TURUN KAUPPAKORKEAKOULUN JULKAISUJA
PUBLICATIONS OF THE TURKU SCHOOL
OF ECONOMICS AND BUSINESS ADMINISTRATION

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Enhancing Organizational Business Process Perception - Experiences from Constructing and Applying a Dynamic Business Simulation Game

Sarja / Series Ae-5:2003 (elektroninen) A-5:2003 (painettu)
ISBN: 951-564-154-3 (elektroninen) 951-564-139-X (painettu)
ISSN: 1459-4870 (elektroninen) 0357-4652 (painettu)

ACKNOWLEDGEMENTS

...think about the coach, who knows that the athlete can jump 2.40,
but is satisfied with 2.25 m. You should take on the challenge.
The competition jumps at least 2.40 m.
An anonymous PhD thesis reviewer (2003)

This doctoral process has taken a long time to mature. During the long project I have been thrown together with many people who have kindly assisted me by creating fruitful settings for research.

My gratitude goes to Professor Sven Carlsson for acting as my opponent. It was not easy to find a suitable person who could master the field of the thesis, especially the combination of organizational theories and the artefact's potential for knowledge creation and sharing. The presence of Sven certainly gives the dissertation process an ending it deserves.

I have had the honor to have two of the very highest class thesis reviewers. When the time came to consider a suitable person to assess this thesis, Professor Pertti Järvinen was the only Finnish name that we came up with. He is a rare scholar who has knowledge in all three fields of Information Systems Science, Organization Sciences and Education. It really has been a pleasure and an honor to get help from the grand old man of the Finnish Information Systems Science society.

My other reviewer, Professor Jan Klabbers is the world's grand old man of the Simulation and Gaming field. Jan had a very strong view of what a good simulation and gaming dissertation should include. This led to changes in the original manuscript. Thus, in the review process the original manuscript of 117 pages plus seven articles became 270+ pages plus four articles. Needless to say, the nature of the work changed during this process. The original idea of an easy to read short stories collection transformed into a somewhat heavy scientific assessment of the artefact and a theorization of the meaning of the value of the innovations in the artefact. In this process the value of the thesis certainly increased. Jan worked almost too hard during the review process and he earns my warmest gratitude for this.

Rector Tapio Reponen has had an important background role in the project. Whenever there has been a situation where some consultancy has been needed, I have been able to trust Tapio to give a helping hand.

My gratitude also goes to my supervisors, Professors Mikko Ruohonen, Reima Suomi, and Hannu Salmela. Mikko helped me to get started with the research and afterwards, throughout the project, he has arranged opportunities for me to prove my competence in the training field. Reima taught me the importance of expressing my ideas clearly. His words “Timo, there is nothing new here” still echo in my mind. Maybe this thesis is more understandable than my early writings. Hannu’s role has not been enviable. As the topic of the thesis is, to a degree, multidisciplinary – the core being somewhere else than in core Information Systems Science – I assume that Hannu has had to work somewhat to align the work in the scientific field. He has, however, supported me well during the last six tough months of the project.

At the beginning of the project – before I enrolled in the academia – the encouraging support from Matti Lainema, Bengt Gustafsson, Kai Mäkelä, and Hannu Räsänen was very important. I thank you for your insightful vision and knowledge of what is possible, lucrative and sensible.

Professors Christer Carlsson and Ralph-Johan Back from Åbo Akademi University played an important role when this personal research project negotiated funding from the National Technology Agency of Finland (Tekes). Christer has also had another important role in the project. During the project I worked for two years in Christer’s Institute for Advanced Management Systems Research (IAMSR) in Åbo Akademi. These two years offered an excellent opportunity to test the artefact of the thesis in full scale training sessions. The importance of this testing possibility was vital as the Turku School of Economics and Business Administration (TSEBA) was never interested in providing a similar possibility.

The scientific strength of the thesis increased through the collaboration with the department of Education in the University of Turku. Professor Erno Lehtinen was very kind to let me take part in the postgraduate seminars and this lead to another vital matter for the project. I was contacted by Researcher Sami Nurmi who asked me to start collaboration with him. Collaboration with Sami has lead to interesting cross-disciplinary research, the most important fruits of which are still to ripen in the future.

Annina Juopperi has had a special role of a patron during the last three years. Annina has had a strong belief that the artefact of the thesis is useful for business organizations and through Annina’s support and that of Tampere University of Technology’s Edutech (Centre for Continuing Education) I have been able to run several company in-house training sessions since October 2000. These sessions have been decisive in collecting credible empiric data to prove the value of the thesis artefact.

Outside my home department at TSEBA it has been quite difficult to create collaboration with other researchers. There is, however, one exception. Professors Lauri Ojala and Olli-Pekka Hilmola have realized the potential in the artefact of the thesis. This collaboration has lead to joint publications and probably will yield many more in the forthcoming years.

I further wish to thank my liaison Matti Oinaanoja and supervisor Jaakko Aalto-Setälä in my first case company for giving me the opportunity and support to study their organizational processes. Towards the end of the research project I also had the opportunity to test the artefact in another case company, Wallac Oy. At Wallac my special thanks go to Merja Nurminen, Lasse Mäkelä and Meri Lattu.

Furthermore, I would like to thank all the members of the department of Information Systems Science in Turku School of Economics and Business Administration. My special thanks to Jussi Puhakainen, who so often has acted as a trusted conversation partner when the peculiarities and illogicalities of the academic environment have defied my comprehension. Virpi Ruohomäki has had a similar role regarding the international settings. And thank you Birgit Haanmäki for taking care of the myriads of practical things at the end of the project. My thanks also go to Eeva Lilley for the virtual language checking.

For the financial support I wish to thank all parties involved. This long study has been funded by Tekes and grants from the Foundation for Economic Education, Vuorineuvos Marcus Wallenbergin Liiketaloudellinen Tutkimussäätiö, Kauppaneuvos Kalle Kuusisen Rahasto, Turun Kauppaopetussäätiö, and The Turku School of Economics Association. Without the support from these foundations I could not have been able to concentrate as well on the research.

Last, but not least thanks go to my family. All the children – Julia, Ava and Max – have understood that especially during 2002/2003 the high piles of paper on the living room floor should not be shuffled. I hope that you will learn anew that your father is also something else than the zombie from spring 2003, when he did not hear or see anything. And Kirsi, you have seen me suffer from several small and even smaller misfortunes but always been able to encourage me to get over them. Thank you for being patient although this effort must often have reminded a never-ending struggle.

Turku, 27th of August, 2003.

Timo Lainema

To Kirsi,
the Fifth Dimension,
the Sixth Discipline.

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APPENDICES

PAPERS

1 INTRODUCTION

Reippaina käymme rekkain alle, kun se tuntuu niin ihanalle
Alanko[1](1980)

1.1 Background

Today, the information needs of decision-makers and the overall organizational – as well as any other – environment are reshaping rapidly. Some decades or even just years ago the focus of information requirements in organizations was mainly on what goes on inside an organization. Increasingly, decision-making will require and use information about the external environment: competitors, new production technologies, new delivery channels, and so on. This shift in focus has increased the rate of changes and insecurity about suitable ways of action. The development of employees' decision-making skills in most business organizations will increasingly become a major challenge for businesses. The productivity of knowledge is becoming the decisive competitive factor for most industries (Drucker, 1997).

Whatever the level of employee performance improvement, people as decision-makers and responsible for task execution need to understand the basic organizational functioning and what they are part of in order to cope with their work tasks. In some business industries this is more important than in some others, but in general these improvement requirements have increased in all sectors. In extreme this means that employees in companies must be able to change their ways of working. These requirements may involve better-coordinated manufacturing and purchasing to make maximum effectiveness in economies of scale and production, local efficiencies of labor force, and efficient purchasing and warehousing of components. Furthermore, by increasing the responsiveness to market trends and customers' requirements, the intention is to gain sales volume and minimize energy waste. Attaining such improvements in productivity would be a significant challenge under traditional slowly evolving circumstances, but the process is made significantly more demanding by the volatile environment that has become evident.

The implications of this situation are that successful organizations are building their success upon less control and more learning – through

[1] Song *Reippaina käymme rekkain alle* from *Täältä tullaan Venäjä.*

continually creating and sharing new knowledge (Senge, 1997). In this process teaching and training methods play a considerable role. Besides the changes in different business environments the higher level business education is in a state of change. For example, Aram and Noble (1999) argue that business schools are not adequately preparing students to understand and cope with the levels of ambiguity and uncertainty they will inevitable face when they take up positions in organizations. They believe that this is because the models of teaching and learning that dominate academic practice are those that are appropriate to the stable, predictable aspects of organizational life and do not include the paradoxical and unpredictable. Some scholars are even more pessimistic about the overall educational situation (Jonassen et al., 1999, p. 199): *Most school curricula focus on the knowledge that students should acquire, even though they do not provide any good reason for acquiring it.* At worst this may lead to situations where content is separated from its authentic context. Thus, learning may become a memorization process of seemingly abstract, self-contained entities, not useful tools for understanding and interacting with the world.

The basic argument for the use of business games is that they allow theory to be put into practice in a risk-free environment and encourage team working and decision-making. The use of business games in business education is mainly addressed to present or future decision-makers in organizations. Business games offer the participants knowledge on how the decisions carried out affect the business environment and thus prepare the participant to learn more about decision-making by experience. In general, the game used should therefore have some properties that describe the actual real-world decision-making environment of the organization in question.

In the future the use of management games in learning will probably be at least as common as today. As Elgood (1996) mentions, technological development will certainly not slow down, and one will be able to simulate more situations with greater realism and greater ease. Work will be seen as an activity that should be rewarding in itself, and enjoyable, and therefore something to which game-playing can be reasonably linked. The comprehensible but arbitrary consistency of a virtuality has been most immediately evident in computer games, which gain tremendous appeal through the ability of the player to engage in the virtual world in earnest (Winograd, 1995).

However, we feel that the above is not quite true with respect to today's business games. While the world around businesses is changing with growing speed the business game processing methods are still the same as 45 years ago. This work examines how to enrich the traditional educational genre of business gaming to respond to the changes in the business context, both concretely and theoretically. This multidisciplinary research is based on several scientific fields. As such, the topics covered should be interesting to an audience from a variety of fields, e.g. management, information systems, education, and simulation and gaming.

1.2 Motivation for the Research

The researcher has found himself involved with business gaming since the early 1980's. The first encounter with business games took place when the researcher was working in an office of a retail company in 1981. The team he was part of was the team that had won the Finnish championship in a management game tournament some years earlier. Being part of this group was fascinating, as it was interesting to see the "busy big bosses" so intensively immersed in something as abstract as gaming, which is not always considered a serious activity.

When the researcher was an MSc student around the turn of the year 1986, he was asked by Lecturer Timo Leino to construct a personal computer based business game – together with fellow student Christian Hassel – it was not difficult to agree to take part in the project. This business game was completed in 1987 (Hassel and Lainema, 1988) and turned out to be a successful one; one modified version of it is still in use at the Turku School of Economics and Business Administration (TSEBA). The researcher also used this game in company in-house training during the 1990's and these sessions were encouraging.

Already at the end of the 1980's the researcher was pondering the possibility of constructing a real-time processed business game, which would better describe the time bound nature of business decisions. The company in-house training sessions and the advances in programming environments (rapid application development tools and their embedded database access libraries) then encouraged the researcher to return to this idea. Modern interactive programming environments make it possible to quickly shape and reshape ideas into working objects, which is a key to effective design and even more important for the interaction-intensive programs (Winograd, 1995), exactly like the artefact of this thesis.

By that time real-time processing seemed to offer a more realistic learning environment than batch-processing, although arguing for this was based on less scientific arguments. The people in business and in academia whom the researcher talked with about his ideas thought, however, that the idea was a promising one. This then lead to the researcher contacting the Turku Centre for Computer Science and TSEBA and, consequently, to enlisting as a researcher in 1997.

Since then many of the original ideas and arguments have changed or been refined, and new ideas have arisen. Still, the main motivation has remained the same: to offer students or business employees a training experience which is both efficient and enjoyable and transmits a verified representation of business operations.

1.3 Research Problem

The research has been carried out in two phases. This is analogous with March and Smith (1995) who state that research activities in design science (research that attempts to create things that serve human purposes; as opposed to natural science, which is aimed at understanding reality) are twofold: *the first phase* is *building an artefact, demonstrating that such an artefact can be constructed*. The first phase in this research entailed the construction of a continuously processed business game. This phase is summarized in the researcher's licentiate thesis (Lainema, 2000). The research problem of the first phase was determined as follows:

Is it possible to construct a business game model in which:

a) The business model works in an interactive, real-time processed connection with the markets.

b) The business model (internal business model) and the market model (external business model) are customized according to the requirements of the training event.

c) The business model demonstrates the total business concept, it includes the main functions of a general manufacturing organization and its most significant stakeholders.

The licentiate study entered into constructing a business game, which includes the three main attributes mentioned above. The main research methodology was constructive. In creating the construction we were interested in describing a holistic business structure with the business functions of a manufacturing company. In the game the players see the functioning of the game company as cross-functional processes. Through playing this game the participants could be trained to understand for example:

- competitor activities in the competitive environment,
- the operation of the supplier-producer-distributor-customer chain,
- monetary processes and funding of the business entity, and
- how to steer manufacturing processes.

From this point forward we mainly use the word *artefact* when we refer to the business game construction developed during the research project. *An artefact is an object that is made by a person, for example, a tool or an ornament* (Collins Cobuild English language dictionary, 1987). We could also use the word *construction* but we feel that this word implies something slightly more physical, while our construction is purely of an immaterial kind. Also the literature discussing constructive research seems to use the term artefact more often than other terms.

As Järvinen (1999; 2001) notes, it is typical of constructive research to build a new artefact based on existing knowledge and/or technical advancements. The results of the first phase of the research are also documented in Chapter 7 and Paper 1 (argumentation for continuous processing; Lainema and Makkonen, 2003) of this thesis. The conclusion of the first phase was stated in the licentiate thesis: *The main result of the research is that with present programming tools and operating systems it is possible to construct a real-time processed business game that differs from the main stream of business games by the way it is operated and processed.*

Järvinen (1999; 2001) continues that after building the new artefact its utility should be evaluated. March and Smith (1995) state that the second phase in design science concerns *evaluating, referring to the development of criteria and the assessment of artefact performance against those criteria*. Thus, the main research questions of the second phase of the research are stated:

> *Do business game participants consider the continuous processing element of the new business simulation game beneficial?*

Minor research questions stemming from the main problem are:

a) *Does the use of the business simulation game increase engagement and make the work more meaningful during the training situation? Thus, does the use of the business simulation game affect on the participants' gaming experiences and working processes in a meaningful way?*
b) *What are the effects of configuring the business simulation game the participants' gaming experiences and working processes? Does configuration increase the feeling of realism?*

The results of this study aim at adding new knowledge to the scientific body of simulation gaming. We feel that this kind of research is very current, as the expectations of the business training field from different simulation tools are notable (Ju and Wagner, 1997; Saffo, 1997). For example Saffo (1997, p. 30) has noted: *In the next decade, the most important new sense-making tools will be those that help people visualize and simulate. Visualization techniques reduce vast and obscure pools of data into easily comprehended images. And* *simulation systems will become intellectual training wheels for executives, allowing them to experiment with strategies in the forgiving world of cyberspace…*

March and Smith (1995) state that significant difficulties in design science result from the fact that artefact performance is related to the environment in which it operates. The artefact must be evaluated, but the evaluation criteria themselves must be also determined for the artefact in a particular environment. This sets ambitious requirements for our work. To make this even more difficult, March and Smith require that after an artefact's performance has been evaluated, it is important to determine why and how the artefact worked within its environment. Thus, we theorize and then justify theories about those artefacts. Building the first of any set of constructs is deemed to be research. The research contribution lies in the novelty of the artefact and in the persuasiveness of the claims that it is effective. Progress is achieved in design science when existing technologies are replaced by more effective ones.

1.4 Theoretical Background of the Study

1.4.1 Theoretical Framework

Figure 1.1 represents the theoretical and conceptual framework of our research. The theoretical foundation of the study relies mainly on research on the experiential learning theory and the constructivist view of learning. We do not consider the business environment part a part of the theoretical framework but a framework for arguing, designing and implementing the artefact.

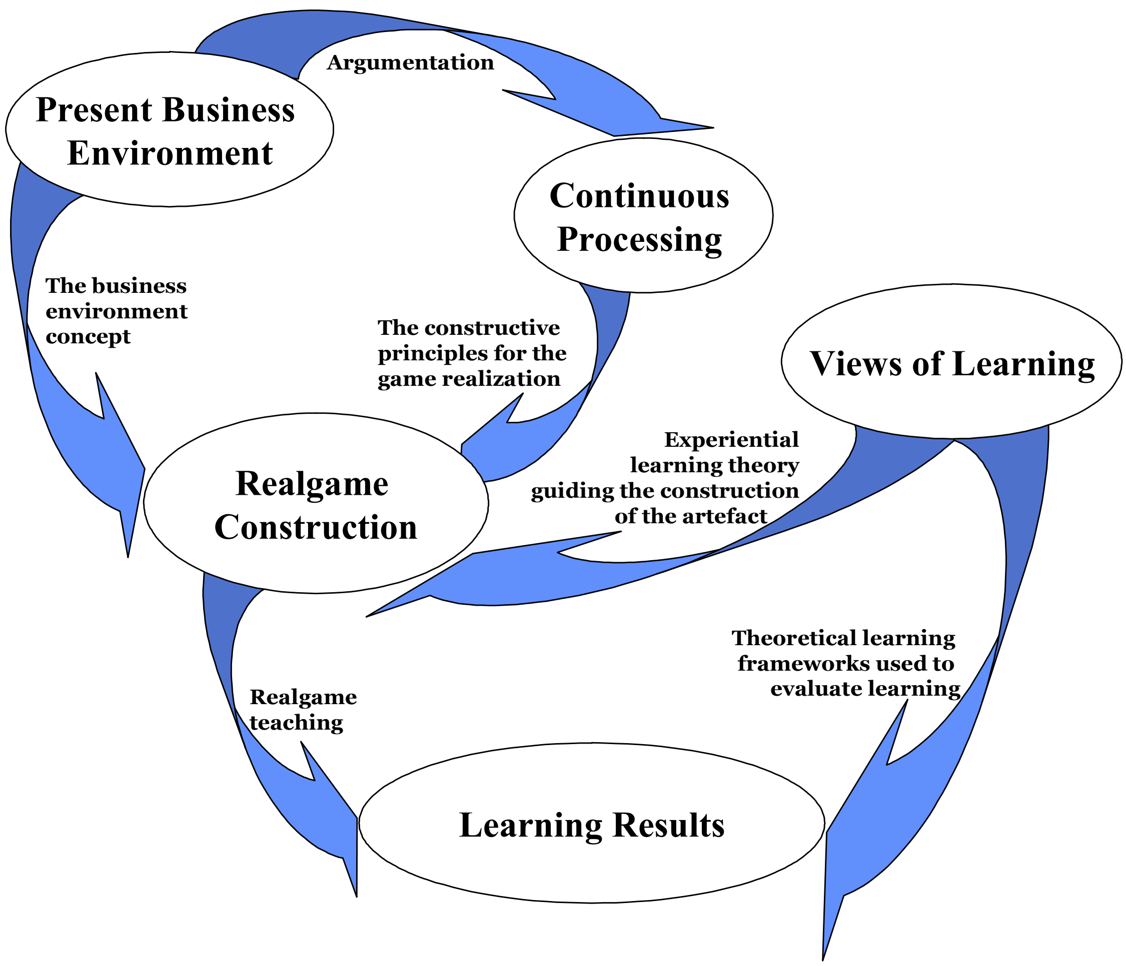

Figure 1.1 The theoretical framework for the research.

Isaacs and Senge (1992) argue that computer-based learning environments can enhance organizational learning by making explicit the assumptions and logical inconsistencies in the operating policies of an organization. Computer-based learning environments (CBLE) foster shared understanding of complex organizational processes and systems. Isaacs and Senge state that the central purpose of CBLEs is to provide decision-makers with new opportunities for learning through conceptualization, experimentation and reflection. They also note that this purpose is not easily achieved in everyday management activities.

CBLEs build on a long tradition of experiential education theory (Isaacs and Senge, 1992). This theory points to the significance of learning through direct experience as opposed to learning through 'instruction'. In experiential education theory learning is said to occur through the resolution of conflicts over different ways of dealing with the world. Kolb (1984) describes a model of experiential learning he calls the Lewinian model. This is an integrated process that begins with here-and-now experience followed by the collection of data and observations about that experience. The data are then analyzed and conclusions of this analysis fed back to the actors in the experience for their use in the modification of their behavior and choice of new experiences. Thus, in this model learning is conceived as a four-stage cycle shown in Figure 1.2. Immediate concrete experience is the basis for observation and reflection. Observations are assimilated into a theory from which new implications for action can be deduced. Implications or hypotheses then serve as guides in acting to create new experiences.

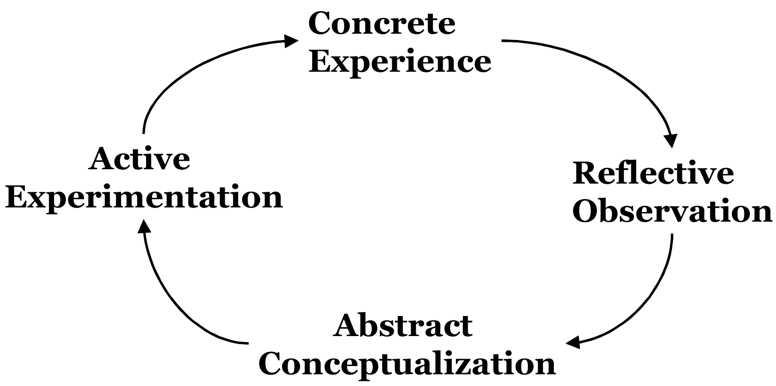

Figure 1.2: The experiential learning model (Kolb, 1984).

Kolb especially notes two aspects of this learning model. The first one is the emphasis on here-and-now concrete experience to validate and test abstract concepts. Kolb argues that immediate personal experience is the focal point for learning. This experience gives life, texture, and subjective personal meaning to abstract concepts and at the same time provides a concrete, publicly shared reference point for testing the implications and validity of ideas created during the learning process. Thus, human beings can share the experience fully, concretely, and abstractly.

The second aspect that Kolb emphasizes in this learning model is that laboratory training is based on feedback processes. The information feedback provides the basis for a continuous process of goal-directed action and the evaluation of the consequences of that action. The laboratory method integrates observation and action into an effective, goal-directed learning process. Isaacs and Senge (1992) describe the ideal learning process presented by Kolb as moving continually from concrete experience, to reflective observation, to abstract conceptualization, to active experimentation, and finally back to concrete experience. Argyris and Schön (1978) have described this process in slightly different terms. In their model the process moves from discovery of problems, to invention of solutions, to production of solutions in action, to reflection on the impact of these actions, and then back to discovery.

In general no particular learning model can be regarded as the best approach (Leidner and Jarvenpaa, 1995); different learning approaches will be appropriate depending on the circumstances (course content, student experience, maturity, intelligence, and instructor goal, skills, and preferences). In this thesis, the experiential learning theory is reinforced with the support of systems dynamics and constructivist learning principles. Constructivism is not a completely new learning paradigm. For example, the ideas of experiential learning have had influence on constructivism. Constructivism was originally based on the belief that technology based learning could convey information and understanding more effectively than teachers. By now it has been realized that you cannot convey understanding; that can only be constructed by learners.

Jonassen and Land (2000) list several constructivist conceptions of learning that share many beliefs and assumptions. These views are based on the belief that learning is neither a transmissive nor a submissive process, but rather a willful, intentional, active, conscious, constructive practice that includes reciprocal intention-action-reflection activities. Besides the process, the different views have in common the assumption that we are obligated to consider not only the performances of the learners, but also the sociocultural and sociohistorical setting in which the performance occurs and the tools and mediation systems that learners use to make meaning.

According to Isaacs and Senge (1992), CBLE research has tended to focus on individual understanding and individual cognitive limits. Nevertheless, the focus of decision-making in organizations tends to be on groups of people who need one another to act. This is where constructivism can most complement experiential learning as one of the most central arguments of constructivism is that learning is an inherently social-dialogical activity. The team learning aspects complicate the learning challenge and embed it within the study of group dynamics and group learning (Note that organizational literature neither offers a definition nor a clear description of what team learning is; Kasl et al., 1997; discussed later in Sections 7.12 and 9.3). Leidner and Jarvenpaa (1995) note that learners tend to generate higher-level reasoning strategies, a greater diversity of ideas and procedures, more critical thinking, and more creative responses when they are actively learning in cooperative groups. A virtual reality – like the construction described in this thesis – supports constructivist and cooperative learning. Students work together to construct the virtual world by contributing their own views of how the reality should operate. This is the area we are studying in this thesis.

1.4.2 Information Systems Science

The UK Academy of Information Systems (UKAIS; Avison, 1997) defines the field of Information Systems (IS) as the study of information systems and their development. This is a multi-disciplinary subject and addresses the range of strategic, managerial and operational activities involved in the gathering, processing, storing, distributing and use of information, and its associated technologies, in society and organizations. The Information Systems function has the responsibility to track new information technology and assist in incorporating it into the organization's strategy, planning, and practices (Couger and Davis, 1995).

The discipline of Information Systems may not necessarily seem to be the most obvious discipline within which to construct new learning environments. However, we want to argue why IS is a respectable and actually a very fertile field for the study. As Galliers (1997) argues, in an applied discipline such as Information Systems, it is important to undertake research that is seen to be relevant by colleagues in industry, government, commerce and academia. Probert (1997) states that IS is problem-driven, and those problems have been ultimately problems of management within organizations. This is also one of the starting points of this dissertation.

The discipline of IS calls upon many areas of knowledge and this knowledge is gained through the incorporation of topics from other domains of knowledge (Stowell and Mingers, 1997). IS is largely concerned with developing more effective organizational information systems, but IS can also become the discipline that concerns itself with the nexus of varied domains like technology, information, mathematics, linguistics, semiotics, psychology, sociology, etc, as the discipline bears upon the evolution of human communications and society. Stowell and Mingers (p. 9) suggest that *it is only if we adopt a 'transdisciplinary' approach can we begin to understand both the evolving nature and impact of technology upon society, and consequently provide us with a chance of influencing what might emerge in the future rather than simply suffering it*. Davis (2000) notes that looking at the academic field of information systems, its scope in terms of technology, development processes, and applications has expanded dramatically in the past 30 plus years. The scope is so large in the year 2000 that subfields have begun to emerge. The field of IS has natural overlap with other disciplines, and these intersections should remain part of the domain of IS discipline (Davis, 2000). Members of the field should not refuse any help from other disciplines, given the richness and complexity of the main research object – information systems – and its numerous facets (Banville and Landry, 1992).

The above argumentation gives support for creating business learning environments within IS. If we aim at giving a holistic view of business and linking this to education, we really are dealing with multi-disciplinary issues. This is the supportive side of IS. But there are also some dangers here. Jones (1997) argues that as we in IS need to have a broad understanding of social processes, there is a risk of poor quality research as people struggle to operate in areas in which they are inadequately qualified. This is the risk we have recognized. Learning as a phenomenon is quite far from the normal research issues in IS and that is why we have both studied some learning theories and carried out cooperative research with the department of Education of the University of Turku. Jones gives support for this by arguing that IS researchers need to engage with many disciplines, rather than assuming that the department within which they are located defines the boundaries of the subject. IS researchers should also seek to do research which is good in terms of other disciplines (to go back to the original texts in the reference discipline to gain genuine appreciation; Paper 2 of the thesis represents this kind of research).

In a sense the nature of our work falls well within IS. Avison (1997) states that much of the research in IS does not fit easily into a research category. IS research is multi-disciplinary and multi-faceted, and one would expect there to be many appropriate research methods. On the other hand, Landry and Banville (1992) suggest that no single method could ever capture all the richness and complexity of organizational reality, and that a diversity of methods, theories, and philosophies is required. At the same time, we acknowledge that some concepts and related bodies of knowledge will be discarded as not being sufficiently useful for the discipline and others will be added. This does not, however, mean that the inclusion of a rich set of intersections with other disciplines should be precluded (Davis, 2000).

1.5 The Structure of the Thesis

In Chapter 2 we will introduce the design methodology which creates a holistic framework for the research process. Table 1.1 introduces the research phases of the design methodology.

Table 1.1: Research phases and the structure of the chapter of the thesis.

Research phase	**Tasks carried out / Outcome**	**Chapters or papers of the thesis**
(a) The initial state	The heuristic theoretical justification of the construction, the construction of a proposition for problem resolution.	Chapters 3, 4 and 5. The nature of organizational environment, organizational ideas utilized in building the artefact -> implications for business process learning through experiential (game-based) learning = theoretical framework.
(b) Specification and implementation	The actual artefact construction process. The artefact (the instantiation).	This is not a core phase of the thesis. However, Section 6.1 discusses the actual construction process project. The outcome of the development project is introduced in Sections 7.1-7.7.
(c) The final state	The artefact to be used in production.	This is not a core phase of the thesis. However, Chapter 7 introduces the outcome of the research in the form of a computer application.
(d) Evaluation	Assessment of the learning experience.	Chapter 6. Several training sessions in company in-house training and university settings. A larger case research study (with some action research characteristics) in a business organization. Also Papers 1, 3 and 4 introduce some participant evaluation from artefact training sessions.
(e) Theorize	Description of why it worked. Theorizing about the artefact characteristics and its usefulness as a learning facilitator.	In Chapter 7 the artefact characteristics are reflected on the theoretical justification of the construction, presented in Chapters 3, 4 and 5. Also Papers 1, 2, and 3 reflect on the theoretical justification of the construction.
(f) Justify	Description of how it worked.	This issue is not dealt with in this thesis.
Result: A more effective learning environment than existing technologies?		

The different phases are described and argued in the following chapters. The first chapter of this thesis is an introduction to the research area. The second chapter of the thesis introduces the methodology used and describes the research process. Thus, this chapter creates a framework for the whole thesis.

The third chapter describes the organizational and environmental context for the use of continuously processed time bound learning tools. This topic is wide and we have selected only some phenomena to be described. However, we feel that these selections are the most important ones to champion a wider change in business curricula and learning environments (though our artefact, naturally, offers a solution to a certain specific and narrower learning problem). The main environmental themes to be described are the concept of time, the time spans in organizational decision-making, organizational structures, and the discussion evolving around business processes. A major source behind the changes in these themes is the emergence of the post-industrial world in which the influence of computers is radically transforming the nature of work. In new work communities workers collaborate across disciplines, assess the relevance of information for a given purpose, construct plans in response to novel situations, and engage in self-directed learning in furtherance of their own capacities and those of the enterprise. These communities depend on active, flexible, self-generating knowledge – adaptable to rapidly changing requirements (Zuboff, 1988).

The fourth chapter of the thesis defines the basic concepts relevant to this thesis. This involves mainly simulation and gaming terminology.

The fifth chapter introduces the theoretical background for the research. This includes theories and principles which all deal with learning, and especially learning through experiments or using learning technologies. Experiential learning theory has always been influential in the field of business gaming. During the late 1980's some other thoughts or principles of learning arose, which also have clear links to simulation gaming and learning business processes. The two of these which we find most important for the work are organizational learning (especially the branch expressing the importance of systems dynamics) and constructivism. These two learning principles have partly the same roots and they both support and give more depth to experientialism.

Chapter six discusses the evaluation of the artefact. The research process description gives a narrative about the development, testing, and evaluation project.

The seventh chapter introduces the artefact in the form of game screen copies and theorizes about the nature of the artefact. We are speculating on the artefact characteristics and whether its continuous nature might produce a different kind of learning experience compared to batch-processed learning environments.

The eighth chapter of the thesis introduces briefly the four papers of the thesis and states how they contribute to the whole structure of the thesis.

The ninth chapter gives conclusions on the research problem and suggests new research areas.

Figure 1.3 shows how the different chapters and papers contribute to the theoretical framework.

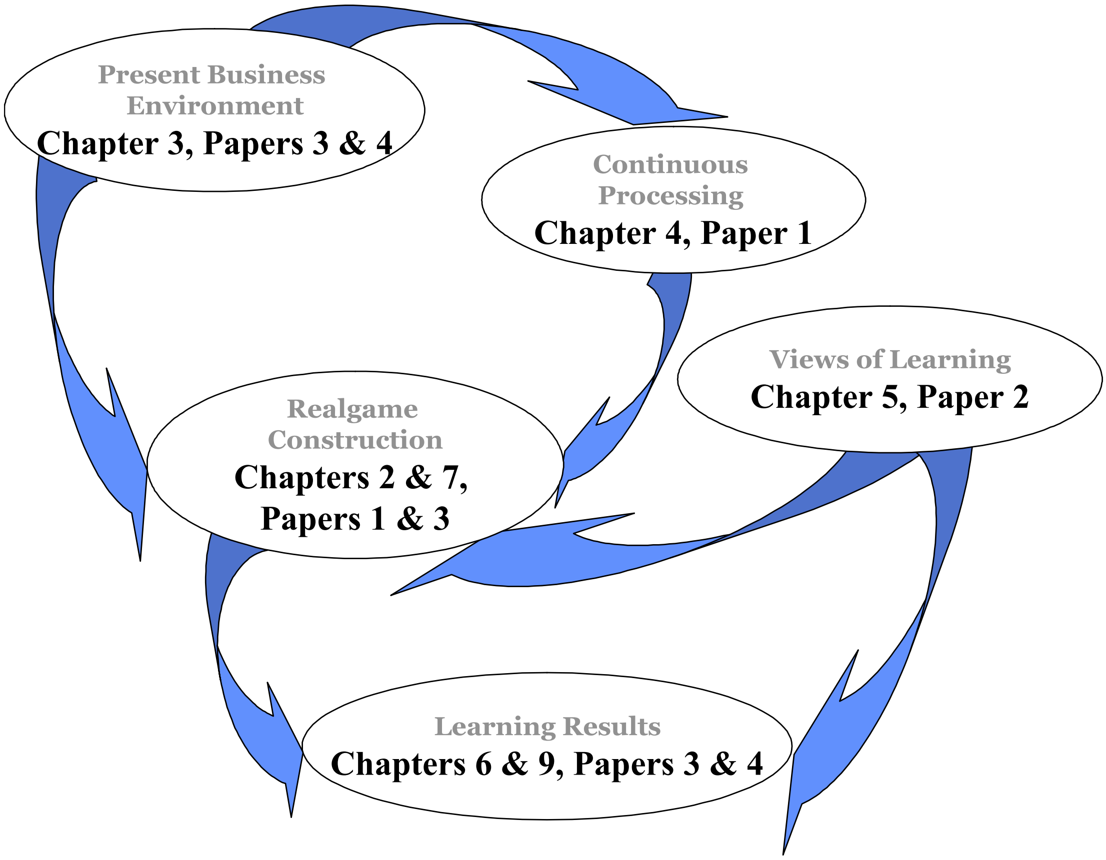

Figure 1.3: How different thesis chapters and papers contribute to the theoretical framework.

1.6 Summary of Findings

The findings of the study are described in more detail in Section 9.1. As a conclusion from the research results we state that the major research question (or the assumption underlying it) has been strengthened. Continuous processing in the business simulation game seems to be beneficial for learning and it facilitates the development of holistic understanding of business processes. We are also convinced that the use of the business simulation game increases engagement and makes the work meaningful during the training situation. At the same time we have to note that we do not have unambiguous results as to whether the configuration of the artefact increases the feeling of realism.

