 dimensions in CMMS were checked, but not thereafter.

15.4.6 Efficiency of operational technology

Particularly process management literature (e.g. Harrington, 1991; Hammer and Champy, 1993; Davenport, 1993) warned that there is a chance to misuse information technology. Consequently, in the development phase of CMMS it was proposed that it should be evaluated whether the applied technologies and tools are used efficiently or not. In the case projects G and H this measurement dimension was approached by asking the following two questions:

- Do you know manufacturing technology's costs and benefits?
- Do you know information technology's costs and benefits?

In the case projects G and H, the costs and benefits of manufacturing technology were known because the measurement of these values were seen as a part of a normal manufacturing practise. The information concerning the current manufacturing technology was also needed when building the simulation game model. The evaluation idea of information technology's costs and benefits was new and the values were not clear in either of the case projects G and H. However, the issue was discussed and costs/benefits of information technology were tried to be evaluated in both project management teams G and H. It was concluded that the investments in information technology could possibly be tracked but that the benefits of the information technology are not so easily calculated. Finally, this question was defined not to be relevant for achieving success in the current project while the selection and evaluation of information technology was seen to be within the scope of other projects.

According to the experiences in the case projects G and H, the utilisation of the measurement question for qualifying manufacturing technology's costs and benefits was a value adding activity at the beginning of the project when the values where needed for building the simulation game. Thereafter, once the values were known, this measurement question was not needed during the case projects G and H.

It can be proposed that discussion concerning information technology's costs and benefits was a value adding activity only in the first measurement meeting, where all the 12 dimensions in CMMS were checked, but not thereafter. The discussion enabled the project management teams G and H to position the current project in relation to costs/benefits of information technology. The conclusion was in both case projects G and H that it is not essential to pay attention to the information technology when the information technology will be the same throughout the project. However, it was noted that the way of using the current information technology might change as a result of the project.

15.5 The measured simulation-game-based change process

The development projects G and H utilised both the simulation games and the change management measurement system together as a change management tool. Thus, the development projects G and H were performed under two major conditions, which together form a new ensemble, that is, the measured simulation-game-based change process, abbreviated MSCP. In this section, the measured simulation-game-based change process is discussed and reflected with the theory. Features of this novel ensemble with references to theory are brought forward in Table 15.5-1. It can be proposed that MSCP fulfils the following conditions. First, MSCP improves coherence, and systematisation in change, and thus enhances success possibilities of a change project. Second, MSCP includes the five generic process development phases: 1. Direction setting; 2. Understanding and analysis; 3. Design; 4. Implementation; 5. Stabilising the new approach and continuous improvement. In particular, MSCP can promote continuous improvement through empowerment and through an active job experience (see Karasek and Theorell, 1990) where a high decision latitude and high psychological demand are experienced. Third, MSCP improves systematisation from learning, knowledge management and teamwork point of views. Fourth, MSCP utilises the general measurement principles found in the literature (see Chapter 6).

Table 15.5-1. Features of the measured simulation-game-based change process and references to theory.

Reference to theory	**Features of the measured simulation-game-based change process**
Reflections with project management, Chapter 3	Improves coherence, and systematisation in change, and thus enhances success possibilities
Reflections with process change management frameworks, Section 4.2	Includes the five generic development phases: 1. Direction setting; 2. Understanding and analysis; 3.Design; 4. Implementation; 5. Stabilising the new approach and continuous improvement
Reflections with organisational learning, knowledge management, and teamwork, Section 4.3	Improves systematics from learning, knowledge management and teamwork point of views
Reflections with change management measurement principles and frameworks, Chapter 6	Utilises the guidelines for performance measures, measurement system and measurement process

Based on empirical research it was found that the relative importance of the measurement dimensions and measures in CMMS change as the project proceeds. Thus, the measurement dimensions and questions in the change management measurement system should be applied and weighted according to their impact on each of the project stages. The measurement dimensions of CMMS which have the best impact when applied in the beginning of the project and the measurement dimensions which can benefit the project more continuously and more evenly throughout the project are proposed below together with examples of the subject matters in measurement questions.

The three measurement dimensions of change project management having the best impact at the beginning of the project are proposed to be as follows: 1. Effectiveness of project process, e.g. the quality of project planning. 2. Effectiveness of project technology, e.g. selection of needed technologies and tools. 3. Efficiency of project technology, e.g. the needed know-how concerning the project technology should be good enough already in the beginning of the project otherwise there may be technology costs without much benefits.

The following three measurement dimensions of change project management are suggested to be evenly important throughout the project. 1. Effectiveness of human resources, e.g. communication and information. 2. Efficiency of human resources, e.g. the role of Project Manager is essential; invested work time is particularly meaningful; motivation, learning, teamwork and educational skills, and sense of coherence can be measured throughout the project. 3. Efficiency of project process, e.g. comparison of milestones, schedules, budgets and project scope to the project plan throughout the project.

The three measurement dimensions of manufacturing operations management having the best impact at the beginning of the project are proposed to be as follows. 1. Effectiveness of operational process, e.g. checking of strategy basis for the project gives motivation to the project. 2. Effectiveness of operational technology, e.g. the state and competitiveness of the current manufacturing technology and information technology. 3. Efficiency of operational technology, e.g. the costs and benefits of the current manufacturing technology and information technology.

The remaining three measurement dimensions of manufacturing operations management are suggested to be evenly important throughout the project: 1. Effectiveness of human resources, e.g. understanding of manufacturing terminology and manufacturing process. 2. Efficiency of human resources, e.g. flexibility and productivity of workers. 3. Efficiency of operational process, e.g. measurement against operational process development targets such as throughput times and work-in-process inventories.

Consequently, because the importance of the measurement dimensions and measures change depending on the characteristics of each project step, it is proposed that the measurement system should flexibly allow customised measures for all the project steps.

An interesting feature in change management measurement was that, in general in the case projects G and H, the scores when given by the Project Manager and Production Manager differed greatly from the scores given by the project personnel (see Figures 10.1-2, 11.5-2, 11.6-3). This indicates that the project management and the project personnel had a different level of understanding and different view of the project reality on those points of the project when measurement was performed. It can be asked what this difference tells us about the project performance. An explanation could naturally be that Project Managers have better understanding at the beginning of the project while they have been planning and preparing the project. It can be hypothesised that at the end of the project, when both Project Managers and the project personnel have had a mutual development experience, the difference in understanding and in ways of seeing the project could be narrower.

15.5.1 Reflections on project management

The central matter in project management literature that was found particularly essential from the viewpoint of this research was that in order to achieve a successful project there is a need for a coherent development process that is well understood, highly capable, and in control (Wheelwright and Clark, 1992). In the case projects G and H, it was not only realised that the applied simulation-game-based change process is systematic and well suited for manufacturing process development but also that the measurement of change management improves systematisation and coherence of the change process. Comparison of the case projects D, E and F, which were not measured during the projects, with the measured case projects G and H, shows that the measured projects are more coherent and better under the control of the project management team than those which were not measured. Through measurement both the project management and project personnel understand the change process better than without measurement. Consequently, it can be proposed that the measurement of change management enhances coherence and possibilities for success in the simulation-game-based manufacturing process development projects.

The essential, interlinked project management processes and knowledge areas, found in five approaches examined in project management literature in Chapter 3 (Wheelwright and Clark, 1992; Duncan, 1996, ISO1006:1997(E); Kerzner, 1998; LaRoche, 1998), were concluded as follows:

- Strategy and direction setting related processes and knowledge areas,
- Human resources related processes and knowledge areas
- Time, cost, quality and control related processses and knowledge areas
- Technology related processes and knowledge areas.

Based on development of CMMS (Chapter 9) and experiences in the case projects G and H (Chapter 10 and 11), it is suggested that all the essential project processes and knowledge areas mentioned above are also taken into account in the measured simulation-game-based change process.

Generally, the comparison of the case projects G and H gave evidence that the application of CMMS was practical and had positive influence on the project management task. In particular, it is proposed that particular attention should be paid on measuring and consequent timely reactions in the early phases of the project. This finding bears out the suggestions done by both Verganti et al. (1998) and Thomke and Fujimoto (1998) in product development process context. Verganti et al. (1998) emphasises importance of early and continuous feedback which enables rapid learning. Thomke and Fujimoto (1998) define a concept called front-loading as a strategy that seeks to reduce development time and costs by identifying and solving design problems as early as possible. Consequently, as an outcome of this research, it can be suggested that also in the simulation-game-based manufacturing process development projects, the problems should be identified and solved already in early phases of the project. The first phases of the project are critical for achievement of a good project trajectory.

15.5.2 Reflections on process change management

Process change management was defined according to the literature (Chapter 4) as *management which characteristically aims at performance improvements in manufacturing processes through innovations* (see e.g., Moss Kanter, 1983; Harrington, 1991; Hammer and Champy, 1993; Davenport, 1993; Hannus, 1994; Smeds, 1994; Kotter, 1995, 1996; Vollmann, 1996; Katzenbach, 1996; Carnall, 1999). Based on literature (Chapter 4: Hannus, 1994; Harrington, 1991; Davenport, 1993; Smeds, 1994; Kotter, 1995, Rummler and Brache, 1995, Vollmann, 1996) it was argued that sound change management processes comprise at least the following five generic development phases (see also Table 4.2-1):

1. Strategic issues and direction setting phase;
2. Understanding and analysis phase;
3. Design phase;
4. Implementation phase;
5. Stabilising the new approach and continuous improvement phase.

