Measuring Simulation Based Change Management in Manufacturing

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Abstract: In this chapter, a balanced and holistic approach for the assessment of change management in context of tailored simulation gaming and computer simulation is developed. The change management measurement framework distinguishes between internal efficiency and strategic effectiveness from human resource, process and technology points of view. In addition, the change projects itself and the outcomes of the project, i.e. the changes in operations, are evaluated separately in the framework. The framework is applied to analyze and compare the change projects in three Finnish manufacturing companies. The results indicate that the framework explains the difference between successful and less successful change management in manufacturing processes. By applying the measurement framework in practice, organizations can continuously improve their change management capabilities. More empirical research is needed to test the framework further.

1. INTRODUCTION

Enterprises have to change and develop their performance continuously in order to survive. In addition to being effective in their current processes, they now have to develop their capability for change management. The level

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of competition is shifting from the management of operations to the efficient and effective management of change [1].

Simulations have been successfully applied as change management tools in Finnish industry during the last ten years [2, 3, 4, 5]. The change management method discussed in this chapter applies tailored simulation games and computer simulations in process development.

2. LITERATURE REVIEW AND STATE-OF-THE-ART IN MEASURING CHANGE PROJECT MANAGEMENT

It is commonly agreed that all the development activities in a company should be prioritized and based on carefully crafted business strategy [6, 7, 8, 9, 10, 11]. In addition, the selected development activities should be executed with the best possible input /output. These ideas also apply to change project management in manufacturing processes. Consequently, the management of change projects in manufacturing should also be measurable. Only when we are able to measure the efficiency and effectiveness of change project management is it possible to continuously improve the organization's change management capability. With effectiveness we mean the external, strategic performance, "doing the right thing", where strategically correct processes are developed, and strategically sound targets are pursued. By efficiency we mean the internal, operational performance of change management: "doing it right", reaching the objectives of the change project with the best possible input/output.

To ensure the effectiveness of change project management 'the balanced scorecard' by Kaplan & Norton [8] can be used. Davenport 1993 [6] identifies four criteria that guide change process selection:

1. Strategy;
2. Process Health;
3. Process Qualification, i.e. the process has a committed sponsor, and
4. Manageable Project Scope.

In addition to process selection, Davenport sees that human resources and technology are important factors of change. The measures for the development projects are normally timetables, milestones or preliminary goals and budgets. Harrington 1991[7] provides the five phases of business process improvement as follows:

1. Organizing for Improvement;
2. Understanding the Process;
3. Streamlining;
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 which defines milestones according to the five phases and makes a detailed plan for 90 days. Kotter 1995 [10] suggests the following eight phases for transformation 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. Institutionalizing new approaches.

In addition to literature review Managing Directors from three global consulting companies were interviewed to define the state of the art in measuring change management projects. In the following, the central results from the interviews are briefly given.

Consulting Company A uses the following six key points as measures for manufacturing process change projects:

1. Are objectives discussed and agreed upon within a team?
2. What kind of know-how or experts are needed?
3. 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;
4. Basically change projects are measured by objectives and milestones. Sometimes actions to be taken can be used as measurements: whether actions are taken or not is thus 'checked';
5. Operational measures such as quality, throughput times, punctual deliveries or same day deliveries, service level, creativity, stakes in personnel training, use and stakes in information technology, are used;
6. The use of creativity, the ability to create and the climate for innovation are the change measurement areas which should be developed further.

Consulting Company B applies the business measurement framework according to which strategy is measured by business results: a popular tool for this is the balanced scorecard [8]. 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 in different oraganizational groups. Changes in behaviour are measured by asking how people can see, perceive and verify changes in themselves, in their work environment, in their colleagues, managers and subordinates. Based on these questions Change Journey Assessment Profile is made, to detect and measure whether the change is successful or not.

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

3. FRAMEWORK FOR MEASURING CHANGE MANAGEMENT

The framework is a synthesis of the consultant survey, in particular business measurement framework of Consulting Company B and of Davenport [6], Harrington [7] and Kotter [8]. It focuses on operational excellence and change management. The measures for assessing change management in manufacturing processes can be basically classified into two types. The first type assesses change project management itself, and the second measures 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 (Figure 1).

In this framework we assume that change management and manufacturing operations are competitive factors that have risen from business strategy. Furthermore, it is noticeable that changes in the

measurements of a manufacturing operations' operational excellence result at least partially from change management.

Change management measurements can be divided between strategic effectiveness and internal efficiency. Examples of both types are given in table 1.

Table 1 : Change Management Measures.