1.7 How to Read This Thesis

To provide a logical flow of ideas, it is suggested that the reader – in order to get a coherent view of the entirety – proceeds in the following order through the chapters and papers (all the papers are introduced in Chapter 8) of this thesis:

1. Chapters 1 – 4
2. Paper 1
3. Chapter 5
4. Paper 2
5. Chapter 6
6. Papers 3 and 4
7. Chapter 9.

2 ARTEFACT DESIGN METHODOLOGY

2.1 The Nature of the Research Subjects

Morgan (1983a) states that the rationale for a particular research strategy is grounded in a network of assumptions regarding the researcher's view of the social world. This image favors a particular epistemological stance in suggesting that certain kinds of insights, understanding and explanation may be more appropriate than are others. The image generates specific concepts and methods of study through which knowledge of the phenomenon can be obtained. Methodologies are the puzzle-solving devices that bridge the gap between the image of a phenomenon and the phenomenon itself. Methodologies link the researcher to the situation being studied in terms of rules, procedures, and general protocol. We will introduce later (Chapter 3) our image of the organizational phenomena and their nature, which have been embedded in our learning artefact. We now proceed by introducing the methodology of this thesis.

Our research subjects are multiple (Figure 1.1, Theoretical framework). We are dealing with:

- constructive research (design science/artefact building and evaluation),
- organizational theories (social science/business environment), and
- educational theories (social science/learning).

The artefact building phase, however, is not interesting to us research-wise, but only a mandatory phase through which to reach more interesting research subjects. The educational science section is embedded in the artefact evaluation phase. This means that learning that may take place during the use of the artefact is an important part of the evaluation phase. Figure 2.1 defines the interrelationships between our main research subjects.

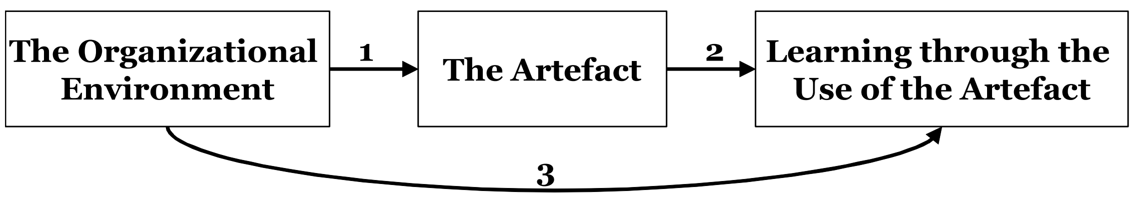

Figure 2.1: The relationships between the research subjects.

Järvinen (2000a) notes that to exploit the results of the recent studies researchers must master more than one research approach to a certain extent. The characteristics of the organizational environment create the content and structure of the artefact (Arrow 1). The artefact is then applied in learning situations (Arrow 2). Studying learning demands that the assumptions about the organizational environment are represented in the artefact (Arrow 3).

Here we use the term *artefact* to describe something that is human constructed (Collins Cobuild English Language Dictionary, 1987). March and Smith (1995) list the following artefact types: *constructs* (describe a problem and specify solutions), *models* (set of propositions expressing relationships among constructs), *methods* (set of steps used to perform a task), and *instantiations* (realization of an artefact in its environment). In March and Smith's terminology the term that best describes our artefact is called *instantiation*.

March and Smith (1995) regard the construction of an artefact as its own branch of science (design science; the opposite being natural science). March and Smith do not mention social science as its own branch at all, but – for example – Iivari (1991) takes into account the special character of IS and computer science and identifies three different methodologies (constructive, nomothetic i.e. natural science, and idiographic i.e. social science). We feel a bit uneasy with all these classifications, especially as the evaluation phase in our research includes, for example, methods of data gathering and reasoning, which belong to or are at least mostly used within social sciences. Furthermore, the classification between constructive research (design science) and action research (social science) below includes some inconsistencies (for example, Järvinen, 1999, incorporates action research into the construction building-evaluation process). In our view constructive research should be categorized within social sciences at least when artefacts are designed to be used in the context of the social world. This is especially so in our case because

1) the artefact building process involves capturing "knowledge about social constructs" (organizational characteristics; organizations build up from individuals), because
2) in training use the artefact most of all describes a social environment, and also because
3) the construction process involves cooperation between the artefact builder and the people operating in the real world context.

2.2 The Methodology of Designing Artefacts (Constructivism)

What have I accomplished? The beauty of my dream has vanished!
And breathless horror and disgust now fill my heart.
For this I have deprived myself of rest and health,
have worked my brain to madness…
Shelley[2] (1818)

Järvinen (1999) notes that it is typical of *constructive research* to build a new artefact based on existing knowledge and/or technical, organizational etc. advancements. Kasanen et al. (1993) state that constructions refer to entities which produce solutions to explicit problems. By developing a construction, something that differs profoundly from anything that existed before, is created. In constructive research the aim is to solve problems associated with management by building models, diagrams, plans, or organizations.

We will introduce two different views of the process of constructive research. The first one is from March and Smith (1995). As a starting point March and Smith make a division between design sciences (research that attempts to create things that serve human purposes) and natural sciences (aimed at understanding reality). Here design science is the equivalent of constructive research. From this point forward we will use the term *design science* in order to avoid confusing constructivism (the design science) with the constructive view of learning.

The second view of design science research from Järvinen (1999) is an expanded model of March and Smith's. Järvinen rightfully states that March and Smith's decision to accept natural science as the only one to describe the world is too restrictive. That is, social sciences are needed to describe the human side of life.

March and Smith (1995) state that research activities in design science are twofold: the first phase is building an artefact, demonstrating that such an artefact *can* be constructed. The second phase in design science concerns evaluating, referring to the development of criteria and the assessment of artefact performance against those criteria.

March and Smith (1995) state that significant difficulties in design science result from the fact that artefact performance is related to the environment in which it operates. The artefact must be *evaluated*, but also the evaluation criteria themselves must be determined for the artefact in a particular environment. March and Smith require that after an artefact's performance has been evaluated, it is important to determine why and how the artefact worked within its environment. Thus, we *theorize* and then *justify* theories about those

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[2] Shelley, Mary (1818). Frankenstein.

artefacts. Building the first of any set of constructs is deemed to be research. The research contribution lies in the novelty of the artefact and in the persuasiveness of the claims that it is effective. Progress is achieved in design science when existing technologies are replaced by more effective ones. If the artefact is novel then actual performance evaluation is not required at all.

Järvinen (1999) further develops the framework of March and Smith. He gives different alternatives for the artefact construction process. The purpose of the construction process is to achieve a movement from *the initial stage* to *the target stage*. If the building task is ill-defined, we need to have *a specification process* to find the desirable final state for the artefact. This specification process can be parallel with the *implementation process* (this definition sounds a bit like the prototyping approach to system development; see e.g. Reynolds, 1995). Together the above-mentioned phases form a research process presented in Figure 2.2.

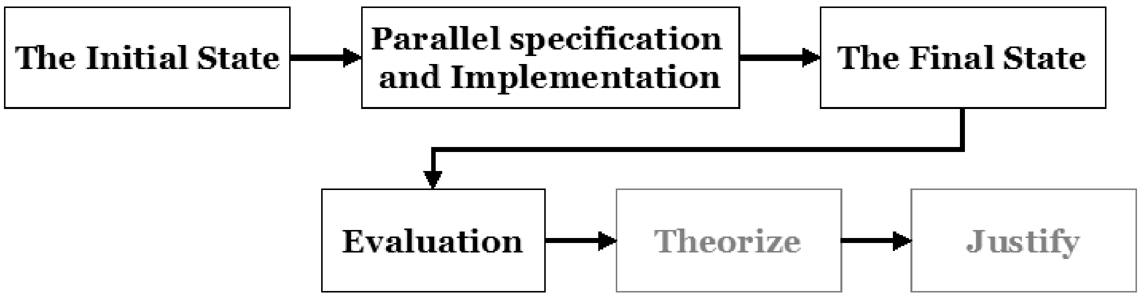

Figure 2.2: The design science research process (adapted from March and Smith, 1995, and Järvinen, 1999). The Evaluation and Justify phases are not part of the design science process, but apply natural science methods to artefacts (March and Smith, 1995).

Järvinen argues that the technological and theoretical advances utilized in building the artefact must be described in the study report. Furthermore, informational and organizational ideas utilized in building the artefact must also be described. The function of the construct is to describe a certain part of reality. The range of the new construct can be wider or narrower than the old one (we would also like to add *different*).

March and Smith (1995) stated that actual performance evaluation is not required for novel constructs. Järvinen is not satisfied with this. He argues that the new artefact should always be evaluated. According to Järvinen, the researcher could ask whether the new artefact better differentiates and/or describes the phenomenon – to which this construct refers to – from other phenomena than any other conceivable construct. The researcher might also question the potential benefits of the new construction in use. When discussing March and Smith's term instantiation, Järvinen states that a new instantiation can support users' learning and understanding when they use the new artefact. Furthermore, the meaning of the sender should be communicated with the model representation to the receiver without any change. As the last improvement to March and Smith's work Järvinen suggests that instead of experimenting once with the artefact, a longer period of experimentation should be conducted, as many implications of a certain artefact will appear during the long use of the artefact.

Kasanen et al. (1993) divide the design science (constructive) research process into similar phases as Järvinen (1999). According to Kasanen et al. the innovation (initial) phase is often heuristic by nature. In such a case the theoretical justification of the construction and testing of the construction typically take place retrospectively. The innovation phase (i.e. the construction of a proposition for problem resolution) is the core element of a successful design science study, since, if the researcher is not able to produce any new solution to the problem, then there is obviously no point in going on with the study.

In this study the innovative contemplation (the initial phase) has been the central element of conducting the study. The starting point of the study was an idea that motivated us to build a new artefact.

Remenyi and Williams (1996) note that a researcher may want to investigate an entirely new aspect of a subject on which little has been published, perhaps based on ideas or thoughts that arise from the researcher's own experience. The information generated in this way will form a *primary narrative*. Remenyi and Williams state (p. 137): *When we attempt to develop models of the world, these start as narrative descriptions within which our imagination is allowed to range freely and widely over many possibilities*.

The initial (idea) of this research is based on assumptions and findings about the present business environment. The construction is aligned within the existing literature of business games and educational computer-based learning environments.

The usability of the construction can be demonstrated through the implementation of the solution (Kasanen et al., 1993). Furthermore, the novelty and the actual working of the solution have to be demonstrated as well. However, the practical functioning of a construction is not at all that self-evident, not least because of the active role of the participants of the organization where a managerial construction is to be imported. A construction that is considered adequate in narrow technical terms does not necessarily work in practice. The actual usefulness of a managerial construction is never proved before a practical test is passed.

We have mainly followed the synthesis of March and Smith's and Järvinen's design science research process suggestions (Figure 2.2). Table 1.1

represents the research project according to the phases of Figure 2.2 (column *Research phase*). The most significant difference between our research process and the one Järvinen recommends concerns the actual building phase (Specification and implementation). Järvinen (1999) states: *In order to get a scientific merit for it, she* [the constructor] *must describe the building process in detail, argue her selections and explain her decisions.* We have not quite followed this advice. The actual construction process does not include any novel technologies. For example, real-time processing is not a new concept but has been commonly in use in airline ticket reservation systems from the early 1970's (Murdick and Ross, 1971), and object-oriented programming languages and environments are widely in use today (Nickerson, 2001). The novelty of our work lies in the application of old technologies in a novel domain. As Cunningham (1997) states, many new ideas and concepts are really rearrangements of ideas which have existed in other forms. Yet, they may be quite unique in their new presentation as they are arranged within new patterns, themes, and logic, which indicate unique directions. We hope that we have succeeded in describing this novelty of the application domain in Paper 1 (Lainema and Makkonen, 2003).

Before commenting the action research perspective of our research, we quote Duffy and Jonassen (1992), who refer to instructional designs (artefacts) by noting (p. 1): *That is, our theory of learning is implicit in our design, and hence one can come to a reasonable understanding of our beliefs about learning from an analysis of that design. While instructional designers typically may not have the time or support to explicitly apply a theory of learning during a design or development task, the theory is nonetheless an integral part of the instruction that is produced*. Thus, besides of the findings from the organizational environment, our constructive work always includes unconscious personal influences which are not all explicated.

Our constructive research process includes a research phase (d, Evaluation; Figure 2.2) which includes action research (AR) characteristics. As the constructed artefact is a business game construction, it is natural that the research concerning the evaluation of the artefact is carried out in cooperation with industrial partners. In fact, this kind of collaboration was carried out already in the Specification and implementation phase (b; Figure 2.2) to ensure the validity of the artefact. With this cooperation the aim has been to gain insight into organizational processes to be described with the artefact. As Kasanen et al. (1993) note, this is also a presupposition of design science (constructive) research: a thorough understanding of organizational processes is needed in order that the intended changes can be accomplished in practice. Simon (1978) has stated that first hand contacts to business operations lead to the observation of the procedures, which are used to find decision outcomes.

This is more than just to observe the outcomes. According to Simon problem solving and the mechanisms of decision-making present a fascinating and important research field of human behavior.

To highlight the close relationship design science research and AR may have Järvinen (1999; 2000b) states that a research method where both the building and the evaluation sub-processes belong to the same process is called AR. Thus, for Järvinen, AR belongs to design science (c.f. March and Smith, 1995), but for example Iivari (1991) categorizes AR as belonging under social sciences. Furthermore, the division between AR and case study is blurred as Galliers (1984) notes that AR could be seen as a subset of the case study and field experiment categories (note that Galliers does not have design science research in his classification at all; Järvinen 2000b). Also for Cunnigham (1997) action research presents one form of case research where cases focus on research and learning through intervening and observing the process of change.

Our research could be categorized as belonging under AR, but we feel that, research-wise, building a concrete artefact gains more from the design science research framework. However, our work includes some elements that are in the core of the AR framework (like the desire to help an organization to train its employees to understand phenomena defined by the organization). Both of the industrial collaboration projects are described in this thesis (the cooperation in Section 6.4 and the learning case in Paper 4).

The term action research is widely credited to Kurt Lewin (Susman and Evered, 1978; Stowell et al., 1997), whose work highlighted the need to bridge the gap between social action and social theory in which the researcher, rather than being an outside objective observer, becomes a visible and active participant in the social group under investigation. This practical involvement is a means of initiating a process of change within the group as well as generating knowledge concerning ways in which attitudes are developed and changed. The emphasis of Lewin's work is more concerned with individual and small groups than larger scale social systems. During the last fifty years AR has been applied to a wide range of application areas and incidents where the need to change has been paramount.

Stowell et al. (1997) mention that in Information Systems Science (IS) AR offers an alternative to the traditional positivist approach to inquiry. At the same time they state that relatively little attention has been paid to how an AR study can be undertaken. AR is at present generally accepted as a diverse concept with many different strands that have different meanings being attributed to the concept over many years.

Action research is often confused with case study research (Avison, 1997), but whereas case study research examines phenomena in their natural setting with the researcher as an independent outsider (Yin, 1989) in AR the researcher is a participant. In fact, AR is notable for the deliberate intervention of the researcher. Rapoport (1970; referred to in: Susman and Evered, 1978; Susman, 1983; Stowell et al., 1997; Puhakainen, 2001) emphasizes the overall aims of AR which he views as contributing:

a) to the practical concerns of people in an immediate problematic situation, and
b) to goals of social science by joint collaboration within a mutually ethical framework.

Thus, AR unites theory and practice (Susman, 1983). To these two aims by Rapoport (1970), Susman and Evered (1978) add a third one emphasizing the notion that AR should also develop the self-help abilities of those people facing problems. The participants should benefit from the collaborative learning experience as a result of the social inquiry. The collaboration work is carried by a set of beliefs that are at least provisionally, if not strongly, accepted so that an inquiry can proceed (Susman, 1983). In fact, Susman would like to see the client as committed as the researcher to carry out the solutions of the research.

Susman and Evered (1978) define AR as a cyclical process which comprises of five iterative phases (Paper 4 in this thesis representing research that follows these phases): Diagnosing, Action planning, Action taking, Evaluating, and Specifying learning.

These phases are carried out to varying degrees collaboratively between the researcher and the client. From the problem representation by both observation and reasoning the researcher reaches a solution to the problem and tests the solution through action (Susman, 1983). Elden and Chisholm (1993) add that reports seem to show a focus upon the ‘self development capacity’ within the areas of application so that learning still continues after the researcher’s role within the engagement has been completed.

Cunningham (1997) finds two different types of AR: *diagnostic AR* and *experimental AR.* In the diagnostic type the underlying theme is to work collaboratively with managers and workers to understand and study the problems affecting them. Constructive ideas for problem-solving would emerge in this collaboration. In the experimental type the theories are tested through experimentation before using them in practice. Our work probably has more characteristics of experimental AR.

Also Stowell et al. (1997) distinguish two different modes of AR within IS: a field study mode and a consultancy mode. The *field study approach* AR is adopted as an appropriate way of carrying out field studies in order to learn about ideas that have been formulated previously as a result of critical evaluation of the literature and practice. The aim of this mode is foremost to learn about the nature of the research ideas in a practical situation by gaining an understanding of their use. This should allow reflection upon the original ideas and encourage the researcher to re-evaluate the theoretical grounds of the research ideas. Action is theory-led since the researcher is primarily interested in learning about the research ideas from their practical application. This description corresponds to the licentiate thesis phase of the research at hand (Figure 2.3).

In the second AR mode (Stowell et al., 1997), the *consultancy mode*, the researcher takes advantage of a real-world problem situation as a means of obtaining research material. The prime purpose is to feed the lessons learnt from previous action back into the problem situation with the intention of bringing about change. This is the kind of AR we have carried out in the second phase of our research as the constructed artefact has been applied in real-world organizations. Figure 2.3 represents how reflections tend to take place in the two AR study modes.

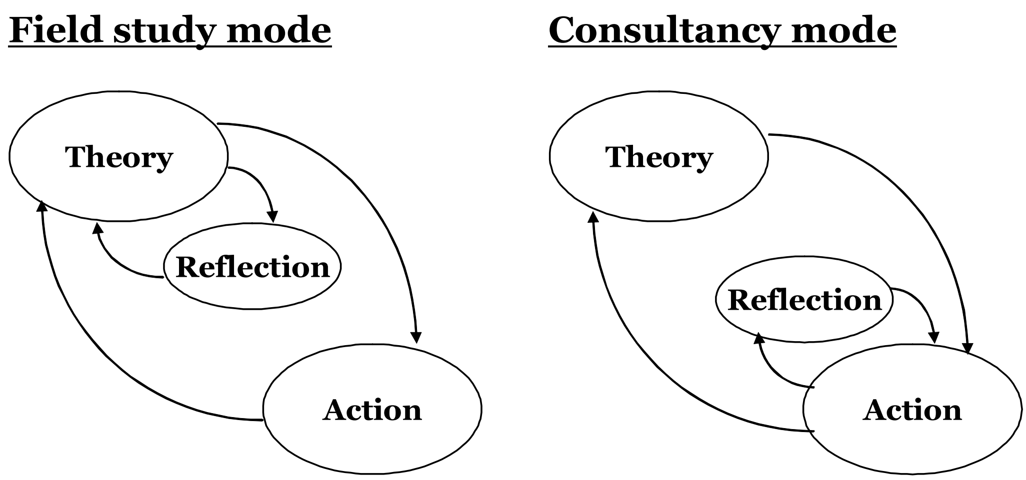

Figure 2.3: The two action research study modes (Stowell et al., 1997).

The difference between AR and case study research can often be difficult to make. In our case we may imagine two different training alternatives. In the first one an organization sends its employees to training without specifying to the game operator/researcher what the learning topics are that should be covered during training. In the second one the researcher/operator actively discusses the content and structure of the training with the organization and according to this conversation modifies the learning environment and its structure. If the learning outcomes of these events are the research phenomenon, then – in our view – the second training case has characteristics of action research, but how about the first one? We may ponder whether there was any cooperation between the parties (Yin, 1989, states that in case research the researcher has *little* control over events) and whether there was any research problem at all. Also, in student education the client (the future employer of the student) is not visible at all.

As the differences are so vague, we have no difficulty in getting support for the use of our chosen methods from other methodologies, like case study research. Futhermore, AR literature rarely discusses the use of data collection techniques.

3 ORGANIZATIONAL CHARACTERISTICS ADOPTED IN DESIGNING THE ARTEFACT

As in all discourse, there is a danger that we may become trapped by the limitations of the images or metaphors through which we shape inquiry.
Morgan (1983b)

There are two frameworks from the field of management sciences that we are going to apply when we position our artefact in the field of organizational functioning. In other words, we search for some characteristics of the organizational environment and then base our artefact on these. The purpose of the artefact is to convey these characteristics to the participants of a training session through the use of the artefact. The frameworks to be applied are the Gorry and Scott Morton (1971) framework for information systems development, and the framework in Morgan (1997) presenting patterns of organizational and management characteristics in four different types of environments facing different rates of change. A word of justification for the selection of these two models is in place.

The framework of different organizational structures represented in Morgan (1997) is not a new one. Morgan develops the work represented by Burns and Stalker[3] already in 1961. However, what Burns and Stalker stated about flexibility has become more relevant than ever. The artefact of the thesis represents the open system or contingency view of business organizations.

The Gorry and Scott Morton (1971) framework is more than 30 years old, but it is still a valid and applicable framework for managerial activities and has gained a classical reputation. For example, Sloan Management Review stated in 1989 that different types of management information systems can be argued from the decision-making perspective Gorry and Scott Morton provide in their framework. The authors themselves (Gorry and Scott Morton, 1989) note that the argumentation of the framework is still, in 1989, sound as regards the decision-making styles. The artefact of the thesis represents the Gorry-Scott Morton framework in the form of different organizational decision-making levels.

Besides these two models we will first argue the need of business training providing a holistic view of organizational functioning. This argument is put forward based on the changes that have occurred in the business environment during the last two decades. The starting point in this discussion is the findings

[3] Burns, T., and Stalker, G. M. (1961). The Management of Innovation. London: Tavistock.

of Zuboff (1988) clarifying the implications of post industrialism for working environments.

Put together, these three components – the need for a holistic view (from the environmental discussion), the central role of time in decision-making (Morgan, 1997) and the need for understanding different decision-making levels (Gorry and Scott Morton, 1971) – create a framework to be used in arguing the structure and properties of the artefact of this thesis. In Sections 3.1 – 3.3 we will discuss the phenomena/frameworks to be used in our reasoning supporting the use of continuously processed learning environments. The actual reasoning and argumentation takes place in Section 3.4. Before proceeding, we want to clarify one point in our style of presentation. In reality, organizations and their environments are not as easily classified into extreme representatives of certain organizational stereotypes as we may have presented in this work. For example, it may be difficult to find organizations representing a pure form of an open system (discussed in Subsection 3.2.1). Still, the world of organizations is apparently moving gradually towards the open view. As this move takes place, what we are suggesting should become more relevant.

3.1 Characteristics of the Present Business Environment: the Holistic View Argument

At most mass-production corporacies, if you see a snake, the first thing you do is go and hire a consultant on snakes. Then you get a committee on snakes, and then you discuss it for a couple of years. The most likely course of action is nothing.

Zeleny (1989, p. 88)

In this section we will introduce organizational phenomena which call for a more holistic understanding of business functioning. To some extent, the origins of most changes lie in the modern knowledge society. We will first introduce how the knowledge society has altered the requirements of work and after this reflect on what the implications of the knowledge society are for decision-making.

3.1.1 Knowledge Society

The terms "knowledge industries", "knowledge work" and "knowledge worker" are only 40 years old. Today everyone uses these terms, but understanding their implications for managing people and making them productive is still not complete. For example, Davenport et al. (2002) note that business people in general understand that knowledge work is in the heart of organizational sustainability and growth, but if companies can enhance knowledge worker productivity in this century anywhere near as much as they did with manual labor in the last century (roughly 50 times), the payoffs will be astronomical.

What is already clear, however, is that the emerging knowledge society and knowledge economy will be radically different from the society and economy of the late 20th century (Economist, 2001). What is new about this development is not the creation of work based on knowledge – there have always been "experts". What really is new is the large number of professions that involve working with knowledge (and also the increasing computing power). At the same time the number of jobs that demand low cognitive skills is rapidly declining, resulting in less people being involved in the manufacture and distribution of physical goods (Stehr, 2001).

Knowledge work is not the only expression of the changing environment. During the last decade or two the changes in the organizational environment have been more rapid than ever. Across different industries there are significant differences in the environmental characteristics impacting firms. The most relevant of these characteristics is environmental dynamism. Environmental dynamism is the product of several forces operating at one time. These include an increase in the size and number of organizations within an industry, and an increase in the rate of technological change and its diffusion throughout that industry (Li and Simerly, 2002).

While the speed of change is still increasing, many researchers have interestingly described the properties of this environmental dynamism. During the 1980's the time aspect of organizational functioning got increasingly more intention. In many industries planning loops in the product development and process times in the factory were shortened. New generation companies started to compete with flexible manufacturing and rapid-response systems, expanding variety and increasing innovation. New organizational structures enabled fast responses rather than low costs and bureaucratic control. Emphasis was on just-in-time production, total quality control, employee decision-making on the factory floor, or close supplier relationships. Companies concentrated on reducing if not eliminating delays and using their response advantages to attract the most profitable customers (Stalk, 1988). In this section we give a brief survey on the changing nature of work and the environment shaping it.

Probably the most significant single factor behind this development has been the use of computers in business organizations. Zuboff (1988, p. 243) describes this situation as such where:

> *...an approach to technology deployment that emphasizes its informating* [empowering information technology users to access and use knowledge stored in information systems] *capacity uses technology to do far more than routinize, fragment, or eliminate jobs. It uses the new technology to increase the intellectual content of work at virtually every organizational level, as the ability to decipher explicit information and make decisions informed by that understanding becomes broadly distributed among organizational members. The informating consequences of computer technology challenge the distinction between manual and mental work as it has evolved in the industrial bureaucracy.*

Zuboff (1988) argues that new information and control systems have created an integration of production processes. This integration has created jobs that are intrinsically more responsible. The message underlying this new job structure is that being exposed to data implies that a person sees, comprehends, and is appropriately responsive. The assumption Zuboff makes is that such new visible data becomes the responsibility of those who are able to see it. If organizations are to use information effectively, they must assign each decision to the person best able to make it. Often this will be a worker on an operational level, not a manager. Work (1997) claims that as a result, workers should have access to all the information which they need in their jobs. Workers need to become adept at interpreting the information available to them and to learn to make informed decisions. Zuboff argues that this is the primary reason why work force needs a more general education.

Shared responsibility requires shared information, but it also depends on shared skills (Work, 1997). Every team member must be able to assume any role whether as an operator or as a decision-maker. Thus, each worker must possess a formidable range of abilities rather than a single specialism. Besides technical skills, these include social and intellectual abilities such as fitting into a team and problem solving. In particular, workers will have to share tasks and responsibilities. Employees should be able to share resources, including knowledge, without having to be certain of how precisely each of them will benefit personally – as long as they believe that the company overall will benefit to their collective gain (Ghoshal et al., 1999). This means a shift of emphasis inside the firms: facilitating cooperation among people takes precedence over enforcing compliance, and initiative becomes more valued than obedience. Organizations should make sure that everyone in the company knows how their individual contribution links to the company's overall aspiration. Employees at all levels should possess a deep sense of urgency about the challenge of sustaining success (Hamel and Prahalad, 1994).

There is little evidence that organizations have learned these lessons (Work, 1997). The need for more generalized skills of the work force arises from the simplification of organizational design and the embedding of expertise in software, not from the need to use information more imaginatively. Zuboff (1988) further states that the new communities of knowledge workers require that workers collaborate across disciplines, assess the relevance of information for a given purpose, and construct plans in response to novel situations.

Knowledge has become the key resource. This means that knowledge workers collectively own the means of production. (Economist, 2001). Growth is created from the intellect of knowledge workers, not from the labor of low grade service and production workers (Drucker, 1992). Everyone in the information-based organization should be constantly thinking through what information he or she needs to make a valuable contribution to his or her own job. Drucker states that this may well be the most radical break with the present conventions of work. Knowledge workers therefore see themselves as equal to those who retain their services, as "professionals" rather than as "employees" (Economist, 2001). The knowledge society is a society of seniors and juniors rather than of bosses and subordinates.

All the above discussion leads, according to Zuboff (1988), to a situation where information workers need formidable capabilities in order to make decisions in information-rich environments. This means that to develop the talents required, managers must become 'drivers of learning' rather than 'drivers of labor'. Work (1997) makes a strong conclusion from this: organizations cannot achieve radically improved levels of productivity and quality until their managers abandon the notion that workers cannot be trusted.

Zeleny (1989) mentions two modes of planning and decision-making which nicely describe the changes suggested by Zuboff and the other authors. In *the first one*, all local knowledge is conveyed to the central planning authority, which integrates the information and then communicates plans back to the local agents for the purpose of coordinating local action. In this mode coordination is separated from action. Division, specialization, task-dedication and sharp delineation of function are characteristic of these kinds of organizations. Such organizations are bound to become neither competitive nor self-sustaining. Thus, the value of local knowledge is neglected and the local agents transform into simple executors of substantially limited responsibility without freedom to act (this corresponds to the mechanistic view of organizations described in 2.2.1). But, at the times of rapid change and required flexibility, this is not desirable. Local agents possess crucial and irreplaceable knowledge of the particular circumstances of time and place. According to Zeleny we should treat this unique knowledge of people, local conditions and special circumstances as an asset to be enhanced and enriched, not replace it with context-free and locally useless directives.

In *the second mode* the central or strategic knowledge is supplied to the individuals as an additional knowledge, needed by them in order to coordinate their own plans and action. Zeleny states that at the times of rapid change and required flexibility, adaptation and responsiveness, ultimate decisions must be left to the people who are familiar with particular and local circumstances. Local decisions are properly made by those who possess the necessary local knowledge, in a proper place and at an appropriate time. The knowledge of the employees has to be enhanced. So, proper use of the locally operational knowledge increases organizational flexibility and its responsiveness to external and internal fluctuations (this corresponds to the organic view of organizations; Subsection 3.2.1).

Enhanced flexibility is necessary for coping with the ever-increasing environmental dynamism. In a knowledge-oriented society, planning must be a process of continuous broadening of requisite organizational ability to cope with the ever-wider ranges of relevant internal and external fluctuations. In this pursuit actions which increase organizational flexibility are important. Achieving flexibility demands increase in employee responsibility taking, self-control, and decision-making in ever-wider areas (Zeleny, 1989; Heifetz and Laurie, 1997).

Our conclusion about the above discussion is that if workers are to become adept at making informed decisions, they need to know the outcomes of their decisions. As educators we need to be able to deliver a holistic view of organizational and environmental functioning. In Section 3.4 we will discuss this aspect more and link it to the other arguments of the work and thus create a framework for the artefact of the thesis.

3.1.2 Decision-Making

The changes discussed above have implications to the managerial level, too. For example, originally the main goal in strategic planning was to make the right prediction of the future and the attention was on planning methods. Nowadays, it has been realized that mastering the future does not necessarily demand predicting. The faster and more effectively we can react to changes, the less we have to be able to predict them. Näsi (1991) states that the development of traditional strategic thinking has moved from the strategic planning and portfolio management stages to a new stage which he describes as the strategic game playing stage, which calls for the ability to create and develop the alternatives by the decision-maker him/herself.

Mintzberg and Lampel (1999) describe ten schools of strategy making. They seek to show how some recent strategy work tends to cut across historical perspectives. One of the schools they name is the learning school. In the learning school of strategy people are inclined to experimentation, ambiguity, and adaptability. The intended message of the learning school is to learn, the realized message is to play (rather than pursue), and the associated homily is: “if at first you don’t succeed, try, try again”. In the learning school view strategies are emergent, *strategists can be found throughout the organization*, and so-called formulation and implementation intertwine.

Senge (1997) predicts that in the future leadership will be distributed among diverse individuals and teams who share the responsibility for creating the organization’s future. This building of a community of leaders within an organization requires recognizing and developing:

- local line leaders; managers with significant bottom-line responsibility, such as business unit managers, who introduce and implement new ideas;
- executive leaders; top-level managers who mentor local line leaders and become their ‘thinking partners’; and
- internal networkers; people, often with no formal authority, such as internal consultants or human resources professionals and front-line workers, who move about the organization spreading and fostering commitment to new ideas and practices.

In knowledge-creating organizations, these three types of leaders absolutely rely on one another. None alone can create an environment that ensures continual innovation and diffusion of knowledge. Thus, the organizations need the enhancement of people’s capabilities and knowledge to achieve results in line with their deepest personal and professional aspirations. Learning arises from practice, too: people working together to achieve practical outcomes and building practical know-how in the process (Senge, 1997). Managers should focus on building the core organizational processes to integrate the capabilities across organizational units to create new combinations of resources and knowledge. The more specific the employee’s knowledge and skills are to a company’s unique set of customers, technologies, and equipment, the more productive they become and the more efficient the company becomes (Ghoshal et al., 1999).

Besides the demands to leader development there are changes that affect the whole decision-making procedure. Karin and Preiss (2002) note that business processes have various interactions, which have changed as the business world has moved from a static to a dynamic environment. Interactions have become more bi-directional (compared to mono-directional) and they extend over a longer period of time and often deal with external situations. Market conditions that change with time are influenced by more environmental factors than before. This has brought about drivers for the business processes (Karin and Preiss, 2002):

- Multi-modal inter-process interactions.
- Business processes are dynamic, meaning time-dependent.
- New operational procedures are being implemented.
- New nominal definitions and concepts are being created.

Figure 3.1 (Karin and Preiss, 2002) shows a diagram of an iterative managerial process. It includes intake of information, analysis, decision and action. This creates a decision loop where information is transmitted once in a decision period, instructions are given and for the remainder of the period the actions taken do not change. This is what takes place in batch-processed business games. Figure 3.2 (Karin and Preiss, 2002) shows the same decision loop as a continuous dynamic process, where information is continuously gathered, decisions continuously reviewed, and the ensuing courses of action change continuously. The latter described the decision-making situation in a continuously processed business game (Paper 1 of this thesis demonstrates how the difference appears in games and further argue for the latter type of decision-making environment).

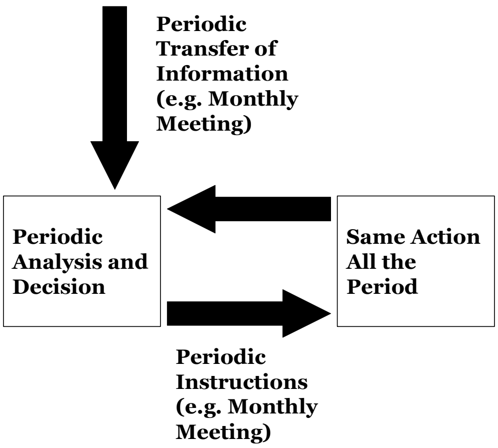

Figure 3.1: An iterative managerial process (Karin and Preiss, 2002).

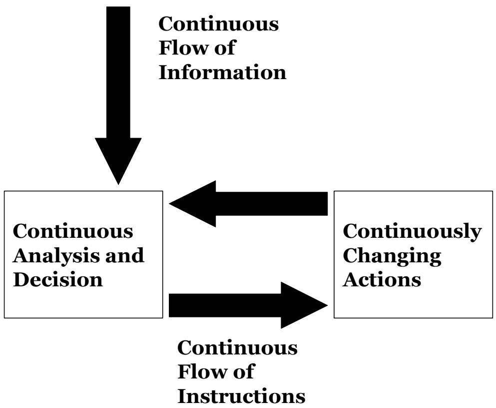

Figure 3.2: A continuous dynamic managerial process (Karin and Preiss, 2002).

We could not verbalize the change in the environment better than Karin and Preiss (2002, p. 65) do:

> *When Figure* 3.1 *applies to business situation, the business model is piecewise static. Static because over one decision period the operational plan does not change, piecewise because at the end of a decision period the plan changes suddenly. When Figure* 3.2 *applies, the business model*

> *is dynamic – for example, suppliers to supermarkets that are required to replenish stock at least twice a day, according to sales data. Such a supplier continuously monitors the sales at all branches of the client supermarket… The variables in this example, such as quantities to be stocked, are both continuous and dynamic. Continuous, because the values take continuous values, and dynamic, because the values of the variables change with time.*
> *In the past, the scenario above could have been expressed by a discrete and static variable. Imagine that the supplier takes orders once a month to supply goods to a customer order in only four lot sizes: small, medium, large and extra large. The variable describing the quantity to be supplied is then a discrete variable, having only four possible values. It also is static, since once specified it remains unchanged for a month.*

The above example distinctly defines the difference between batch-processing and continuous processing. It also has similarities with the organizational models to be described in Subsection 3.2.1. It is typical of this kind of dynamic environment that real-time tasks exert more pressure on the decision-maker. Therefore, it is difficult to process all the available information (Lerch and Harter, 2001).