The measured simulation-game-based change process (see Figure 13-1) comprises all these five generic development phases. However, in the case projects G and H, mainly the first three generic phases were in focus from the viewpoint of change management measurement. During the implementation phase as well as during the stabilising the new approach phase primarily the manufacturing process parameters mentioned in the project objectives were measured. Thus, the CMMS was not applied systematically during and after the implementation phase while the researcher was no longer actively involved in the project. However, the Project Manager in the case project G felt that the measurement of change management would have been useful during the implementation phase and thereafter. In the case project H, Project Manager and Production Manager even applied measures during the implementation phase independently, i.e., without the involvement of the researcher, for finding out what was the willingness to change among the newly formed manufacturing team. In addition, Project Manager and Production Manager of the case project H thought after the project that it would be a good idea to apply the change management measures in future projects, too.

15.5.3 Reflections on organisational learning, knowledge management, and teamwork

Learning was argued to be an essential component of change in Section 4.3 and the following generic elements were concluded to be needed in successful organisational learning and knowledge management projects:

1. **Strategy, vision, objectives (**Nonaka and Takeuchi, 1995; Davenport et al., 1998; Garvin, 1993, Mohrman and Cummings, 1989; Senge, 1990; Allee, 1997)

2. **Systematic learning, knowledge management and teamwork processes** (Argyris and Schön, 1978; Mohrman and Cummings, 1989; Senge, 1990; Garving, 1993; Nonaka and Takeuchi, 1995, Katzenbach, 1996; Katzenbach and Smith, 1999; 1996; Biech, 2001)

3. **Learning climate and knowledge environment (**Mohrman and Cummings, 1989; Allee, 1997, Davenport et al., 1998; Argyris and Schön, 1978; Senge, 1990, Nonaka and Takeuchi, 1995; Katzenbach and Smith, 1999; Biech, 2001).

These three elements are also taken into account in the measured simulation-game-based change process. In the case projects G and H, strategy, vision and objectives of the company as well as strategy, vision and objectives of the current project were communicated to the project personnel after which it was measured how well the project personnel understood the communicated issues. Thus, the basis and motivation for organisational learning and knowledge creation in the simulation games and in the project meetings were established.

According to the case project experiences, it is proposed that the measured simulation-game-based change processes as in Cases G and H are more systematic learning, knowledge management and teamwork processes than the change processes without measurement as in Cases D, E and F. The measurement according to CMMS enabled the project management teams in the case projects G and H to react when particular learning needs were detected. Such a mechanism was not available in the case projects D, E and F. Furthermore, based on experiences in the case projects G and H, it can also be suggested that in the simulation games and debriefings a basis for a learning climate and knowledge environment for the development projects is created. Through measurement the quality of the created learning climate and knowledge environment can be assessed. Measurement also communicates to the participants the issues which are a part of a good learning climate, knowledge environment and teamwork. For example, questions can be asked, such as how open the communication was and what was the motivation to create, share and use knowledge. Moreover, the measured simulation game experiences bear out the idea (c.f. Smeds, 1997) that simulation games support all four modes of knowledge conversion and the knowledge spiral by Nonaka and Takeuchi (1995, pp. 71–72), where tacit knowledge is involved (see also Figure 4.3.1-1). Thus, it is possible that through knowledge conversion in the simulation game facilitated learning environment the project organisation achieves a state of double loop learning that leads to innovation and new practises in reality. It is proposed that this happened in the case projects D, G and H where new manufacturing practises were created.

According to Karasek and Theorell (1990) it was argued that learning happens and motivation to develop new behaviour patters exists at its best when psychological demands (or development challenge) and decision latitude (or empowerment) are high. Based on experiences in case projects G and H it can be proposed that in the simulation-game-based learning environment it is possible to achieve such a learning environment where psychological demands (or development challenge) and decision latitude (or empowerment) are high. In the case projects G and H, the psychological demands were basically high through the challenging development targets. Also, it can be proposed that decision latitude was relatively high in the simulation games. At least, according to the measurements, in the case projects G and H, communication, participation, learning, and group work worked relatively well. In addition, motivation and top management support were experienced positively. Consequently, these experiences bear out the idea according to which tailored simulation gaming facilitates empowerment and learning during the change project (c.f. Smeds, 1994, 1997; and Riis et al., 1996).

15.5.4 Reflections on change management measurement principles and frameworks

The subject matters for building performance measures and the change management measurement frameworks were examined and concluded in Chapter 6. The proposed change management measurement guidelines were then taken into account in the construction of CMMS. Thereafter, CMMS was utilised in the case projects G and H. According to these case studies it is proposed that the measurement principles concluded in Chapter 6 are valid as they were applicable and successfully utilised in practise. It is not necessary to repeat these measurement guidelines here as they can be found in Section 6.3.

Measurement in the case projects G and H pointed out the essential issues in change and thus facilitated both learning of the project management team and other change project personnel. Both of the case project teams G and H improved their performance by reacting to the measurements. Thus, measurement of change management improved change management capability of both project organisations G and H. Consequently, it is proposed that the experiences in the case projects G and H bear out the importance of measurement as was argued in the literature (Rummler and Brache, 1990; Harrington, 1991; Brown, 1996; Kaplan and Norton, 1996; Laakso, 1997; Kezbom et al., 1989; Carnall, 1999; Olve et al., 1999). This research also confirms the key results of the Hawthorne Experiments, i.e., Hawthorne Effect, according to which participants have tendency to improve their performance when personal interaction is increased and when participants have possibility of influencing on the decision making-process in matters concerning themselves (Scheur, 2000, p. 85; see also Mayo, 1933). In case projects G and H, measurement promoted personal interaction and participation in decision making among the project management team as well as among the whole change project personnel.

In addition to the performance measurement frameworks examined in Chapter 6, it is worth mentioning what Neely and Adams (2001) question in their article concerning Performance Prism Framework that includes the following measurement dimensions: stakeholder satisfaction, strategies, processes, capabilities, and stakeholder contribution. They (Neely and Adams, 2001) questioned "how can multiple, seemingly conflicting measurement frameworks and methodologies exist?" The answer was (Neely and Adams, 2001) as follows: "They can coexist because they all add value. They all provide unique perspectives on performance. They all furnish managers with a different set of lenses thorough which to assess the performance of their organisations." Consequently, it may be suggested that the performance measurement framework, the measurement system and the measured simulation-game-based change process developed in this research are adding value by providing unique perspectives on performance. In other words, CMMF, CMMS and MSCP are designed to help manufacturing companies to develop their manufacturing processes.

A tailored simulation-game-based change process was utilised in this research, but it can be proposed that the measurement framework and system are generic enough to be used also in change processes such as proposed by Davenport (1993), Harrington (1991), and Kotter (1995).

15.6 Suggestions for future research

In future, the now achieved and reported results may help process developers, managers, consultants, researchers and others in change management and development endeavours. Even though quality assessment tests for evaluation of this research are relatively strict, it can be proposed that more development and validation for the research results should be done in similar contexts to this research as well as in other contexts and conditions. Interesting new research questions and development challenges for further development may be formulated, for example, by changing one or more of the conditions under which this research was carried out. The seven conditions and proposals for variations of these conditions are given below:

1. Industry type and company size: e.g., manufacturing, construction, planning; small, medium or large company.
2. Type of process under development: e.g., discrete part manufacturing, new products development, administrative processes.
3. Type of intended change: e.g., incremental improvement as a project, improvement according to principles of continuous improvement, one-time radical improvement
4. Applied change management methodology: e.g., application of the simulation gaming based change management method as in this research or other approaches.
5. Organisation type: e.g., traditional and innovative organisations according to criteria presented by Mohrman and Cummings (1989), other organisation types.
6. Project organisation and project management team: e.g. as in the case projects of this research, change teams brought forward by Hannus (1994, see Section 4.2), other types.
7. Facilitator: e.g., internal change agent in a company, external consultant or researcher.

It was found during this research that the measurement values between project managers and other change project personnel were different in the project, and it was hypothesised that the difference in measurement values between these two organisational groups should converge as the project proceeds. Consequently, it can be proposed that there is a need for finding out how the difference in the measurement values of project managers and other change project personnel could be utilised in future projects. More research can also be proposed to be necessary for testing the proposed MSCP in order to find out what could be the more optimal number of measurements throughout a change project, and what could be the improved measures and measurement questionnaires, what could be the better way of weighting the measures and measurement dimensions as the project proceeds, and what could be the better way of evaluating the measurement system. The developed measurement questions applied and tested in the case projects G and H were initial attempts and thus it is acknowledged that better and more sophisticated measurement questions may be formulated and developed in future research cycles.

Generally speaking, it can be suggested that market-based validation of the developed constructs through market tests presented by Kasanen et al. (1993) should be continued in the future. It can also be proposed that development of the change management measurement framework, system and the measured simulation-game-based change process should continue further according to the hermeneutic spiral (Gummesson, 1991) and according to the further innovation action research cycles (Kaplan, 1998) where each stage of research provides a new level of understanding that is turned to preunderstanding in the next research cycle.

16. Discussion through the quality criteria

Sections 16.1–16.6 evaluate and discuss the contribution of this research through the quality assessment criteria developed and brought forward in Section 2.5.7.

16.1 Innovative solution

The first quality criterion of pragmatic concern questions: has this research produced an innovative solution to a real world problem?

> The developed change management measurement framework and system were new managerial tools and applied in the case projects G and H. In addition, the measured simulation-game-based change process is new. Because an innovative solution was defined as a new problem solving managerial construct that is applied in practise, it can be proposed that the innovativeness criteria is fulfilled in this research.
>
> The research question *"How can change management be measured in order to help manufacturing companies develop their manufacturing processes when applying tailored simulation games as a developmental tool?"* is argued to be relevant and a real world problem both in Chapter 1: Introduction and in Section 2.1: Pre-understanding. Furthermore, the relevance and the practical concern of the research problem is augmented in Part I, Part II and Part III of this dissertation. Consequently, it is suggested that this research has produced an innovative solution to a real world problem.