CHANGE PROJECT MANAGEMENT MEASURES		
	Effectiveness	**Efficiency**
1. Human resources measures:	includes sponsorship, innovative climate, communication of corporate strategy, desire of owners, willingness to change, evaluation of the understanding of objectives	includes invested time of mgt. and employees, productivity, perseverance in change, social skills, educational skills, sense of coherence,capability, motivation, resistance to change
2. Process measures:	includes strategy alignment, identification of critical success factors, use of generic change management methods and creativity techniques, quality of planning	achievement of objectives compared to plan including milestones, timetables, budgets, project scope
3. Technology measures:	identification of strategically right technologies, tools in the change project	cost efficient use of technology (simulation games, computer simulations, computer-aided creativity tools and information systems), need for training concerning technology
OPERATIONAL EXCELLENCE MEASURES		
	Effectiveness	**Efficiency**
1. Human resources measures:	competencies and skills, education, operational expertise, customer and process awareness	input/output measurements on human productivity, quality and flexibility
2. Process measures:	strategy alignment (links between operational performance and strategic competitive factors), and profitability	operational input/output measurements such as productivity, volume, lead time, flexibility, amount of work-in-process, quality
3. Technology measures:	selection of strategically right technologies and tools (process technology and IT)	productivity of technology, cost/benefit measurements

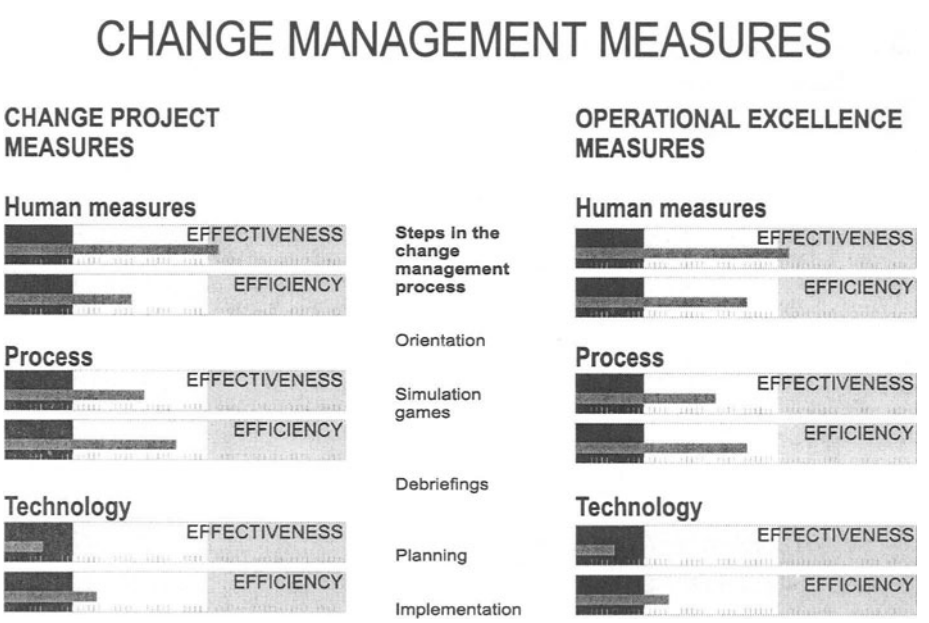

Figure 1. Framework for measuring change management in the manufacturing environment when applying simulation as a developmental tool.

4. TAILORED SIMULATION GAMING AS A BALANCED CHANGE MANAGEMENT METHOD

Simulation gaming can be thought as a tool for balanced change management in accordance with the developed measurement framework. Simulation game project is a holistic approach when modelling and developing work systems including at its best all the three central aspects of reality: human resources, processes and technology. In addition games can be applied in all three phases of development: understanding present system, prototyping new system and training to operate new system (Riis et al 1996 [12]). The difference between a simulation game and a computer simulation method is that in a game, there is always an active group of people. For computer simulations this is not necessary, as the simulation software specialist 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 broader computer simulation seminars.

In particular simulation gaming facilitates empowerment and learning during the change project. When participation, a common understanding, motivation and commitment in change is created, more viable ideas are developed and finally organization is able to implement planned changes in reality, c.f. Riis et al 1996 [12], Moss Kanter 1983 [13], Smeds 1997 [2]. From organizational learning point of view gaming supports both single and double loop learning depending on development targets. 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 organization (Argyris and Schön 1978 [14]). Senge (1990) [15] uses terms adaptive and generative learning for single and double loop learning respectively. According to Nonaka and Takeuchi 1995 [17, p. 46] the capacity of double loop learning is build into a knowledge creating company. They argue that organizational learning develops in a dynamic knowledge conversion process between the individual and the organization, and between tacit and explicit knowledge. Simulation games support all steps in the knowledge conversion process where tacit knowledge is involved, c.f. Riis et al (1996) and Smeds (1997):

- Socialization: the individual, tacit knowledge is shared through the joint game experience;
- Externalization: tacit knowledge is made explicit through conceptualization and dialoque in the game and in the debriefings;
- Combination: different bodies of explicit knowledge is combined into a new design in debriefings or design teams as a simulation game after effect rather than during the actual game;
- Internalization: alternative designs are experimented in games; learning by doing and adopting the new way of working, conversing explicit knowledge back to tacit individual knowledge.