3.2 The Framework of Different Rates of Environmental Change: Process and Time Arguments

So far we have described the general environmental characteristics of business organizations. From now on we will concentrate more on the issues which are directly relevant to our work and will be used as argumentation for our artefact. These issues include the changes in organizational structures and the role of time in decision-making, and actually are both outcomes from the environmental changes.

3.2.1 Organizational Structures

Businesses today often operate in competitive environments that are increasingly turbulent and unpredictable (Drucker, 1997; Eisenhardt and Brown, 1999; Beer and Nohria, 2000). The turbulence in the business environment and the technological change put pressure on organizations to be sure they can effectively meet the fundamental changes that are occurring (Scott Morton, 1991). External forces associated with environmental turbulence (social, political, technical and economic) and the timing of organizations' responses under such conditions have become crucial to firm survival (Scott Morton, 1991; Waller et al., 1999). There is no reason why organizations would necessarily continue in their present form. It is not possible to survive as a company by just working harder within existing organizational structures and using conventional practices and tools. The environment may be so uncertain that no amount of analysis will allow us to predict the future (Scott Morton, 1991).

While bureaucratic organizations once dominated many aspects of society, most of them are in the process of being reshaped along with the changing demands and challenges of the world around them. This can sometimes lead to significant transformations in organizations (Morgan, 1989). Conventional views on management (e.g. the positioning school of management, Porter, 1996) assume that the future is knowable and it is possible to reposition in more profitable industry segments through systematic analyses of environmental and industrial factors. Leadership of change belongs to one small group of people, typically located at the top of the formal hierarchy. The goal is to create an economically performing organization weighted by clock time. The faster the lower levels of the organization can align themselves with the top's directives, the faster the desired economic performance is assumed to be realized (Huy, 2001). Huy mentions that at best these kinds of commanding interventions can be used to change tangible entities, such as people (downsizing) or formal structures and systems (divestment). However, it is unlikely that one can decree a lasting qualitative change in basic beliefs or values. It is also likely that many agents applying the commanding intervention hold a time perspective that favors the near future. Ghoshal et al. (1999) state that machine-like systems or control are not helpful in a situation where the most important corporate resources are not financial funds in the hands of the top management but the knowledge and expertise of the people on the front lines.

As a result, newer forms of organization appear that are much more like networks than hierarchical structures. These new forms can be e.g. project-based organizations or loosely coupled organic networks (Morgan, 1989). And this restructuring has, of course, taken place over the past decade, e.g. business units have increasingly taken the role of strategy formulation away from corporate headquarters (Whitney, 1996), which is in line with what was described in the previous section. This change makes sense, as business units are closer to customers, competitors, and costs (although Whitney states that business units can fail by losing their focus on the organization's priorities).

To give an example, a project-based organization has decided to tackle most of its core activities through project teams (Morgan, 1989). There may be functional departments but they only play a supporting role. This kind of organization relies in the dynamism and innovativeness of teams and tries to give them a free rein within the parameters and values that senior managers used to define. The organization is much more like a network of interaction than a bureaucratic structure. Much effort is devoted to creating shared appreciations and understandings of the nature and identity of the organization and its mission, but always within a context that encourages a learning-oriented approach.

The above discussion describes the changes in organizational structures, but as a frame of reference we use a continuum describing the relationship organizations have to their environment. This framework has its roots in the work represented by Burns and Stalker's[4] in 1961. They illustrated that when the change in environment becomes the order of the day, open and flexible styles of organization and management are required (Morgan, 1997). Table 3.1, modified from Morgan, captures salient aspects of Burns and Stalker's study, illustrating extreme patterns of organization and management in organizations experiencing different rates of environmental change (the original Morgan table includes four different classes of change rates; we have included only the two extreme classes).

[4] Burns, T., and Stalker, G. M. (1961). The Management of Innovation. London: Tavistock.

Table 3.1: Extreme patterns of organization and management in organizations experiencing different rates of environmental change (adapted from Morgan, 1997).

Nature of environ-ment	Stable environment: technological and market conditions well understood.	Highly unpredictable: rapid technological advance and boundless market opportunities.
Nature of task facing a firm	Efficient production of standard products. Rational decision-making: formal logic and analysis.	Exploitation of rapid technical change through innovation and exploration of new market situations. Intuitive, non-linear approaches. Complex information processing skills based on pattern recognition.
Organi-zation of work	Clearly defined jobs arranged in hierarchical pattern. Interdepartmental communication and coordination are often poor, and people have a myopic view of operations: no overall grasp of the situation facing the enterprise as a whole. Actions encouraged by one element often entail negative consequences for others.	Deliberate attempt to avoid specifying individual tasks; jobs defined by the individuals concerned through interaction with others. An organization of interrelated subsystems. Individuals belong to groups or departments that belong to larger organizational divisions. Stresses the importance of being able to scan and sense changes in task and contextual environments, of being able to bridge and manage critical boundaries and areas of interdependence, and of being able to develop appropriate operational and strategic responses.
Nature of authority	Clearly defined and vested in formal position in hierarchy; seniority important. All responsibility for the organization of work is shifted from the worker to the manager	Pattern of authority informal and constantly changing as roles become redefined with changing circumstances; vested in individuals with appropriate skills and abilities.
Produc-tivity through	Scientific precise methods to determine the most efficient ways of doing work. High degree of specialization in different functional areas.	Flexibility and capacities for creative action are more important than narrow efficiency.
Commu-nications system	According to pattern specified in various rules and regulations.	Completely free and informal; the process of communication unending and central to the concept of organization.
Nature of employe e commit-ment	Commitment to responsibilities associated with their own particular jobs; loyalty and obedience important.	Full commitment to the central tasks facing the concern as a whole and an ability to deal with considerable stress and uncertainty.
Attitude towards the environ-ment	*More or less ignorant about the role of the environment: a closed system that can be designed as clearly defined structures of parts. Goals predetermined, not designed for innovation => Great difficulty in adapting to changing circumstances. May lead to: "Wrong thing well" or "Right thing too late".*	*Open systems best understood as ongoing processes rather than as a collection of parts. Attention devoted to understanding the business environment defined by the interactions with customers, competitors, suppliers, and so on.*
	MECHANISTIC ⟷	ORGANIC
	Mechanistic View; Organizations as Machines; Taylorian View	Sociotechnical View; Organizations as Open Systems

There are many aspects to be considered from the point of view of training and education in Table 3.1. Two most important for our field of interest are business processes and time (which have a linkage between each other; time is always embedded as one central factor in processes). In Section 3.4 we will argue that the batch-processing in games tends to represent a mechanistic view of organizations, whereas with continuous processing it is possible to describe a more organic view.

The business process discussion of this thesis is represented at the beginning of paper 4. As a summary of the need to understand business processes we refer to Hammer (1996, pp. 5-6) who argues:

> *The problems that afflict modern organizations are not task problems. They are process problems… We are inflexible not because individuals are locked into fixed ways of operating, but because no one has an understanding of how individual tasks combine to create a result, an understanding absolutely necessary for changing how the results are created… In short, our problems lie not in the performance of individual tasks and activities, the units of work, but in the processes, how the units fit together into a whole.*

For example, Dutta and Manzoni (1999) argue that instead of being hierarchical and functional organizations should transform towards a process view of an organization. This process view emphasizes how an organization actually does what it is required to do across departments and functions. The focus in the process view is on trying to communicate how an organization works together to create value for its customers, as opposed to how it is structured. This might imply the need for training which offers employees holistic understanding about the causal interdependencies of organizational processes.

3.2.2 Time and Decision-Making

Work expands so as to fill the time available for its completion.
Parkinson[5] (1957)

Traditionally, the goal of management science has been to control uncertainty. But many scholars today admit that it is impossible to have total control over uncertainty. E.g. Angell (1997) states that the only logical approach to management is to initiate plans, but to be flexible enough to react quickly to whatever risks or opportunities appear, and to maintain the initiative. A key element here is time, or the progress of time and the ability to live with it. In

[5] Parkinson, C. N. (1957). Parkinson’s Law and Other Studies in Administration. Houghton Mifflin, Boston, p. 2.

that sense it is surprising how little had been written about time in the field of management and organization by the end of the 1980's. Bluedorn and Denhardt (1988) find only three major reviews of time and organization. The small amount of research on time is striking since time is a key point in understanding organizations (Lee and Liebenau, 1999). Time is often considered as natural and taken-for-granted, requiring no explanation. This notion is prevalent also in management and organizational studies (Lee and Liebenau, 1999). However, there has been a clear understanding that time is closely related to organizational productivity and that time can be viewed as a resource to be managed. Time is considered one of scarce resources, one to be measured and manipulated in the interest of organizational efficiency and effectiveness. One of the most difficult problems in organizational management is to bring objects to the right place at the right time. Bluedorn and Denhardt (1988) quote Moore[6] (p. 8):

> *Thus one element of temporal ordering is synchronization. Other activities require that actions follow one another in a prescribed order; thus sequence is a part of temporal order. For still other activities, the frequency of events during a time period is critical; thus rate also is one of the ways that time impinges on social behavior.*

Bluedorn and Denhardt (1988, p. 304) argue: *The problem of rate, sequence and synchronization are central to the understanding of time as an organizational resource*.

Today many groups in organizations must adapt their pacing of task behaviors quickly to changes in time resources (note that determining time as a resource is not without problems – e.g. you cannot buy extra time – but here we have used the terminology by Bluedorn and Denhardt. Lee and Liebenau also call time a resource). Barkema et al. (2002) found out that besides the speed of organizational processes and activities, also the pace of activities is an important factor. Different organizational processes require different paces and the management challenge is to discover and manage the optimal temporal progression of various processes. Also, time is not evenly distributed. For example, project work groups steadily increase attention to time as deadlines near (Waller et al., 2002; Gersick, 1989). As an example Gersick (1994) gives three approaches on how to manage the temporal pacing of organizational work. *First*, the managers of a young business might simply work as fast as they could, moving ahead when a subtask is accomplished and changing strategy as soon as events show such a change to be necessary. There would

[6] Moore, W. (1963). Man, Time and Society. Wiley, New York.

be no temporal patterning and no transition periods. *Second*, an organization might stay with its business plan, making no fundamental changes, with its success or demise depending on the match between its original plan and its environment. In a *third* scenario, progress would be punctuated with an organization persevering with basic strategies for relatively long periods and making changes in concentrated bursts. Changes and discontinuous advances would be irregularly spaced, and instead of occurring as needed, they would be unlikely to occur until performance decrements forced the organization into near crisis.

We will now introduce an underlying structure for how activities can be mapped on time. For this we use the classification by Ancona et al. (2001) who divide variables of time (variables through which the time phenomena can be described) in three categories. These categories are *Conceptions of Time*, *Mapping Activities to Time*, and *Actors Relating to Time*. We are especially interested in the second category, Mapping Activities to Time, which has clear implications for the decision-making in time depended environments like continuously processed games.

In the *Mapping Activities to Time* category activities or events are mapped to time. Examples include rate, duration, allocation, scheduling, and entrainment. Many variables in this category involve an explicit and deliberate creation of order. These variables are divided into five subcategories. We will now treat those subcategories that are relevant to decision-making in a business game environment. We will also later in this work discuss how these subcategories relate to batch-processing and continuous processing. Although the term is not mentioned, Ancona et al. actually describe a succession of dependent events as business processes.

In *single activity mapping* the concern is on how an activity is positioned on the continuum – its scheduling. The focus is on the rate at which the activity occurs on the time continuum; how long the activity lasts. Figure 3.3 shows how single activities can be mapped on time (1a and 1b). Both of the cases in Figure 3.3 have a specified duration. In case a, the activity occurs early and has a constant pace. In case b, the activity occurs later and has a more irregular pace of completion. A typical example of this kind of increasing intensity is a situation where a deadline approaches and a workgroup is motivated to pay more attention to time (Gersick, 1989).

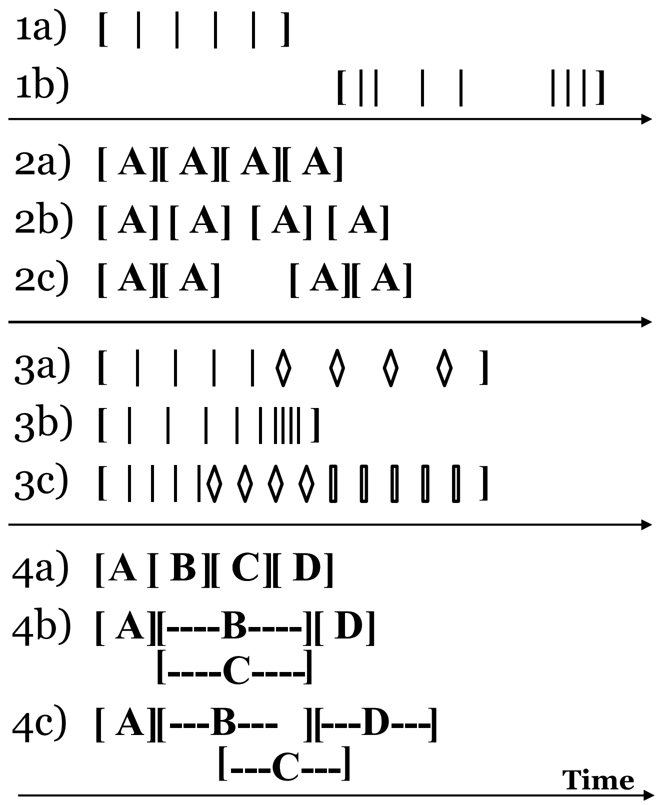

Figure 3.3: Single Activity Mapping (1a and 1b), Repeated activity mapping (2a, 2b, and 2c), Single activity transformation mapping (3a, 3b, and 3c), and Multiple activity mapping (4a, 4b, and 4c) (adapted from Ancona et al., 2001).

In *repeated activity mapping* (Figure 3.3; 2a, 2b, and 2c) an activity is repeated multiple times. In a simple repetition or cycle the activity takes place and begins again (case 2a). More complex forms of repetition include characteristics like the rhythm with which the activity is repeated, the frequency of that repetition, and the interval between repetitions of the activity (cases 2b and 2c).

In *single activity transformation mapping* (Figure 3.3; 3a, 3b, and 3c) a qualitative transformation changes the old activity into a new one. In case 3a, a transformation occurs at the temporal midpoint and alters the form of activity. In case 3b, an imposed deadline forces an increasing pace of activity as the deadline approaches. In the transformation process there can also be development patterns, which have a form of different stages (e.g. a lifecycle) (case 3c).

In *multiple activity mapping* (Figure 3.3; 4a, 4b, and 4c) activities have a relationship between each other. In this kind of construction, the concern is the amount of time that must be distributed among multiple activities. Another variable connected to multiple activities and their mapping to time is ordering or the sequence of activities. When two activities conflict, one activity may be rescheduled. In some instances, synchrony is based on a relationship between starting and ending times with no overlap (case 4a). Activity mapping can also involve perfect synchrony or concurrence, where the activities occur at the same time (case 4b). Synchrony can also indicate a relationship between an activity's beginning and end times but with overlap among activities (case 4c). People in a polychronic culture value engaging in several activities or events at the same time. Conversely, people in monotonic cultures prefer to engage in one activity at a time (Bluedorn and Denhardt, 1988). By jointly holding a polychronic view of time, members of a given culture see the world and interact in a particular manner. A polychronic group maps many activities simultaneously on its temporal map, whereas a monochronic group maps these activities sequentially, one following another (Waller et al., 1999).

Based on the different *Mapping Activities to Time* category Ancona et al. (2001) create four propositions of which two describe the distinction between the two possible decision-making categories relevant to simulation and gaming. Their second proposition is based on mapping a repeated activity to time. They state that (p. 524) *here the goal is to do the same thing over and over in an organization, often at the same time each year. An example would be budgeting... When this process is finished, other activities replace it, but the same process is repeated the following year in a predictable, cyclical manner*. The important focus is on replicating the same process in each iteration of the activity, in a manner consistent with a cyclical view of time. They then state their second proposition: *A task described by repeated activity mapping is highly congruent with a culture based on cyclical time* (Ancona et al., 2001, p. 524).

When Ancona et al. (2001) move to multiple activity mapping, they note that a level of complexity is added since this category must include the temporal characteristics of each activity, as well as the interplay across activities. In this case activity maps are short-term projects that need to be done as soon as possible. The maps describe how time is allocated to the most pressing projects. Mapping includes multiple activities that are all fast paced and have short-term time horizons and short cycles. The interdependence of activities in multiple activity mapping sometimes requires rescheduling of activities, allocation of time across activities, and ordering of the activities to ensure the correct prioritization of work across projects. Based on this argumentation they give their fourth proposition (p. 525): *A task described by multiple activity mappings that contain fast-paced, short-term, short-cycle activities that are frequently rescheduled and reallocated is highly congruent with the individuals having a high sense of time urgency, a present time orientation, and a short-term time horizon*.

We further give one more classification of time, the functional roles of time (Lee and Liebenau, 1999). Here we can find two separate roles for time. When time takes the role of an *independent variable*, the focus is on the impacts of temporal factors on various organizational processes. Here the study concentrates on various temporal factors affecting various aspects of individual, group or organizational behavior. For instance, how does time pressure affect individual problem-solving performance? Time can also play the role of a *dependent variable*, when we raise questions of how various organizational factors affect the way individuals conceptualize, experience and use time, and how those factors may alter the temporal patterning of behavior.

Reflecting on the discussion in Subsections 3.2.1 and 3.2.2 our conclusion is that organizations are increasingly paying attention to

a) causal interdependencies of organizational processes and
b) the time dimension of organizational functioning.

This means that employees in organizations need to be more aware of the nature of these phenomena. This is also reflected in the structure of the artefact of the thesis. In Section 3.4 we will discuss these aspects more and link them to the other arguments of the work.

3.3 The Gorry and Scott Morton Framework for Managerial Decision-Making: Decision-Making Levels Argument

Now that we have introduced dynamism in the business environment (Section 3.1) and organizational structural characteristics (Section 3.2), we proceed by arguing the need to represent different decision-making levels. We will use the Gorry and Scott Morton (1971) framework to argue for the need of training environments including different decision-making levels.

First of all, Gorry and Scott Morton state that an understanding of managerial activity is a prerequisite for effective systems design and implementation. They base their framework on two authorities: Anthony[7] and Simon[8].

Gorry and Scott Morton use Anthony's categorization of managerial activity, which includes three classes: *operational control, tactical planning* (originally management control), and *strategic planning*. The boundaries between these categories are often not clear. *Operational control* concerns tasks and should assure that these tasks are carried out effectively and

[7] Anthony, R. N. (1965). Planning and Control Systems: A Framework for Analysis. Harvard Business School Division of Research Press, Boston.
[8] Simon, H. A. (1960). The New Science of Management Decision. Harper & Row, New York.

efficiently. There is little judgment to be exercised in the operational control area as tasks, goals, and resources are carefully delineated through the tactical planning activity.

Tactical planning: In this process the management assures that different resources are obtained and used effectively and efficiently in the accomplishment of the organization's objectives. This involves interpersonal interaction, takes place within the context of the policies and objectives developed in the strategic planning process, and assures effective organizational performance.

Strategic planning is the process of deciding on the objectives of the organization, on the changes in these objectives, on the resources to be used, and on the policies used to govern the resources. The major problem in this area is predicting the future (*predict* is the very verb Gorry and Scott Morton use). The strategic planning process involves a number of people who operate in a very creative way. The problems they handle are complex.

The information requirements of these three types of activities are very different from one another. In *strategic planning* the relationship of the organization to its environment is a central matter of concern. Assumptions about the future are particularly important. The information needed is aggregate information and obtained mainly from sources external to the organization itself. As decision-making is non-routine by nature the demands for information occur infrequently.

The task orientation in *operational control* requires information of a well-defined and narrow scope, is detailed, and arises mainly from sources within the organization. This information is used frequently. The information needs of *tactical planning* fall between the extremes of the two previous ones and much of it is obtained through human interaction (though today information systems definitely play an increasingly important role here).

The other classification Gorry and Scott Morton use in their framework deals with the structure of the decision-making problem, or ways in which the manager deals with the existing problems. Here they use Simon's (1960) classification of programmed and non-programmed decisions. Programmed decisions are repetitive and routine, to the extent that a definite procedure has been worked out for handling them. If a particular problem occurs often enough, a routine procedure will be worked out for solving it. Decisions are non-programmed to the extent that they are novel, unstructured and unusually consequential. There is no ready-made method for handling the problem because it hasn't arisen before, or because its precise nature and structure are elusive or complex. Afterwards the authors (Gorry and Scott Morton, 1989) note that enrichment especially in the category of semi-structured problems would have emphasized the amount and diversity of knowledge that often matters in semi-structured problems.

Gorry and Scott Morton use the terms structured and unstructured instead of programmed and non-programmed. In the unstructured case the human decision-maker must provide judgment and evaluation to problem definition. In a structured situation much of the decision-making process can be automated (thus, become computer-supported). Table 3.2 summarizes the observations about the categories of management activity and the types of decision problems.

Table 3.2: The matrix of categories of management activity and types of decision problems (adapted from Gorry and Scott Morton, 1971).

		Categories of Managerial Activity		
		Operational Control	**Tactical Planning**	**Strategic Planning**
Type of Decision-Problem	**Structured**	Account Receivable	Budget Analysis	Tanker Fleet Mix
		Order Entry	Short-Term Forecasting	Warehouse and Factory Location
		Inventory Control		
	Semi-Structured	Production Scheduling	Overall Budget	Mergers and Acquisition
		Cash Management	Budget Preparation	New Product Planning
			Sales and Production	R&D Planning
	Unstructured			

Table 3.2 includes a dashed line separating structured from unstructured decisions. Gorry and Scott Morton (1971, p. 54) state: *As we improve our understanding of a particular decision, we can move it above the line and allow the system to take care of it, freeing the manager for other tasks*. This is one point we are going to use when we argue for several decision-making levels in our artefact. We are arguing for down-top progression when introducing different areas of business processes decision-making. Higher level decision-making should be based on knowledge of the foundational

operational processes and decision-making problems; otherwise there is a danger of distorted higher level decisions based on wrong assumptions about operational level phenomena.

When we move from the operational level to the management and even to the strategic level, the time range of our decisions becomes longer. The three managerial activity levels go well together with what Ancona et al. (2001, p. 525) sketch out:

> *Imagine a firm made up of three temporal zones. The first zone would be the fast-paced, short-term, short-cycle one..., while the second and third would have a medium – and long-term time frame. The first, fast-paced, temporal zone should be made up of employees with a high sense of time urgency, a present time orientation, and a short term time horizon. This temporal zone should also develop a culture of speed. The second and third temporal zones, instead, should move toward more future time orientations, medium- and longer-term time horizons... A design framework that explicitly incorporates the development of temporal zones in the design of organizations would allow the organization to optimize its ability to meet the temporal demands of its tasks.*

The above leads us to the third argument behind the artefact of the thesis: we need learning environments which represent organizational decision-making starting from the operational structural level of decisions and continuing towards the tactical and strategic levels (more unstructured problems). This is also reflected in the structure of the artefact of the thesis. In Section 3.4 we will discuss this third aspect and link it to the other arguments of the work.

3.4 Synthesis of the Requirements

The three requirements of Sections 3.1 – 3.3 create the basis for the argumentation of the construction of the artefact described in this thesis. These requirements and how they are taken into consideration in the artefact of thesis are presented in Table 3.3. Table 3.3 also briefly explains why each of the requirements may be only partly represented in batch-processed games. The argumentation why different phenomena should be represented explicitly is presented in Paper 1 of this thesis. Paper 2 argues the need for providing learning tools which represent realistic and complex models of reality, are authentic, facilitate continuous problem solving and meaningful learning, and embed learning in social experience.

Table 3.3: Organizational and environmental requirements and how they are taken into consideration in the artefact of thesis.

	HOLISTIC VIEW of business environment (internal and external)	**PROCESS AND TIME dimensions of organizational activities**	**DECISION-MAKING LEVELS**
Argued in...	**Section 3.1: Characteristics of Present Business Environment**	**Section 3.2: The Framework of Different Rates of Environmental Change**	**Section 3.3: The Gorry and Scott Morton Framework for Managerial Decision-Making**
Basic message to be considered in this thesis	The changing nature of work in some business industries demands flexibility, responsiveness and an ability to understand the organizations as entities where different organizational parts (functions, tasks, people) work together in synthesis with their environment to reach a common goal.	The open system view emphasizes the nature of organizations as ongoing processes within its environment rather than as a closed collection of parts. The diminishing time available for decision-making forces organizations to act without perfect information about the background factors.	On the one hand, decision-makers need to understand the operational view of organizational decision-making as it serves as the basis for all organizational activities. On the other hand, it is useful to show the employees on the operational level how decision-making on the upper levels is connected to operations.
Problematic in traditional batch-processed business games because...	Not necessarily problematic in batch games (there exist business games which provide a holistic view on an aggregate level), though this holistic view is always given on a aggregate level of simplification and the transaction specific view is missing.	Processes are hidden, as all the participants can see is aggregate level information. The time dimension of decision-making not realistically embedded. This means that both the process view and the time bound nature of decision-making are missing. Batch-processing describes decision-making as a process where information is perfect and the time used in reacting to changes has no significance.	Operational decision-making usually missing. A top level decision-making experience provided without first making sure that the operational level is known and understood.
The artefact of this thesis...	Aims at giving a holistic view by introducing typical business functions/tasks of a manufacturing (as stated in the original first phase research problem) organization.	Represents business processes on transaction specific level. Processes/events/tasks unfold in steps of one hour (game internal time) revealing the different phases in processes.	Represents organizational decision-making starting from operational structural level of decisions and continues towards the tactical and strategic levels (more unstructured decisions).

(1) The 'HOLISTIC VIEW' proposition goes as follows: If workers are to become adept at making informed decisions, they need to know the outcomes of their decisions; the cause-effect relationships of their decisions and outcomes. If each worker must possess a formidable range of abilities (technical skills, social and intellectual abilities, problem-solving, sharing of tasks and responsibilities) rather than a single specialism (as was described in Subsection 3.1.1), then there are severe challenges to teaching methods and content (as discussed also in Paper 3). Understanding how individual contribution links into the overall goals and ability to deal with novel situations demands from the learning tools/methods/contents above all the ability to deliver a holistic view of organizational and environmental functioning. This is something that we have tried to include in the artefact business environment.

(2) The 'PROCESS AND TIME dimensions of organizations' proposition goes as follows: For us batch-processing (described in more detail in Paper 1) follows the mechanistic view of organizations. The batch-processing decision-making process is a budgeting process, where the top level corporate decision-makers make the decisions on behalf of the whole organization. In continuous processing the participants are part of the business process which evolves as the time proceeds. The decision-making starts from the operational level. The dynamics between different organizational tasks and functions is explicit (in the form of processes). Table 3.4 rounds up the differences in the characteristics of batch and continuous processing.

Table 3.4: Differences in characteristics between batch-processing and continuous processing.

Batch-processing	**Continuous processing**
A more mechanistic view: a closed system that can be designed as clearly defined structures of parts.	Closer to an open system view: best understood as ongoing processes rather than as a collection of parts.
Centralized decision-making on the highest level of the business organization.	Decentralized decision-making also on the lower decision-making levels close to the actual action.
Discrete; stagnant momentary views on financial and materials situation.	Continuous; the view is continuously evolving representing the process nature of business operations, on a transaction specific level.
Hierarchy, top-down view.	Process, bottom-up.
Long-term decision-making	From short to mid-term (sometimes also long-term) decision-making.
Goals -> Targets	Process -> Outcomes.
Less potential for double-loop learning? (see Chapter 5)	More potential for double-loop learning in the sense that the processes in the game are transparent and explicit, compared to batch games where the processes are hidden? (see Chapter 5)

From the temporal point of view batch-processing offers a cyclical process which normally has a constant pace, though the pace can sometimes also be made shorter or longer between the activities. Referring to Ancona et al.'s temporal classifications, batch-processing corresponds to the repeated activity mapping of Figure 3.3, represented here as Figure 3.4.

a) **[A][A][A][A]**

b) **[A] [A] [A] [A]**

c) **[A][A]   [A][A]**

→ **Time**

Figure 3.4: Repeated activity mapping, possible in batch-processing (Ancona et al., 2001).

Continuous processing, as time bound processes, is also able to represent all the other activities described in Figure 3.3. Some examples:

- Single activity mapping: we have received a big order which should be delivered by the delivery due date. As this date approaches, we have to pay increasing attention to ensuring that our production will meet the deadline.
- Repeated activity mapping: raw material purchases in continuous processing can take place like in a) and b) classes of Figure 3.3. Usually an organization aims at maintaining its raw material purchases constant, but in the times of a sudden demand in finished products the purchases have to be hastened.
- Single activity transformation mapping: an example could be the process of transforming the raw materials to semi-finished products and then to finished goods.
- Multiple activity mapping: besides the materials process, in continuous processing the participants also have to take care of funding, selling activities, productivity follow-ups, and so on. These different activities do not necessarily follow the same pace: some may be non-stop activities; some may require attention at long intervals.

We find support for our aim of representing the flow of time and business processes from Teach (1990). He notes that while business simulation designers like to comment on how realistic their games are, the truth is that very few simulations are even close to reality. Teach finds two reasons for this. First, shackling of decision-making to the reporting or accounting cycle (pp. 114-115):

How realistic is it to have simulated clock stop, to have perfect financial and operations statements be made available, and to have all the marketing research that was requested, regardless of its difficulty, be made available at the end of the last day of the period? Another ridiculous situation is that every firm receives their data at the same time and no further competition takes place until all participants make either new decisions or have repeated old ones, again all at the same moment of time.

The above statement by Teach supports the concept of continuous processing which makes the flow of time transparent/explicit. The second reason Teach finds concerns the aggregate level information of business gaming. Teach's comment on this supports directly the aim of representing business processes, but also the representation of different decision-making levels (p. 115):

If one quizzes a simulation participant who has not had previous business experience about an invoice, it becomes apparent that few have any comprehension of the importance of such a document, or even its very existence…. A famous quote states, "I know one half of my advertising dollars are wasted, but I just don't know which half." This statement has no relevance to current business simulation players. Business simulation players never develop the concept that company sales are the result of many individual transactions, and that manufacturing is a complex, but controllable process. Today's powerful desktop computers and the availability of easy-to-use database software make transaction-based simulations a real possibility.

Our next comment on the time aspect is based on the two functional roles of time by Lee and Liebenau (1999). These two roles have some implications for the potential future research use of the artefact of this thesis. In our artefact, time is an independent variable as it flows independently of how the participants of the game act during the game. Time is conceived as *clock time* and time determines or influences the behavior of the participants. Thus, we could well examine the effects of clock time on various behavioral phenomena. Lee and Liebenau note that differences in human time orientations may cause organizational integration to be problematic unless it is properly recognized and managed. For example, the members of both production and sales departments tend to have short time orientations. In contrast, scientists in an R&D department have longer time orientations. Another example; the greater the time pressure, the more vigorous the search for alternatives becomes, and selective perception is the most acute where time pressure is the highest.

In batch-processed games, this is not exactly the case. In batch games time is probably also regarded as an independent variable, but not in the clock time sense but more as a concept of social time (Lee and Liebenau, 1999). Time may exist in many variations according to the individual in question. Lee and Liebenau use the concept of *event time* (Clark[9], 1985) as an opposite to clock time. Event time flows unevenly and discontinuously, and contains varying levels of contingency. Event time is not absolute and each individual may have his/her own time by this definition. Considering this, it would seem that continuous processing and batch-processing also provide a different kind of learning experience (this idea gets support from the findings presented in Paper 4 of this thesis).

As the last comment on temporal issues, we briefly introduce the six dimensions of temporality of business processes (Table 3.5; Lee, 1999). Without going into detail it is quite obvious that batch-processing and continuous processing in games differ from each other in respect of all these dimensions. To take one example, the sequence dimension, batch-processing gives the participants a possibility to adapt to a monochronic way of working, thus performing one task at a time. In continuous processing the work is more polychronic, demanding attention to be given to several tasks in parallel. Here we will not take any stand on the pros and cons of the processing alternatives in relation to these six dimensions. However, this matter is discussed more in detail in Section 7.10.

Table 3.5: Six dimensions of temporality of business processes (Lee, 1999).

Dimension	**Definition**
Duration	The amount of time spent to complete a task or an activity.
Temporal location	The location of activities and tasks at particular points over the continuum of time; when they take place.
Sequence	The order in which activities and tasks take place.
Deadline	The fixed time by when work is to be done.
Cycle	The periodic regularity in which work is completed repeatedly.
Rhythm	The alternation in the intensity of being busy.

(3) The 'DECISION-MAKING LEVELS' proposition goes as follows: We aim at giving the participants a view of business functioning which lays the foundation for higher level decision-making on the operational level problems. The arguments are partly the same as with the previous proposition. We are

[9] Clark, P. A. (1985). A Review of Theories of Time and Structure for Organizational Sociology. In Bacharach, S. B., and Mitchell, S. M. (eds.) Research in the Sociology of Organizations, pp. 35-80, Greenwich, CT: JAI.

offering a bottom-up view on business activities instead of just a top view of business activities. In the business game artefact this means different phases or levels of decision-making and game clock speed. This is introduced in Paper 1 and Chapter 7. These different decision-making levels also follow the path from structured to unstructured decision situations along with two game characteristics. (a) As the game proceeds from the operational level to the tactical and even strategic levels, some structured decisions are automated, like raw material purchases according to reorder points. Thus, once the game participants have learned the characteristics of raw material purchasing and have developed skills to handle it, this decision-making is given to the computer to be taken care of, setting participant decision-making capacity to be used for more complicated, unstructured problems. (b) As the game proceeds from one phase to another, the game clock speed increases. This means that the participants are able to develop a more holistic view with a longer time span than when the game environment proceeds slower, as it is possible to see more clearly the outcomes of decisions (the delays between when decisions are made and their impact will shorten). This faster game execution, of course, means that some operational structured decision-making has to be automated, as was described in (a).

As noted earlier, we acknowledge the need for learning tools which represent realistic and complex models of reality, are authentic, facilitate continuous problem solving and meaningful learning, and embed learning in social experience. The three propositions explicated here shape our conceptual model of how realism should be acquired and embedded in the specific learning tool of this thesis. This conceptual model helps the reader to understand the propositions, examples, and suggestions of Papers 1, 3, 4, and especially the functioning of the artefact represented in Chapter 7.

If we accept a view that learning is a kind of research process where the learner strives to gain understanding about the functioning of the phenomenon to be learned (= to be understood) – like the views of learning described in this thesis (experientialism and constructivism) – then the goals of carrying out organizational research are in line with the goals of learning about organizations. Thus, the attributes of the approach of synthesis from Miller and Mintzberg (1983) support our aim of providing a holistic process oriented learning artefact for organizational training. In the following, some attributes Miller and Mintzberg give for an approach that favors synthesis of internally consistent processes together with our view of how we have taken these attributes into account in our artefact building (citations from Miller and Mintzberg, pp. 62-63):

- *A large number of attributes – ideally of state, process, and situation – are studied simultaneously in order to yield a detailed, holistic,* *integrated image of reality*: The artefact provides a detailed and complex view of organizational processes with their flow of information, not just the attributes of its structure.

- *Causation is viewed in the broadest possible terms*. The holistic view of business operations representing networks of causation, not just unidirectional causation between pairs of variables nor even multiple forms of causation. A system in which each attribute can influence all of the others by being an indispensable part of an integrated whole.
- *Time and process are taken into account where ever possible*. The artefact represents time bound business processes, not stagnant states of organizations.