16.2 Pragmatic utility

The second quality criterion was defined to be evaluation practical usability of the solution concept through weak, semi-strong and strong market test brought forward by Kasanen et al. (1991, 1993).

> The criteria for weak market test introduced by Kasanen et al. (1991, 1993) is met in both case projects, i.e., managers (Production

Managers and Project Managers in Cases G and H) responsible for financial results have been willing to apply the construct in their decision making. The criteria for semi-strong market test has also been fulfilled since CMMS has been practised in case projects G and H, and substantial amount of data has been analysed.

It can also be proposed that the criteria for a strong market test have been fulfilled. Namely, case projects G and H achieved successfully its objectives from a change project management point of view, as seen from the change project management measurements. Case projects G and H were better under PMT control than Case projects D, E and F, which did not apply the construct. Basically, project management teams in preliminary Cases D, E and F did not have other systematically measured project performance data to react during their projects but the project schedules. An exception exists, in the case project D, the second simulation game intervention was measured: the results were positive and the project personnel willing to start practising the new ways of working.

Furthermore, manufacturing throughput time decreased 54% on average within six months after the last simulation phase in Case G: after nine months the decrease was about 70% (see Table 17.2-1). In Case H, manufacturing throughput time decreased 48% on average within six months after the last simulation game. In Case D, manufacturing throughput time decreased 46% on average within six months after the last simulation while no changes in terms of throughput time were reported by project managers of Cases E and F.

Consequently, the change management in case projects G and H was better compared to case projects D, E and F, which did not apply CMMS. Thus, it can be suggested that the criteria for the strong market test have been fulfilled.

Table 17.2-1. The decrease in manufacturing throughput time in Cases D, E, F, G and H.

	Time after the last simulation	Case D	Case E	Case F	Case G	Case H
Decrease in manufacturing throughput time (%)	6 months	**46%**	**0%**	**0%**	**54%**	**48%**
	9 months	*Not available*	*Not available*	**0%**	**70%**	*Not available*
	12 months	**60%**	*Not available*	**0%**	*Not available*	*Not available*

16.3 Validity, applicability and generality of the results

The questions for assessment of validity, applicability and generality of the results are answered and discussed as follows:

- Has the theoretical connection to the solution been demonstrated (Kasanen et al., 1991, 1993; Eden and Huxham, 1996)?

  The theoretical connection of the developed change management measurement system is brought forward and the new construct is developed through synthesis in Part I. Thus, it is proposed that the theoretical connection to the solution concept is demonstrated.

- Have opportunities for triangulation been exploited and reported (Eden and Huxham, 1996)?

  The essence of triangulation is that the researcher applies two or more methods of data collection on the same research problem in order to increase the reliability of the results (Gummesson, 1991; Frankfort-Nachmias and Nachmias, 1996). In this research, the data collection methods were as follows:

- Direct observations:
  - The researcher observed how case projects D, E, F, G and H are proceeding and wrote the project diaries. As an output the project descriptions are presented in this dissertation.
  - Project management team members in case projects D, E, F, G and H kept project diaries on what kind of project activities they and project personnel did during the projects and how long the execution of those activities took.

- Interview surveys:
  - The researcher interviewed Managing Directors from three global consulting companies; in Chapter 7 the results of consultant surveys are brought forward.
  - The researcher interviewed Project Manager of Case G and both Project Manager and Production Manager of Case H afterwards about their experiences in applying CMMS, results of these interviews are presented in Sections 10.6 and 11.9. Recommendations, comments and critics were recorded and taken into account in the suggestions for practising CMMS.

- Questionnaire surveys:
  - CMMS was tested through a questionnaire survey after Case projects D, E, and F, where the respondents were project personnel, Project Managers and Production Managers, the results are reported in Chapter 10.
  - Development, application and testing of questionnaire surveys for change measurement in Case projects G and H facilitated incremental method development. Project management teams discussed measures and their improvement needs before and after actual measurement events. Thus, the meetings, where the measurements were examined and analysed, facilitated incremental method development during case projects G and H.

Thus, it can be proposed that opportunities for triangulation have been utilised and reported in this research.

- To whom the results apply, what is potential for general adequacy and what are the more general features becoming visible in the construction (Kasanen et al., 1991, 1993; Gummesson, 1991, Eden and Huxham, 1996)?

  According to Kasanen et al. (1991, 1993) it is quite likely that a solution or construct which works in one firm is useful in several other similar firms, i.e., grounds for generalising results of a constructive research differ radically from an attempt to make statistical inferences from a small sample. Thus, it can be argued that CMMF, CMMS, and MSCP can be useful in several other similar companies in context of discrete manufacturing process development. Consequently, it can be proposed that results of this research are applicable at least under the following conditions:

  1. Industry type and company size:
     - Industrial manufacturing companies
     - In case companies the number of personnel was between 120 and 300. It can be proposed that the number of employees working in a company or division can vary out of these limits and CMMS is still applicable for measurement of change management in development projects. The restriction comes through resources available in the project, i.e., the more involved people the more effort is needed to conduct the measurements and manage the project.
  2. Type of manufacturing process under development:
     - Material flows and products are discrete
     - Manufacturing process can include both manual and automated work phases
  3. Type of intended change:
     - Reengineering type of change. All the case projects had radical improvement targets, e.g. to halve manufacturing throughput times and work-in-process inventories.

4. Applied change management methodology:
   - Tailored simulation-game-based change process. The applied change management methodology in the case projects G and H utilises simulation gaming as described in Chapter 5.
5. Organisation type:
   - According to criteria presented by Mohrman and Cummings (1989) organisations in the case projects G and H were defined to be between traditional and innovative but pursuing to be innovative. Consequently, if organisations in future projects are striving to be innovative, it can be proposed that these future projects have at least as good a possibility to succeed as the case projects G and H had.
6. Project management team
   - The members of project management teams in the case projects were the Production Manager, Project Manager and a representative from change project personnel. It can be suggested that in new projects a similar project management team structure might work as well.
7. Facilitator:
   - The researcher worked as a facilitator in the case projects D, E, F, G and H. Thus, it can be proposed that if the same researcher is facilitating new similar projects, it is conceivable that the new project can perform at least as well as Cases G and H did. Thus far, there are no experiences reported with other facilitators and other case projects. Therefore, more research is needed with new facilitators who are willing to test and develop the solution concept in practise.

The theory basis of developed construct gives possibilities to generalise results more. Namely, Kasanen et al. (1991, 1993) propose that when a working construction is created, it is the proper time to consider what are the more general features of the construction. In this research the construct is based on theory found in project management, process change management and performance measurement theory together with results from a consultant survey and experiences in the preliminary case projects D, E and F. Thus, it can be proposed that the following measurement principles and measurement dimensions in CMMS can be both adaptable and practicable in broad range of process development projects:

1) Two measurement principles:

- Effectiveness principle: doing strategically the right thing, includes adaptability, reflects quality
- Efficiency principle: doing it right, economically, with best possible or optimal input/output, reflects productivity

2) Two main measurement dimensions:

- Change project management dimension
- Process or system to be developed dimension,

3) Three sub-measurement dimensions:

- Human resource dimension
- Process dimension
- Technology dimension.

The measurement principles and dimensions mentioned above were proposed and tested in initial implementations. For the future, there remain more action research cycles to be done. It can be asked what could be better or at least complementary ways of measuring change management, how CMMS and CMMP can be improved and applied in other contexts, projects and under other conditions?

- Does other research confirm the findings and do the results bear out the theories and models available in the literature (Gummesson, 1991)?

In Sections 15.2–15.5 this quality criterion is taken into account as the research results are discussed with the theories and models found in the literature.

- Does the new theory allow us to look anew at the world (Reason and Bradbury, 2001)?

  The developed constructs, i.e., CMMF, CMMS and MSCP, are novel answers to the research problem "*How can change management be measured in order to help manufacturing companies develop their manufacturing processes when applying tailored simulation games as a developmental tool?*" Consequently, based on the research results, it can be proposed that the suggested change management measurement framework, system and the measured simulation game-based change process enable us to look anew at the world of simulation-game-based manufacturing development projects as more systematic and more manageable than before. Particularly, the measurement system and process should flexibly allow customised measures for each project step, and the measurement system should be balanced, i.e. both the development project and the process under development should be measured. In addition to the generalisations in the previous paragraph, new research questions and hypotheses were formulated based on the research results in Chapter 15.

16.4 Action research process

- Has this research had a high degree of methodology and orderliness in reflecting on, and holding to, the emerging research content of each episode of involvement in the organisation (Eden and Huxham, 1996)?

  The applied intervention process presented in Figure 5-1 was systematic in each involved case organisation and both epistemic and pragmatic viewpoints of the research were communicated to the project personnel during the action research. In order to reflect and hold to the emerging research content a project diary was kept and project data was collected during each case project by the researcher. In addition, data collection needs as well as responsibilities for data collection for the Project Managers and Production Managers in the case projects D, E, F, G and H were defined. Due to the evolution of the research and systematic change management measurement, the degree of methodology and orderliness in reflecting on, and holding to the emerging research content of each episode of involvement was higher in case projects G and H than in case projects D, E and F. Thus, it can be proposed that this quality criteria was well met in case projects G and H while in case projects D, E and F this quality criteria was satisfactorily met.

- Has the construct been informally evaluated during its implementation (Kaplan, 1998)?

  Informal evaluations of the change management measurement system were performed by the researcher mainly through personal involvement in the implementations.

- Have opportunities, to get feedback from managers and academics through speaking about the innovation and writing articles, been utilised (Kaplan, 1998)?