5. APPLYING THE SIMULATION GAME BASED CHANGE MANAGEMENT METHODOLOGY

The change management method, i.e. the change process in all three cases, and checking points for change management measures are presented in Figure 2. The method is especially well suited to the improvement of production management and the enhancement of process knowledge. In addition, possible.

In Step 1, the process to be developed is selected, and both development objectives and change management measures are set.

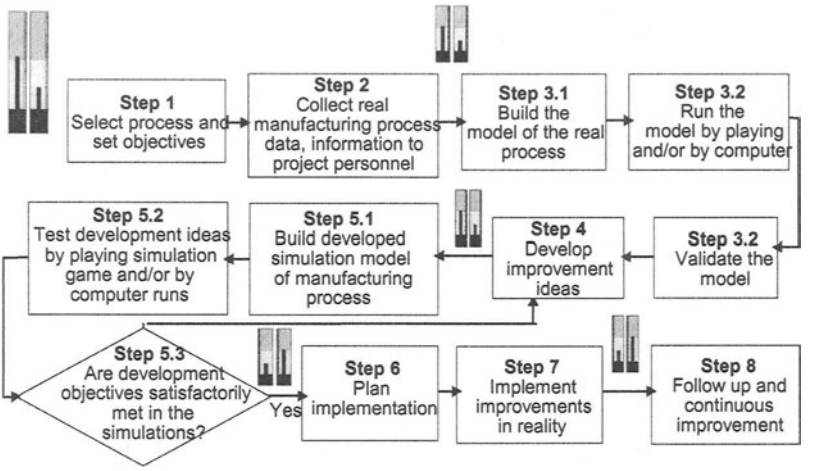

Figure 2. Change process and example checkpoints for change management measures.

After the data collection on actions, customers, products, cycle times and resources in Step Two, it is possible to build a simulation model of the real manufacturing process in Step 3.1, and print the playing cards for the simulation game, Step 3.2. The cards represent real actions, resources and cycle times for actual products, orders and customers. Furthermore, a play-watch is programmed so that it can be simulated during one day, several days, weeks or even months. In addition, there is a time capacity sheet in front of every player. When a player gets the card he or she fills in the starting and closing time of each action, and writes the respective cycle time on the capacity sheet. When the capacity is full, the card cannot be forwarded, and neither new cards nor tasks can be taken by the player. In Step 3.3 the simulation model is validated and if the model reflects reality well enough, the project proceeds into the generation of development ideas. In Step 5 development ideas are tested and if objectives are satisfactorily met implementation planning takes place in Step 6. Implementation in reality is in Step 7 and follow-up in Step 8.

6. EMPIRICAL ACTION RESEARCH IN CHANGE MANAGEMENT

Three empirical action research studies in change management were carried out in three Finnish case study companies (D, E and F) from June 1997-March 1998. In case companies D and F, simulation games were used as development tools, whereas in case E only computer simulation was used.

The Steps of the change project in all three case studies are described in Figure 2. However, the change management measures described in this paper were not available during the projects but later on for evaluation. The first author worked in the projects as a research consultant working together with the project personnel of the case study enterprises. From a practical point of view he worked as a change agent by introducing the method, i.e., steps one through eight in Figure 2.

It is noteworthy that the manufacturing processes under change and having change objectives in all three case projects D, E, F were approximately the same size. In particular, a common factor was the need for change from the push type production control to the pull principle. In addition, the common objectives in each case were as follows: 1) to cut manufacturing throughput times by 20-40 % depending on products in Case F and by 50 % in cases D and E; (2) to halve the WIP inventory; (3) to identify bottlenecks in production, and (4) to commit the employees to the project.

Case Enterprise D provides manufacturing services for the electronics industry. The total number of personnel was 220 when the project started June 18, 1997. The project started with a delay, on September 3, 1997, due to a lack of time and resources for data collection and for the preliminary preparation in the company. Because the project was lagging behind in its original timetable, we proceeded directly to the improvement idea generation phase rather than an exhaustive modelling of present operations. The development ideas pull-type production control and cellular manufacturing were thought to be the keys to facilitate production control, improve teamwork, speed up manufacturing throughput time and decrease WIP. First two simulation game days arranged in October 2 and 3, 1997. The last two debriefing and discussion meetings were held after the simulations on November 10 and 20, 1997, when the project was lagging 51 days from the original plan. The total mount of used managerial and blue collar man hours in the simulation project was 435.