How well we have succeeded in embedding these attributes into the artefact design remains to be proved in the rest of this work.

4 BASIC CONCEPTS AND APPROACHES TO SIMULATION GAMING

In this chapter we introduce the central concepts dealt with in this thesis. First, the basic vocabulary of simulation and simulation gaming is presented. We will then proceed to business gaming, which is the central application area to be studied in this thesis. Emphasis is given especially to the processing methods of business games and how the flow of time is managed in business games.

4.1 Simulation Gaming

As a matter of fact, you can feed almost anything, any sequence of formal symbols, obeying some syntactic rules of operation, into a computer. But the fact that you can do that, and play with rules you have invented, is no guarantee at all of any meaningful scientific concepts being involved in your formal language.

Aulin (1989)

When we are talking about business games in this thesis, we regard them as belonging to *simulation gaming* instead of just gaming or just simulation. The word ‘simulation’ is sometimes considered too mechanistic for educational purposes. Simulation also refers to activities where an optimum for some problem is searched for, while this is not usually the aim of an educational game. On the other hand, the word ‘game’ can imply time wasting, not taking things too seriously and engaging in an exercise designed purely for fun. The concept of simulation gaming seems to offer the right combination and balance between the two. The community of gamers have adopted a less accurate but more acceptable name for their enterprises. Simulation gaming is also the term that the educational gaming community has adopted (Greenblat, 1988). We start by defining some basic vocabulary.

4.1.1 Model

A model of a system or a process is a theoretical description that can help you understand how the system or process works, or how it might work. (Collins Cobuild English language dictionary, 1987).

Models are abstractions of reality (Brown, 1975). They may be pictorial, physical, graphical, mathematical, or statistical by nature. The abstraction or interpretation of reality only needs to contain the essential ingredients of the situation or the object of interest. Forrester (1961) defines a model as a substitute for some real equipment or system. This kind of model is used to improve our understanding of obscure behavior characteristics more efficiently than could be done by observing the real system. The term model is often used to refer to anything, which influenced, shaped, or inspired a simulation (Forrester, 1961).

Inbar and Stoll (1972, p. 28) define the term as *referring to a set of relationships among units, where both the relationships and the units are stated in abstract or highly general terms*. Thus, the model is a representation of a structure (Whicker and Sigelman, 1991). Bunge (1973) states, that if the object represented in the model is concrete, then the model is an idealization of the object. The representation of a concrete object is always partial and more or less conventional.

Pidd (1998) mentions that models of various types are often used in management science. Models are representations of the system of interest and are used to investigate possible improvements in the real system or to discover the effect of different policies on that system. A model, compared to the real system, can yield information at lower cost (Forrester, 1961). Knowledge can be obtained more quickly and for conditions not observable in real life.

Lipsey and Courant (1996) note that no one believes that simple models catch everything about the complex interactions in the reality. But models do alert us to watch for certain forces when we are building more complex models or creating more general theories. When studying a phenomenon we try to find the most essential features of the phenomenon. In practice, all factors that have an impact in the reality cannot be included. The factors selected for the model are called known and the excluded ones unknown (Järvinen, 1999).

A *dynamic model* deals with time-varying interactions. A dynamic model is a model in which conditions change with time (Forrester, 1961).

A model can be evaluated in terms of its fidelity with real world phenomena, completeness, level of detail, robustness, and internal consistency (March and Smith, 1995). Järvinen (2001) supplements the previous with form and content.

4.1.2 Theory

A theory is an idea or set of ideas that is intended to explain something. It is based on evidence and careful reasoning but it cannot be completely proved (Collins Cobuild English language dictionary, 1987).

Models and theories are intimately related. The relationship is largely one of a degree of elaboration. According to Inbar and Stoll (1972), a model is always at a higher level of generality than a theory, and thus always simpler than reality. *A model is elaborated into a theory once the qualitative and quantitative nature of both the units as well as of their input-output relationships has been specified* (Inbar and Stoll, 1972, p. 29). Once the conditions under which the qualitative or quantitative differences in the input-output relationships occur have been specified, a theory can be analyzed into a standard set of elements.

Weick (1995) – when discussing theories in organizational studies – notes that products of the theorizing process seldom emerge as fullblown theories, which means that most of what passes for theory consists of approximations. Few of these approximations take the form of strong theory. Weick argues (p. 387): *…it is tough to judge whether something is a theory or not when only the product itself is examined. What one needs to know, instead, is more about the context in which the product lives. This is the process of theorizing. ...* (p. 389:) *The process of theorizing consists of activities like abstracting, generalizing, relating, selecting, explaining, synthesizing, and idealizing.*

Sutton and Staw (1995) state that lack of consensus on exactly what theory is may explain why it is so difficult to develop theory in the behavioral sciences. For example, there is lack of agreement about whether a model and a theory can be distinguished.

4.1.3 Simulation

Simulate, simulates, simulating, simulated: *If you simulate a set of conditions, you reproduce these conditions, for example in order to conduct an experiment* (Collins Cobuild English language dictionary, 1987).

Simulation: *A simulation is also an attempt to solve a problem or to work out the consequences of doing something by representing the problem or possible course of events mathematically, often using a computer* (Collins Cobuild English language dictionary, 1987)

Simulation means (Dictionary of Computer Science, 1989): *the use of a data processing system to represent selected behavioral characteristics of a physical or abstract system*. For example *the representation of air streams* *around airfoils at various velocities, temperatures, and air pressures*. The content of simulation varies depending on in which discipline the word is defined. Different sources all define the basis of simulation to be an imitation of the behavior of some existing or intended system. But what platform is needed to simulate and what the applications of simulation are, differ between different disciplines. While the model is typically a representation of a structure, the simulation is a representation of the structure in action (Whicker and Sigelman, 1991). What is simulated is some of the critical features of the reality (Saunders, 1995).

Naylor (1971, p. 2) defines simulation of economic systems as *a numerical technique for conducting experiments with certain types of mathematical models which describe the behavior of a complex system on a digital computer over extended periods of time*. The principal difference between a simulation experiment and a real world experiment is that, with simulation, the experiment is conducted with a model of the real system instead of with the actual system itself. Naylor states that the simulation is processed on a digital computer. According to most other definitions simulations can vary in forms. E.g. Inbar and Stoll (1972) mention that simulations can be board games or they may employ the computer or they may utilize both people and computers. Pidd (1998) notes that computer simulations are used when it is impossible or inconvenient to find some other way of tackling the problem. In such simulations, a computer is used because of its speed in mimicking a system over a period of time. Pointlike similarity is an exception rather than the rule. Bunge (1973) mentions that an illusion of perfect formal analogy can be produced only in special cases, as in certain mechanical or hydraulic analogs of electric circuits.

Elgood (1996) gives a broader definition of simulation. Word simulation is used to describe activities in which any of the following characteristics seems to dominate:

- a physical means of reproducing, off-the-job, the phenomenon being studied,
- a precise focus on a single, specialized phenomenon, so that the lessons are not obviously transferable to other areas, and
- absence of direct human opponents, the challenge being ‘player versus environment’ rather than ‘player versus player’.

Computer simulation involves experimentation on a computer-based model of some system (Pidd, 1998; Figure 4.1). The model is used as a vehicle for experimentation, often in a ‘trial and error’ way to demonstrate the likely effects of various policies. Those policies, which produce the best results in the model, would be implemented in the real system.

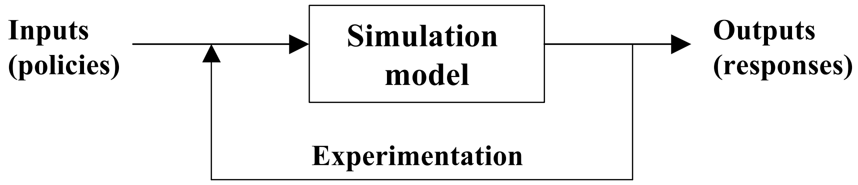

Figure 4.1: Simulation as experimentation (Pidd, 1998, p. 5).

The purpose of using simulations is to gather understanding of the original object by studying the behavior of the simulation (Bunge, 1973, p. 125): *Without analogy there might be no knowledge: the perception of analogies is a first step towards classification and generalization*. On the other hand, Bunge warns us about the inability to distinguish analogy from equivalence, which may lead to the classical yet mistaken belief that analogy is the source of induction.

Computer simulation methods have been developed since the early 1960's and may well be the most commonly used of all the analytical tools of management science (Pidd, 1998). Morecroft (1992b) notes that in the past business computer models were thought of as technical tools for tightly structured problems of prediction, optimization, or financial planning. Increasingly models are seen to have a different and subtler role as instruments to support strategic thinking, group discussion and learning in management teams.

4.1.4 Classes of Simulation

Inbar and Stoll (1972) present the following framework for classifying different types of simulations (Figure 4.2).

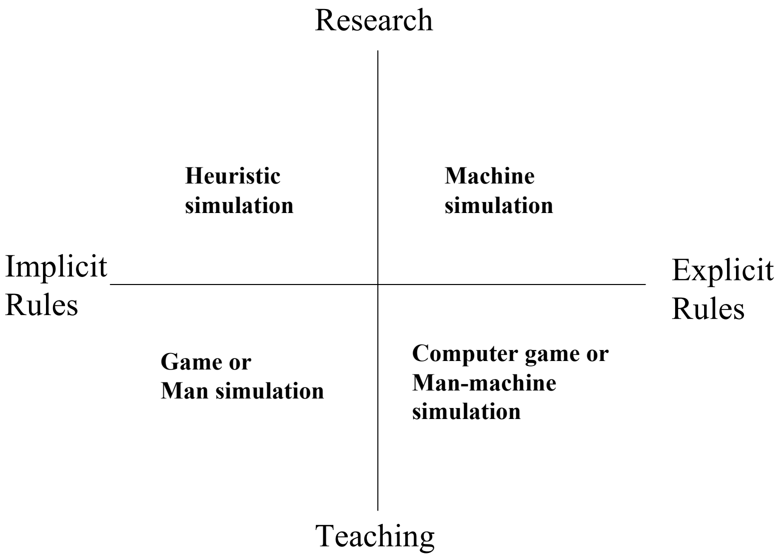

Figure 4.2: Mode of simulation as a function of the designer's goal and state of available knowledge (Inbar and Stoll, 1972).

Other classifications are also available, but the Inbar and Stoll mode presents continuums between implicit/explicit rules and research/teaching. The simulation types in the Inbar and Stoll model can be named otherwise, but the idea itself remains. E.g. Whicker and Sigelman (1991) divide the simulations in social sciences into:

- person-person simulation (game or man simulation), which involves interaction between two or more people. These can include research on small-group decision making, heuristic or learning purposes, entertainment.
- person-machine simulation (computer game or man-machine simulation) involves interaction between a computer program and a person responding to input from the computer, with the individual's responses influencing future input from the computer. These can include e.g. business strategy games.
- Machine or all-computer simulations (machine simulation) do not require player input while the simulation is executing. These can include e.g. simulations of physical reactions.

According to Inbar and Stoll, *heuristic simulations* are solely for the benefit of the designer and can be of any form. What they exactly mean by heuristic simulation remains unexplained. We suppose that by this term they refer to a hermeneutic circle (Burrell and Morgan, 1979, pp. 237-238), where rules of interpretation move in a circular and iterative fashion towards an increased understanding of the objectifications of the mind.

Man simulation emphasizes that the decision-makers are human actors. Inbar and Stoll (1972) cite that there has been considerable disagreement as to whether man simulations could be called simulations. Simulations designed for operation by computers differ drastically in technical apparatus and appearance from those designed for human actors. This might also hint at why the term simulation gaming is in use today.

Games (man simulations) are widely used in business training. To take one example, Goodwin and Franklin (1994) describe the use of the Beer Distribution Game in management development programs. The training events where Goodwin and Franklin used the Beer Game aimed at illustrating systems thinking to managers. The game simulates the production and distribution process (factory, distributor, wholesales and retailer) of beer. The outcomes of the training described by Goodwin and Franklin are typical for such games:

- the simulation reveals the functioning of the game process to the participants,
- participants learn the reactive nature of their decisions, and
- participants understand how a systems perspective is necessary to cope with the problems inherent in the game's structure.

Also in Finland there is a tradition of using man simulations in participative development of work in organizations. For example, Ruohomäki has successfully applied the Work Flow Game (Ruohomäki 1995; 2002; 2003) to the development of real-world administrative work processes in administration and business. The positive effects of games, such as the Beer Game and the Work Flow Game, are well recognized. Ruohomäki describes in her dissertation (2002) how organizational changes can be carried out through the use of simulation gaming. For a description of the Work Flow Game method see Piispanen et al. (1996).

Machine Simulation stresses the exclusive reliance on a computer. The flexibility of a computer program that is supposed to simulate human action is merely a reflection of the programmer's limited capabilities. Because of the extreme precision required for programming a process, only certain problems tend to be computer-simulated. The practical value of the pure machine simulation is therefore highly questionable in tasks requiring simulation of human behavior. Whicker and Sigelman (1991) note that computer simulations are best equipped to address numerical problems.

Inbar and Stoll (1972) note that the more one intents the simulation to be used for teaching rather than for research purposes, the more it should take on the form of a man (or man-machine) simulation so that the players have a chance to learn about the process. Lane (1992) discusses the same issue. He mentions that in reality any problem is embedded in a network of political, cultural and power relationships. Thus, it is naive and futile to imagine that these can all be cut through because a solution is known to be mathematically optimal. According to Lane, any solution which requires action to be taken, will need to address the relationships of those involved and account for them and take time to organize their re-configuration.

Man-machine or *computer game simulation* indicates that some decisions are programmed to be made by computers. In computer games human actors play the role of decision-makers, but the computer is also a participant, responsive to the player's activities. Thus, the computer takes a role or roles in the game. This means that the computer model must be programmed in detail so as to be responsive to any action on the part of the real-life player.

If we agree that there are limitations to the use of computer simulations in training business decision-making we can further discuss what would be a better option. If we consider that Inbar and Stoll (1972) are right about machine simulations (the more one intents the simulation to be used for teaching, the more it should take on the form of a man or man-machine simulation), it must be the same with computer games. Computer games include human participants (who compete against each other in the game), but are still characterized by e.g. automated market mechanisms. We once again have the same problem as we have with computer simulations: a computer program tries to process something, which in reality is human behavior. Inbar and Stoll note briefly that the more we want to use the simulation for teaching and training, the more important it is that the form be a man simulation, preferably a game in the strict sense of the term. If so, should we not try to channel our efforts more towards building human to human interactive games (as suggested in Figure 4.3)?

Also Lane (1992) discusses this topic. He states that we need to represent the presence of real individuals in our models, not the hypothetical 'rational economic man'. When discussing systems which have in them the arbitrary behavior of real people, Lane argues that it is necessary to capture the idea that systems are not controlled by omniscient optimizers, hypothetical 'rational economic men' capable of sifting all incoming information and processing it accurately to configure an optimal policy decision in consequence.

But manually played games lack the use of automated information gathering and processing. Because these games do not use computers as part of the game process, they do not include realistic balance sheets, income statements, inventory reports, sales reports, and so on. This is a setback if the game is intended to describe the holistic business structure. Without automated data processing it is difficult to get a holistic picture of the effectiveness and profitability of the game organization. The advent of the powerful computer means that large amounts of data can be represented as an aid to decision-making and in that sense information itself has become a tangible resource. Actually some board games include the use of a computer as an optional extension, but still the intersection between the game processing and the information systems needs some input effort from the participants. And this in turn is troublesome and will reduce the fascination of game playing (making the suggestion in Figure 4.3 not that straightforward). Gredler (1996) mentions that manual games (board games) are limited in the amount and extent of feedback they can provide for learner actions. The use of computers makes the development of sophisticated games in which students apply a broad base of knowledge to solve complex problems possible.

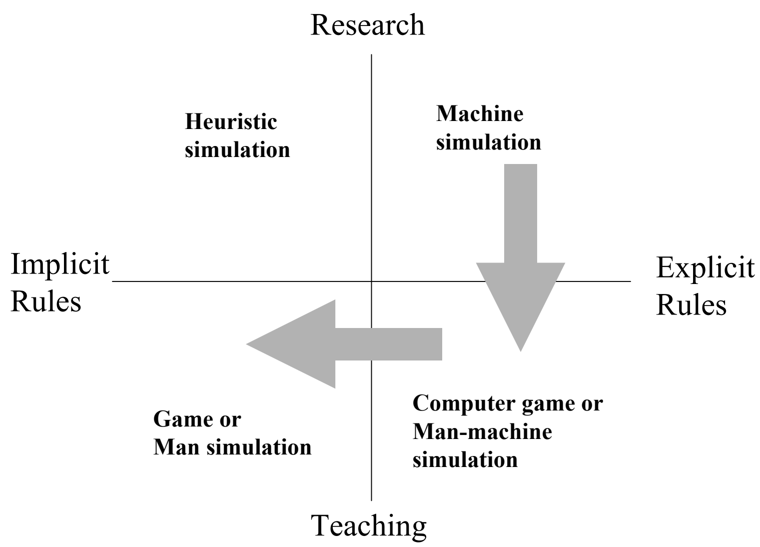

Figure 4.3: Suggested increase in learning potential for simulation participants in different types of simulations (interpretation from Inbar and Stoll, 1972).

4.1.5 Simulation Processing Types

There are two main types of processing a simulation (Wyatt, 1975; Dictionary of Computer Science, 1989): continuous and discrete event. The choice between these two in any particular case is determined by the nature of the system to be simulated and the purposes that the simulation is intended to achieve (Dictionary of Computer Science, 1989).

Discrete simulation (or discrete event simulation) refers to an abstraction which relies on a step-by-step representation (Wyatt, 1975). In discrete event simulation it must be possible to view all significant changes to the state of the system as distinct events that occur at a specific point in time (Dictionary of Computer Science, 1989). The simulation then achieves the desired behavior by modeling a sequence of such events, treating each individually.

Continuous simulation refers to the abstraction of the real process being simulated to a set of mathematically continuous functions (Wyatt, 1975). A continuous simulation views changes as occurring gradually over a period of time and tracks the progress of these gradual changes (Dictionary of Computer Science, 1989).

Also Whicker and Sigelman (1991) divide simulations into two categories by the way they deal with the progressing of the simulation model. The first one is the batch-processed or non-interactive model, in which all behavior subroutines are spelled out beforehand, in the computer code. Thus, no human input is required. The second one is the interactive model, in which the model's performance is periodically adjusted to account for input supplied by the modeler while the model is running. According to Whicker and Sigelman this requires the model to stop in midstream to pose a question to the modeler. When the model receives the answer, it will proceed accordingly. Here, the batch-processed mode corresponds to discrete event simulation and the interactive mode corresponds to continuous simulation.

For discussion about the application of batch-processing and continuous processing in business gaming, see Paper 1 of this thesis.

4.2 Games and Business Games

Game: *A game is an activity or sport involving skill, knowledge, or chance in which you follow fixed rules and try to win against an opponent or to solve a puzzle* (Collins Cobuild English language dictionary, 1987).

Partly, the terminology of business games is not well established. The most common term used is "business game" but several other terms are also in use. Here we will define the most common terms used in context of (computer-based) business learning environments.

Klabbers (1999) notes that gaming is sometimes associated with something that is frivolous, just for the fun of it. This hampers its scientific endeavor and the more serious connotations of gaming in the scientific arena. The term *game* is used to describe activities in which some or all of these characteristics are prominent (Elgood, 1996):

- human, humanly controlled, opponents, whose actions have an effect upon each other and upon the environment,
- an emphasis on competitiveness and winning,
- an emphasis on pleasure, humour and enjoyment,
- a repetitive cycle of making decisions and encountering a result, allowing the hope of improvement and 'doing better next time'.

Games are played when one or more players compete or cooperate for payoffs, according to an agreed set of rules. Players behave as themselves though they may well display exceptional behavior (Jaques, 1995). Games are social systems and they include actors (players), rules and resources, which are the basic building blocks of social systems (Klabbers, 1999; 2001; Figure 4.4). In each game, the players (actors) interact with one another, while applying different rules, and utilizing different resources (Klabbers, 2003).

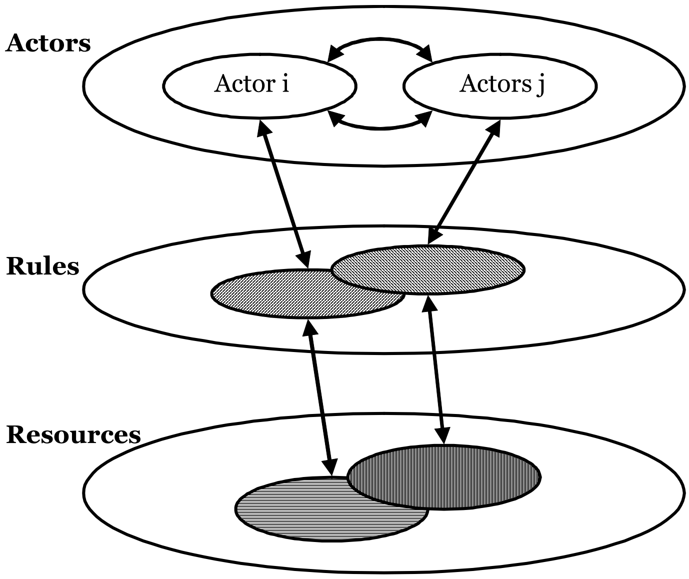

Figure 4.4: The basic structure of games (Klabbers, 1999).

Tsuchiya and Tsuchiya (1999) note that the simulation gaming community is still struggling to establish itself as a discipline, although 35 years have passed since the International Simulation and Gaming Association (ISAGA) was established. To be a discipline, simulation gaming needs a theory, methodology, and application and validation. Of these, forming a theory is the most difficult challenge. Similar comments come from Wolfe and Crookall (1998). Referring to prior research they conclude that the educational simulation gaming field has been unable to create a generally accepted typology, let alone taxonomy, of the nature of simulation gaming. According to them this is unfortunate because the basis of any science is its ability to discriminate and classify phenomena within its purview, based on underlying theory and precepts. Without this, the field has been stuck, despite its age, at a relatively low level of development.

In most cases, the terms *business game* and *management game* can be used interchangeably and there is no well-established difference between these two terms. Greenlaw et al. (1962, p. 5) determine a business game (or business simulation) as *a sequential decision-making exercise structure around a model of a business operation, in which participants assume the role of managing the* *simulated operation*. The descriptions given for a management game, for example, by Forrester (1961) and Naylor (1971) do not differ from the previous. However, Elgood (1996) determines that in a management game profit is not the dominant measure of success. Keys and Wolfe (1990) define a management game as a simplified simulated experiential environment that contains enough verisimilitude, or illusion of reality, to include real world-like responses by those participating in the exercise.

Gredler (1996) divides experiential simulations into the following four categories:

1) Data management simulations,
2) Diagnostic simulations,
3) Crisis management simulations, and
4) Social-process simulations.

Business games are most often of the first kind. A participant in a data management simulation typically functions as a member of a team of managers or planners. Each team is managing a company allocating economic resources to any of several variables in order to achieve a particular goal.

Business strategy games are intended to enhance students' decision-making skills, especially under conditions defined by limited time and information (Whicker and Sigelman, 1991). They vary in focus from how to undertake a corporate takeover to how to expand a company's share of the market. Typically, the player feeds information into a computer program and receives back a series of optional or additional data that are conditional upon the player's initial choices. The game proceeds through several series of these interactive, iterative steps. As can be noted, Whicker and Sigelman's definition does not consider continuous processing an alternative.

In business games players receive a description of an imaginary business and an imaginary environment and make decisions – on price, advertising, production targets, etc. – about how their company should be run. A business game may have an industrial, commercial or financial background (Elgood, 1996). Ju and Wagner (1997) mention that the nature of business games can include decision-making tasks, which pit the player against a hostile environment or hostile opponents. These simulations have a nature of strategy or war games, but usually are very terse in their user interface. Other types of managerial simulations are resource allocation games, in which the player or players have to allocate resources to areas such as plant, production, marketing, and human resources, in order to produce and sell goods.

According to Senge and Lannon (1997) in managerial microworlds – like business games – unlike in the actual world, managers are free to experiment with policies and strategies without fear of jeopardizing the company. This process includes the kind of reflection and inquiry for which there is no time in the hectic everyday world. Thus, Senge and Lannon argue, managers learn about the long-term, systemic consequences of their actions. Such "virtual worlds" are particularly important in team learning. Managers can learn to think systemically if they can uncover the subtle interactions that thwart their efforts.

Naylor (1971) gives quite a detailed view of the contents, structure, and operating of management games. Today, this description by Naylor is still valid for most of the business games. Business games are built around a hypothetical oligopolistic industry consisting of three to six firms, whose decision-makers or managers are the participants of the game. Each firm or team is allocated a specific amount of resources in the form of cash, inventories, raw materials, plant and equipment, and so forth. Before each operating period the players make decisions. Naylor mentions that these decisions can concern, e.g., price, output, advertising, marketing, raw material acquisition, changes in plant capacity, and wage rate. This information is read into a computer that has been programmed on the basis of a set of mathematical models that provide a link between the operating results and operating decisions of the individual firms, as well as the external environment (the market). On the basis of (a) a set of behavioral equations, such as demand and cost functions, and a set of accounting formulas that have been programmed into the computer, and (b) the individual decisions of each firm, operating results are generated by the computer in the form of printed reports – for example, profit and loss statements, balance sheets, production reports, sales reports, and total industry reports – at the end of each operating period. Usually the environment can be changed by the administrator of the game by altering the parameters of the operating characteristics of the game. In each case, the firms find it necessary to react according to the magnitude and the nature of the change imposed by the external environment. Naylor mentions that some of the more complicated and more realistic games even permit multiple products, plants, and marketing areas, stochastic production periods, stochastic demand, labor negotiations, and the sale of common stock.

4.2.1 History of Business Games

The first use of games for education and development was the war game simulations in China in about 3,000 B.C. These games bore a vague similarity to the early 17th century chess (Keys and Wolfe, 1990). In the Western world, war games date back to at least the German *Kriegspiel* of the mid-nineteenth century (Faria and Dickinson, 1994). Faria and Dickinson note that different war games have also been conducted in Japan before the Second World War and war games have been long used by the British and the Americans to test battle strategies.

Military officers trained with war games in the 1930's and 1940's started the use their military training in managing civilian businesses. Some of the business game evolution can be traced to a 1955 Rand Corporation game, which simulated the U.S. Air Force inventory management within its supply system (Jackson[10], 1959; referred to in Keys and Wolfe, 1990). Greenlaw et al. (1962) state that business simulation exercises may be considered an outgrowth of earlier developments in three fields: military war gaming, operations research, and educational role-playing.

According to Naylor (1971), the use of games in business and economics goes back to 1956 when the American Management Association developed the first so-called management decision-making game, called the Top Management Decision Game. Faria and Dickinson (1994) and Greenlaw et al. (1962) also find this the first widely known business decision-making simulation, although Greenlaw et al. date the origin of the game to 1957 and further specify that it was the first non-military competitive business game. Greenlaw et al. note that the Top Management Decision Simulation stimulated the design and use of dozens of other games. In this simulation five teams of players operated firms competing in a hypothetical, one-product industry. Teams made quarterly decisions covering price, production volume, budgets, research and development, advertising, and sales force and could request selected marketing research information. During the period 1955-1957 only one or two new games appeared each year (Faria, 1990).

A rapid growth in the number of business games occurred over the years from 1958 to 1961 (Faria, 1990). Greenlaw et al. (1962) had made a summary of some business games available by the beginning of the 1960’s. The summary includes 89 different business games or different versions of a certain business game developed by industrial firms, business associations, educational institutes, or governmental units. Naylor mentions already in 1971 that hundreds of management games have been developed by various universities, business firms, and research organizations. These management games have been used both for research purposes and for training people in diverse disciplines such as management, business operation, economics, organization theory, psychology, production management, finance, accounting, and marketing. Also Faria and Dickinson (1994) note that the number of simulation games grew rapidly in the 1960’s. McRaith and

[10] Jackson, J. R. (1959). Learning from Experience in Business Decision Games. California Management Review, Vol. 1, No. 2, pp. 92-107.

Goeldner[11] (1962; referred to in Faria and Dickinson, 1994) list 29 marketing games, of which 20 had been developed by business firms and nine by academians for university teaching. In 1969 Graham and Gray[12] (referred to in Faria and Dickinson, 1994) listed nearly 200 business games of different varieties. Horn and Cleaves[13] (1980; referred to in Faria and Dickinson, 1994) provided a description of 228 business games. Faria[14] (1989; referred to in Faria and Dickinson, 1994) mentions that over 200 simulations were in use in the USA in over 1.700 business schools. Overall, taking advantage of computer games in education increased enormously through the 1960's to the 1980's (e.g. Ju and Wagner, 1997).

At the end of the 1980's Faria (1990) estimated that there were approximately 228 games available in the USA, and that there were around 8.500 instructors using business games. At that point Faria also believes that there is a large and growing number of business schools instructors and business firm users of simulation games. Still, Faria estimated that only 12.5 % of all US business firms with training and development managers used computerized business games.

The penetration of business gaming in academia is fuelled by the following factors (Burgess, 1995): the increase in student numbers, the increase in new courses, increased adoption of methods supporting diverse learning styles, and the increasing availability of technology. Dickinson and Faria (1996) state that in US over 200 business games are being used by nearly 9.000 teachers at over 1.700 colleges offering business programmes.

Larsen and Lomi (1999) describe the shift of the objectives of management gaming. They state that until the early 1980's simulation was used to forecast the behavior of a variety of sub-system level variables, ranging from the cash flow and financial performance of a company, to the inflation and unemployment rates of an economy. They state further, that during the last 15 years a new way of thinking about simulation emerged. Instead of focusing on predicting, simulation progressively became a tool to help management teams understand their company and industry's problems and opportunities. Simulations could prepare for the future and reduce the sensitivity of possible strategies to changes in alternative frames of reference – or mental models.

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[11] McRaith, J. R., and Goeldner, C. R. (1962). A Survey of Marketing Games. Journal of Marketing, Vol. 26, No. 3.

[12] Graham, R. G., and Gray, C. F. (1969). Business Games Handbook. American Management Association, New York, NY.

[13] Horn, R. E., and Cleaves, A. (1980). The Guide to Simulation/Games for Education and Training. Sage Publications, Beverly Hills, CA.

[14] Faria, A.J. (1989). Business Gaming: Current Usage Levels. Management Development Review, Vol. 8, No. 2, pp. 58-66.

Larsen and Lomi (1999) further note, that the emphasis of computer-based simulation models has shifted:

1. from predicting the future, to understanding how multiple possible futures might be linked to decisions and actions that must be taken today, and
2. from designing the best strategy, to analyzing how robust our preferred strategy would be under different assumptions about how the future might unfold, or about how the past actually produced the events that we perceive.

4.2.2 Types of Business Games

Business games can be classified according to several properties. The first taxonomies were introduced already in the beginning of the 1960's (see e.g. Greenlaw et al., 1962). Here we introduce the taxonomy from Biggs (1990) (Table 4.1), which is practically identical with the taxonomy from Greenlaw et al.

Table 4.1: Business game taxonomy and the artefact of the thesis (adapted from Biggs, 1990).

Dimension	**Description of alternatives**	**The artefact of this thesis**
Functional or Total enterprise	Designed to focus specifically on problems of decision-making as seen in one functional area; OR Designed to give participants experience in making decisions at a top executive level and in which decisions from one functional area interact with those made in other areas of a firm.	Total enterprise, though when played in the first phase manufacturing and material processes are emphasized.
Competitive or Non-competitive	Whether the decisions or participants influence the results of other participants or not.	Competitive
Interactive or Noninteractive	In an interactive game participants respond to the questions at the computer, receive an immediate response, and then submit additional decisions. In a noninteractive game decisions are submitted to the game administrator.	Interactive
Industry specific or Generic	In an industry specific game the authors attempt to replicate closely the actual industry. In generic games only general business relationships are replicated.	Can be both industry specific and generic, depending on whether the game model is *configured/tailored* for the customer.
Played by Individuals or by Teams		Teams
Deterministic or Stochastic	The stochastic alternative is probabilistic, including chance elements.	Stochastic
Mainframe or Microcomputer		Microcomputer
Degree of complexity	Two dimensions of complexity: (a) game decision input variable complexity (b) the computer model complexity	Very complex in both respects.
The time period simulated	E.g. day/week/quarter/year	Flow of time is continuous, the smallest change being one hour. In a normal training some 5 to 10 months are simulated.

4.2.3 The Business Gaming Process

The activities carried out during a simulation game training session are (Villegas, 1997):

- Theoretical instruction: the teacher goes through certain relevant aspects of a theory and participants can intervene with questions and comments.
- Introduction to the game: the participants are told how to operate the computer and how to play the game.
- Playing the game: participants get the opportunity to practice their knowledge and skills by changing different parameters of the game and reflecting on the possible consequences of these changes. Permanent contact with the participants is advisable, as well as keeping the training going to maintain a positive atmosphere and to secure that the participants feel engaged.
- Group discussions: Each of the participants is given a possibility to present and compare their results from the game with the results of others. The participants are encouraged to present their results to others. The teacher should continually look for new ways of enriching the discussions and to help the participants to find the connection between the game results and the problems in real world. The quality of this group discussion plays a relevant role in the training as it will affect the participants' transfer of knowledge and skills into the real world.

The last phase in the list above is usually called debriefing. Debriefing is the most important part of the simulation/gaming experience (Crookall, 1995). We all learn from experience, but without reflecting on this experience the learning potential may be lost. Simulation gaming needs to be seen as contrived experiences in the learning cycle, which require special attention at the stages of reflection and generalization (Jaques, 1995) (see the experiential learning cycle in Figure 5.1).

Thiagarajan (1995) lists six phases of debriefing, presented as a flexible suggestion and not as rigid requirements:

1. How do you feel? Gives the participants an opportunity to get some of their strong feelings about the simulation game off their chest.
2. What happened? Makes it possible for the participants to compare and to contrast participant recollections and to draw some general conclusions during the next phase.
3. What did you learn? Encourage the generation and testing of different hypotheses. Ask the participants to come up with general principles

based on their experiences from the game and to offer evidence to support or to reject the principles.
4. How does this relate to the real world? Encourage a discussion of the relevance of the game to the participants' real world workplace.
5. What if…? Encourage the participants to apply their insights to new contexts.
6. What next? Participants use their insights to come up with strategies for the simulation game and for the workplace.

Van Ments (1996) notes that the aim of debriefing is to: deal with factual errors and to tie up loose ends (including scoring); draw out general conclusions about the session; and deduce general lessons which can be extrapolated to the real world. Furthermore, the participants should not be allowed to conclude what was learned without receiving feedback (Gentry, 1990). The participants need to articulate their perception of what was learned, and the instructor needs to put things into a broader perspective. Gentry also expresses that process feedback is much more valuable than outcome feedback. As games are less-than-perfect representations of the real world, it should be the decision process used that needs to be applauded or critiqued, not the gaming outcome.

4.2.4 The Management of Time in Business Games

There is no question that the phenomena we want to understand are defined, in part, by their time scales
Weick (1999, p. 800)

Much of the efforts of business game designers seem to have been made to introduce and cover new (or even old) problem areas with safe technological solutions (see, for example, Töyli, 2001). Not as much research has been devoted to test new technological solutions, which might offer whole new ways of introducing the problem areas. In that sense the field of business gaming has been the same for already more than 40 years (from the end of the 1950's).

Burgess (1995) discusses how business gaming software could be improved. He quests for more realistic games by increasing the level of complexity. However, any increase in game complexity tends to reduce the extent of participants' learning. Burgess suggests the following aims:
a) base games on real market scenarios;
b) use multimedia;
c) use continuous simulation, the so-called interactive approach, rather than the existing dominant method of discrete simulation.