  Opportunities to get feedback through speaking about innovation in conferences and in writing articles has been utilised. The following research articles and presentations have been published during this research:

  - Taskinen, T. (1998, 1999a, 1999b, 2000a and 2000b) and
  - Taskinen, T. and Smeds, R. (1998a, 1998b, 1999a, 1999b and 2000).

16.5 Action researcher

This quality criterion evaluates **the characteristic of the action researcher**. According to Kaplan (1998) the problem of the independence and objectivity of the action researcher remains, i.e., there is tension between the knowledge the action researcher has about the phenomenon for evaluation purposes versus the advocacy position of the action researcher for the developed approach. Independence and objectivity are difficult to evaluate while the action researcher is deeply involved in the project and at the same time he or she should maintain a certain distance. Thus, the researcher should possess characteristics such as pre-understanding, commitment, integrity, candour and honesty (Gummesson, 1991).

Pre-understanding of the researcher in the beginning and how it thereafter evolved according to the hermeneutic spiral was described in Chapter 2 (and thus it is not necessary to repeat here), and based on that description it is proposed that the researcher had enough pre-understanding at the beginning of the research assignment. The completion of the first loop around innovation action research cycle (see Figure 2-2) reflects the fact that the researcher was committed. Despite the fact that independence, integrity and objectivity criteria are difficult to evaluate, it can, however, be proposed that these criteria are not fully fulfilled in this research because the researcher himself has been so closely involved in the case projects and in the research process that an unbiased distance has been difficult to maintain. Therefore, it is suggested that in the future action research cycles, the evaluation of the developed construct could be performed for example, as Kaplan (1998) suggests, by an independent and unbiased evaluation team. Thus, the validity of the results could be improved. However, it should be noted that the researcher has consciously pursued objectivity, candour, honesty, integrity and openness, the proof of which are the quality criteria according to which this research is evaluated.

16.6 Scientific contribution

This quality criterion evaluates **the value of the results to the scientific community, contribution to increased knowledge and enduring consequence** (Gummesson, 1991; Reason and Bradbury, 2001). The examination of quality criteria brought forward in Sections 17.1–17.5 are necessary but not sufficient for qualifying the scientific contribution of this research, therefore the following two interlinked quality assessment questions should still be answered:

- Does this dissertation contain sufficient detail and precision so that others can independently develop and validate the ideas (Kaplan, 1998; Gummesson, 1991; Kasanen et al., 1991 and 1993; Eden and Huxham, 1996)?

  Manufacturing and business process developers, management, consultants, researchers and naturally case companies (D, E, F, G, H) are the intended customers for the outcomes of this research work. The structure and evolution of this research is described (see Table 1.4-1 and Figure 2.3-1) in a way that customers should be able to understand how the results are achieved. The case projects, development and testing of CMMF, CMMS, CMMP and MSCP have been described to make action research and findings traceable. In particular, in Chapter 12, the case projects G and H are compared in order to find a more sophisticated understanding of the change management measurement process applying CMMS. It can be proposed that customers of this research could try out and adapt the central ideas in CMMS and CMMP to their own development projects, i.e., there is the possibility that customers could also develop CMMF, CMMS, CMMP and MSCP further according to their own emerging needs. Consequently, it is suggested that this quality criteria is fulfilled, i.e., that this dissertation contains sufficient detail and precision so that others can independently develop and validate the developed ideas.

- The concept has severe limitations if it continually requires the active involvement of the action researchers for each implementation (Kaplan, 1998). This criteria can also be understood to be included in the criteria of the semi-strong and strong market tests by Kasanen et al. (1991, 1993) if the construct is evaluated in the contexts of other companies and facilitators than in the original case research. Thus, this quality question is formulated as follows: **Is the solution concept deliverable by people other than the original proponent?**

  This is a hard question to answer reliably since there is no experiences in other context than described in this research. However, it can be proposed that this research has performed the first loop around the innovation action research cycle (see Figure 2-2) ending in the initial implementation. The next action research cycle, a natural step in the evolution, could be the development of the solution concept in context of facilitators and case companies other than described in this dissertation. Thus, through continuous development and evolution this quality criteria can be reliably validated and enduring consequences that might follow this research assessed.

17. Conclusions

This constructive action research suggests three novel constructs for manufacturing process development. The first construct is the change management measurement framework, abbreviated CMMF. The second is the change management measurement system, abbreviated CMMS, and the third proposed construct is the measured simulation-game-based change process, abbreviated MSCP.

CMMF forms 12 measurement dimensions, of which six gauge the change project management itself and six others the changes in manufacturing operations. These two proposed main measurement dimensions are logically interlinked as the development project has influence on the manufacturing operations. Both of the main measurement dimensions are divided into three sub-measurement dimensions of human resources, processes and technology, which are further divided according to the principles of effectiveness and efficiency. The CMMF is visualised as a radar in Figure 16-1.

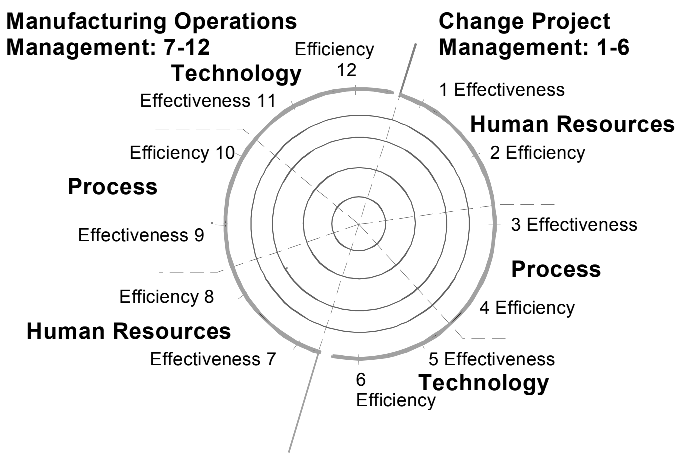


Figure 16-1. The 12 dimensional change management measurement framework.

The CMMS is developed from the CMMF by suggesting measurement questions for each of the 12 measurement dimensions. Then, the CMMS is tested and developed further in practice. As an improvement idea for applying the CMMS in practice, the measured simulation-game-based change process is proposed.

The case results suggest that there is a need for *balanced change management measurement* where both the change project management and the manufacturing operations management are measured, e.g. as according to the CMMF and CMMS. The balanced measurement improves the systematics and coherence of the change process and thus also the change management capability of the organisation is enhanced. Through balanced measurement most of the critical success factors can be identified beforehand, already at the beginning of the project. *Discussion and preparation of the measures* for the actual project can reduce the risk of failure through increasing systems thinking and decreasing the number of otherwise unanticipated factors. Furthermore, the balanced measurement of change management can facilitate *constructive discussion not only in the first phases but at all stages of the project*. In the early phases, measurement facilitates discussion and communication in planning, and thereafter in the follow-up, feedback, debriefing and other project meetings. Measurement contributes to the project's success by providing performance data, which can lead to reactions through improved understanding, discussion and co-operation.

In addition, the empirical results suggest that *the relative importance of the measurement dimensions and measures change as the project proceeds*. Thus, the measurement dimensions and questions in the change management measurement system should be applied and weighted according to their impact on each of the project stages. Consequently, it is proposed that the measurement system should *flexibly allow customised measures for all the project steps*, e.g. as in the proposed MSCP. The proposed change management measurement process suggest that particular attention should be paid to measurement and consequent timely reactions in the *early phases of the project*. Reactions to early feedback enable rapid learning and a successful project trajectory can be achieved already in the early phases of the project. Thereafter, through continuous measurement and consequent timely reactions, a successful project trajectory can be maintained until the project end.

The research results support the idea that one key factor for success is how well the project management team *uses the available measurement system*, i.e. how well the measurement related tasks are performed. For example in this research, case project G applied CMMS more diligently than case project H in the first project phases, due to which case G achieved better project performance. Thus it is suggested that the project management team's ability and diligence to use the applied measurement system needs managerial attention. In change management capability improvement, the measurement of *human resource subject matters* is fundamental to success, and it is proposed that in future research cycles particular attention should be paid to development of measures concerning psychological, behavioural and teamwork matters.

These theoretical findings are novel hypothesis that should be further empirically researched.

The theoretical basis of the developed three novel constructs creates some possibilities to generalise the results. It is suggested that the measurement principles and measurement dimensions in CMMF, CMMS and MSCP could be both adaptable and practicable over a broad range of process development projects. This hypothesis needs however to be tested in new change projects in different empirical settings.

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Appendix A:

The planned project schedules, realised project schedules and invested work hours in the case projects D, E and F

Table A-1. Planned project schedule, realised project schedule and invested work hours in the case project D.

	Case D	**Planned project schedule**	**Realised project schedule**	**Delay in end of step**	**Number of blue collar**	**Invested time [hours]**				
Step No.	**Task**	**Due date 1997**	**Due date 1997**	**[days]**	**Em-ployees**	**Blue-collar employees**	**Project Champ**	**Prod. Mgr**	**Total hours**	**Total %**
1	Project kick-off and setting of objectives	*June 18*	*June 18*	*0*	*0*	*0*	*0*	*5*	***5***	***1%***
2	Data collection and process modelling	*June 18 – Aug. 10*	*Sept. 3–22*	*43*	*0*	*0*	*48*	*20*	***68***	***18%***
3	Building the simulation model of present processes and first simulation game	*August 11 – 31*	*Sept. 23 – Oct. 3*	*33*	*13*	*101*	*36*	*1*	***138***	***32%***
4	Generation of development ideas for improvement	*Sept. 1–10, 1997*	*Sept. 3–4*	*0*	*0*	*0*	*0*	*7*	***7***	***2%***
5	Testing new ideas by playing simulation game	*Sept. 11–30*	*Oct. 3 – Nov. 20*	*51*	*13*	*133*	*81*	*3*	***217***	***50%***
	Number of days from the start of Step 1 to the end of Step 5	*104*	*155*	***Invested time***	***[hours]***	*234*	*165*	*36*	***435***	***100%***
					%	*54%*	*38%*	*8%*	***100%***	

Table A-2. Planned project schedule, realised project schedule and invested work hours in the case project E.