Case Enterprise E is also a supplier in the electronics industry, but the products are mainly made of sheet metal. The company had about 140 employees when the project started in August 20, 1997. The project ended November 6, 1997 when project was lagging 13 days. The total mount of invested man hours was 139. From the practical point of view the project proceeded according to plan with one exception. Because of the other duties of the project champion, 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.

A group of managers joined the computer simulation seminars. There was no blue collar employee participation in the project and no participative simulation game. After the second simulation seminar the new layout and production control method were accepted by the participants.

Case Enterprise F is an engineering workshop. The amount of personnel was 240 when project started in November 1997. After the project started, it was soon found that the Project Champion and other employees were overloaded by the implementation task of a new enterprise resource planning system and both 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 showed the problems of the present manufacturing system. The biggest problem was in synchronization, i.e. different manufacturing functions were manufacturing the parts punctually but for different end products. The new pull production control principle was tested in the simulation game seminar on 12 March, 1998. The implementation of improvements was set to start in September 1998. Total amount of invested managerial and blue collar employee hours for the project was 280.

7. TESTING THE CHANGE MANAGEMENT MEASUREMENT FRAMEWORK

The change management framework was tested through a questionnaire survey. The respondents were project personnel, Project Champion and Project 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 2. The survey results are summarized in the comparative radar in Figure 3 as a relative comparison between the cases. Figure 3 shows that Case D had the best overall change management performance while Case E was the second best and Case F came third. Same order can be found also in realized improvements of operational excellence in both 6 and 12 months after the second simulation round.

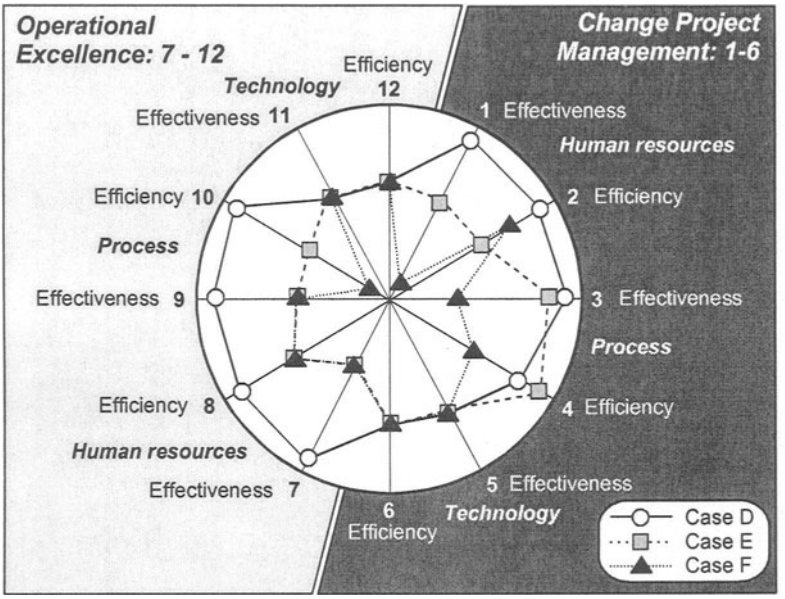

Figure 3. Comparative values of change management measurements in cases D, E and F.

8. CONCLUSIONS

The developed change measurement framework together with tailored simulation gaming forms a holistic and balanced approach for change management. The approach utilizes measures for three central aspects of reality under change - human resources, processes and technology - and differentiates both strategic effectiveness and internal efficiency within each aspect.

The first analyses of the three case studies indicate that the measurement framework (Figure 1) for the assessment of change management in context of simulation gaming explains differences between successful and less successful change projects in manufacturing processes. In particular, good values in change project measurements correlate to the speed of improvement in reality. The sequence of cases D, E and F along both the change project management and operational excellence measures in Figure 3 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.

These two exceptions show that it is important to concentrate on what is strategically essential and only then concentrate on internal efficiency.

Human resource efficiency of change project in Case F has higher value than Case E. 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, i.e. blue collar involvement, is higher in Case F. The problem in Case F was the time usage in a non-strategical way from human resource point of view. The same phenomen can be detected when comparing strategic effectivess and internal efficiency of change processes between cases D and E. In Case E, the problem in change process effectiveness was the poor determination of resources in the beginning, which induced that manufacturing of a certain product group only could be simulated. Furthermore, there were no blue collar involvement in Case E because of computer simulation. The process efficiency measure detected the achievement of objectives compared to the plan and Case E was lagging only 13 days while Case D lagged 51 days.

We applied tailored simulations in the change management process as shown in Figure 2. However, we believe that the measurement framework is generic enough to be applied in change processes as well as when using other approaches, e.g. such as those used by Davenport [6], Harrington [7] and, Kotter [10]. By applying the measurement framework in practice, organizations can continuously improve their change management capabilities. More empirical research is needed to further test and develop the framework.

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