Our research is connected to two of these suggestions: (a) and (c). Paper 4 and Chapter 7 of this thesis introduce how the thesis artefact can be configured according to real world business environments. Continuous processing is discussed especially in Paper 1, but also in Paper 3 and Chapter 7. In this section we will introduce those findings on continuous processing that we have not introduced in the papers. When we talk about continuous processing, we specifically mean continuous processing in a game where there are several companies competing against each other, over a computer network. Thus, single player games do not belong to the area of our interest.

Besides those sources arguing for continuous processing there are authors who call for transparent business simulations. Transparency is discussed in our Paper 1, but we will briefly introduce what transparency means in this context. Transparency is connected to continuous processing as it reveals the process structure of business processes, thus showing how business operations and different events unfold. Here we refer to Machuca (2000) who states that traditional business games are of the black-box type where the internal structure of the simulation that generates the results is not very well known (hidden). As a result (p. 233):

1. *the learning assumed is attained through a system of trial and error in which the player does not really know the origin of the results obtained, although he or she bases his or her decisions on these (the symptoms of the problem);*
2. *the basic structure of the simulation model might be erroneous, with no possibility of detecting this fact. This may lead to faulty learning with little chance of correction; and*
3. *adaptation with a view to suiting the learning to changing conditions becomes practically impossible.*

The problem with batch-processing is nicely put forward by Feinstein et al. (2002, p. 736): The greatest weakness of these games is their inability to provide the learner with a dynamic environment. Time, in essence, stands still while the teams are implementing their decision strategies. Then, time jumps forward at the end of each round. Although players are under a time deadline and decision time might be included in the adjustment of variables, players cannot observe the impact interactions of their decisions with external and competitor variables until the round is complete. Further, creating what-if scenarios is extremely difficult. Decisions are made based upon what happened in the last rounds, not what is happening at the time. However, Feinstein et al. do not hypothesize with the possibility of continuous gaming but, instead, suggest continuous event computer simulations as training devices.

Rather few scholars discuss continuous processing as a game processing alternative and even fewer scholars discuss examples of these. The authors theorizing continuous processing are Churchill (1968); Patz (1990), Thavikulwat (1996), and Lawrence (1997).

Churchill (1968) is the first author we have found who mentions real-time processing in a business gaming context. He mentions having been involved in the construction of a business game to be played through teletypes on a time-sharing system. But he aims even further (p. 574): *Hardware limitations have prevented us from achieving a true "real time" game. That is, the game* [the one in use] *still is structured into discrete periods and no advantage accrues to the team that is able to respond most quickly to feedback for a given set of decisions. With the GE 635 equipment, we hope to develop this into a true "real time" game*. We have no knowledge of what happened to this real time game project, but probably the game was never finished, as no source has mentioned this suggested real time game.

Patz (1990) suggests that business games should be made open systems instead of their present closed system nature. In short the open system term by Patz means that the market model of the game has an artificial intelligence base that generates market dynamics and eliminates the need for fixed or predetermined market algorithms. These simulations generate environments that emerge over time as a result of participant behaviors. Patz argues that the closed system approach of business games gives little opportunity for participants to act upon rather than just react to the preset macroeconomic and commodity demand function. Thus, the participants' decisions and their effects lie within the limits set by the established algorithms. According to Patz, simulations should become continuous rather than discrete processes. Furthermore, Patz notes that this means that simulations may assume the day-to-day character of ongoing business while encouraging the development of long range strategies.

Thavikulwat (1996) divides the treatment of time in computerized business games into three dimensions: scale, synchronization, and drive. Most business game simulations impose fixed scaling. *Fixed scaling* means that the game decision-making is shackled to constant reporting cycles. The opposite – *flexible scaling* – allows the participants to select the length of successive periods. *Synchronized* gaming means that all game participants are bound to the same period lengths of decision-making. *Unsynchronized* gaming means that the participants of a game can themselves decide at what pace to advance. Thavikulwat sees four different drive-design possibilities. An *administrator-driven simulation* requires the administrator to collect and process the participants' decisions. Administrator-driven simulations have a long tradition and they remain pervasive in computerized business simulations. A *participant-driven simulation* advances time upon the participant's command. A *clock-driven simulation* advances time in concert with the computer's internal clock. Thavikulwat mentions that this design would be elegant in games that allow for interdependence among the participants. An *activity-driven simulation* advances time when the participants are active.

Lawrence (1997) argues that in the real business world any company would face major problems if it had to keep to the decisions made in the budgeting process. Lawrence claims that batch simulation (batch-processing) locks companies into fixed reporting forms and procedures. At the end of the period a predetermined set of reports is delivered to each company. There is no freedom to structure the simulation output in a manner that facilitates the company's chosen decision processes. In general, such business simulations tend to lock their participants into a particular approach towards decision-making which reduces their potential value. Further, the acute lack of flexibility discourages creativity, which is often a trait which should be emphasized in management training. Such an architecture also means that the only data available for analysis are period to period macro or aggregate level parameters. No data is provided on the transactional level because batch simulations do not generate it.

The authors giving real examples of computerized continuously processed games are Chiesl (1990) and Gray (1995). Furthermore, we are going to introduce one real-time processed game emerging from the field of video gaming; Capitalism Plus.

Chiesl (1990) quests for realistic business episodes for university classrooms. He mentions that interactive computer terminals offer the possibility to construct dynamic simulations without a fixed time period or a specific number of required decisions. Chiesl calls this technique *interactive gaming*. Chiesl states that the present (this is in 1990) business games are time fixed format games and their decisions are based on a predetermined decision interval, for instance, quarterly or monthly reports. Especially, he states that marketing simulations are not realistic when decisions can only be implemented once a month and market data can only be retrieved or outputted once a month. This does not represent the working of today's dynamic business world. Chiesl asks for continuous data input and output when students want it, not when the game designers allow the students to input and output at some arbitrary discrete time format. Chiesl refers to this characteristic as verisimilitude. Thus, participants experience a business environment that has the appearance of being true and real. Chiesl describes his own computerized game construction, the Interactive Real Time Simulation. He argues that this simulation is interactive in two respects. First, when participants input decision variables (pricing, distribution, quality decisions) the computer terminals interact by instantly displaying the results (outputs) of their decisions to the participants and also by providing them with new and continuous market research information. Therefore, the participants are interacting with the simulation by sending and receiving information via the computer terminal. Secondly, the players interact with other participants. This means that the decisions made by the players have an influence on the results of the other players. Chiesl states that none of the literature, by 1990, concerns itself with simulations that would be interactive in both of these respects. Another difference to the majority of business games is that Chiesl's interactive simulation does not require a specific set of decisions to be input in each time period.

Gray (1995) describes a simulation game using a network of computers, allowing individual teams to enter decisions while reacting to those made by other teams. He calls this kind of gaming 'hot' gaming. According to Gray, the type of learning from this environment produced different kind of learning than other computer-based training types: the game illustrated contextual goals, connectedness, the 'here-and-now', cognitive modeling and social relationships. The participants do not interact only with each other but the simulation is another actor in the performance. This game – BUSGAM – runs for 60 to 80 decision periods, each at four- or five-minute intervals (thus being batch-processed, but producing a feeling of continuous flow of time). Gray finds that the direct, interactive, competitive environment with time progression generates higher participant motivation.

Capitalism is one of the business games on the video game side that comes closest to traditional educational business games. Capitalism (released 1995) and its successor Capitalism Plus (Enlight Software, 2003) are detailed financial simulations which have also been used in university settings. In these games you control a business from the ground up, trying to dominate all industries and make as much profit as possible. You choose from many types of businesses to delve into, including setting up department stores, factories, farms, mines, and oil wells. You are given an amount of capital to begin with, and the stock of your company is made public. Chown (2002) reviews the real-time processing multi-player method of Capitalism Plus: *Capitalism Plus runs "real-time", i.e. it uses continuous time where events tick by if you sit back and do nothing. If you wish you can freeze the game and issue new orders while the world waits, or you can crank the speed right up so that weeks just flash by. The problem with this system is that while it works fine in solo play, it makes the multiplayer game awkward – as you can't play with 2 PCs hooked up over a network real-time… the computer AI instead takes over a player while the opponent plays his/her turn (by default one year long). This obviously isn't ideal and can cause some problems. Direct head-to-head would* *be more fun, even if it meant running at a fixed game speed*. The multi-playing in Capitalism is supported by up to eleven players playing on one computer, or playing by email. The company that produces CAPITALISM (Enlight Software; http://www.enlight.com/) is developing a new version called MBA Capitalism aimed at serious business education. Despite promises this new version has not yet been published.

By the taxonomy of Thavikulwat, the artefact of this thesis is flexibly scaled, synchronized, and clock-driven. The construction Chiesl describes resembles the artefact of this thesis in that the company decisions and the results from the market are sent continuously between the companies and the market.

Continuous processing as a serious processing method will cause some changes in the way the business gaming literature discusses the gaming process. For example, the following statement by Graf and Kellogg (1990, p. 238) should be rephrased: *The number of times a decision must be made for a participant to develop an understanding of the phenomena is at the heart of the concept of iterations. ...iterations specifically focus on the number of decision phases and is not time bound as is duration*.

But why have continuous models not been constructed before? Patz (1990, p. 164) may give us one possible explanation: *Simulation purposes, for the most part, are decided by coding convenience rather than pedagogical, conceptual, or theoretical relevance*. Our own assumption for the lack of continuous business game constructions is the following. First, as can be understood from the comments of Patz, the construction of a real-time processed business game is a more laborious task than constructing a batch-processed game. Thus, it is very difficult to allocate enough human resources to such a development project.

Secondly, very often the developers of business games come from business economics, not from computer science or information systems. The alternative processing methods may not even occur to these business-oriented people. Furthermore, with just the basic skills in programming the batch-processing method is much easier to realize than real-time processing.

However, the situation should not be as gloomy as Merrill (1992) describes. He claims that instructional development is too cost intensive and that most of our instruction is stand-up presentation that everyone acknowledges as inadequate, irrelevant, and incomplete. He further claims that the existing cases of dynamic, effective, appealing, experiential environments, which everyone recognizes as significant improvements over our usual instructional experiences, are extremely expensive to develop and are thus out of reach for most learners. This should not be true today with the new rapid application development environments (see, for example, Winograd, 1995, who states that modern interactive programming environments emphasize quick turnaround).

4.2.5 Validity of Business Games

I don't know but I've been told…
Page, Plant and Jones [15](1971)

We will first specify the terms evaluation and validation. *Evaluation* [i]*s a decision about the significance, value, or quality of something based on a careful study of its good and bad features* (Collins Cobuild English language dictionary, 1987). In our work evaluation refers to the artefact's capability of facilitating participant business process perception. Evaluation is dealt with in Section 6.3 and in Papers 3 and 4, where we deal with learning through the use of the artefact.

In this chapter we deal with validation. *Validation*:

- Is [a] *test to determine whether an implemented system fulfills its specified requirements* (Dictionary of Computer Science, 1989).
- *…normally refers to a somewhat subjective assessment of likely suitability in the intended environment* (Dictionary of Computing, 1986).

In our work, validation refers to the correctness of the artefact processes compared to the real world processes. As a measure of validity we can assess the experienced company employee participants' views on the usefulness of the artefact in representing a holistic view of a manufacturing company's business processes, and also how useful the participants regarded the continuous nature of the artefact (Table 6.5 introduced later and participant opinions from the tailored Alpha case introduced in Paper 4).

In the early years of business gaming, much attitudinal research was conducted with the belief that positive attitudes were indicative of learning. But it seems that attitudes about the game, the course, and student feelings of self-worth are related more to game performance (Wolfe, 1990). In the field of simulation gaming the validation of games is divided into two separate areas: external and internal validation. External validity is determined by the game's degree of realism (Saint-Germain and Laveault, 1995). Players must use strategies similar to those they would use in real life. Game decisions and strategies must result in consequences on the success-failure feedback. External validity focuses on the transferability between the virtual activity and

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[15] Song *Black Dog* from *Led Zeppelin IV ('Untitled').*

reality while internal validity focuses on the coherence within the framework itself. Internal validity concerns procedural rules, game development, role play (Saint-Germain and Laveault, 1995).

Dickinson and Faria (1996) note that two approaches have been used to investigate *external validity*:

a) correlation between a business executive's simulation performance and his or her real-world performance,
b) a longitudinal research where a student's business game performance is compared to some measure of subsequent business career success.

Both of these methods raise some concerns in our mind. First, profit making in a game does not correspond to learning. Thus, should the validity aspect not be more concerned with whether the participants learn the right things? Secondly, those participants, who make the most mistakes, usually also learn the most. Thirdly, is success in real-world equal to a better understanding of business logic? We would like to argue that factors like individual character and gender play an important role in the real-world, but not necessarily in games.

Fourth, making the biggest profit sounds like quite a one-sided goal and research variable. Surely business organizations can succeed well in the light of some other values (like human wellbeing and committed employees) and short-term profit making may be secondary. This is in line with what Burgess (1999) notes: participant performance in business games is assessed by reference to the financial performance. Now, the implicit assumption underlying this stance is that good financial performance is a good measure of the participant's overall achievement, encompassing strategy formulation and implementation. Burgess (1999) refers to the management literature about the difficulty of ascertaining in practice a direct relationship between the two variables. This highlights the danger of assuming that good performance implies good strategy. Fifth, a formally excellent strategy may not necessarily lead to success in a game. In a truly interactive game, how a certain strategy works depends on the opponents' strategies. For example, if all the participants choose the same formally excellent strategy, probably none of the participants succeeds very well. Sixth, as Burns et al. (1990) note, there exists a false assumption which connects measures of performance and measures of learning in many studies. But performance indicants can imply learning when learning has not occurred.

Burns et al. (1990) further list fundamental difficulties in measuring learning:

- There is no baseline to determine whether or not the learner has already achieved the learning from some previous learning experience.

- The assessment of learning is subjective in that some minimum level of performance or change in performance must be specified as the point where learning has been demonstrated.
- Most tests of learning are custom-made and are never subjected to rigorous reliability and validity assessment.
- The measurement instrument must be properly matched to the type of learning involved.

The problems in this area become obvious when we read Wolfe and Roberts (1993). They note that only two "true" external validity studies have been conducted before 1993. The first one by Norris and Snyder[16] (referred to in Wolfe and Roberts, 1993) where the subjects (n= 100) completed a questionnaire five years after graduation and after having played a simple business game in student teams. The subjects' career success was measured by the number of promotions obtained, hierarchical proximity to the respondent's chief executive officer, and percentage of salary increases obtained. Game success was measured by variance between gaming ROI and career success. No relationship was found.

The second study Wolfe and Roberts (1993) refer to is their own (Wolfe and Roberts, 1986[17]). The subjects (n= 142) were placed in a single-member company within a fairly complex business game. Single members as observational subject were selected because the authors wanted to measure directly the outcomes obtained by the student in isolation. Game results were recorded by ROI, total earnings, and ROE. Participant career success was measured by salary levels, promotions and expressed career satisfaction. Weak but significant relationship was found between a player's ROI and salary, and the other variables. But other college-related career factors, such as the student's major and grade-point-average were more strongly related to salary improvements. The authors themselves noted that their study design did not consider the participants' group decision-making, leadership, or social skills.

The 1993 study from Wolfe and Roberts (1993) was an extension to their 1986 study. The game employed was the same and the data collected from the questionnaires was also the same. The players also rank-ordered their teammates' (group size was 4-5 persons) social and leadership dimensions. The participants returned a questionnaire semiannually for five years after graduation. The participants' performance in the business game team predicted with some degree of accuracy their future career success. Statistical significance was found but the authors themselves note that it could be

[16] Norris, D. R. and Snyder, C. A. (1980). External Validation of Simulation Games. Simulation & Games, Vol. 13, pp. 73-85.
[17] Wolfe, Joseph, and Roberts, C. R. (1986). The External Validity of a Business Management Game: A Five-Year Longitudinal Study. Simulation & Games, Vol. 17, pp. 45-59.

questioned whether the results were meaningful and predictive, as several potentially invalidating features should be considered: Different careers feature disparate salary levels, salary increases follow dissimilar patterns and various industries feature divergent salary levels. Five years is also a relatively short time for most careers to develop.

Regarding the results and constraints from the studies introduced, it is no wonder that similar studies have not been carried out since. Wolfe, together with two other researchers, has noted (Burns et al., 1990) that almost none of the results of an internally valid experiential learning effect study can be generalized because it is bound by sample constraints, course-specificity, institutional boundaries, or treatment idiosyncrasies. Thus, research on all types of learning is implicitly weak in external validity.

Dickinson and Faria (1996) note that *internal validity* has also been examined in two ways:

a) better students should outperform poorer students,
b) whether the participant decision in a simulation competition, over time, conforms to the environment of the simulation.

While the dynamics of the simulation and the actions of the competing companies will certainly influence participants' decisions, the simulated environment must also be considered and, ceteris paribus, participants' decisions should reflect or adapt to this environment. If this type of adaptive decision-making does occur, the simulation can be said to be internally valid.

Keys and Wolfe (1990) list a number of studies which found superior results for game-based groups versus case groups either in course grades, performance on concept examinations, or goal-setting exercises. They also note (p. 313) that it appears that the simulation's face validity is of paramount importance, as *others have begun to question the theoretical validity of the models employed in various simulations*.

The above discussion concerning simulation gaming validation represents the North-American stand to the subject. Paul et al. (1996) introduce a perspective which takes into account the human nature and real-world dynamism in their view of simulation modeling. First, in real-world situations problems are owned by interest groups. The definition of problems is influenced by the owners of the problems. This, Paul et al. state, is not usually explicitly acknowledged in simulation modeling. Second, because the real-world problems are complex, formulating them is difficult. Third, a dynamic logical model needs to be turned into a computer model with relative ease. If not and if the process takes a long time, contact with the real problem starts to diminish. We thus come to the following problem: since the real world is both complex and dynamic, total model confidence can never be realized, since no computer-based simulation model can be either truly verified, or validated, against the real world. Also the simulation models are quantitative by nature. But it is extremely difficult to model subjective factors, which may still have an impact on the problem. Paul et al. come to the following conclusion: *The role of computer-based simulation modeling is in helping to provide an understanding of the problem rather than finding the right answer*.

Gosenpud (1990) describes the problematic area illustratively: The learner often learns things not intended by the designer, and often this unintended learning is more valuable because it is relevant to the learner. Evaluation, defined by the designer, may miss the real worth of the experiential experience because *what is valuable for the learner is defined by the learner and may have nothing to do with the designer's intention*. In addition, in experiential learning intended outcomes are often vague since the focus of learning is usually on very complex, abstract phenomena. If specifying the outcomes is difficult, then instead of trying to predefine what participants have learned, participants should simply be asked what they have obtained from a given experience. Gosenpud himself notes that this suggestion runs counter to some common wisdom in the field: Most researchers stress the importance of keeping dependent measures concrete and specific and measuring dependent variables as precisely consistent with designer goals as possible. Gosenpud suggests that instead of studying "Is a teaching method effective or not?" the researchers should study "What makes a given teaching method effective?".

Gosenpud (1990) further argues that some learners learn better with one teaching method than with another. Or, a given teaching method is effective for one type of learningtask but not for another. Factors influencing the effectiveness of the method include instructional goals, course content, instructor characteristics, learner characteristics, organizational support for the instructional method, and instructor-learner compability.

Validity in the positivist tradition means that the rules of correspondence of a particular game with its reference system – usually a particular company operating in a particular market – are well defined and fully estimated, according to the objective criteria of truth. This is not a realistic aim to achieve with an artefact such as the one described in this thesis. The term *validity* is sensitive to its context of use. Thus, the term *validation* should be used for the positivist epistemology, and *verification* for the normative approach. Verification allows qualitative judgment on concepts and their use, it results from negotiating the meaning of the artefact for practical use by those involved. It is context dependent and open for debate. Verification is inter-subjective. Validity aims at universal truth, which for good reasons is beyond the scope of the artefact of this thesis. For these reasons we prefer to use the term verification instead of validation from this point forward.

5 LEARNING THEORIES RELEVANT FOR THE ARTEFACT DESIGN AND UTILIZATION

Yet, taking in information is only distantly related to real learning.
Senge (1990)

A thorough assessment and evaluation of the ability of our artefact to facilitate learning is beyond the scope of this thesis. Debriefing and assessment in the form of evaluation and follow up studies will take place in the next phase of our work. This next phase of the study should deal with questions like "How do participants construct and test knowledge during a session from the flow of data and information available?" However, in this chapter we will discuss learning theories or views of learning that are relevant to computer based learning environments, as a motivation for possible future research contributions.

Klabbers (2003) has noted that studying interactive learning through gaming and simulation is productive only if a suitable epistemology is available to connect learning through a specific game with learning through gaming. But, (p. 260): *A comprehensive theory about learning and knowing through gaming and simulation is not yet available due to competing epistemologies.* Furthermore, the community of gamers seems to be more interested in the instrumentality of games (methods and techniques of game design and use) (Klabbers, 2003). Naturally this complicates our effort of discussing relevant learning theories. It is only with a clear hypothesis about the process of learning that one is able to choose an adequate research design to evaluate learning effectiveness properly and to draw meaningful conclusions (Herz and Merz, 1998).

The field of different educational and learning theories and paradigms is often confusing. Whether different views on learning are considered to be closely related or even the same depends on the reviewer. For example, the line between experiential learning and organizational learning is blurred. To take one example, Holmqvist (2000) in his dissertation does not draw a line between the two but seemingly without problems puts these theories together[18]. Furthermore, experiential learning and constructivism build on the thoughts of the very same authors (Dewey, Lewin, Piaget; see Kolb, 1984; Mirvis, 1996) when developing their views of learning, thus making these views on learning look quite similar in many respects.

We start by introducing experiential learning theory which has long been the inspiration for building computer based learning environments. Also organizational learning literature embodies support for game-based learning. This support comes especially from Senge and his view of systems thinking. The third view on learning introduced is constructivism which is the most recent of the views and especially applicable in the field of computer based learning.

5.1 Experiential Learning

The fact that people do learn through experience is beyond challenge.
Cheetham and Chivers (2001)

Educational games and simulations are experiential exercises (Gredler, 1996). Experiential learning theory is one of the most influential theories of management learning. In professional education literature, virtually nothing has been said about experiential learning theory, which prevails in industrial settings (Ekpenyong, 1999; industrial settings probably meaning business organizations). For example, the massive *Handbook of Research for Educational Communications and Technology* (Jonassen, 1996) with its 1,265 pages does not use the term experiential learning at all and does not in its independent 42 chapters once refer to Kolb's (1984) *Experiential Learning,* the central work in the field. Ekpenyong (1999) finds two reasons for the neglect of experiential learning in professional education literature: (1) The lack of a formal theory of experiential learning; and (2) The dominance of experiential learning in industrial and non-school settings.

Experiential learning theory points to the significance of learning through direct experience as opposed to learning through 'instruction'. According to experiential learning theory, the most powerful learning comes from direct experience – through action taking and seeing the consequences of that action.

[18] As an example of the freedom of creating different concepts and ways of thinking in the field, Holmqvist (2000) defines experiential learning of organizations [!] as follows (p. 35): *experiential learning is the social production of organizational rules which leads to stabilising or changing organisational behaviour*. This definition places experiential learning under organizational learning. Holmqvist further claims that his definition is similar to Argyris and Schön's single-loop and double-loop learning (these concepts introduced in Section 5.2), simplifying the concepts even more.

Learning is said to occur through the resolution of conflicts over different ways of dealing with the world. It suggests a holistic integrative perspective on learning that combines experience, perception, cognition, and behavior (Kolb, 1984). Experiential learning relates specifically to the development of adults (Cheetham and Chivers, 2001). There are several different models of experiential learning which all have in common the belief in experience and reflection on it. Thus, there is not a single theory of experiential learning but a range of related concepts and models of learning (Cheetham and Chivers, 2001).

Although John Dewey (1859-1952) is recognized as one of the major contributors in experiential learning, he did not address how the scientific method in learning was to be operationalized. It was not until the early 1970's that Kolb[19] addressed this problem (Ekpenyong, 1999).

Kolb (1984) describes an experiential learning model he calls the Lewinian model which is (p. 21): *an integrated process that begins with here-and-now experience followed by collection of data and observations about that experience. The data are then analyzed and conclusions of this analysis fed back to the actors in the experience for their use in the modification of their behavior and choice of new experiences*. Thus, in this model learning is conceived as a four-stage cycle shown in Figure 5.1. Immediate concrete experience is the basis for observation and reflection. Observations are assimilated into a theory from which new implications for action can be deduced. Implications or hypotheses then serve as guides in acting to create new experiences.

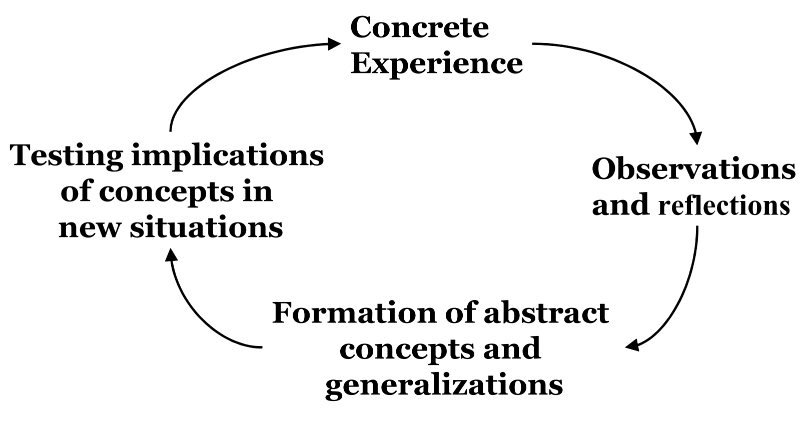


Figure 5.1: The Lewinian experiential learning model (Kolb, 1984).

[19] Kolb, D. A., Rubin, I., and McIntyre, J. (1979). Organizational Psychology: An Experiential Approach. Prentice-Hall.

Kolb especially notes two aspects of this learning model. The first is the emphasis on *here-and-now concrete experience* to validate and test abstract concepts. Kolb argues that immediate personal experience is the focal point for learning. This experience gives life, texture, and subjective personal meaning to abstract concepts and at the same time provides a concrete, publicly shared reference point for testing the implications and validity of ideas created during the learning process. Thus, human beings can share the experience fully, concretely, and abstractly.

The second emphasized aspect of this learning model is that laboratory[20] training is based on *feedback processes*. The information feedback provides the basis for a continuous process of goal-directed action and evaluation of the consequences of that action. Lewin believed that much of organizational ineffectiveness resulted from an imbalance between observation and action (Kolb, 1984). The laboratory method integrates observation and action into an effective, goal-directed learning process. The four-stage cycle of experiential learning is very similar to the organizational structure of typical simulation games (Herz and Merz, 1998).

Experiential learning does not require that learners should be consciously aware of their own specific learning needs. It can be argued that it is often not until some time after the initial learning process, and perhaps a period of reflection, that learners are able to recognize the things that were important for them to learn (Cheetham and Chivers, 2001).

Kolb (1984) also represents two other models of experiential learning, the model by Dewey and Piaget's model of learning and cognitive development. Especially Dewey's[21] model is remarkably similar to that of Lewin, including phases of:

1) observation of the surrounding conditions;
2) knowledge of what has happened in similar situations in the past;
3) judgment which puts together what is observed and what is recalled to see what they signify.

This process is similar to the Lewinian model in the emphasis on learning as a dialectic process integrating experience and concepts, observations, and action (Kolb, 1984).

Kolb (1984, pp. 25-38) combines the different views and lists the propositions of experiential learning:

- Learning is best conceived as a process, not in terms of outcomes
- Learning is a continuous process grounded in experience

[20] Word 'laboratory' comes from the foundational work of Kurt Lewin and the learning arrangements he used in the 1940's. Kolb, 1984.

[21] Dewey, John (1938). Experience and Education. Kappa Delta Pi.

- The process of learning requires the resolution of conflicts between dialectically opposed modes of adaptation to the world.
- Learning is an holistic process of adaptation to the world.
- Learning involves transactions between the person and the environment.
- Learning is the process of creating knowledge.

Also Argyris and Schön (1978) have described the process of experiential learning in slightly different terms. In their model the process moves from discovery of problems, to invention of solutions, to production of solutions in action, to reflection on the impact of these actions, and then back to discovery (Figure 5.2).

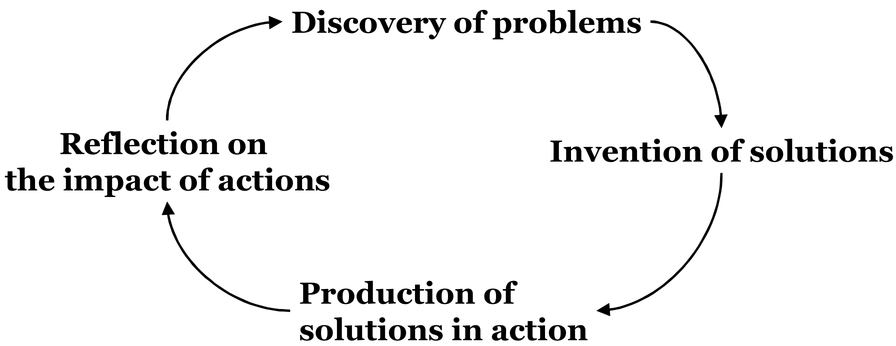


Figure 5.2: Learning cycle by Argyris and Schön (1978).

Ekpenyong (1999) examines several experiential learning strategies and defines experiential learning as (p. 462) …meaningful learning or problem-solving, which involves purposeful behaviour with an anticipation of the probable consequence of such behaviour.

Another technique within the experiential learning genre is action learning. Action learning is often used as a synonym for experiential learning (Zuber-Skerritt, 2002). It is a procedure in which a group, or “action learning set”, tackles a work-based problem, in stages, with intermediate periods of analysis and reflection upon what has been learned. Within this process, learning is considered to be just as important as solving the problem (Cheetham and Chivers, 2001).

At this point of discussion it is difficult to make a clear distinction between experiential learning and organizational learning. These two concepts seem to merge into each other. For example, the following models obviously describe experience based learning models, but have quite clear connections to the ideas of organizational learning (some of the authors themselves are recognized well in the field of organizational learning).

Isaacs and Senge (1992) redraw the Argyris and Schön cycle as it might operate in management situations (Figure 5.3). Isaacs and Senge argue that if this learning cycle operated effectively, new insights about the real world would be continually discovered and embedded in improved mental models. Decisions would be invented based on new mental models, those decisions would be enacted and then the outcomes would be reflected upon to produce new insights.

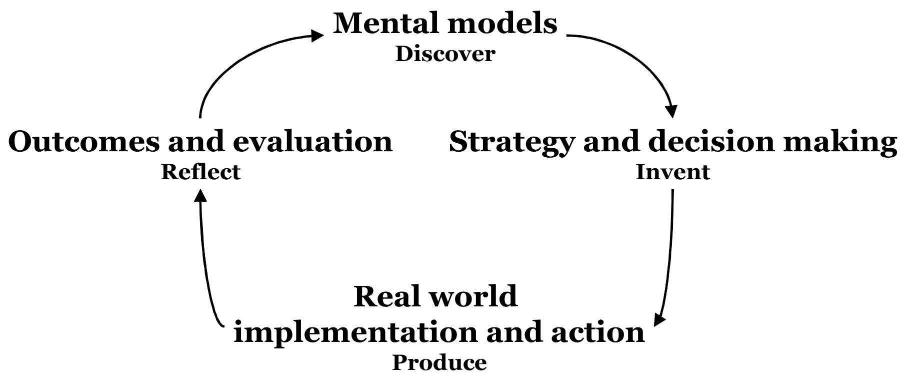


Figure 5.3: The learning cycle in management situations by Isaacs and Senge (1992).

The term mental model means the conceptual model that each member of the management team carries in his or her head to explain the way the business operates (Morecroft, 1992b). A mental model can be described as a network of facts and concepts. The structure and content of a given network contains our understanding of social and physical phenomena. The longer we think about a certain topic, the more facts and concepts we remember, and the more complex the network becomes. Thus, it is useful to think of mental models as a dynamic pattern of connections comprising a core network of familiar facts and concepts. Furthermore, mental models include a vast matrix of potential connections that are stimulated by thinking and by the flow of conversation. Morecroft (1992b) states that people may carry around quite different mental models of the business. These varied models enter the debate and determine the quality of action plans. Mental models are involved in the recognition of strategic issues or environmental scanning, and they shape executive debate and dialogue. The quality of action plans depends on both the adequacy of mental models (how well they mimic reality) and the use of the participants' knowledge and mental models (whether the participants are truly engaged in the debate). Morecroft (1992b) argues that:

- to be effective, models must become an integral part of debate and dialogue,
- models should help to activate and capture knowledge and improve communication between members of the organization, and

- models should allow people to experiment with their knowledge in order to improve their mental models, and thereby learn.

Isaacs and Senge (1992) have further discussed the problems mentioned by Senge (1990). They mention that the designers of computer based learning environments argue that the ideal learning cycle fails to operate effectively in organizations because of limits at each point in the cycle:

- Decision-makers have diverse and typically tacit mental models, making the development of strategies a process of negotiation among competing recommendations, not a rational comparison and testing of alternative assumptions.
- Delays between when decisions are made and their impact may be very long, often many years for strategic decisions.
- Additional delays between action and perceived consequences arise because of the time needed to collect, disseminate and interpret data.
- Actions taken in one area may have significant effects in distant parts of the system, but these effects may be obscure to the original actors. Thus, decision-makers cannot see the consequences of their decisions.
- Differences in mental models held by decision-makers can lead to widely different interpretations of available data. Furthermore, the sources of the data may be rarely investigated and tested.
- Environmental factors, such as uncontrollable and unanticipated changes in markets, economic conditions, or competitor actions inevitably alter the impact of decisions. This is especially true over the long time spans relevant to organizational actions. Isaacs and Senge call these factors the Confounding factors.

These limits affecting the ideal learning cycle are embedded to the cycle in Figure 5.4.

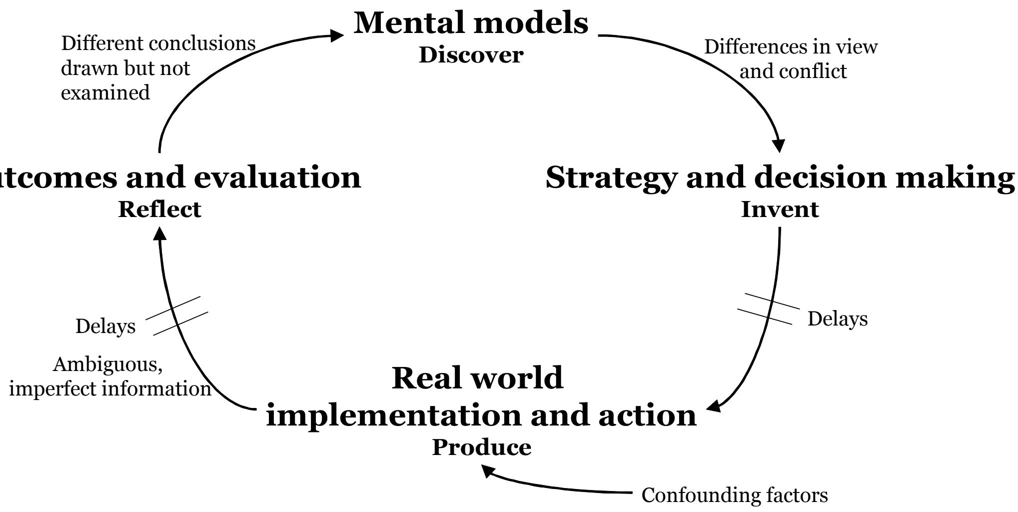


Figure 5.4: The obstacles and breakdown of the ideal learning cycle in managerial CBLE learning (Isaacs and Senge, 1992).