	Case E	**Planned project schedule**	**Realised project schedule**	**Delay in end of step**	**Number of**	**Invested time [hours]**					
Step No.	**Task**	**Due date 1997**	**Due date 1997**	**[days]**	**White Collar**	**White Collar**	**Project Champ**	**Prod. Mgr**	**Man. Dir.**	**Total hours**	**Total %**
1	*Project kick-off and setting of objectives*	*Aug. 20–21*	*Aug. 20–21*	*0*	*0*	*0*	*0*	*2*	*2*	***4***	***3%***
2	*Data collection and process modelling*	*Aug. 21 – Oct. 3*	*Aug. 21 – Oct. 10*	*7*	*0*	*0*	*40*	*8*	*0*	***48***	***35%***
3	*Building the simulation model and first computer simulation seminars*	*Oct. 1–10*	*Oct. 10–22*	*13*	*6*	*18*	*5*	*3*	*0*	***26***	***19%***
4	*Generation of development ideas for improvement*	*Oct. 10–22*	*Aug. 25 – Oct. 10*	*0*	*0*	*0*	*3*	*3*	*0*	***6***	***4%***
5	*Testing new ideas in a computer simulation seminar*	*Oct. 23–24*	*Oct. 23 – Nov. 6, 1997*	*13*	*6*	*18*	*3*	*3*	*0*	***24***	***17%***
6	*Discussion and further planning*	*After Oct. 25*	*January, 1998*		*6*	*18*	*5*	*5*	*3*	***31***	***22%***
Number of days from start of Step 1 to end of Step 5		***65***	***78***	***Invested time***	***[hours]***	*54*	*56*	*24*	*5*	***139***	***100%***
					%	*39%*	*40%*	*17%*	*4%*	***100%***	

Table A-3. Planned project schedule, realised project schedule and invested work hours in the case project F.

	Case F	Planned project schedule	Realised project schedule	Delay in end of step	Number of blue- collar employees	Invested time [hours]				
						Blue- collar employees	Project Champ	Prod. Mgr	Total	
									hours	%
Step No.	**Task**	**Due date 1997**	**Due date**	**[days]**						
1	Project kick-off and setting of objectives	Nov. 5	Nov. 5–9, 1997	4	2	14	7	7	**28**	**10%**
2	Data collection and process modelling	Nov. 5–14	Nov. 5, 1997 – Jan. 7, 1998	7	6	48	34	5	**87**	**31%**
3	Building the simulation model and first simulation game seminars	Nov. 14–30	Jan. 14–23, 1998	55	4	32	8	8	**48**	**17%**
4	Generation of development ideas for improvement	Nov. 14–30	Feb. 12, 1998	74	1	4	4	4	**12**	**4%**
5	Testing new ideas by playing simulation game	Nov. 14 – Dec. 4	Feb. 13 – Mar. 10, 1998	96	6	72	18	15	**105**	**38%**
Number of days from start of step 1 to end of step 5		**29**	**125**	**Invested Time**	**[hours]**	170	71	39	**280**	**100%**
					%	61%	25%	14%	**100%**	

Appendix B:

The planned project schedules, realised project schedules and invested work hours in the case projects G and H

Table B-1. The project plan, realised project schedule and invested work time in the case project G.

	Case G	Original plan	Realised project schedule	Delay in step end	Number of blue-collar employees	Invested time [hours]					
Step No.	**Task**	Due date	Due date	[days]		Blue-collar employees	Project Champ	Prod.Mngr	Tech.Dir.	Total hours	Total %
	Preliminary discussion	June 23, 1998	June 23, 1998	0	0	0	3	3	1	6	*0,6%*
1	**Project kick-off and objectives setting**	Sept. 22–23, 1998	Sept. 22–23	0	0	0	7	3	0	10	*1,1*
2	**Data collection and process modelling**	Dec. 31, 1999	Dec. 3, 1998 – Jan. 7, 1999	0	3	36	39	2	0	77	*8,3*
3	**Building the simulation model of present processes and first simulation game seminars**	Jan. 24, 1999	Jan. 12 – Feb. 7, 1999	0	18	345	38	1	1	384	*41,6*
4	**Generation of development ideas for improvement**	Jan. 31, 1999	Feb. 4 – Feb. 11, 1999	11	18	40	14	8	0	62	*6,7*
5	**Testing new ideas by playing simulation game**	Feb. 28, 1999	Feb. 12 – Mar. 15, 1999	15	18	339	40	6	1	385	*41,7*
	Number of days from the start of step 1 to the end of step 5	160	175	**Invested time**	**[hours]**	760	141	23	3	927	*100,0%*
					%	*82,3*	*15,3*	*2,5*	*0,3*	*100,0%*	

Table B-2. Original project plan, realised project schedule and invested time in Case H during the first two simulation game rounds in the case project H.

	Case H	Planned project Schedule	Realised project schedule	Delay in end of step	Number of blue-collar	Invested time [hours]						
Step No.	Task	Due date	Due date	[days]	employees	Blue Collars	Proj. Chmp1	Proj. Chmp2	Prod. Mngr	Mng Dir.	Total	
											hours	%
	Preliminary discussion	June 2, 1998	June 2, 1998	0	0	0	3	0	4	0	7	1,4
1	Project kick-off and objectives setting	Sept. 11–30, 1998	Sept. 11–30, 1998	0	0	0	17	3	6	0	26	5,4
2	Data collection and process modelling	Sept. 11– Oct. 15	Sept. 11 – Oct. 15, 1998	0	0	0	39	21	5	0	65	13,4
3	Building the simulation model of present processes and first simulation game seminars	Oct. 15–28, 1998	Oct. 15–28, 1998	0	9	90	0	20	16	0	126	26,0
4	Generation of development ideas for improvement	Nov 6, 1998	Oct. 30 – Nov. 24, 1998	0	8	12	6	3	6	0	27	5,6
5	Testing new ideas by playing simulation game	Nov. 24 – Dec. 31, 1998	Nov 12, 1998 – Jan 19, 1999	19	11	77	93	56	7	1	234	48,2
	Number of days from the start of step 1 to the end of step 5		131	Total Invested time	**[hours]**	**179**	**157**	**103**	**44**	**1**	**485**	100,0
					%	36,9	32,4	21,2	9,1	0,2	100,0	

Table B-3. Project plan, realised project schedule and invested time in the third simulation game round in the case project H and total invested time from the project kick-off.

	Case H	Planned project schedule	Realised project schedule	Delay in end of step	Number of blue collar	Invested time [hours]						
Step No.	Task	Due date	Due date	[days]	Employees	Blue Collar	Proj. Chmp1	Proj. Chmp2	Prod. Mngr	Mng Dir.	Total	
											hours	%
2	Data collection and process modelling	Jan. 25 – March 12, 1999	Jan. 25 – March 12, 1999	0	0	0	35	13	4	0	52	6,4
5	Testing new ideas by playing the third simulation game	March 15–30, 1999	March 15–30, 1999	0	10	200	51	24	5	1	281	34,5
	Total cumulative invested time from the project kick-off				[hours]	379	242	140	52	2	**815**	100,0
					%	46,5	29,7	17,2	6,4	0,2	100,0	

Appendix C: Examples of the measurement questions applied in the case projects G and H

- Pages C2–C4: Questionnaire according to all the 12 dimensions in the change management measurement system.

- Pages C5: Questionnaire applied in the project management meeting.

- Pages C6–C8: Questionnaire applied in the project meetings for assessment of human resource related subject matters.

- Pages C9–C12: Questionnaire for evaluation of the first and second simulation game.

- Page C13: Questionnaire for evaluation of the idea generation meeting.

The measures for change project management
Human resources:
a) Effectiveness
1. Have strategic issues, visions and company's objectives communicated to the project personnel during the project? (scale 1–5):
2. Management support to the project, i.e. sponsorship? (scale 1–5, 1 = no sponsorship at all, 2 = a little, 3 = I do not know/can not say, 4 = medium, 5 = high)
Evaluated by project personnel (mean):
Evaluated by Project Manager(s) and Production Manager (mean):
3. Innovative climate, (scale 1–5): 1= not innovative at all, 2 = a little, 3 = to some extent innovative, 4 = medium, 5 = very innovative)
Answer of Project Personnel (mean):
Answer of Project managers (mean):
4. Have you found out project personnel's understanding concerning manufacturing terminology? (scale 1–5):
Human resources:
b) Efficiency:
1. Is the invested time in project known? Is there a project diary?
Invested time by Project Champions and Production Manager?
Invested time by blue-collar employees?
2. Measuring communication and understanding: Does project management team (PMT) measure communication and inform project personnel?
Does PMT react to these feedback measurements?
3. What is the motivation level and willingness to change among project personnel? (scale 1–5, 1 = no at all, 3 = to some extent, 5 = very good)
Project Champions and Production manager (mean):
Blue-collar employees (mean):

The measures for change project management
Processes:
a) Effectiveness:
1. Strategy alignment, Was the project based on corporate strategy?
Scale 1–5: *1 = not at all, 3 = I do not know/can not say, 5 = Yes, completely*
Answer of Project Managers:
Answer of Production Manager:
2. How well timetables, milestones, budgets and resources are determined?
Scale 1–5: *1 = Disagree completely, 2 = Disagree in some degree, 3 = Do not know/Can not say, 4= Agree in some degree, 5= Agree completely*
Project Manager:
Answer of Production Manager:
3. Are the critical success factors of the project determined? (Scale 1–5):
Processes:
b) Efficiency:
1. Achievement of objects compared to plan:
1a) Has project proceeded according to the plan? (scale 1–5): If not, how many days is the difference and why?
1b) Has project proceeded according to the planned budget and resources? (scale 1–5): If not, why? What is the difference?
The measures for change project management
Technology
a)Effectiveness:
Have you listed and identified the needed tools and know-know? (Scale 1–5):
b) Efficiency:
b1) Have you evaluated operational know-how concerning the use of needed tools? (scale 1–5)
b2) Is there need for training concerning the needed tools? (scale 1–5):

The measures for manufacturing operations management
Human resources:
a) Effectiveness
a1) Do you encourage employees to learn multiple skills? (scale 1–5, 1 = not at all, 2 = a little, 3 = I do not know/can not say, 4 = medium, 5 = highly) If yes, how?
a2) Have you made a skill matrix? (*scale 1–5)*
b) Efficiency:
b1) Do you measure human productivity? (scale 1–5): If yes how?
b2) How flexible is the human work capasity %?
The measures for manufacturing operations management
Process measures
a) Effectiveness
1. What is the strategic meaning of the manufacturing process? (scale: core process = 5 / non core process = 1)
b-1) Efficiency
2. Are the subsistent values of the manufacturing process parameters stated in the objectives of the development project known and measured systematically? (Scale: 1–5) If no, when do you start measuring and when do you have those values?
The measures for manufacturing operations management
Technology
a) Effectiveness
Is there a process for evaluation, selection and benchmarking of manufacturing technologies in the company? (scale: 1–5, Yes = 5 /no = 1):
Is there a process for evaluation of information technology in the company? (scale: 1–5, Yes = 5 /no = 1):
b) Efficiency:
Do you know the manufacturing technology's costs and benefits? (scale: 1–5, Yes = 5 /no = 1):
Do you know the information technology's costs and benefits? (scale: 1–5, Yes = 5 /no = 1):

Examples of the measurement questions used in the project management meeting.

	Please evaluate the correctness of the statements according to the following scale (1–5) by circling the appropriate choice. 1 = strongly disagree 2 = disagree 3 = neither agree nor disagree, cannot say 4 = agree 5 = strongly agree					
		1	**2**	**3**	**4**	**5**
1	The project is based on the strategy of the company.					
2	The project has clear objectives and milestones.					
3	The project is budgeted well enough and necessary resources (work time, materials) are allocated and reserved beforehand.					
4	The critical success factors of the project have been defined. Scale 1–5, (Yes = 5 /No = 1)					
	What are the critical success factors of the project?					
5	Name the tools that you have used or are going to use during the project:					
6	Comments on the project:					

Examples of the measurement questions concerning human resource related subject matters in information and debriefing meetings.

	Scale 1–5: 1 = fully disagree, 2 = disagree, 3 = can not say, 4 = agree, 5 = fully agree					
	Objectives	**1**	**2**	**3**	**4**	**5**
1	I do understand the objectives and visions of the project					
2	I do understand the objectives and visions of the company					
3	I do understand the objectives and visions of my work team					
4	I do understand my own the objectives and visions					
	General information	**1**	**2**	**3**	**4**	**5**
5	I have received enough general information about the project.					
	Meaningfulness	**1**	**2**	**3**	**4**	**5**
6	What is your opinion, how important and meaningful is this project for the company? (Scale 1–5)					
	1 I think that this project is not important and meaningful at all					
	2 I think that this project is not important and meaningful					
	3 I think that this project is somewhat important and meaningful					
	4 I think that this project is important and meaningful					
	5 I think that this project is really important and meaningful					
		1	**2**	**3**	**4**	**5**
7	What is your opinion, how important and meaningful is this project for the development of your own work?					
	1 I think that this project is not important and meaningful at all					
	2 I think that this project is not important and meaningful					
	3 I think that this project is somewhat important and meaningful					
	4 I think that this project is important and meaningful					
	5 I think that this project is really important and meaningful					
	Information at the current meeting	**1**	**2**	**3**	**4**	**5**
8	Did you get enough information at the current meeting?					
	1 I think the information was totally inadequate					
	2 I think the information was inadequate					
	3 I think the information was somewhat adequate					
	4 I think the information was adequate					
	5 I think the information was totally adequate					

	Innovative climate	**1**	**2**	**3**	**4**	**5**
9	How do you feel about your own possibilities to influence the development of your own work environment?					
	1 = My possibilities to influence are really weak					
	2 = My possibilities to influence are weak					
	3 = My possibilities to influence are somewhat good					
	4 = My possibilities to influence are good					
	5 = My possibilities to influence are really good					
		1	**2**	**3**	**4**	**5**
10	How often do you think about the development of your own work?					
	1= never					
	2 = twice a year					
	3 = monthly					
	4 = weekly					
	5 = daily					
11	How often do you express your development ideas to your supervisor?					
	1= never					
	2 = seldom					
	3 = sometimes					
	4 = often					
	5 = always					
12	When you expressed your ideas, did you get reasonable feedback?					
	1= never					
	2 = twice a year					
	3 = monthly					
	4 = weekly					
	5 = daily					
13	Do you have discussions on the development of production work and working environment with your colleagues					
	1= never					
	2 = twice a year					
	3 = monthly					
	4 = weekly					
	5 = daily					

14	How do you feel the creativity and development atmosphere in your workplace?					
	1 = No creativity nor development spirit at all					
	2 = A little creativity and development spirit					
	3 = Somewhat creativity and development spirit					
	4 = Considerably creativity and development spirit					
	5 = Much creativity and development spirit					
	Terminology	**1**	**2**	**3**	**4**	**5**
15	Several questions concerning the manufacturing terminology used in the company, for example:					
	How well do you understand what manufacturing throughput time stands for?					
	1 = Not at all					
	2 = A little					
	3 = Somewhat					
	4 = Considerably well					
	5 = Very well					
	Please evaluate the correctness of the following statements according to the scale 1–5: 1 = fully disagree, 2 = disagree, 3 = can not say, 4 = agree, 5 = fully agree					
	Top Management Sponsorship	**1**	**2**	**3**	**4**	**5**
16	The top management of the factory supports this project sufficiently.					
	Support of colleagues	**1**	**2**	**3**	**4**	**5**
17	My colleagues support this project sufficiently.					
	Personal motivation	**1**	**2**	**3**	**4**	**5**
18	I myself support this project sufficiently.					
	Relaxation moment at the meeting	**1**	**2**	**3**	**4**	**5**
19	The relaxation moment at the beginning of the meeting was					
	1 = Extremely uncomfortable and disturbed greatly my concentration in the meeting					
	2 = Uncomfortable and disturbed my concentration in the meeting					
	3 =Neither uncomfortable nor comfortable					
	4 = Comfortable and helped me to concentrate in the meeting					
	5 = Extremely comfortable and helped me greatly to concentrate in the meeting					
20	Tell your own words the objectives of this project:					
21	What are the most important development objects and improvement suggestions?					

The applied questionnaire and the examples below are modified and enhanced from the research done by Ruohomäki (1994). Originally her questionnaire was developed in context of simulation-game-based administrative process development. However, it can be proposed that the questionnaire by Ruohomäki (1994) modifiable, due to its general nature, for assessment of human resource related subject matters in the simulation game intervention in manufacturing process context.

The questions 1–24 are examples of the measurement questions in the first simulation game. The questions 25–40 are added when evaluating the second simulation game.

	Reality	1	2	3	4	5
1	What is your opinion ? Did the simulation game face up to reality?					
	1 = It did not face up to reality at all 2 = It faced up to reality slightly 3 = It faced up to reality to some extent 4 = It faced up to reality well 5 = It faced up to reality completely					
	Information and guidance beforehand	**1**	**2**	**3**	**4**	**5**
2	Did you get enough accurate information and guidance about the simulation game beforehand?					
	1 = The information and guidance were completely insufficient 2 = The information and guidance were quite insufficient 3 = The information and guidance were somewhat sufficient 4 = The information and guidance were quite sufficient 5 = The information and guidance were completely sufficient					
3	What were your thoughts before the games? What kind of stand did you take beforehand?					
	Please evaluate the correctness of the following statements according to the following scale (1–5): 1 = strongly disagree 2 = disagree 3 = neither agree nor disagree 4 = agree 5 = strongly agree					

	Objectives of the game	1	2	3	4	5
4	I learned new things about our manufacturing process during the game.					
5	I got a general view of the manufacturing processes.					
6	Needs of the other work phases could easily be seen during the game.					
7	It was easy to see the bottlenecks of the process during the game.					
8	It is worthwhile playing simulation games when changing working methods and especially before extensive changes in working methods.					
9	The simulation game helped me to understand the problems in the manufacturing process.					
10	In my opinion, the objectives of the simulation game were appropriate.					
	Playing the simulation game helps me to understand other people's viewpoints better.					
	Communication	**1**	**2**	**3**	**4**	**5**
11	In my opinion, important and essential matters were discussed during the simulation game days.					
12	I had a good opportunity to express my opinions and ideas during the simulation game days.					
13	I had a good opportunity to hear other people's opinions and ideas.					
	Group work	**1**	**2**	**3**	**4**	**5**
14	I actively took part in group work.					
15	It was easy for me to express viewpoints and ideas during the simulation					
16	There was much co-operation in the group.					
17	We achieved good results together.					
	Learning	**1**	**2**	**3**	**4**	**5**
18	The games helped me to understand how my job is connected to a bigger picture.					
19	Due to the simulation games I better understand what the problems and causes of the manufacturing process are.					
20	I learned which tasks are taken care of by others.					
	Practical arrangements	**1**	**2**	**3**	**4**	**5**
21	I was content with the illustrations (instructions, transparencies, clock, charts, boards)					
22	Room arrangements were carefully laid out (space, furniture, lightning).					
23	The point of the time for the simulation games was suitable for me					
24	I was satisfied with guidance and help during the simulation games					

Examples of the measurement questions in the second simulation game.