Senge (1990) notes that what makes things problematic in real world is that the most critical decisions have system wide consequences that stretch over years or decades. This is closely related to the organizational tradition of attempting to surmount the difficulty of coping with the breadth of impact from decisions by breaking problematic issues up into components. According to Senge, the result is that the analysis of the most important problems in companies – the complex issues that cross functional lines – becomes a perilous or nonexistent exercise. This is very similar to what Spiro et al. (1991) find: learning a complex concept from erratic exposures to complex instances, with long periods of time separating each encounter, as in natural learning from experience, is not very efficient.

Recent ‘chaotic’ or time-sensitive insights provided by general system theory have suggested some problems in Kolb’s original model. First, it assumes a linear learning process without any layers, lapses or jumps. Second, it supposes a free exchange between the learning system and the environment. Third, it suggests that this exchange also follows a linear, thus predictable course (van Mens-Verhulst, 1996).

Another issue that also has to be taken into account is that there appears to be considerable evidence that different people learn in different ways and this presents a challenge to anyone seeking to offer general advice on learning design (Cheetham and Chivers, 2001). How people prefer to learn is their learning style preference. Differences in learning styles are a result of such things as past life experiences, genetic make-up, life and educational experiences, and the demands of the present environment (Kolb, 1984). Zapalska and Dabb (2002) note that students who prefer – and benefit from – learning on technologically based courses are different from those who prefer more traditional courses. Students interested in technology-based courses are independent learners who prefer a more abstract way of thinking (Cohen, 1997). Cohen's results obtained from studies of technology-rich learning environments suggest that especially gifted students desire opportunities to use computers as cognitive tools that explore deeper connections in a subject rather than merely using the technology as a vehicle to produce "glitzy" presentations without much depth.

Kolb's model has been the target of much criticism because of its potential theoretical limitations. According to this criticism Kolb's model provides only a limited account of the many factors that influence learning, e.g. that individual experience comes at the expense of social and institutional aspects of learning (Kayes, 2002). On the other hand, Kayes criticizes the critique by stating that the critiques of experiential learning often distill the model into a simple formula, risking replacing the broad and diverse tradition of management learning with alternatives that are 'intoxicatingly' simple. Cheetham and Chivers (2001) note that the proposition that learning through experience takes the form of a neat cycle is also open to challenge. Learning seems likely to be a more complicated and multifaceted process. Thus, learning is more fragmented, and often more chaotic, than the cycles suggest.

Critiques of experiential learning fail to preserve its two fundamental assumptions (Kayes, 2002): (a) the inherent potential of human beings to learn, and (b) the belief that learning lies in problem solving. The critique amounts to privileging one aspect of learning over another and thus selectively devaluating the holistic nature of learning. Kayes suggests that an alternative approach should preserve the dialectic nature of experience and account for its social aspect more fully. Kolb's model also looks at learning primarily from the individual's point of view, which is not sufficient to explain learning within the organizational context. However, while the formulaic way in which Kolb has been interpreted may not represent reality accurately, his theory provides those who wish to be more learner-centered with a starting point for thinking about their practice (Marsick and Watkins, 1990).

5.2 Organizational Learning and Some Related Concepts

The development of organizational learning has gained influences over a long period of time from a vast amount of scholars, starting from Dewey and Lewin (for an introduction to the foundations of organizational learning, see Mirvis, 1996). The first integrated theory of organizational theory was presented by Argyris and Schön (Nonaka, 1994; Mirvis, 1996). Argyris and Schön (1978) state that organizational learning occurs when individuals within an organization experience a problematic situation and inquire into it on behalf of the organization. These individuals experience a surprising mismatch between expected and actual results of action. They respond to that mismatch through a process of thought and further action that leads them to modify their images of organization or their understandings of organizational phenomena and to restructure their activities so as to bring outcomes and expectations into line, thereby changing organizational theory-in-use.

Marsick and Watkins (1990) note that when organizations learn, individuals become agents who in some way influence the way the others in the organization think, act, and learn. According to them, organizational learning might be defined as the organization's capacity to create, diffuse, and use knowledge in response to non-routine events. Organizational learning involves both maintenance and transformative processes – learning must occur at both levels. Marsick and Watkins further note that there has been little empirical research on organizational learning because the concept is more easily grasped as a metaphor than reality.

The central terms in Argyris and Schön's vocabulary are single- and double-loop learning (Argyris and Schön, 1996; Argyris, 1991, 1995). *Single-loop learning* is instrumental learning that changes strategies of action or assumptions underlying strategies in ways that leave the values of a theory of action unchanged. In such learning a single feedback loop connects a detected error to organizational values and norms. *Double-loop learning* results in a change in the values of theory-in-use, as well as in its strategies and assumptions. The double loop refers to the two feedback loops that connect the observed effects of action with strategies and values served by strategies. When Argyris and Schön discuss a theory-in-use/values, the content of the terminology is similar to mental models discussed in Section 5.1. These two modes of inquiry are regularly carried out in organizations in the form of detection and correction of error.

Single-loop learning is sufficient when error correction can proceed by changing strategies and assumptions within a constant framework of values and norms. It is instrumental and concerned primarily with effectiveness. In some cases, however, the correction of error requires inquiry through which organizational values and norms themselves are modified (Argyris and Schön, 1996).

Argyris (1993, p. 2) has named double-loop learning as *genuine organizational learning*. Organizations learn when individuals learn and *act* as instruments of the organization; individuals learn on behalf of the organization (Argyris and Schön, 1996). Illustratively, some sources call Argyris and Schön's work action science (Marsick and Watkins, 1990).

Morgan (1997) has explained the role of single- and double-loop learning in organizations. Budgets and other management controls often maintain single-loop learning by monitoring expenditures, sales, profits, and other indications of performance to ensure that organizational activities remain within established limits. Double-loop learning depends on organizational members skilled in understanding the paradigms, metaphors, mind-sets, or mental models that underpin how the organization operates.

The practice of double-loop learning has become well established at a strategic level in organizations (Morgan, 1997). But the real challenge is to ensure that the strategic and operational dimensions are in synchrony, and this is where problems often arise. Strategic development may run ahead of organizational reality because of the tendency for current operations to get caught in patterns of single-loop learning. Organizations have to recognize that genuine learning is usually action based and thus must find ways of helping to create experiments and probes so that they learn through doing in a productive way. Morgan further defines that a top down approach to management, especially one focusing on control through clearly defined targets, encourages single-loop learning but discourages the double-loop thinking that is so important for an organization to evolve.

A central work in the field of organizational learning has been Senge’s *The Fifth Discipline* (Senge, 1990). Senge's aim of changing the way we think resembles largely the concept of double-loop learning. Senge notes that the central message in *The Fifth Discipline* is that our organizations work the way they work, ultimately, because of how we think and how we interact. Only by changing how we think can we change deeply embedded policies and practices. Only by changing how we interact can shared visions, shared understandings, and new capacities for coordinated action be established. Senge thinks that this kind of change is more radical than ‘radical organization redesigns’.

Redesigning mental models is different from re-engineering business processes. As Senge puts it, we do not have mental models, we are our mental models. Learning that challenges mental models is immensely challenging and it can occur only within a community of learners. Furthermore, ultimately change is limited unless people have new ways of understanding their practical business issues – not just better ways to interact. Also, if people cannot express their assumptions explicitly in ways that others can understand and build upon, there can be no larger process of testing those assumptions and building public knowledge. (Another thing is that even highly intelligent individuals often – when facing failures in their single-loop learning strategies – become defensive and put the blame on everyone but themselves; see the discussion from, for example, Argyris, 1991).

Senge (1990) proposes five principles of learning organizations:

1) Systems thinking (the fifth discipline, which integrates the other disciplines);
2) Personal mastery;
3) Mental models;
4) Building shared vision; and
5) Team learning.

Senge (1990) mentions that in order to understand problems in organizations we have to look in to the underlying structures which shape individual actions and create the conditions where events become likely. The systemic structure here is concerned with the key interrelationships that influence behavior over time. The systemic structure does not mean interrelationships between people but, e.g., swings in orders and inventories, delays intervening between different stages in a supply chain, the limited information available at each stage in the system, goals, costs, perceptions, and fears that influence an individual's behaviour. Individuals are part of the system because they have the power to alter the structures within which they are operating.

Panagiotidis and Edwards (2001) state that within Senge's framework the social world is not made up of 'hard', objectively identifiable business systems and business problematic areas, but it is made up of systems and problematic areas that exist in the mind of the observer. Further, in a political organization (like any business organization) the systems paradigm should deal with the relationship between power and organizational ideology at the level of the organization's purpose in order for organizational learning to take place.

One of the fundamental arguments of Senge (1999) is that people do not usually see the structures at play much at all. Rather, people just find themselves feeling compelled to act in certain ways. This is something that justifies the use of dynamic models like business games: in games the players are part of a larger system that most perceive only dimly.

Senge (1990) describes the systems perspective with the following diagram (Figure 5.5), which shows that there are multiple levels of explanation in any complex situation. *Event explanations* doom their holders to a reactive stance. Senge claims that event explanations are the most common in contemporary culture, and this is why reactive management prevails. *Pattern of behavior explanations* focus on seeing longer-term trends and assessing their implications. These explanations begin to break the grip of short-term reactiveness. They suggest that it is – over a longer term – possible to respond to shifting trends.

The structural explanation is the least common and most powerful. It focuses on answering questions like "What causes the patterns of behavior?"

Structural explanations are important because they address the underlying causes of behavior at a level within which the patterns of behavior can be changed. A structure produces behavior and changing the structure can produce different patterns of behavior. This produces generative learning: as we understand the structures that cause the behavior, we see more clearly our power to change that behavior, to adopt policies that work in the larger system.

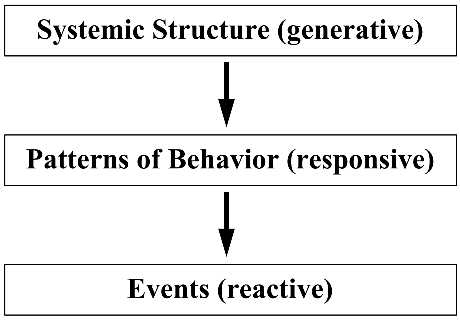


Figure 5.5: Multiple levels of explanation in a complex situation (Senge, 1990).

This model of levels of explanation has some similarities with our aim of representing different decision-making levels with the artefact of this thesis. The operational level equals to events. The longer the time span, the more able we are to understand the patterns of causal relationships. But to be able to understand the generative systemic structure, the reactive, operational level has to be understood first.

Lähteenmäki et al. (2001) argue that no successful attempts to create a holistic model of organizational learning have been accomplished, although the elements for its construction should already be in existence. The most prominent models to conceptualize organizational learning seem to be the division between single-loop and double-loop learning (Argyris and Schön, 1978) and the division between adaptive and generative learning (Senge, 1990). Lähteenmäki et al. note that although both Argyris and Senge aspire to explain organizational learning, they concentrate on the learning of individual members in the organization and almost totally neglect the idea of an organization as a learner itself. However, Lähteenmäki et al. (2001) do not mention the model by Kim (1993), representing a framework which integrates several of the learning concepts introduced here: experiential learning, single- and double-loop learning and system thinking (discussed later in this section).

Kim (1993) builds a theory about the process through which individual learning advances organizational learning. He starts by arguing that organizations ultimately learn via their individual members. The transfer mechanism between individual and organizational learning is at the heart of organizational learning. Kim starts his reasoning by introducing the OADI cycle (Observe, Assess, Design, Implement) of experiential learning, which – according to him – best accommodates *operational* and *conceptual learning*. Compared to Kolb's (1984) cycle this cycle includes terms with *clearer connections to activities conducted in an organizational context* (p. 38). In the OADI cycle (Figure 5.6, the *Individual Learning* box) people experience concrete events, actively observe what is happening, assess their experience by reflecting on their observations and then design or construct an abstract concept. People test the design by implementing it in the concrete world, leading to a new cycle. Operational learning represents learning at a procedural level, where one learns the steps in order to complete a particular task (know-how). Operational learning accumulates and changes routines, but routines also affect the operational learning process. Conceptual learning is concerned with why things are done in the first place, sometimes challenging the nature of prevailing conceptions and leading to new frameworks in the mental model (know-why).

For Kim (1993) the OADI cycle is incomplete as it *does not explicitly address the role of memory, which plays a critical role in linking individual and organizational learning* (p. 39). Integrating the role of memory requires an explicit distinction between conceptual and operational learning. This is why Kim adds mental models to the OADI learning cycle (Figure 5.6, *Individual Learning* + *Individual Mental Models*). Mental models represent a person's view of the world, including explicit and implicit understandings. Mental models determine how stored information is relevant to a given situation.

Organizational learning, then, is tremendously more complex and dynamic than a mere magnification of individual learning. The meaning of the term learning remains essentially the same but the learning *process* is fundamentally different at the organizational level. An organization learns through its individuals and is affected either directly or indirectly by individual learning – through a set of shared models (Argyris and Schön, 1978). Here Kim (1993) states that various theories of organizational learning have been based on theories of individual learning. However, if a distinction between these two is not made explicit, a model of organizational learning will become a simplistic extension of individual learning. Kim now proposes the OADI-SMM model (Figure 5.6; SMM: *Shared Mental Models*) which addresses the issue of the transfer of learning through the exchange of individual learning and shared mental models. Analogous to individual learning, organizational learning is defined as *increasing an organization's capacity to take effective action* (p. 43). The cycles of individual learning affect learning at the organizational level through their influence on the organization's shared mental models. The parts of an organization's memory that are relevant to organizational learning – individual and shared mental models – may be explicit or implicit, tacit or widely recognized, but they have the capacity to affect the way an individual or organization views the world and takes action. *Organizational learning is dependent on individuals improving their mental models; making those mental models explicit is crucial to developing new shared mental models* (p. 44). However, this process allows organizational learning to be independent of any specific individual.

Individual frameworks become embedded in the organization's *weltanschauung* (Kim, 1993). The organization's view of the world slowly evolves to encompass the current thinking of its members. Individual routines that are proved to be sound over time become standard operating procedures. The weltanschauung is a reflection of the organization's culture, deep-rooted assumptions, artefacts, and behavior rules. In the OADI-SMM model organizational double-loop learning occurs when individual mental models become incorporated into the organization through shared mental models, which can then affect organizational action. The whole OADI-SMM model is required to represent organizational learning.

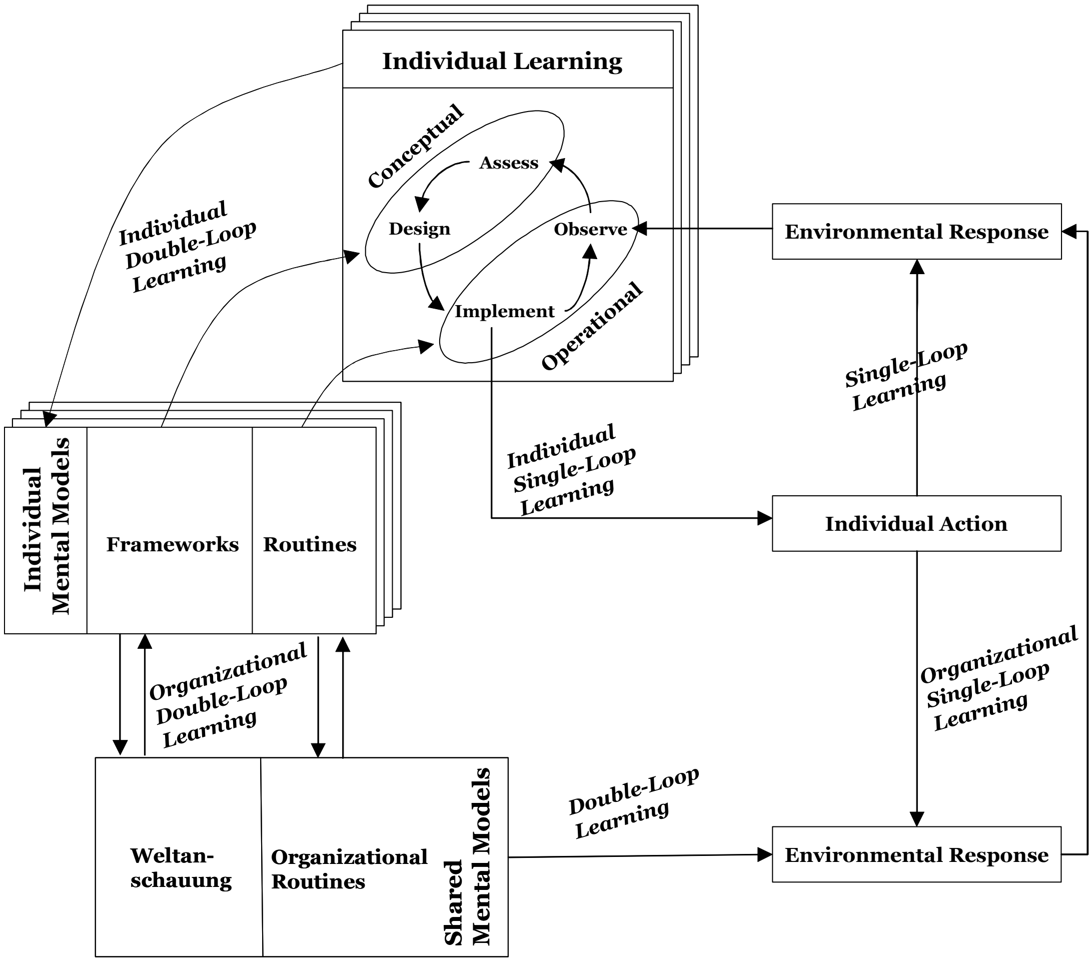


Figure 5.6: Kim's (1993) integrated model of organizational learning (the OADI-SMM model: Observe, Assess, Design, Implement – Shared Mental Models).

For Kim (1993), individual mental models play a pivotal role. If what matters is not reality but perceptions of reality, then fundamental to learning is a shared mental model. But mental models are a mixture of what is learned explicitly and absorbed implicitly. This is why it is difficult to articulate them and share them with others. Making mental models explicit requires a language or tool with which to capture and communicate them. Kim argues that most efforts at mapping mental models result in static representations of phenomena which are usually highly dynamic and non-linear. Thus, new tools, such as microworlds or learning laboratories (Senge, 1990), are required. They should be able to address the problem of incomplete learning cycles. The spirit of the learning laboratory is one of active experimentation and inquiry where everyone participates in surfacing and testing each others' mental models. The use and successive iterations of a learning laboratory are expected to affect the organization's shared mental models through changes in its *weltanschauung* and also, of course, standard operating procedures. Our aim at building the artefact of this thesis has been to advance conceptual learning, which helps explicate know-why, offering guidelines for operationalizing know-how.

Robey et al. (2000, p. 130) define organizational learning as *an organizational process, both intentional and unintentional, enabling the acquisition of, access to, and revision of organizational memory, thereby providing direction to organizational action*. Several viewpoints support Kim's framework. First, Robey et al. state that organizational view organizational learning as an *organizational* process to distinguish it from learning that might occur, for example, at individual level. Second, organizational learning is as a *process*, not a configuration of structural components. Third, organizational learning is considered to be both *intentional* and *unintentional*. Fourth, their definition gives a central role to *organizational memory*, which implies that knowledge can be stored both in human and artefact repositories. Organizational memory includes shared understandings of an organization's identity, the mental models that represent the organization's theories-in-use, and both cognitive and behavioral routines. Finally, they consider the organizational learning process to be undertaken to guide *organizational action*. All these are in line with the assumptions in Kim's framework. For us it seems that Kim has been able to successfully create a framework that can be utilized when considering the possible role of learning environments in organizational learning.

As Lähteenmäki et al. (2001) note, most of the models of organizational learning are based on few interviews, insights and discussions with managers in client companies, and usually the origin of the models is not present. This applies also to Kim's (1993) work. Kim himself states (p. 49): *...my discussion is more a set of assertions based on anecdotal evidence and preliminary research than a set of facts that has been supported by extensive longitudinal studies and rigorous research*. Thus, further work is needed for a better understanding of the role of mental models in individual and organizational learning, and the methods with which to capture the understanding of dynamic complexity. Kim's work is of particular interest to us because it states the role and position of computer-based learning environments within the context of organizational learning. And as Järvinen (2001b, p. 215) states, [w]*e must organize a competition between different frameworks on organizational learning and select the one that best corresponds to the domain under consideration*.

Paul et al. (1996) note that if a simulation model is developed which can be discussed and refined by stakeholders, this process of refining is effectively a negotiation. It allows stakeholders to impose their perspectives on the model, gain insight into the perspectives of other stakeholders, and work towards a common compromise: a negotiated mental model. Thus, the effectiveness of computer-based simulation models rests on their use as ‘dynamic intermediaries’ to facilitate understanding between stakeholders. A computer-based simulation model is explicitly a tool to enable the understanding of a problem situation to develop, to be discussed, and to be refined toward a solution.

Before moving further, we want to present what kind of form the concrete learning activities should take. Marsick and Watkins (1990, p. 245-246) give recommendations for building learning modules around experience modules (their term for this is action learning). People should work on projects that are real, preferably in teams in an environment outside their immediate work group so that they can question taken-for-granted norms and protocols, and so they are not constrained by habitual status, power, or other interpersonal patterns. There are three main components to action learning: a project (experience), seminars in which participants reflect on both content (the problem) and process (learning skills), and back-home experience. All three segments run parallel: the participants and the facilitator build linkages among them since the problems encountered in training or real life are often the same. Learning is a long-term developmental process, not as “sexy” as many of the one-minute solutions available in the management training market. Learning requires that some portions of the formal classroom activity be devoted to reflection in groups on the experience so that lessons can be drawn that are more generic than the specific project. This also requires trainers to reexamine their beliefs about learning because they must act as learning consultants, not classroom delivery specialists.

5.2.1 Systems Thinking

Reality is made up of circles but we see straight lines.
Senge (1990)

Virkkunen and Kuutti (2000) state that in many cases problem identification and problem solving can be hampered because the actors do not recognize the systemic and collective nature of their problems and try to manage situations by individual solutions. Furthermore, the unit of analysis in organizational learning has to be systemic because it has to help us to analyze the interrelations between the different aspects of an activity.

Living systems have integrity. Their character depends on the whole. The same is true for organizations; to understand the most challenging managerial issues requires seeing the whole system that generates the issue (Senge, 1990). Virkkunen and Kuutti (2000) claim that organizational learning is a multi-faceted and multi-phased phenomenon, a complex interplay between different elements of a system. It means that organizational learning cannot be studied by reducing the scope to one or another element. A minimal meaningful system as a whole should be taken as the unit of analysis and intervention.

However, people are taught to break problems apart, to make complex tasks and subjects more manageable. After this we can no longer see the consequences of our actions. We lose our intrinsic sense of connection to a larger whole (Senge, 1990). Another reason supporting holistic models is that when people in organizations only focus on their position, they have little sense of responsibility for the results produced when all positions interact (Senge, 1990). And when people only focus on their position, they do not see how their actions extend beyond the boundary of their position. When these actions have consequences that come back to hurt them, they misperceive these new problems as externally caused.

For Senge (1990) the foundation for organizational learning is systems thinking. By systems thinking he means a discipline of seeing wholes. Thus, systems thinking is a framework for seeing interrelationships rather than separate things, for seeing patterns of change rather than static snapshots. Systems thinking has its roots in cybernetics and engineering. During the last forty years systems thinking tools have been applied to understanding corporate, urban, regional, economic, political, ecological, and physiological systems.

Jackson (1997) notes that systems thinking has had two paradigms. The first one – the 'hard' systems orthodoxy – lasted from the time of the Second World War up until the 1970's. Operational research, systems analysis and systems engineering are examples of these hard approaches. The dominant paradigm guiding the activity of systems thinkers went unchallenged and facilitated a practice of 'normal science'. The paradigm was based upon positivism and functionalism. Typical methodology brought success over a relatively narrow range of management problems: allocation, inventory, replacement, queuing, sequencing, routing, and so on (Jackson, 1997).

In the 1970's the confidence in the methodology began to wane as the researchers started to tackle more complex problem situations with strong behavioral and social aspects. Systems thinking was unable to cope with multiple perceptions of reality and to handle extreme complexity. However, during the late 1970's and 1980's, soft systems thinking and critical systems thinking were successful in establishing themselves as important currents in the systems tradition (Jackson, 1997).

What makes systems thinking even more important today is the increasing complexity of our world. Senge (1990) divides complexity into two types: detail complexity (e.g., many variables included in a decision situation) and dynamic complexity (situations where cause and effect are subtle, and where the effects of interventions over time are not obvious). Dynamic complexity can be found in situations where the same action has dramatically different effects in the short run and the long run. Senge mentions that the real leverage (that actions and changes in structures lead to significant, enduring improvements) in most management situations lies in understanding dynamic complexity, not detail complexity. Examples of dynamic complexity mentioned are balancing market growth and capacity expansion, developing a profitable mix of price, product, quality, design, and availability. Another is improving quality, lowering total costs, and satisfying customers in a sustainable manner.

Senge concludes that the essence of systems thinking lies in a shift of mind:

- seeing interrelationships rather than linear cause-effect chains, and
- seeing processes of change rather than snapshots.

Virkkunen and Kuutti (2000) note that one of the basic practices in science is to analyze a phenomenon by dividing it into elements and by studying these elements separately. But, when dealing with a multi-faceted and dynamic phenomenon this approach will easily lead to distortions. The key to seeing reality systematically is seeing circles of influence rather than straight lines (Senge, 1990). The technique used for this is a simple one. The basic structures are a *reinforcing feedback*, a *balancing feedback* and a *delay*. Certain systemic structures that recur again and again can be formed from these basic structures. These are called systems *archetypes* and there are only a limited number of them (see Figure 5.7). This suggests that management problems are not unique but something that experienced managers know intuitively (producing a sense of déjá vu). This is in line with what already Simon (1978) notes about experienced chess players and human decision-making: what appears to distinguish expert from novice is – besides of quantity and variety of information – the expert's perceptual experience, which enables him to detect familiar patterns in the situations that confront him. By recognizing these patterns the expert retrieves speedily a considerable amount of relevant information from long-term memory.

The logic represented in Figure 5.7 flows as follows. At the beginning of the game there might be plenty of uncovered market volume. This leads to rapid sales growth and increased cash flow. This, in turn, might lead to increased investments in advertising and other sales activities. This reinforcing process may continue for some time until a balancing process takes effect. Sales slow down when the market is saturated, when competition grows, or when customers turn reluctant. If there is no significant competition one limiting factor for the growth might become from long delivery times. If capacity is not increased in balance with the increasing number of orders (this might even be impossible because of the long time needed to build new capacity) there will before long exist a rising number of delivery backlogs. Delivery backlogs lead to delayed deliveries and diminishing customer satisfaction and, eventually, a diminishing number of incoming orders.

Typical for a *limits of growth archetype* is that the worst thing a decision-maker can do is to push hard on the reinforcing process. Instead, the decision-maker should remove or weaken the source of limitation. In this case, the source of limitation is the insufficient capacity, not supporting increased sales activities.

In this *limits of growth* archetype we might also include a *shifting the burden* archetype. For example, when the amount of incoming sales takes a downward turn, a short-term solution is to invest more on sales promotion. This brings positive results in the beginning. When this correction method is used more and more, it gradually loses its effect. Over time, the capabilities of the fundamental long-term corrective solution (increase capacity) may become disabled (losses and no capital to invest), leading to even greater reliance on the symptomatic solution (more promotion activities).

This same process may take place with slightly different variations. For example, the impulse for the process might be bad sales and overinvestment in sales promotion activities. As this kind of investments usually have an impact delay, the decision makers might think that the increased investments have no effect, causing them to further invest on promotion activities. As the investments finally start to take effect the increase in sales may be so huge that the company again faces problems with timely deliveries.

As has been already argued the fundamental learning unit is not the individual but a team of people who need one another to take new actions. Senge and Fulmer (1993) argue that properly designed and conducted managerial microworlds can meet the conditions of participative and future-oriented learning – providing a way of anticipating the consequences of contemporary decisions and involving a number of people in both the learning process and the opportunity of sharing mental models.

Collaborative learning is better than individual learning for organizational purposes. Team skills are sorely needed in today's interdependent, networked world. Senge (1990) mentions that the discipline of team learning starts with the capacity of members of a team to suspend assumptions and enter into a genuine 'thinking together'. According to Senge, team learning is vital because teams, not individuals, are the fundamental learning unit in modern organizations: unless teams can learn, the organization cannot learn.

Stacey et al. (2000) conclude that systems thinking represents a significant extension of scientific management in its focus on interaction and makes three important contributions:

- The emphasis on interaction leads to an improved understanding of regulatory procedures.
- Thinking in terms of interconnections and the consequent awareness of causal links that are distant in time and space alerts managers to the unexpected consequences of their action.
- The awareness that managers are also part of the system they identify and design leads to greater attention to matters of participation and ethics.

Klabbers (2000) discusses system dynamic models, their use as learning environments, and different modes of simulation. Traditional system dynamic models are closed as their decision rules are fixed. That is, all the information to explain a system's behavior is included in the model and the models are not self-organizing in the sense of generating new model structures to cope with new circumstances. Klabbers sees these restrictions as hampering the mapping of vital social processes in system dynamics models as important structures of the culture cannot be formalized. Klabbers argues that these characteristics of system dynamics modeling limit their reach as experiential learning environments. In other words, improving management practices implies changing organizational structures, but system dynamics tools are of limited use here because of their mechanistic approach. This is why Klabbers thinks that learning environments based on traditional system dynamics tools are limited in scope regarding organizational learning.

Klabbers (2000) calls for self-organizing systems which can change e.g. from a "bad" organization to a "good" one. As in the traditional system dynamics it is not possible to make intermediate adjustments in the parameter setting during the simulation run, there is a need for multi-actor simulation incorporating system dynamics models. In a multi-actor simulation setup actors communicate, share or withhold values, knowledge, and information to gain influence. Actors enact a system of interactions through rules. They develop strategies for steering the resources, mapped in the simulation model. The actors should have distributed access to the model, which means that they are only able to influence parts of the model. In addition actors should have the possibility to intervene in the behavior of the subsystem of resources. These intermediate interventions allow for adapting the strategies as the social system develops over time. For us this sounds a lot like traditional business gaming. What Klabbers sees crucial here is that the interventions in the learning environment have to deal with the design of new structures.

Klabbers (2000) goes on introducing three modes of simulation: Mode I closed simulations where there is no intervention between the model and the participants during the simulation run; Mode II open models where participants have direct access to the stepwise progressed model; Mode III participative model building. In *mode II* the participants cannot adjust the structure specifications of the models. Thus, the potential for experimenting is bound by the structure of existing rules and resources. The simulation is rule-driven and maps operational processes. Klabbers (2000) claims that this type of simulations cannot catch the flavor of more fuzzy and less structured sort of work of the upper level of management involved in long-term strategic and normative decisions. These kinds of simulations he also calls *rigid-rule games* (Klabbers, 1996).

Klabbers (2000) characterizes the *mode III* participative model building as follows. The participants of the current system dynamic related learning environments cannot adapt the model structure to newly emerging views. The next logic step is to arrange learning environments in which the learners are given the opportunity to interactively build their own system of resources and rules. An increasing level of interactivity means increasing opportunities for transforming the existing structure of the social system. Klabbers does not give any clear examples of what these possibilities of transforming the structures might be in practice. What we are wondering is whether our artefact is capable of allowing this kind of restructuring. Klabbers calls mode III type of games *free-form games* (Klabbers, 1996).

Probably our artefact cannot do this restructuring in as a pure form as Klabbers suggests but the artefact has some properties that can be classified as belonging to mode III. For example, in the Alpha case (Paper 4) one participant group decided to get rid of the physical manufacturing function. Alpha has in reality always been a company producing high tech equipment and this idea of the group was revolutionary. Thus, the group decided to test whether it could remain competitive by focusing on software production. Actually the group succeeded well in the game, but after the game in the debriefing session it was criticized for carrying out an unrealistic strategy. But what the group did was that they transformed the model structure according to their own emerging view. Later in an interview the group clarified its strategy and stated that the intention was to test whether this new idea would be a sustainable one and even whether this strategy should be discussed at Alpha as a realistic real world strategy.

We do not claim that our artefact is what Klabbers suggests with mode III but we want to state that the distinction between modes II and III is not that clear. But we truly think that Klabbers is right when arguing for mode III learning environments. The artefact of this thesis might provide a certain intermediate phase in the search of mode III learning tools. And actually the artefact can provide a mode III learning environment if the participants are given the possibility to modify the game configuration parameters. As the artefact is configurable, the game internal and external environment can be adjusted according to the needs of the participants. This, however, demands considerably more time and examination from the participants than the normal gaming mode of the artefact.

5.2.2 Complexity

For even the very wise cannot see all ends.
Tolkien[22] (1954)

Although complexity is not a main research interest of this thesis, the term has already appeared several times in the preceding sections. There is obvious congruence between complexity and continuous processing, more than between complexity and batch-processing. Complexity is sometimes identified as another strand of systems thinking (Flood, 1999). But some, like Stacey et al. (2000), argue that systems thinking seeks to apply the methods of natural science to human action, thus subjecting human action to systemic rules, locating human participation outside the system that is being explained. We will briefly introduce some complexity issues that are relevant regarding continuous processing.

The artefact of this thesis is defined as a *continuous dynamical system which includes causality* (Aulin, 1989). The artefact includes three types of causality: (a) causal relation between the? different states, with difficulties associated with the verification of the relation (e.g. human decision-making); (b) causal laws where the dependence between states on time is explicitly indicated (e.g. a delivery emerging from an order); (c) causal recursion, implying a complete state-description of the dynamical system concerned (see e.g. Figure 5.7, Limits of growth archetype). The artefact is a continuous dynamical system of a continuous flow including *full causal recursion* (i.e. does not have any rest state to be reached in a finite number of steps) (Aulin, 1989). This kind of dynamical system includes both subjective and objective complexity (Aulin, 1989). The artefact is subjectively complex in the sense that most rules of the game are simple and the complexity follows from the number of different possibilities being too great for a player to keep them in mind. We regard the artefact also as objectively complex as many of the causal relationships in the artefact are such that the players cannot form exact rules for them. This is especially the case with events including competitor actions – the human component – as part of them.

[22] Tolkien, J. R. R. (1954). The Lord of the Rings. Quote from Gandalf's talk to Frodo.

De Geus (1988) mentions some reasons why computer models should be used instead of natural learning processes such as management team meetings. First, although the models in the human minds are complex, most people can deal with only three or four variables at a time and do so through only one or two time iterations. If we computerize the mental model of the person who stops thinking after a few iterations, however, the model will almost certainly show the results of continued iterations. This will happen even though the modeler is incapable of arriving to the results of the continued iterations because of his incapability of processing enough iterations.

Another reason for modeling decision-making with computers is that in working with dynamic models, people discover that in complex systems cause and effect are separated in time and place. De Geus mentions that to many people the insight to these causal phenomena is counterintuitive. Thus, we are not able to find other trigger points than the most immediate causes to create effects requested. The use of dynamic models helps us discover other trigger points, separated in time and place from the desired effect.

Especially the second reason advocates the use of interactive and continually evolving models. If people are to learn about causal relationships and interdependencies, we need training tools, which can represent these causalities. To put it in another way, if we fail to think explicitly of a successful business as a dynamic feedback system generating complex, unstable behavior, we also fail to identify the action criteria for continuing success (Stacey, 1992). Stacey claims that successful business organizations are non-linear feedback systems. These kinds of systems fail when they are taken to positions of stable equilibrium, as they are trapped into simply repeating the past.

Though we have not included the complexity aspect of the organizational environment as a research topic in our studies, we believe complexity is present in the business construction environment more authentically than in traditional business games (see the discussion in Section 7.11). Complexity is also an issue which regularly pops up in the comments of the game participants. Thus, it is worth noting some comments on this aspect. The complexity of the artefact learning environment arises from the constantly evolving continuous process structure and the transaction specific level (meaning that the game events are presented as single business transaction) of information.