In addition to the questions applied in the first simulation game the following questions were used for the evaluation of the second simulation game.

	Please evaluate the correctness of the following statement according to the scale (1–5):					
	1 = fully disagree, 2 = disagree, 3 = can not say, 4 = agree, 5 = fully agree					
	Starting to practice the new working methods	**1**	**2**	**3**	**4**	**5**
25	It is worthwhile to start practice the new working methods.					
26	I am willing to practice the new ways of working.					
27	The development objectives can be achieved in reality.					
	Feelings after simulation game	**1**	**2**	**3**	**4**	**5**
28	What was your mood after the simulation game?					
	1 = very negative					
	2 = negative					
	3 = neutral					
	4 = positive					
	5 = very positive					
		1	**2**	**3**	**4**	**5**
29	Participation in the simulation game was					
	1 = a completely useless experience					
	2 = to some extent a useless experience					
	3 = neither a useless or a useful experience					
	4 = a useful experience					
	5 = an extremely useful experience					
	Testing and planning the new working methods	**1**	**2**	**3**	**4**	**5**
	Please evaluate the correctness of the following statement according to the following scale (1–5): 1 = fully disagree, 2 = disagree, 3 = can not say, 4 = agree, 5 = fully agree					
30	In my opinion it is worthwhile to practice the new working methods by playing simulation game.					
31	The usefulness of the new working methods could be seen during the development game.					
32	During the development game I learned the pull production control principle.					
33	The new working method seemed to be a good solution.					
34	My opinion is that the development objectives can be achieved in practice.					

	Economical issues and evaluation	**1**	**2**	**3**	**4**	**5**
35	It is economically worthwhile to play simulation game when developing manufacturing.					
36	It came out during the development game that decrease of work-in process inventory in practise is economically worthwhile.					
37	Simulation gaming helps to minimise the economical risk when changing ways of working.					
38	During the simulation game days I learned better than previously what are the economical terms such as throughput time and work-in process inventory.					
39	Because of participation in simulation games I am more ready than previously to take part in preparation of economical measures for manufacturing.					
40	It is economically worthwhile to practise and learn new ways of working without disturbing manufacturing.					

Examples of the measurement questions for debriefing and idea generation meeting.

	Utility of debriefing and idea generation meeting	1	2	3	4	5
1	1. In my opinion, participation in the information and idea generation meeting was					
	1 = a completely useless experience 2 = to some extent a useless experience 3 = neither a useless or a useful experience 4 = a useful experience 5 = an extremely useful experience					
	Please evaluate the correctness of the following statements according to the following scale (1–5) by circling the appropriate choice. 1 = strongly disagree 2 = disagree 3 = neither agree nor disagree 4 = agree 5 = strongly agree					
	Information about simulation game results	1	2	3	4	5
2	I got enough information about the simulation game results for idea generation.					
	Group work	1	2	3	4	5
3	Idea generation when working in pairs is more efficient than working alone.					
4	In my opinion, the size of the project group was appropriate.					
5	I actively took part in the group work.					
6	There was much co-operation in the group.					
7	It was easy for me to express opinions and ideas in the meeting.					
		1	2	3	4	5
8	Shared simulation game experience made group discussion and idea generation easier.					
9	We achieved good ideas together.					
	Understanding of the new production control principle	1	2	3	4	5
10	I understood the principle of pull production control.					
11	What are the central objectives of the project?					

Appendix D:

The comparison of the case projects G and H according to the central events, project schedule, measurement activities and invested work time

From project kick-off to the first simulation game – the central events, time observations concerning the schedule, measurement activities and invested work time in the case projects G and H are brought forward in Tables D-1 and D-2.

Table D-1. Central events, time observations and measurement related activities in the case projects G and H.

Central events during the project chronologically ↓	Time observations				**Measurement activities**	
	Days from kick-off		% of calendar days until first implementations in reality		**Case G**	**Case H**
	Case G	Case H	Case G (100%=211 days)	Case H (100%=422 days)		
Kick-off meeting	0	0	0%	0%	**Determination of** both objectives and **measures according to CMMS**	Determination of objectives
Project management meeting	89	19	42%	5%	**Measurement of all the 12 dimensions in CMMS**	**Determination of measures according to CMMS**
Project meeting	113	26	54%	6%	Information to project personnel, **measurement of all the 12 dimensions in CMMS, measurement of human resource related subject matters**	Information to project personnel
Simulation Game I, first day	117	46	55%	11%	Feedback and more information	More information, **measurement of human resource related subject matters**
Simulation Game I, second day	118	47	56%	11%	**Measurement of all the 12 dimensions in CMMS and human resource related measurements concerning the simulation game**	**Human resource related measurements concerning the simulation game**

Table D-2. Invested working hours in the case projects G and H.

Organisational unit	Invested working hours		% of all invested hours till implementation planning	
	Case G	Case H	Case G 100% = 927)	Case H (100% = 818)
Project Manager 1	**87**	**59**	**9,4%**	**7,2%**
Project Manager 2	-	44	-	5,4%
Blue-collar employees	**381 (18 employees)**	**90 (9 employees)**	**41,1%**	**11,0%**
Production Manager	9	31	1,0%	3,8%
Top Management	2	0	0,2%	0,0%
Cumulative invested working hours	**479**	**224**	**51,7%**	**27,4%**

From debriefing of the first simulation game to the second simulation game – the central events, time observations concerning the schedule, measurement activities and invested work time in the case projects G and H are compared in Tables D-3 and D-4.

Table D-3. Central events, time observations and measurement activities in the case project G and H.

Central events during the project in implementational order	Time observations				Measurement activities	
	Days from project kick-off		% of calendar days until first implementations in reality		Case G	Case H
	Case G	Case H	Case G	Case H		
Project management meeting: analysis of simulation game results, further planning	132	49	63%	12%	**Analysis of previous measurements**	**Analysis of previous measurements**
Feedback, information, debriefing and idea generation meeting	139	52	66%	12%	**Analysis of previous measurements**	**Measurement of human resource related subject matters**
Project management meeting: further planning	-	59	-	14%	-	**Analysis of previous measurements**

Table D-4. Comparison of invested working hours between the case projects G and H.

Organisational unit ↓	**Invested working hours**		**% of all invested hours till implementation planning**	
	Case G	**Case H**	**Case G** (100% = 927)	**Case H** (100% = 818)
Project Manager 1	14	6	1,5%	0,7%
Project Manager 2	-	3	-	0,4%
Blue-collar employees	40 (18 employees)	12 (8 employees)	4,3%	1,5%
Production Manager	8	6	0,9%	0,7%
Top Management	0	0	0,0%	0,0%
All together in this phase	**62**	**27**	**6,7%**	**3,3%**
Cumulative invested working hours from the kick-off	**541**	**251**	**58,4%**	**30,7%**

Second simulation game and debriefing in the case projects G and H – the central events during the projects, time observations concerning the schedule, measurement activities and invested work time are compared in Tables D-5 and D-6.

Table D-5. The central events, time observations and measurement activities in the case projects G and H.

Central events during the project in implementa-tional order ↓	Time observations				Measurement activities	
	Days from the project kick-off		% of calendar days until first implementations in reality		**Case G**	**Case H**
	Case G	Case H	Case G	Case H		
Project management meeting	-	69	-	16%	-	**Effectiveness measurements concerning the project process**
Project management meeting	-	74	-	18%	-	**Measurement of all the 12 dimensions according to CMMS**
Feedback and information about the next simulation	152	97	72%	-	**Measurement of human resource related subject matters**	
Simulation Game II, first and second day	153–154	97–98	73%	23%	**Measurement of human resource related subject matters concerning on the simulation game**	**Measurement of human resource related subject matters concerning the simulation game**
Project management meeting	160	123	76%	29%	**Analysis of previous measurement results and further planning**	**Analysis of previous measurement results and further planning**
Feedback and debriefing meeting	173	130	82%	31%	**Measurement of all the 12 dimensions according to CMMS and in particular measurement of human resource related subject matters, implementation planning**	**Measurement of human resource related subject matters**
Project management meeting	-	138		33%	-	**Measurement of all the 12 dimensions according to CMMS, in particular effectiveness measurement of the project process, further planning**

Table D-6. Comparison of invested working hours between the case projects G and H.

Organisational unit	**Invested working hours**		**% of all invested hours till implementation planning**	
	Case G	**Case H**	**Case G** (100%=927)	**Case H** (100%=818)
Project Manager 1	40	93	4,3%	11,4%
Project Manager 2	-	56	-	6,8%
Blue-collar employees	339 (18 employees)	77 (11 employees)	36,6%	9,4%
Production Manager	6	7	0,6%	0,9%
Top Management	1	1	0,1%	0,1%
All together in this phase	386	234	41,6%	28,6%
Cumulative or all invested working hours from the kick-off	**927**	**485**	**100,0%**	**59,3%**

Third simulation game and debriefing in the case project H – the central events, time observations concerning the schedule, measurement activities and invested work time are brought forward in Tables D-7 and D-8.

Table D-7. Central events and measurement activities in the case project H.

Case H			
Central events during the project in implementational order	Days from the project kick-off	% of calendar days until first implementations in reality	**Measurement related activities**
Information to project personnel	186	44%	Measurement of human resource related subject matters
Simulation Game III, first and second day	187–188	45%	Measurement of human resource related subject matters concerning the simulation game
Project management meeting	194	46%	Analysis of previous measurements and measurement of all the 12 dimensions according to CMMS
Information, feedback and debriefing meeting	200	47%	Measurement of human resource related subject matters
Project management meeting: implementation planning start	217	51%	Analysis of previous measurements

Table D-8. Invested working hours in the case project H.

Case H		
Organisational unit	**Invested working hours**	% of all invested hours till implementation planning (818)
Project Manager 1	86	10,5%
Project Manager 2	37	4,5%
Blue-collar employees	200 (10 employees)	24,4%
Production Manager	9	1,1%
Top Management	1	0,1%
All together in this phase	333	40,7%
Cumulative invested working hours from the kick-off	**818 hours**	**100,0%**

Appendix E:

The project schedule and the measurement related activities in the case project G

Practical functioning of CMMS in Case G			
Content			
Section*	**Central events during the project in chronological order**	**Due Date**	**Measurement related activities**
10.1 From the project kick-off toward the first simulation game		**1998**	
	Project kick-off meeting	Sept. 2–3	Determination of measures according to CMMS
	Project management meeting	Dec. 21	Measurement of all the twelve dimensions in CMMS and analysis
		1999	
	Information meeting for project personnel	Jan. 14	Measurement of all the twelve dimensions in CMMS, in particular measurement of human resource related subject matters such as information, meaningfulness, innovative climate, and how well terminology is understood
10.2 First simulation game and debriefing	Feedback, more information, Simulation Game 1	Jan. 19–20	Measurement of all the twelve dimensions in CMMS, in particular measurement of human resource related subject matters concerning the simulation game
	Project management meeting, game results new ideas	Feb. 2	Analysis of previous measurements
	Feedback, debriefing, and idea generation meeting	Feb. 9	Analysis of previous measurements
	Feedback, Information about the next simulation	Feb. 22	Measurement of human resource related subject matters concerning the idea generation and information meeting
10.3 Second simulation game and debriefing	Simulation Game 2	Feb. 23–24	Measurement of human resource related subject matters concerning the simulation game
	Project management meeting,	March 2	Analysis of previous measurements, implementation planning
	Feedback and Debriefing, implementation planning	March 15	Measurement of all the twelve dimensions in CMMS, in particular measurement of human resource related subject matters such as information, meaningfulness, innovative climate, terminology, Analysis of measurements
	Implementation start	April 6	
10.4 Measurements after implementation planning	Project management meetings	April–Sept.	Measurement of invested work hours and changes in reality, i.e., changes in work-in-process inventories and manufacturing throughput times
10.5 Feedback discussion	Project management team meeting	Sept.	Comments and evaluation of CMMS by Project Manager

* *The structure and content of Chapter 10 are arranged chronologically according to the realised project schedule in the case project G*

Appendix F:

The project schedule and measurement related activities in the case project H

Practical functioning of CMMS in Case H			
Section*	**Central events chronologically**	**Due Date**	**Measurement related activities**
		1998	
11.1 From project kick-off to first simulation game	Project kick-off	Sept. 11	
	Project management meeting	Sept. 30	Determination of measures according to all the twelve dimensions in CMMS
	Information meeting for project personnel	Oct. 7	
	Simulation game 1, first day	Oct. 27	Measurement of human resource related subject matters before the simulation game
	Simulation game 1, second day	Oct. 28	Measurement of human resource related subject matters concerning the simulation game
11.2 Debriefing of first simulation game and idea generation	Project management meeting: further planning	Oct. 30	Analysis of the previous measurements
	Feedback, debriefing, information, idea generation	Nov. 2	Measurement of human resource related subject matters
	Project management meeting: further planning	Nov. 9	Analysis of the previous measurements
11.3 Toward second simulation game	Project management meeting	Nov. 19	Measurement of project process effectiveness
	Project management meeting	Nov. 24	Measurement of all the twelve dimensions according to CMMS
11.4 Second simulation game and debriefing	**Simulation game 2, 1st and 2nd day**	Dec. 17–18	Measurement of human resource related subject matters concerning on the simulation game
		1999	
	Project management meeting: further planning	Jan. 12	Examination and analysis of the previous measurements
	Feedback and debriefing meeting	Jan. 19	Measurement of human resource related subject matters such as information, meaningfulness, innovative climate, sponsorship etc.
11.5 Toward third simulation game	Project management meeting, further planning	Jan. 27	Measurement of all the twelve dimensions according to CMMS
	Information for project personnel concerning the third simulation game	March 16	Measurement of human resource related subject matters such as information, meaningfulness, innovative climate, terminology, sponsorship, support of colleagues, personal motivation

11.6 Third simulation game and debriefing	**Simulation game 3, 1st and 2nd day**	March 17–18	Measurement of human resource related subject matters concerning the simulation game
	Project management meeting: survey results	March 24	Analysis of the previous measurements and measurement of all the twelve dimensions according to CMMS,
	Information, feedback and debriefing meeting	March 30	Measurement of human resource related subject matters such as information, meaningfulness, innovative climate, terminology etc.
	Implementation planning start	April 16	Examination and analysis of the previous results
11.7 Measurements after implementation planning	Project and project management meetings	Oct.–Dec.	Measurement concerning the willingness in change and changes in reality, i.e., changes in work-in-process inventory and manufacturing throughput time
11.8 Feedback discussion	Project management team meeting	Dec. 22	Comments and evaluation of CMMS by Project Manager and Production Manager

* *The structure and content of Chapter 11 are arranged chronologically according to the realised project schedule in the case project H.*

Appendix G:

The method for processing measurement data

The measurement values for the radars in Sections 8.1, 9.6, 10 and 11 are calculated basically according to the following principles. Firstly, the sample means $\bar{x}_q$ for each of the measurement questions under the measurement dimensions are calculated by applying Equation G-1 (Kreyszig, 1993).

$$\bar{x}_q = \frac{1}{n}\sum_{i=1}^{n} A_i = \frac{1}{n}(A_1+A_2+A_3 \ldots A_n)$$

A_i = answer of respondent i to the measurement question q

n = the size of the sample = number of respondents

Equation G-1. The sample mean $\bar{x}_q$ of a sample $A_1, A_2, A_3, \ldots, A_n$.

Secondly, the sample means $\overline{X_d}$ for the measurement dimensions d are calculated by applying Equation G-2. Thereafter, the measurement radars could be drawn.

$$\overline{X_d} = \frac{1}{m}\sum_{q=1}^{m} \bar{x}_q = \frac{1}{m}(\bar{x}_1+\bar{x}_2+\bar{x}_3 \ldots \bar{x}_m)$$

$\bar{x}_q$ = the sample mean for the question q under the measurement dimension d.

m = the size of the sample, i.e., number of sample means $\bar{x}_q$ under the measurement dimension d

Equation G-2. The sample mean $\overline{X_d}$ of a sample $\bar{x}_1, \bar{x}_2, \bar{x}_3, \ldots, \bar{x}_m$.

It should be noted that in order to facilitate the combination of the measurements, i.e., rank values, into a single index in Section 8.1, and Chapters 10 and 11 that would describe the performance of each measurement dimension, the scale for the measurement dimensions can be interpreted as follows: 1 = very poor performance, 2 = poor performance, 3 = average performance, 4 = good performance, 5 = very good performance.

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Measuring Change Management in Manufacturing Processes

A Measurement Method for Simulation-Game-Based Process Development

Abstract

The aim of this research is to find an answer to the research problem, which is *"How can change management be measured in order to help manufacturing companies develop their manufacturing processes?"* To solve the research problem, a constructive action research method is applied. The proposed solution to the research problem, i.e., a change management measurement system, is developed based on principles found in project management literature, process change management literature, performance measurement literature, three consultant surveys, and three case projects. Two of these three case projects applied simulation games as developmental tool, while one applied computer simulation. The proposed change management measurement system is evaluated through these three case projects, and thereafter both practised and further elaborated through two new case projects. The two new case projects are compared for gaining more sophisticated understanding of emerging patterns, and improvement suggestions for simulation-game-based change process utilising the change management measurement system are brought forward. Finally, the results are discussed, and the research and its contribution are evaluated through the quality criteria developed for this research.

The measures in the change management measurement system are classified into two types: the first type gauges change project management itself, and the second assesses the outcomes of the change project, i.e., the improvements gained in manufacturing operations. Both of these types are measured in three dimensions: human resources, processes and technology, which are further divided into effectiveness and efficiency. Effectiveness is defined as the external, strategic performance: "doing the right thing," where strategically correct processes are developed, and strategically sound targets are pursued. Effectiveness includes adaptability. Efficiency is defined as the internal, operational performance: "doing it right," reaching the objectives of the change project economically and ideally with the best possible input/output. Consequently, the change management measurement system forms 12 measurement dimensions out of which six dimensions measure change project management itself and the other six dimensions measure changes in the manufacturing operations.

The proposed change management measurement process suggest that particular attention should be paid to measurement and consequent timely reactions in the early phases of the project. Reactions to early feedback enable rapid learning and a successful project trajectory can be achieved already in the early phases of the project. Thereafter, through continuous measurement and consequent timely reactions, a successful project trajectory can be maintained until the project end.

The case results suggest that there is a need for balanced change management measurement where both the change project management and the manufacturing operations management are measured. The balanced measurement improves the systematics and coherence of the change process; thus also the change management capability of the organisation is enhanced. In addition, it is proposed that the measurement system should flexibly allow customised measures for all the project steps. Furthermore, the research results support the idea that one key factor for success is how well the project management team uses the available measurement system, i.e. how well the measurement related tasks are performed. In change management capability improvement the measurement of human resource subject matters is fundamental to success, and it is proposed that in future research cycles, particular attention should be paid to development of measures concerning psychological, behavioural and teamwork subject matters.

Keywords
industrial management, change management, measurement, performance, quality control, modification, process control, evaluation, innovation, manufacture, processing, simulation, efficiency

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