Complex systems theory (or complexity theory) is not so much a single theory as a perspective for conceptualizing and modeling dynamic systems (Morel and Ramanujam, 1999). Today organizations are routinely viewed as dynamic systems of adaptation and evolution that contain multiple parts which interact with one another and the environment. Yet – Morel and Ramanujam

(1999) argue – any representation of organizations as dynamic systems of adaptation and evolution implicitly assumes that organizations are "complex systems" as described by scholars in the emerging multidisciplinary field of complex systems theory.

Morel and Ramanujam (1999) note that complex systems are difficult to define (as can be seen from the diverse definitions following) but easy to recognize. Complexity theory deals with dynamic non-linear systems (Baets, 1998). Although a deterministic system (i.e. there is no random behavior) may become “chaotic”, a set of equations should be able to describe this system. For Baets “chaotic” means that as observers of the system we cannot immediately and easily write down the behavior in the form of equations. When change occurs in complex systems it occurs in a non-linear fashion (Kirshbaum, 1998). Linear change is where there is a sequence of events that affect each other in order as they appear one after the other. In contrast, in non-linear change, one sees elements being changed by previous elements, but then in turn these changed elements affect the elements that are before it in the sequence. Dooley and Van de Ven (1999) state that the most commonly held model of non-linear dynamics is that “chaotic” dynamics arise from a stable and deterministic non-linear system, consisting of a small number of interacting variables. This produces behavior that appears irregular to the degree that it seems random moment-by-moment. Stepping back and viewing the system over a long period of time yields distinctive patterns that clearly are not random. In non-linear systems, intervening to change one or two parameters by a small amount can drastically change the behavior of the whole system, and the whole can be very different from the sum of its parts (Anderson, 1999). Complex systems change inputs to outputs in a non-linear way because their components interact with one another via a web of feedback loops. This is also how we see the difference between batch and continuous processing in gaming. This issue is discussed more in Section 7.11.

Kirshbaum (1998) states that it is usually fairly easy to calculate what will develop in the next stage of system development when one has extensive knowledge of the previous stage. This knowledge is usually of a range of possibilities that can develop next, as in the process flow of the batch-processed business game. But as one begins to deal with stages of development farther and farther down the sequence of developmental stages, it becomes more and more difficult to predict what will develop based only on knowledge of that first stage, even when that knowledge is extensive. Even though there is logical development from stage to stage, there is an increasing inability to predict what will actually be the next development. But yet all these changes are still logical results of that tiny change, it just becomes increasingly difficult to predict exactly which result will actually occur.

Senge (1990) divides complexity into two types: detail complexity (e.g., many variables included in a decision situation; Aulin's, 1989, subjective complexity) and dynamic complexity (situations where cause and effect are subtle, and where the effects over time of interventions are not obvious; Aulin's, 1989, objective complexity). Dynamic complexity can be found in situations where the same action has dramatically different effects in the short run and the long run. As already mentioned earlier, Senge mentions that the real leverage in most management situations lies in understanding dynamic complexity, not detail complexity.

Figure 5.7 gives an example of one systems archetype often happening in the artefact of this thesis. Senge calls this archetype 'limits of growth'. Figure 5.7 includes only a part of the factors taking place in an order-delivery process. Thus, the factors not represented in the figure make the real situation even more dynamically complex.

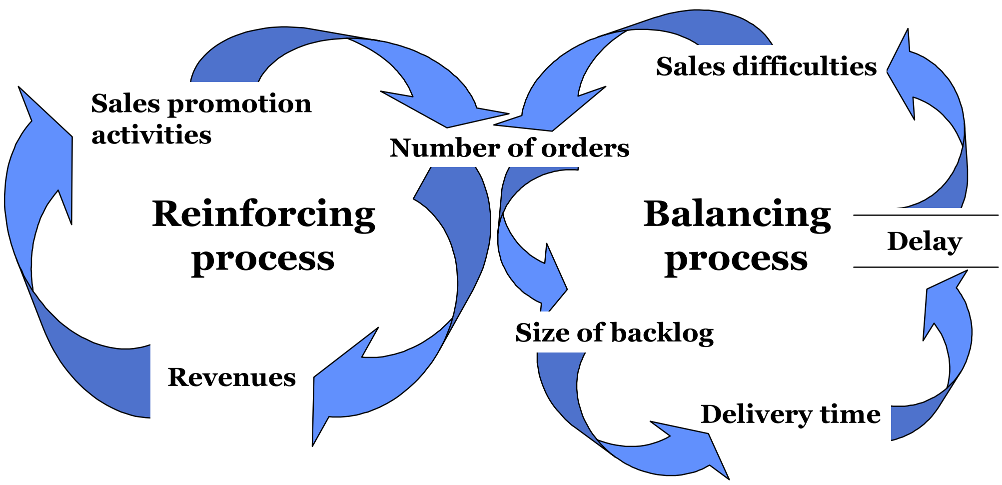


Figure 5.7: Limits of growth archetype (adapted from Senge, 1990).

Isaacs and Senge (1992) state that in the field of computer-based learning environments there is a significant gap between insights of problems and new behavior, particularly when it concerns problems that are complex, non-routine and threatening. However, we feel strongly that in order to understand a complex process we have to be able to witness and see it, and – more precisely – we have to able to interact with this process. This is in line with the new views on learning which encourage the use of complex learning environments by arguing that students cannot be expected to learn to deal with complexity unless they have an opportunity to do so. We are expected to create shared environments that permit exploration by students and enable them to understand the kinds of problems and opportunities that experts in various areas encounter and the knowledge that these experts use as tools (Cognition and Technology Group at Vanderbilt University, 1992).

In this section we have dealt with organizational learning, systems thinking, and complexity. So, how do these come together? A short synthesis of these three is in place. According to Sterman (2001), systems thinking is a method to enhance learning in complex systems. Systems thinking is grounded in the theory of non-linear dynamics and feedback structures. Sterman notes that to understand policy resistance, we must understand both the complexity of systems and the mental models that we use to make decisions. Most cases in policy resistance arise from dynamic complexity, the counterintuitive behavior of complex systems that arises from the interactions of the agents over time (not from combinatorial complexity in finding the best solution out of an astronomical number of possibilities). Dynamic complexity can arise even in simple systems with low combinatorial complexity. Where the world is dynamic, evolving, and interconnected, we tend to make decisions using mental models that are static, narrow, and reductionist. Among the elements of dynamic complexity that people find most problematic are feedback, time delays, and non-linearity. As a conclusion, to improve our ability to learn about and manage complex systems, we need tools capable of capturing the feedback processes, time delays, and other sources of dynamic complexity. The tools must enable us to understand how these structures create a system's dynamics. In systems with significant dynamic complexity, computer simulation will typically be needed (Sterman, 2001).

5.3 Simulation Gaming as a Learning Facilitator

LEARNING modified by ATTITUDE =
f[EXPERIENTIAL USED (CONCEPTS, NATURE, CONDUCT)
determined by (STUDENT ATTRIBUTES, EDUCATOR CONSIDERATIONS)]
Burns et al. (1990)

Experiential simulations share several key characteristics (Gredler, 1996):

- The learner is a functional component of the situation and experiences it from the inside.
- The learner takes on serious responsibilities as a participant in an ongoing fluid situation.
- The intent is for the participant to experience the effects of his/her decisions.
- The simulations are able to provide opportunities for students to develop their cognitive strategies because the exercises require that they organize and manage their own thinking and learning.

The last of the above characteristics is probably the most important argument for game developers and trainers. Senge and Fulmer (1993) argue that simulations designed for general purpose management learning are useful for helping individuals to see relationships between various business decisions and potential outcomes. The insights gained from experience with these activities may be transferred to an organization when participants face situations that remind them of similar challenges faced in the simulation.

According to Elgood (1996) games in general have some advantages compared to lectures:

- Games can have considerable subject knowledge built into them. They can pose a problem, demand an answer and respond to the answer with a judgment that is knowledge-based and right. The student learns by experience rather than by hearsay.
- In a lecture it is not guaranteed that the information transmitted is also listened to and understood. Although this cannot be guaranteed in a game environment either, the nature of business games usually creates interest on the subject matter, because the participants are themselves operating on the matter. This would suggest that in games even if less is being officially transmitted, much more is being received.
- In games motivation is further enhanced by the expectation of enjoyment and freedom of action that is associated with the word 'game'. Human individuals are often competitive by nature.
- In games there is usually discussion between the participants. Thus, the views of many people are being considered. Elgood mentions that the process of understanding may receive more help from discussions with somebody operating at one's own level rather than with an expert.

Compared to spoken information business games are good in that sense that they are visual by nature. When people see visual representations of complex phenomena, they tend to understand the phenomena better as well as remember longer what they have understood. It helps them to keep from getting confused as they are overwhelmed by more and more data. Players learn and become better problem solvers, allowing them to master successively more complicated tasks and to transfer expertise (Porter, 1995; according to the constructivist view, expertise is being *constructed*, not transferred).

The means of simulation gaming to be used to change governing mental models and to create a shared mental model among participants (Tsuchiya and Tsuchiya, 1999) are the following:

- Voluntary learning: the fun element of gaming encourages us to participate.

- Creation of turmoil: the conflict and turmoil created by a game raises a doubt in mental models and lessens the resistance to change.
- Big picture: when the participants grasp the whole, the individual mental models become larger. As a consequence, compatibility of participants' mental models increases and the creation of a shared mental model becomes possible.
- Compression: compression of time and space makes experiential learning possible and accelerates the learning process: the outcomes of actions are experienced in a short period of time.
- Risk-free environment.
- Shared experience: essential for the creation of a shared mental model.
- Rich interpretation of history: the expansion of our comprehension of past experience through gaming enables us to learn from small episodes within the real world.
- Cause maps: the cause maps developed through participation in playing help participants to interpret and make sense of their lives.

Wolfe and Crookall (1998) state that despite the widespread use of simulation gaming, one is still struck by the gaps in the knowledge about the educational simulation/gaming process, or about those elements that contribute to its effective or ineffective use. The complex experiential learning environment of a business game poses several problems (Keys and Wolfe, 1990):

- There is such a variety of stimuli in the complex environment of a game that it is difficult to determine the exact stimuli to which learners are responding.
- The learning cycle for game participants is much longer than what most other exercises produce.
- The proper place for feedback and debriefing is not as obvious as in simple exercises.

As a summary from a literature survey, Keys and Wolfe (1990) note that many of the claims and counterclaims for the teaching power of business games rest on anecdotal material or inadequate or poorly implemented research designs. These research defects have clouded the business gaming literature and have hampered the creation of a cumulative stream of research.

Dickinson and Faria (1995) sum up the findings of five major review articles (viewing all together 160 studies) on the effectiveness of business game training compared against other instructional methods. The conclusions were that simulation gaming was found to be superior in 46.9 %, not as effective in 16.9 % and no learning differences were reported in 36.2 % of the cases. Dickinson and Faria conclude from these reviews that simulation games are at least as good as other instructional methods and possibly superior. To us this conclusion seems a bit naïve as drawing this kind of assumptions of the applicability of simulation gaming in general in different educational situations is quite questionable. As Villegas (1997) notes, there is no concrete evidence that simulation games are superior or more effective than other techniques used in training. Another point of view comes from Gosenpud (1990) who states that researchers should stay away from the kind of study where the experiential method is compared with others (usually in terms of some very general measure of cognitive learning). This kind of study is value laden, stimulates unnecessary controversy, and the knowledge gained from it is in terms of winners and losers and nothing else.

We think that it would be more beneficial to study what kind of simulation games are applicable to what kind of situations and to what kind of target groups. Actually, Keys and Wolfe (1990) notes that most of the research has been focused on team performance in games, not learning. Often the assumption has been that high performance teams learn the most from a game experience. Thus, they note, research is needed to evaluate the relationship between learning in a management game and performance in a game. We would like to comment that *we need research on the conditions which facilitate learning through gaming*. The participant performance in the game is interesting mostly from the point of view of student assessment.

Considering the efforts to validate games it is surprising that: *We still know very little about game internal learning processes* (Keys and Wolfe, 1990, p. 318). However, despite the criticism, one of the major criticisms on gaming is quite inconsistent. Business games are often criticized because of the lack of well designed evaluative studies to establish learning validity. Although this criticism certainly is partly true, it should be recognized that it applies even more so to learning from the commonly accepted teaching methodologies such as cases, lectures, or simpler exercises (Keys and Wolfe, 1990).

5.3.1 Challenges to Computer-Based Learning Environments

Gredler (1996) finds the following weaknesses in games and simulation research, and at the same time presents how the discipline of education sees simulation and gaming:

- Comprehensive design paradigms derived from learning principles have not been available. Poorly developed exercises are not effective in achieving the objectives for which simulations are most appropriate: developing students' problem-solving skills.
- The lack of well-designed research studies. Much of the published literature consists of anecdotal reports and testimonials.

- Most of the research is flawed by weaknesses in both design and measurement.
- Most studies compare simulations to regular classroom instruction. However, the instructional goals for which each can be most effective often differ. The lecture method is likely to be superior in transmitting items of information. But simulations have the potential to develop students' mental models of complex situations as well as their problem-solving strategies.

Isaacs and Senge (1992) argue that computer-based learning environments (CBLE) can enhance organizational learning by making explicit the assumptions and logical inconsistencies in the operating policies of an organization. CBLEs will foster shared understanding of complex organizational processes and systems. However, there exist individual, group and organizational counter-pressures that will limit the success of some CBLEs in producing significant, enduring organizational learning. In the following we will describe the theoretical framework Isaacs and Senge propose for indicating directions for designing CBLEs to overcome these counter-pressures. We would also like to note that the North-American business game literature hardly ever cites the research that has been published in the European Journal of Operational Research (e.g. the papers referred to in this thesis: Isaacs and Senge, 1992; Morecroft, 1992b; Lane, 1992) though this source supplies some very coherent descriptions of challenges and benefits of game based learning environments.

First, Isaacs and Senge (1992) note that confronting management problems that are complex, non-routine, and counter-intuitive, such as CBLEs pose, can create embarrassment and threat, and tend to trigger a set of self-fulfilling and self-sealing behaviors that diminish learning and the likelihood of change. This shows in the participants' tendencies to approach CBLEs as traditional games to be mastered rather than as learning tools. There is a significant gap between insights and new behavior, particularly when it concerns problems that are complex, non-routine and threatening. Isaacs and Senge argue that evidence also suggests that both practitioners and researchers tend to disregard or remain unaware of this gap.

Secondly, CBLE research has tended to focus on individual understanding and individual cognitive limits. Nevertheless, the focus of decision-making in organizations is on groups of people who need one another to act. This is why Isaacs and Senge argue that individual learning is increasingly irrelevant if not translated into team learning. Taking into account the team learning aspects complicates the learning challenge and embeds it within the study of group dynamics and group learning.

The third problem Isaacs and Senge note in the use of CBLEs is that efforts to alter decision-making or learning at local level in an organization often have significant impact on the larger organizational learning system. Furthermore, designers of CBLEs have their own model of learning, and they need to recognize that their interventions may pit two distinct and incompatible learning models against one another. CBLEs may encourage policies that trade off narrow functional objectives for system-wide improvement. Prevailing management systems may, however, understate the long-term in favor of short-term financial results as organizational measures and rewards may be predominantly functionally oriented.

As a CBLE is placed in the learning cycles introduced in Section 5.1 this results in the cycle presented in Figure 5.8. In this figure Isaacs and Senge (1992) use the term 'virtual world' by Argyris and Schön instead of CBLE. This figure illustrates to us how a virtual world can turn visible the learning limits that are obscure in real world. Thus, CBLEs provide a rapid, unambiguous, and systemic feedback on actions taken. They provide a relatively low-risk setting in which differences in mental models can be explored and tested. CBLEs can reflect back previously made tacit assumptions and can provide insights into the nature of the complex interactions that determine the consequences of managerial decisions.

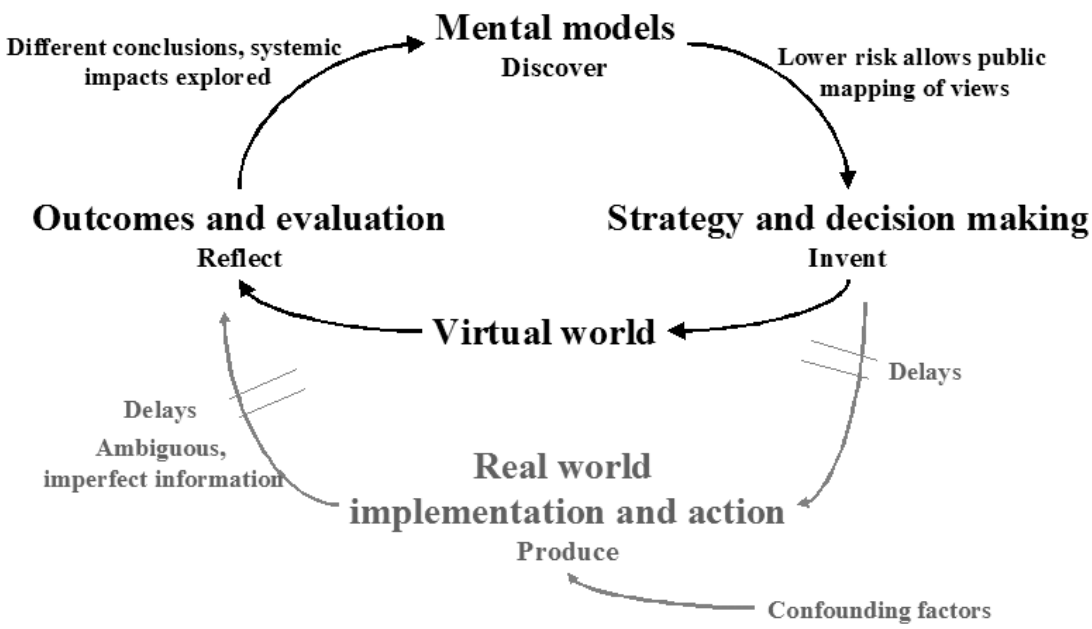


Figure 5.8: The impact on learning using a virtual world (Isaacs and Senge, 1992).

Isaacs and Senge (1992) further argue that the purpose of CBLEs is to foster double-loop learning. CBLEs are often designed to help people see and understand the complex interactions that are producing persistent problems or thwarting efforts at improvement. Often operating policies differ in practice from official policies about how one ought to make decisions. Furthermore, these operating policies are usually in practice partly or largely tacit for the actors in the system. The type of learning required for fundamental improvement involves discovering how established policies are creating problems in organizations and inventing new policies to improve behavior. This is a classic problem of double-loop learning. These learning challenges trigger a predictable set of reactions in individuals. People try to save their faces, try to win and avoid losing, appear rational whatever the actual status of one's reasoning, and suppress emotion (see Argyris, 1991). These personal strategies and reactions are used skillfully but people remain unaware that they are doing so. This all leads to a situation where people seem to act in ways that prevent them from learning about fundamental gaps between their intentions and actions.

The ideal learning cycle represented earlier brings to light an additional difficulty (Isaacs and Senge, 1992). There is no straightforward path between the invention of new strategies and their production. This is particularly true when it comes to a situation that involves double-loop learning. Under the threat or potential embarrassment of questioning basic assumptions and values, individuals frequently produce actions contrary to their inventions and are often unaware of the contradiction. Isaacs and Senge (1992) go on referring to the work of Argyris and Schön, and describe their general theory-in-use, Model I, which describes people's self-defeating behavior under conditions of threat or embarrassment, such as posed by double-loop learning situations (see e.g. Argyris, 1991, 1995; the other theory being espoused theory, which is the one people think they use. There very often exists a contradiction between the way people think they are acting and the way they really act).

As a summary of this discussion; even if CBLEs can illuminate systemic factors, which confound learning, this will not guarantee that appropriate new policies will be recognized or implemented. In addition to the difficulties of understanding organizational settings – long delays between actions and consequences, misinformation, ambiguity, and systemic consequences – there are difficulties in the ways human beings move from new understandings to new behavior. These difficulties are greatest when new understandings produce insight into the counter-productivity of basic assumptions and values.

Despite all the difficulties concerning CBLEs described above, Isaacs and Senge (1992) believe that it may be possible to design CBLEs in such a way as to begin to recognize non-learning behaviors in non-threatening ways and thereby enhance conditions for double-loop learning. CBLEs can introduce participants to the discipline of reflecting on their own behavior and assumptions, to perceiving gaps between their intentions and model outcomes, and also to seeing gaps between their beliefs and their actual behavior.

5.4 Constructivism

Paper 2 of this thesis describes the essential features of constructivism (the learning theory; do not mix up with the constructivist methodology of building artefacts). In this section we only briefly include some comments that are not mentioned in Paper 2.

As we now move more to the side of traditional educational theories (much of the theorizing in experiential learning and organizational learning has taken place in the field of organizational sciences), a brief survey on learning theories is in place. We concentrate mainly on those issues which are central for technology supported learning. In introducing the background of constructivism we refer to Lehtinen and Kuusinen (2001). We will start with behaviorism.

The most influential author in *behaviorism* has been Skinner. He put together a theoretical model of behaviorism, which was based on the central experimental research of behaviorist tradition. Behaviorism was based on *human stimulus-response*. Here whatever had to be learned could be reduced to a linear series of steps: immediate reinforcement by rewards, mastery of simple behaviors leading to mastery of complex behaviors. Learning could only be detected if the external behavior of the learner changed. Only observations that could be detected by sense perception and related measurements could be a source of knowledge. Thus, behaviorism presents a tightly positivistic ideal of science. Behaviorism and its linear programming of instruction led to the first mechanical teaching machines and to the model of Programmed Learning.

In *educational psychology (cognitive psychology)* crude stimulus-response behaviorism eventually gave way to more sophisticated views on human individual *information processing*. Research and theories are based on the individual's information gathering, storing, and usage, which all belong to an area (individual's internal cognitive processes) that could not be studied according to the behaviorist view of learning. Thus, when studying human consciousness we have to study indirect findings.

From the viewpoint of *constructivism*, the basic forms of interpreting human thinking are shaped in the work of Piaget. According to Piaget, the forms of human thinking and knowledge are built through the activities and interplay by which the individual adapts to her environment. Each individual develops those inevitable basic forms of thinking that make it possible to survive in the world. One of the principles in Piaget's thinking was that cognitive constructions develop through action. Processes of the mind develop from action which is originally concrete. They can also later develop through internal mental processes without direct connection to the external action. So, for Piaget, the shaping of cognitive constructions is not passive information adaptation through the senses (empirism/behaviorism) or information selection to channels of limited capacity (information processing), but active functioning in the real-world and coordination of these actions as consistent constructions.

Other influential scientists in the formation of constructivism have been Dewey, Mead and Vygotsky. They all searched for explanations for the dynamic interrelationship between the individual and the environment. An important ingredient of Vygotsky's work is that he started studying human learning from the point of view of how cultural habits, social relationships and the language as a tool of thinking facilitate the condition for learning. The central message in Vygotsky's work is that an essential condition for understanding the psychological development of an individual is to understand the system of social relations within which the individual lives. In other words, an individual continuously carries with her the culture and its meaning in her knowledge, skills, and whole personality.

Another way of looking at different views on learning is described by Duffy and Jonassen (1992). *The objectivist tradition* acknowledges that people have different understandings based on differing experiences. However, the impact of prior experience and human interpretation is seen as leading to partial understandings and biased understandings. The goal here is to strive for the complete and correct understanding. Knowledge is believed to exist independently of instruction and there is no need to look at the instructional activities to see what is learned. Rather, a test that stands separate from the instruction is produced, and it is designed to probe the knowledge acquired in an objective way. The objectivist epistemology underlies behaviorism and much of cognitive psychology. Also constructivism holds that there is a real world that we experience. However, there are many ways to structure the world, and there are many meanings or perspectives for any event or concept. Thus, there is not a correct meaning that we are striving for.

Duffy and Cunningham (1996) note that the term *constructivism* has come to serve as an umbrella for a wide diversity of views. However, they find two similarities among them: (1) Learning is an active process of constructing rather than acquiring knowledge. (2) Instruction is a process of supporting that construction rather than communicating knowledge.

The principles of constructivism support the use of microworlds (Jonassen et al., 1999). Microworlds are exploratory learning environments or discovery places in which learners can navigate, manipulate, or create objects, and test their effects on one another. Microworlds contain constrained simulations of real-world phenomena that allow learners to control those phenomena: direct engagement, the feeling that the computer is invisible, but what is present is the world we are exploring. Microworlds are the ultimate example of active learning environments, because the users can exercise so much control over the environment. They provide the essence of an active learning strategy, but they should be followed up with reflective thinking.

In short, constructivist learning environments (Jonassen et al., 1999) are technology-based environments in which students explore, experiment, construct, converse, and reflect on what they are doing, so that they learn from their experiences. Learners are presented with a complex and relevant problem, project, or experience that they accept or reject as a challenge. Then the environment provides them with the tools and resources that they need to understand the problem and to solve it (or attempt to solve it). These environments are not necessarily dependent on technology, but they are often supported by computers.

The aim of Paper 2 in this thesis is to clarify the concepts and beliefs related to constructivism. Constructivism is not a coherent learning theory. Its assumptions support the use of dynamic learning environments, like business games, and further deepen the possibilities to understand what kind of learning is possible through simulation gaming. Especially the way of interpreting the results in Paper 4 is based on constructivistic principles.

5.5 On the Different Views on Learning

The three views on learning (experiential, organizational and constructivism) introduced have partly the same origin. For example, Argyris and Schön (1996) apply Dewey's[23] term inquiry as a central concept in describing learning: inquiry is the intertwining of thought and action that proceeds from doubt to the resolution of doubt, which in turn is construed as the experience of a problematic situation (mismatch between expected results and results actually achieved). Dewey has also been influential in the shaping of experiential learning. Kolb (1984) notes Dewey's emphasis on learning as a dialectic process integrating experience and concepts, observations, and

[23] Dewey, John (1938). Logic: The Theory of Inquiry. New York: Holt, Rinehart and Winston.

action. Dewey has also been influential in the formation of constructivism (Lehtinen and Kuusinen, 2001). Furthermore, Dewey is not the only common denominator in these views on learning.

Experiential learning is the traditional view of learning used to argue about business gaming. This theory describes well the basic idea in business gaming: Learning through direct experience. In business gaming the participants act as decision-makers and see the consequences of their decisions. An important aspect of this view is that learning occurs through resolution of conflicts. However, in the real world learning from experiences is not that self-evident, as often the decision-makers are not able to see the consequences of their actions (delays, functional borders). This supports the use of learning environments which represent circular cause-effect relationships and where time is accelerated so that the link between a decision and its outcomes becomes explicit.

In the field of *organizational learning* the framework by Kim (1993) integrates experiential learning with the central concepts of organizational learning: single- and double-loop learning, individual and shared mental models, and individual and organizational learning. For us this framework explains the role experiential learning methods may have in the organizational learning context. Furthermore, systems thinking – as Senge (1990) introduces it – argues for the use of tools that reveal systemic structures, to see wholes, interrelationships, and patterns of change. These characteristics seem to support the use of continuously evolving learning environments which represent the flow of dynamic interrelationships. Senge uses the term dynamic complexity which should be revealed to show circles of influence rather than straight lines.

Constructivism has not been used as a reference theory when building the artefact of the thesis. Constructivism, however, is an interesting view on learning and obviously has a lot of explanation power when we study the phenomenon of computer-based learning environments. In constructivism the learning task is not isolated but rather a part of a larger context. We should create projects or environments that capture a larger context in which the problems are relevant. The reason for solving the problems must be authentic to the context in which the learning is to be applied. The problems to be communicated can be much more complex and interconnected than in instruction centered format and the students can form rich mental models more easily. Learning is an inherently social-dialogical activity. Learning is a social, communicative, and discursive process, inexorably grounded in talk. All this speaks for the use of tools like business games. Constructivism has not been the guiding view on learning when designing the artefact of the thesis. However, through the cooperation with the department of Education at the

University of Turku, constructivist influences have affected our work. This can especially be seen in the paper written together with Sami Nurmi (Paper 4) and in Paper 2.

At this point, we will keep the experiential/organizational and the constructivist view apart from each other. However, for us these different views support – not exclude – each other. Together they might be able to give us an enlarged understanding of learning through experimentation and on the basis of that give us more capabilities to study and analyze learning in the organizational context. This research will probably take place later in the future.

6 RESEARCH PROCESS, EVALUATION AND VERIFICATION

This chapter briefly discusses the research process from the development idea to the present day production use of the artefact. We then briefly introduce the 31 training sessions carried out using Realgame and present examples of questionnaires and knowledge tests used during these sessions. Also some questionnaire and knowledge test participant answers are presented and analyzed. Results from these answers are used to evaluate the artefact. Finally, we will discuss the topic of verifying the artefact.

6.1 The Research Project 1996-2003

Stowell et al. (1997) note that an important part of any action research study is noting what happens in order to try and record the development of ideas or changes in practice. Observations should be recorded in such a way that they can be revisited for verification purposes and support critical reflection and learning. Keeping records of the process of the study is an important aspect which requires careful consideration and planning. In this section we will briefly introduce the research project from the idea of constructing the artefact to the thesis at hand. We hope that this narrative will present the major phases that have taken place during the research process. Each of these phases has shaped the artefact and in our view all these phases have added value to the outcome.

Phase 1: Selling the idea (1996-1997)
The idea to start finding partners and funding for the project came up at the beginning of 1996. In January 1996 the researcher met a few personnel officers from some of the biggest Finnish companies, some funding organizations, like Tekes (Finnish Technology Development Centre) and venture capital organizations, and a middle-sized consultancy company. This phase of negotiations continued until spring 1997 without any considerable results. However, the idea was, according to all involved, a good one, and the researcher turned to the university, where he had worked in the early 1990's.

Phase 2: Enrolling to academia and funding from Tekes (1997)
The researcher had introduced the idea at the Turku School of Economics and Business Adminstration (TSEBA) in spring 1997. On behalf of the Turku Centre for Computer Science (TUCS) a funding application was presented to

Tekes. The researcher started to work officially for the research project in June 1997 and the final funding decision from Tekes was received on 23rd of September. During this period the research consisted mainly about getting acquainted with the programming environment and programming.

Lainema (1999; not included in the thesis) was written in December 1997. It introduces well the reasoning that was used in arguing the potential of a real-time processed business simulation game, composing a *primary narrative* (see Remenyi and Williams, 1996, discussed in Section 2.2) of the research. The same reasoning was used both when searching for the business partners and when introducing the idea to Tekes and academia. This was, however, the first time that our ideas were properly put on paper.

Phase 3: Cooperation with the industrial partner (1998-2000)

The cooperation with the first industry partner started in January 1998. Gamma (a pseudonym) is a diversified company concentrated on producing food and animal feed. It also manufactures heavy machinery. At the beginning of 1998, Gamma had more than 500 employees in Finland and its turnover was around 1,000 million FIM (around 167 million euros).

The contact person at Gamma was a business controller in charge of corporate financial reporting. He had strong experience in computing as he had a degree in information systems science and had previously worked in data administration. This cooperation was fluent throughout the duration of the collaboration and the researcher and the contact person met 7 times between January 1998 and September 2000. The program development was done in a prototyping (see e.g. Budde et al., 1992, for prototyping) fashion where the researcher produced operative versions at an early stage and these versions where then demonstrated to the contact person at Gamma. Further development was then done on the basis of the comments on these demonstrations. According to the prototyping fashion, the key element in design was not the accuracy or thoroughness of the prototype, but the communicative role the prototype played (Winograd, 1995). The internal business logic of Gamma was particularly well represented in the artefact: the manufacturing logic of one Gamma business unit was the central theme of this development phase. The business environment of this business unit was quite stable and the market logic of the artefact was somewhat ignored.

Phase 4: The first experiments: student training sessions (1998-2000)

We have gathered a lot of data from student training events and some of this data is presented in Section 6.3. In this thesis we have concentrated on demonstrating the results from the company in-house training sessions as we feel that the studies from company training represent more interesting results.

Altogether the artefact has been used on different university undergraduate courses some 20 times (mainly at TSEBA and Åbo Akademi). The game sessions at TSEBA were all a part of some larger course and we could not gather the kind of data we needed for our analysis from these sessions. In addition, the sessions were often disturbed by technical problems, as the computers in use still had too little computing capacity. Some conclusions could be, however, drawn from playing the game in these sessions:

- It became quite clear that technical problems strongly affect the attitudes of the participants.
- The game training sessions need to be long enough (a minimum of eight hours should be used) as the game produces a complex learning environment.
- Even more important than reserving enough time for the training, it is of primary importance to have enough time for analyzing the events and results from playing the game and to understand the cause-effect relationships of the game model.
- Continuous processing, when there were no technical problems, created an utterly interesting learning environment and the students immersed themselves deeply in the game environment.

Phase 5: The production use of the artefact in university settings and companies & cooperation with the University of Turku (from 2001)

The first proper business game course with the artefact was carried out at Åbo Akademi University in autumn 2001, when the researcher worked there as a researcher. The course lasted six weeks with 4 hour gaming each week. Besides of playing the game the course included student work on assignments. This was the first time we had an opportunity to gather experience about the use of the artefact in the form of a proper course and to develop our research instruments. Results from this course have not been properly analyzed as we found out that the research instruments still had to be improved.

The course described above was the first one carried out in collaboration with the University of Turku, the department of Education. This collaboration greatly improved the methodological quality of the research and also highlighted the need to consider new approaches to learning. Especially the use of Constructivism as a learning framework is due to this collaboration. It also led to new research data collection techniques, which put more emphasis on qualitative instruments. Paper 4 of the thesis is a good example of applying these instruments and shows our latest data gathering instruments in use.

The Training Sessions Carried Out

During the different phases of the research the artefact has been used in the training sessions listed in Table 6.1.

Table 6.1 University and company in-house training sessions carried out during the research project. Column 'N' indicates how many questionnaires were returned, not the actual amount of participants. The session rows in bold are represented in Figures 6.1 – 6.4 (TSEBA= Turku School of Economics and Bus. Adm.; ÅA= Åbo Akademi University; TUT= Tampere University of Technology).

		Date	Course	Duration	N	Comments
1999	**1**	**4/99**	**TSEBA, Information Systems Science (TJ10b)**	**4h**	**43**	**Intro for the game during the class (1.5 h). As a home assignment the students played the game independently. The task was to chart the information requirements of a decision-maker.**
	2	**22.9.99**	**Gamma, demo game**	**5h**	**10**	**Not a networked game. Configured for Gamma environment.**
	3	3.12.99	TSEBA, a marketing course	2h		
	4	8.12.99	ÅA, Information Systems Science	2h		
2000	**5**	**11.2.**	**Marketing course in TUT/Pori**	**8h**	**34**	**Not a networked game.**
	6	3.3.	Game for the faculty of Information Systems Sc., TSEBA	2h	6	
	7	**20.3.**	**ÅA, Information Systems Science**	**2h**	**18**	
	8	**April**	**TSEBA, Information Systems Science (TJv6)**	**4h**	**69**	**Students played the game for 1.5 hours and then they were asked to independently present the material and information flows with a process charting tool.**
	9	**12./19.9.**	**ÅA, Information Systems Science (IS in Practice)**	**2h**	**73**	
	10	5.10.	General Executive MBA, TUT & University of Tampere	3h	5	
	11	10.10.	TSEBA, Information Systems Science (TJT3)	2h	82	Game served as an introduction to business processes.
	12	20.12.	Game for the faculty of Information Systems Sc., ÅA	4h		
2001	**13**	**12.3.**	**An in-house training for a glass manufacturer, arranged by the Tampere University of Technology**	**9h**	**13**	**The game model was configured to resemble the case company's environment.**
	14	21.5.	An in-house training for two companies, TUT	8h		Introductory game, with the configured model of session 13.
	15	27./28.8.	An in-house training for a diversified company, TUT	14h		Part of the case company's management development program
	16	**6.10.**	**An in-house training for two companies, TUT**	**8h**	**18**	**Part of the case companies' management development program**
	17	**Autumn**	**ÅA, Information Systems Science**	**6x4h**	**15**	**Business game course.**
	18	**29./30.11.**	**An in-house training for a diversified company, TUT**	**14h**	**16**	**Part of the case company's foremen's development program**
	19	31.10./ 7.11.	TSEBA, Logistics (LOG3)	8h		The participants played the manufacturing and materials process of the game. There were two game versions, the one played on the second time was much more complex.

		Date	Course	Duration	N	Comments
2002	**20**	**10./11.1.**	**University of Tampere, course Managing Knowledge Work (for employees of companies)**	**10h**	**11**	
	21	**15./22.1.**	**TSEBA, Team course (YLY)**	**8h**	**14**	
	22	18./20./ 22.3.	TSEBA & University of Turku.	20h	16	Game where business students played against students of education.
	23	**3./4.6.**	**In-house training for a diversified company, TUT.**	**14h**	**24**	**Part of the case company's foremen's development program**
	24	13./14.9.	In-house training for two companies, TUT.	14h	22	Part of the case companies' management development program
	25	**16.10.**	**Alpha**	**10h**	**21**	**Described in Paper 4 of the thesis.**
	26	8./11./ 18.10.	ÅA, Information Systems Science (Investment Planning)	10h		
	27	21.10.	University of Tampere, Executive MBA	5h		
	28	**23.10.**	**Alpha**	**10h**	**22**	**Described in Paper 4 of the thesis.**
	29	**28./29.10.**	**TSEBA, Logistics (LOG3)**	**8h**	**31**	**The participants played the manufacturing and materials process of the game. There were two game versions; the one played on the second time was much more complex.**
	30	**4./5.11.**	**TSEBA, Logistics (LOG3)**	**8h**		**The participants played the manufacturing and materials process of the game. There were two game versions; the one played the second time was much more complex.**
	31	**8./22.11.**	**TSEBA unit in Pori, Business Game course**	**16h**	**22**	
2003	**32**	**12.-13.2.**	General Executive course module, TUT	14h		
	33	**17.-19.2.**	University of Bergen	18h		Part of a course on organizational learning.

6.2 Data Collection

The research phases of evaluation, theorizing, justifying (Figure 2.2) require empirical data collection. We have collected both quantitative and qualitative data.

Yin (1989) lists different sources of evidence in case studies. Yin states that some overriding principles are important to any data collection effort when doing case studies. These include the use of: (1) multiple sources of evidence; (2) a study data base (a formal assembly of evidence distinct from the final study report), and (3) a chain of evidence (explicit links between the questions, the data collected, and the conclusions drawn). The data collection techniques that have been applied in this research are:

- questionnaires,
- recordings (case Alpha of Paper 4),
- video recordings (case Alpha of Paper 4),
- concept mapping techniques, and
- interviews (case Alpha of Paper 4).

Our study data base includes the original data sources (tapes, questionnaires) and different formats of electronic files (text, spreadsheet, relational database, statistical analysis program files, and game log database tables including participant decisions and actions during the training events). Appendices A-H present both some questionnaires and knowledge tests (including concept mapping techniques) that have been used during the research project. The appendices have been used as described in Table 6.2.

Table 6.2: Description of the content of some questionnaires and tests used during the research process.

Appendix/ Session/ Date	**Purpose of the questionnaire/test**
A/2/ 22.9.1999	Demonstrative game session for the case company Gamma. The purpose of the questionnaire's closed questions was to collect participant opinions on how well the game illustrated different Gamma business functional areas. The game environment was configured to resemble especially the Gamma materials process. The closed questions also included questions concerning Realgame user interface usefulness. The open questions concerned Realgame usefulness as a training tool in general, how the game should be further developed, and whether the game included potential as a process training tool.
B/17/ Autumn 2001 (6 weeks)	The questionnaire was used on a university business game course. The course lasted six weeks and the students were asked to fill in the questionnaire at the end of the last session. In the closed questions part the students evaluated the game functions and characteristics. Most of the questions are the same as already used in the questionnaire of session 2. Also after session 17 the closed part of the questionnaire has been fixed (if it has been used). The open part has been modified very frequently, to try to capture the special character of each training session in question.
C/17/ Autumn 2001 (6 weeks)	This test represents the first effort to capture knowledge about possible learning taking place through Realgame sessions. Exactly the same test was run both at the beginning of the first course game session and at the end of the last session. The tests included a concept mapping task using a flow charting technique (task 1), a task to describe solutions to a business problem (2), a task to describe characteristics of business operations/situations (3-5), and a task to calculate common financial key figures (6).
D/ 16, 18, 23/ Oct. and Nov. 2001, June 2002	The purpose of the questionnaire was to ask the business participants about their opinion of the game. The closed part of the questionnaire was according to the already fixed structure of questions. The open part questions dealt with the game's ability to give a holistic view of business operations, what the participants thought they had learned during the game, and whether the continuous nature of the game was a significant feature considering learning and understanding.
E/22/ March 2002	Represents a knowledge test that was used on a gaming course where the first half of the participants consisted of business students and the second half of students of education. The test was run both before and after the course. The aim of the test was to compare the working and learning of intermediate experts (business students) and novices (education students). The purpose of the test was to find out the effects of the use of the game on students' substance knowledge. The test included a concept mapping task using a flow charting technique (task 1), tasks to describe solutions to business problems (2-4), and a task to solve a production capacity problem (5; to be solved in groups).
F/26/ October 2002	Used on a university Investment Planning course, where the game formed a virtual world upon which the students had to first create a capacity investment and funding plan and then implement their plan in the game environment. The questions of the questionnaire were open ended questions concerning issues like: did the participants feel that they had learnt something about business processes, did the game help to think about machinery investments, how did the participants feel about the non-complete information (considered a realistic environment by the teachers), did they find gaming useful in the investment planning context, did the use of the game add value that would not have been possible with other teaching methods, and so on.
G/24/ September	Represents the latest version of the "standard" game questionnaire.
H/25&28/ October 2002	This test was used in the case of Alpha, described in Paper 4. The tests included a concept mapping task using a flow charting technique and a task to select from several different operational decisions in a warehousing/manufacturing problem (multi-decision problem). The third part of the test included an evaluation of the outcomes (to seven different factors) of the chosen decisions.

The application of the questionnaires and knowledge tests will be described in Section 6.3 and also in Papers 3 and 4.

As a preliminary comment on the use of these methods we can conclude that our research topic is such that conclusions and research outcomes are difficult to observe directly. The treatment of most of the empirical data we have gathered requires interpretation. The difficulty of interpretation has led us continuously during the research project to modify our research instruments to better capture the nature of learning. As Cunningham (1997) notes, the methods to be employed – even the definition of the problem and the propositions to be tested – undergo modification as interim results are validated or invalidated in practice and in experimentation.

Our use of data collection techniques can also be called triangulation. In triangulation the goal is to (Cunningham, 1997, p. 415) *use qualitative and quantitative data together, and use multiple levels of information and perspectives to provide different viewpoints on a research issue*. The type of triangulation used is *between methods* where comparisons involve the use of different and distinct research methods. If the multiple and independent methods reach the same conclusion, there is a higher level of confidence. The weaknesses of one perspective, method, or design can be strengthened by the counterbalancing strength of another. Triangulation can also involve "multiple researchers". Especially the work introduced in Paper 4 involves triangulation kind of research, where the results from several different kinds of data gathering techniques (but also from the perspectives of two researchers coming from different scientific disciplines) have been combined to make conclusions about the training cases.

6.3 Evaluation

We have found it difficult to create research instruments which would provide fruitful information about the game properties in the context of learning. We acknowledge that the game questionnaires used with Realgame training sessions (Appendices A-H) only take rudimentarily into account the ideas and concepts presented in Chapters 3, 4, and 5. The participant answers to these questionnaires should be viewed as a first initial assessment. The empirical results provided in this section are to be understood to illustrate the utility and service of Realgame for the game users (individual participants and their organization). Further evidence of the artefact capability to function as a tool to improve competence in representing holistic organizational structures, time and business processes, and decision-making levels will necessarily be a research project continuing after this doctoral research (as well as those topics that have been theorized in this thesis, like dynamic complexity). Justifying the game by drawing hypotheses from the theories, designing a survey instrument to measure these hypotheses, and then collecting empirical material to test them and thus providing scientific evidence about the learning outcomes of the game is out of the scope of this study.

Thus, can we say anything about the lessons learned by the individual players, as members of teams? The questionnaires were used as an exploratory tool. The qualitative data gathered (questionnaire open ended questions; analysis of video recordings and interviews in Paper 4) has been clearly more important in evaluating Realgame functioning as a learning tool than the use of closed questionnaire questions.

The closed part of the questionnaire (the 15 themes to be evaluated on a Likert scale; see, for example, Appendix B) has been used to assess the game functionality from the human-computer interaction point of view and to illustrate the client companies' support for the game and its service. Though the questionnaire has evolved during the project, the questions in the closed part have remained the same. For the purpose of evaluating and justifying the game against the theories presented in Chapters 3, 4, and 5, the Likert scale is deemed to be inadequate. The closed part has *not* been used to evaluate Realgame's ability to enhance participants' understanding of the business issues represented in the game. The closed part has been a valuable instrument to evaluate how the Realgame interface acceptability has developed during the game development project. These items have been necessary purely from a technical point of view. Other scaling techniques have not even been considered to assess this game technical quality with as we have thought that this kind of instrument is easy to use and provides adequate information for the purpose.

The following discussion illustrates the assessment of the game functionality from the human-computer interaction point of view, using the Likert scale part of the questionnaires through the whole research project. In the questionnaire closed part the game participants have been asked to estimate the properties and characteristics of the game on a scale from 1 to 7 (from 1 to 5 in the original questionnaire; those sessions in Figures 6.1-6.4 where the questionnaire scale has been from 1 to 5 – sessions 1-13 – have been proportioned to correspond to the scale from 1 to 7). The following graphics include both student and company in-house training data. Company data is marked with a hollow square, student data with filled squares.

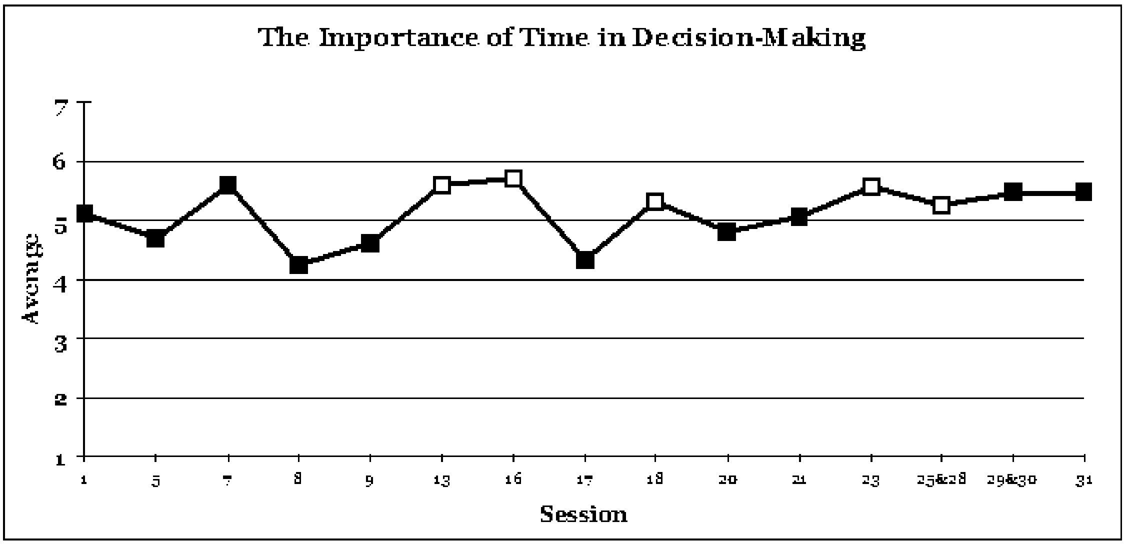


Figure 6.1: Participant responses when they were asked to evaluate the importance of time in decision-making in the game. The session number corresponds to the session number in Table 6.2 (hollow squares represent company data, filled squares student data).

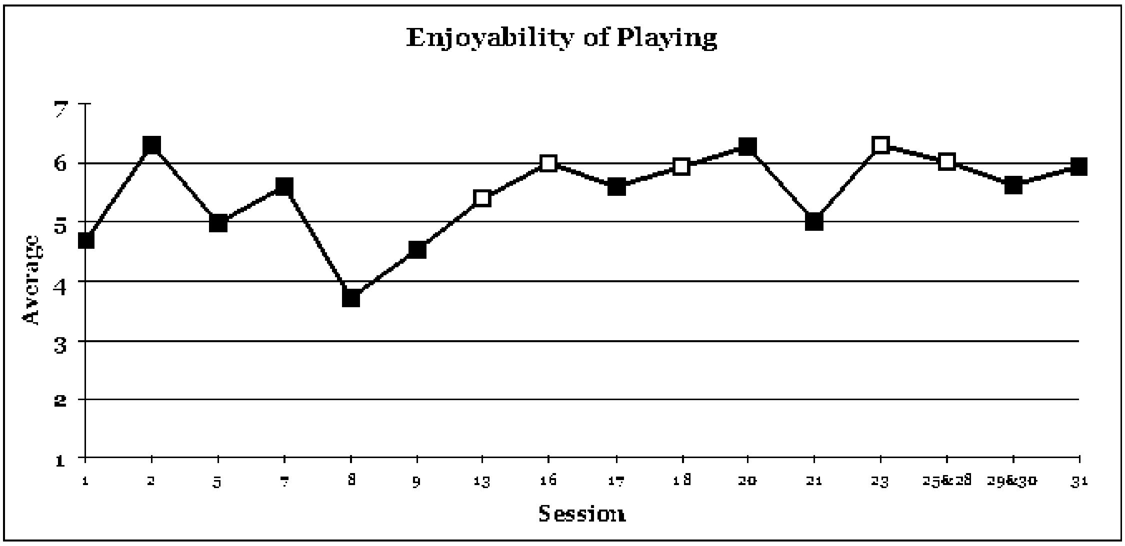


Figure 6.2: Participant responses when they were asked to evaluate the enjoyability of playing the game. The session number corresponds to the session number in Table 6.2 (hollow squares represent company data, filled squares student data).

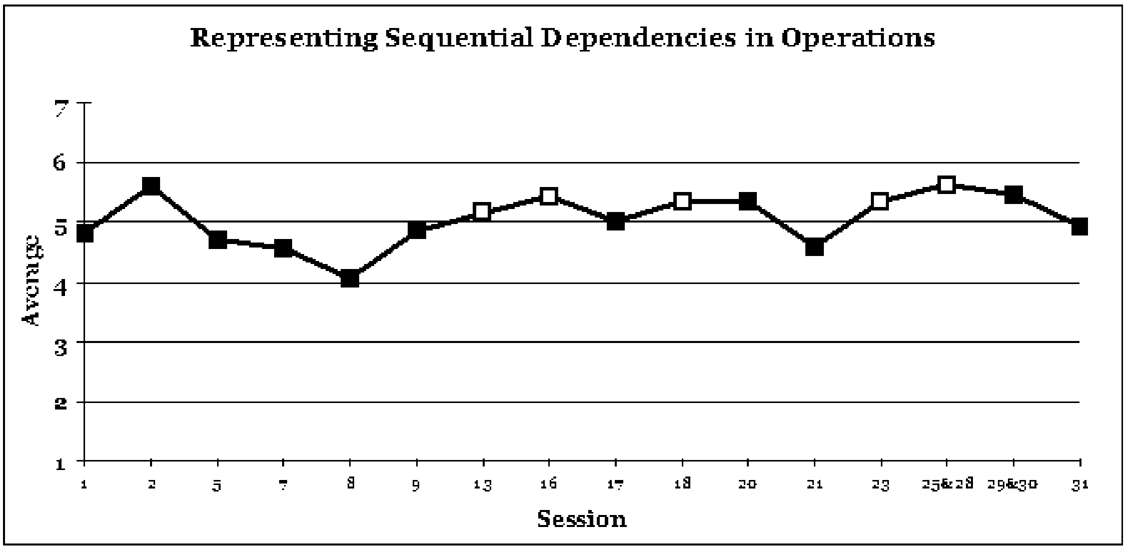


Figure 6.3: Participant responses when they were asked to evaluate the game's ability to represent sequential dependencies in business operations in the game. The session number corresponds to the session number in Table 6.2 (hollow squares represent company data, filled squares student data).

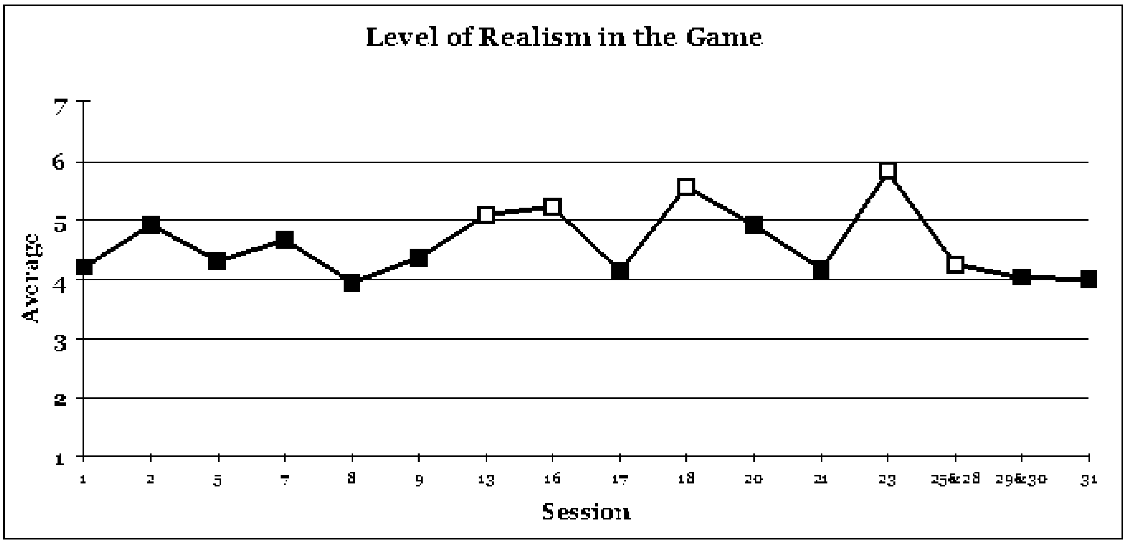


Figure 6.4: Participant responses when they were asked to evaluate the level of realism in the game. Session number corresponds to the session number in Table 6.2 (hollow squares represent company data, filled squares student data).

There are some clear findings from these graphics. First, the game has received clearly better grades from company training sessions than from student sessions. Secondly, the longer the game session, the better the grade. The conclusions from these findings are, for example, that:

- The participants consider the time aspect of decision-making to be well implemented in the game.
- The participants have highly enjoyed the gaming experience and the game interface is easy to use.
- The participants consider that the game illustrates well sequential dependencies in business operations.
- The game creates a complex learning environment which demands at least a whole day's training session.
- The game environment is a demanding one and it seems that students have difficulties in understanding the holistic structure of the game and the connection to the real world.

The last point above supports the discussion about business education we have presented in Paper 3. The methods and tools used in business universities are insufficient to cope with the complexity characterizing business systems. The traditional system of teaching encourages specialization, bringing with it the tendency to optimize partial goals to the detriment of overall objectives (Machuca, 2000). Thus, the students show more difficulties in grasping a holistic view of the game.

We note that in general the grades have been very good except for some of the very first short student training sessions. As an initial exploratory assessment of the game's usefulness in practice we feel that the results are very positive and that the data presented here is sufficient to evidence this.

The following contains a description of the results achieved when using the different questionnaires and tests. We want to emphasize that it is very difficult to determine organizational cognitive changes empirically (Holmqvist, 2000). Also Argyris and Schön (1996) note that it is a challenge to find evidence of a behavior in organizational theories of action.

Appendix A, Session 2, 22.9.1999

The application of this questionnaire is discussed in Section 6.4.

Appendix B, Session 17; Autumn 2001 (a 6 week game course)

Session 17 was a university business gaming course of 2 credits. This was the first gaming session that was arranged together with Sami Nurmi from the department of Education, University of Turku. The course lasted 6 weeks. During each week there was a gaming period of four hours. As such, this session represents the longest Realgame session so far. After each game session the students were given home assignments to be performed before the next game session. The home assignments were about sales forecasting, capacity planning, purchase planning, strategy creation, SWOT analysis, calculating financial key figures, and so on. 19 students enrolled the course, 17 finished successfully. The students were given a grade from the course. This grade was based only on the home assignments and how the groups succeeded in the competition did not affect the grade.

Appendix B represents the regular Realgame questionnaire which has been in use since the very first game sessions. The averages of answers to the closed part of the questionnaire in session 17 are within the averages of other student sessions (see Figures 6.1 – 6.4).

The open ended questions included following kinds of answers. First, some answers to the first open ended question: "*Did the game help you to get a holistic (whole structure) view of business processes? Why/why not?*":

- *I think the main elements were in the process but the whole procvess was very simplified. One extra function in the game could be R&D* [exists in the present Realgame version]. *The players could put some effort in R&D too and come out with better products than the competitors.*
- *I think the game simulated the business processes quite well. However, I'm not sure if it is possible to get a complete holistic view from just a game. I think we got a pretty good view of the whole structure though.*
- *Absolutely yes! Now I have a much better knowledge of what kind of problems a company management might be facing, and perhaps also some knowledge on how to solve similar problems.*
- *Yes, absolutely. Although greatly simplified, it does include all of the essential business processes of a manufacturing company, and the way in which each process supports the others is discernable.*
- *Not really. The representation of events in the game gave a piecemeal impression of what's going on, rather than linking the causes and effects together in a meaningful way. It's a bit hard to say what my response had been if I wasn't already familiar with business process re-engineering, though.*

Some answers to the open ended question: "What do you feel you have learned during the course? What was the most important thing you have learned?":

- *I think I've learned a lot during the course. It was nice to be able to use information you've learned in other courses. That's for instance different ways to optimize production. The most important thing I've learned was about the team work – how easy it is to work as a group when you need to.*

- *The assignments which helped to understand the business process and helped to analyze own situation and the competitor's situation. I think that's helpful to learn for later use in the real life.*
- *I have learned that there is a lot that should be taken into account when you are running a company. All the phases affect each other. The most important thing I learned is that it is important to carefully follow all individual processes.*
- *I feel the most important lesson is the requirement of knowledge about own business processes, and accurate cost and revenue assessment. Also, sufficient knowledge about competitors and a clear strategy are equally important. With the element of little time to make decisions, rapid access to relevant information as well as a clear strategy are imperative to success.*

Some answers to the open ended question: "How useful do you think the Realgame is in teaching business processes (e.g. compared to traditional teaching methods; lectures, seminar working etc.)?":

- *There could be more courses like this. Perhaps the course could include some lectures about business process theories that could then be used in the game.*
- *I think it is very useful as an alternative way of teaching. However, I don't think you can substitute traditional teaching methods with gaming. Using both together is probably the best way. Gaming is however a fun way of learning and it's also important that learning is fun!*
- *Much better, this way you have to learn by doing. Remembering is easier and makes you plan for next time.*
- *I think that it is very useful. As you know we (students, people) learn things most effectively if we can interact, do something ourselves. If we just sit at a lecture listening we don't learn so much, a little bit more if we can write it down, but most effectively if we can do something ourselves.*

Some answers to the open ended question: "Was the working of your group successful? Would you have succeeded better alone?":

- *I found our teamwork to be excellent. This because we all got along very well, and at least I learned many new things from my teammates. I would certainly not have succeeded as well alone.* [a student from a well succeeded group]
- *I think our group sucked thoroughly and deep, if you'll forgive my French. Two working men with too much to do on their hands elsewhere and somewhat lacking personal chemistry, without a clear leader of the orchestra… no. I would definitely have been able to do*

> *better by myself or with a group of three, with clearly defined areas of responsibility – as opposed to the "who happens to have time will perform" kind of organization we had. I'm sorry for the poor show we gave, there just wasn't enough time here… I wound up with an emergency at my job, two persons leaving at the same time, including our biz controller, and have been working almost straight 24's for three weeks now. This week we'll be done.* [a student from the least profitably successful group]

In general, the answers were very positive. Less positive answers came almost without exception from those students who did not manage well in the game competition. The answers to the open ended questions were very similar to answers of any of the other sessions run during the research process. However, we want to point out two potential differences. First, in this session if the game for a group started to go in a bad direction already in the beginning of the course and the students were not able to change this direction, their motivation plunged and this reflected quite clearly in some of the answers (especially the two students in the least successful group). Secondly, as the gaming time was considerably longer than in other sessions, the students were better able to find inconsistencies in the game. This reflects especially in the grades given to some business functions in the closed part of the questionnaire (like the average grades for Marketing, 3.86, and Management of funding, 3.73). These functions were partly incomplete during this game session but have been improved since that.

Appendix C, Session 17; Autumn 2001 (a 6 week game course)

This knowledge test was used also during Session 17 (as was the questionnaire of Appendix B). This test represents the first effort to capture knowledge about possible learning taking place through Realgame sessions. Exactly the same test was run both in the beginning of the first course game session and at the end of the last session.

The first task in the test was a concept mapping task using flow charting technique. The second tasks was to describe solutions to a business problem, from third to fifth the task was to describe characteristics of business operations/situations, and the last task was to calculate common financial key figures. The two researchers graded the test answers together. Separate grades were given to the pre game and post test answers. Grades from the tests were summed and then the averages of the pre and pots test answer sums were compared.

We will first analyze the concept mapping task (task 1). Figures 6.5 and 6.6 illustrate the typical problem we encountered with the concept mapping task of the knowledge test. Figure 6.5 represents the pre test answer of a student.

The drawing represents a quite well thought and concise presentation of the delivery process of a manufacturing company. However, the post test drawing (Figure 6.6) of the same student is simple and superficial, not presenting the same level of detail represented in Figure 6.5.

Then, what are the conclusions on this pair of drawings? First, we have noticed that it is difficult to come up with suitable tasks/processes/topics to be drawn as concept maps. The delivery process gives an example of this. This process is – after all – quite straightforward and probably does not represent a learning topic that is the most potential to be used as an example of how participant mental models have developed. Learning taking place through simulation gaming is about dynamic models, not that much about easily documentable straightforward procedures. We also believe that learning trough simulation gaming is also about tacit knowledge which does not easily turn into explicit drawings. Furthermore, what is learned depends on the individual in question. In that sense it is difficult to determine concept mapping tasks that would function in a rational manner with the majority of the learners. The learning taking place through simulation gaming is about phenomena that are not static, narrow, or reductionist, and are, thus, hard to turn into static drawings. It is difficult to portray feedback processes and time delays with static drawings because a drawing cannot present dynamic structures.

Secondly, it is very difficult to motivate the students to twice build a laborious model on paper. The students were not equally motivated to answer to the post test. There surely are several reasons for this. Maybe the students could not see the reason for this drawing task, thus neglecting it. Also, the students were tired after the last game session. When they then had to draw the concept map they carried this out hastening and bungling. We do not think that postponing the test to some other day would have made the student motivation any better.

Actually, we have not found any solutions to these problems of using concept maps but have lately started to apply other techniques like participant interviews. We see interviewing more potential to reveal personal learning about issues that are may also originally be tacit. The interviewer is able to ask further questions aiming deepening the topic in question and thus leading to answers the learner would not her/himself be able to spontaneously produce. How interviewing has worked in our studies can best be seen in the case of Paper 4. After Session 17 the last two times we applied concept mapping were Sessions 22 (Appendix E) and Sessions 25 & 28 (Appendix H). The results from these were not any better than with the test described here.

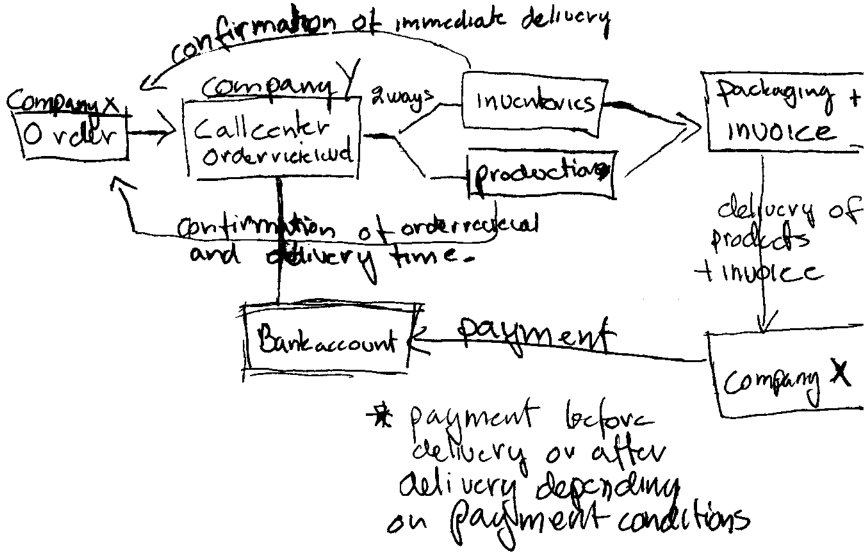


Figure 6.5: An example of a student pre test conceptual map (Realgame Session 17, autumn 2001).

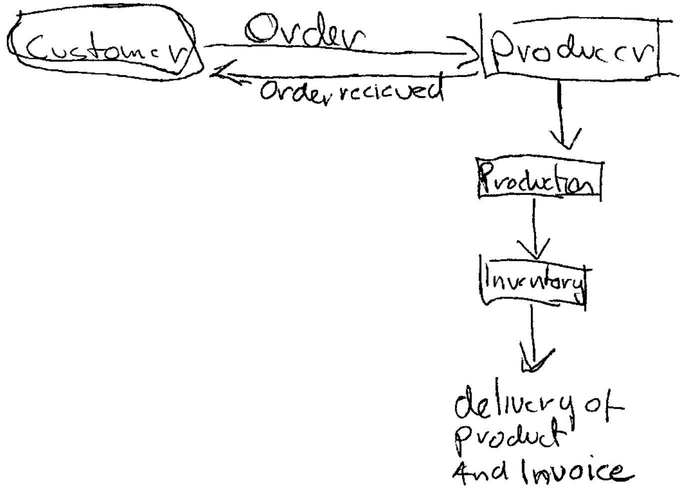


Figure 6.6: An example of a student post test conceptual map (Realgame Session 17, autumn 2001).

Question 2 in the test was: "*How can a company ease its tight cash situation by changing the available payment terms?*" The aim of this question was to reveal whether the students have a perception of how both the payments and incomes affect a company's liquidity. The assumption was that the students understand well that the earlier a company gets the payment from sales into cash, the better the monetary situation. But we also assumed that they do not necessarily have this clear perception of how raw material and other payments affect the cash. These assumptions proved to be right.

In the case of this question the end test answers were worse than the questionnaire answers at the beginning. Analysis of the answers reveals that the average of the knowledge level between the pre and post tests decreased by 6.3 % (from 2.00 to 1.88; scale from 0 to 3). Our assumption is that the students felt that this question was too easy and in that sense they did not concentrate on answering it properly. In other words, they did not consider this question demanding enough and therefore neglected it. This assumption is supported by the following fact. In the pre questionnaire 5 students mentioned both the prolonging of the term of payment when ordering from the suppliers and the shortening of the term of payment when selling to the customers. But from these 5 students only two mentioned both of these possibilities in the end questionnaire. Below an example of such an answer pair (pre and post). This student's pre answer: "*By giving customers a short payment time and by buying from producers who offer longer payment times.*" The previous answer is concise and perfect. However, in the post test the student gives the following invalid answer: "*The company can demand shorter payment periods, usually with some incentive like cheaper prices or faster deliveries.*"

An interesting phenomenon is that four students out of 17 changed the language of their answers from Swedish to English between the pre and post tests. One assumption explaining this is that the students would have liked to use English already in the pre-game test but their vocabulary of the context was not wide enough. As the game interface was in English, the students probably have learned the key expressions in English during the game and have felt more secure to use proper English words after the game sessions.

Question 3 in the test was: "What kind of characteristics can be found in an efficient materials process of a manufacturing company (purchases – inventories – production – inventories – deliveries)? I.e. what are the crucial elements that have to be managed in order for the process to be efficient and economical?" The aim of this question was to reveal how well the students were familiar with some materials process management terms like optimal order sizes and frequencies, inventory management, optimal production batch sizes, order based production, and capacity management.

When analyzing the average knowledge level of the answers we can see that the average was a bit better in the post test (from 2.25 to 2.56; scale from 0 to 4) showing an increase of 13.9 %. Still, three students showed worse results in the posttest, implying that again the students were a bit tired to answer the posttests. It seems that the students answered once thoroughly (either in the pre or post test) and once superficially, as if they had thought that it is enough to answer once and the other time is not necessary anymore. Below in Table 6.3 some examples of pre and post test answers.

Table 6.3: Some examples of answers to question 3 of the knowledge test of Appendix C.

Pre test answer	Post test answer
Purchases must be economical but still be steady and exact. Incoming inventories should be kept as small as possible but still so big that there are no gaps in production. Production should be effective so that no invalid products are manufactured. As little raw materials as possible are used. Production should also be fast. Our sales inventory should be kept as small as possible but we should also be able to meet customers' orders. Deliveries should take place on time in a secure and effective manner. [Original answer in Swedish].	Store should be optimized so [that] not too much is stored. Buy cheap, sell at a price that covers all expenses and perhaps even makes some profit. [Original answer in English].
The main issue is to maintain steady production and as low inventory as possible, especially with high-cost products. On the other hand, inventory must be sufficient to maintain production. It is very important that one element of the production process is not forced to wait for another, i.e. procurement of raw materials must be managed so that orders are sent in time, i.e. raw materials never run out. Also, manufacturing must be steady in order for sales to be able to maintain steady deliveries, since late deliveries are very disadvantageous for a company.	Capacity has to be managed, with as little excess capacity as possible. Also, bottlenecks must be eliminated. In our case, for example, Switch production must be able to keep up with Biocounter production. Purchasing must be effective, not too little supplies, or production will stop. But not too much or inventory will become expensive. Inventory management. The ideal is just-in-time delivery, but this is very difficult, and vulnerable to temporary stoppages. We must see to that our inventory is maintained as small as possible, but still able to handle problems.
Not to produce more than is sold. To be able to foresee the demand. To buy cheap and sell expensive. To be able to change the production fast if demand decreases. To be able to prioritize those products that are the most profitable to manufacture.	Purchases should be carried out so that you buy in time (at a cheap price) the necessary amount of raw materials so that production functions all the time as effectively as possible. Overly big amounts should be avoided so that not too much capital is bound in raw materials. This means that the company should not be an inventory location for the raw materials supplier. Manufacturing should be taken advantage of maximally; you should try to balance production as effectively as possible. It is also positive if manufacturing can be easily adjusted to changes in demand. Finished goods should be found in inventory so that even the biggest orders can be delivered on time. Deliveries should be adjusted according to the customers' needs and price setting should be adjusted after that.

The first example in Table 6.3 shows how the student didn't bother to express all his knowledge about the topic in the post test. The post test answer is clearly less definite than the pre test answer but we have no reason to suspect that he had become less knowledgeable during the game course.

The second example in Table 6.3 shows how the student applied the game experiences to theory. Otherwise, the post test answer is not that different from the pre test answer, but they both are very good.

The third example in Table 6.3 shows a clear increase in awareness about the topic in question. The post test answer is more extensive and the terms used are precise and exact.

Question 4 in the test was: "*What is the relation between cash flow and profitability? E.g. is positive cash flow (cash incomes greater that cash payments) the same as profitability? Explain your opinion.*" The aim of this question was to clarify how familiar the students were with the interdependencies between cash flow and profitability. Thus, we wanted to know how clear it was that, e.g., positive cash flow may originate from withdrawing a bank loan (but the company operations may still be making a loss), or negative cash flow may originate from paying for heavy investments (but the company operations may still be profitable). In other words, we wanted to clarify whether the students were aware of typical accounting allocation axioms.

The pre and post test answers were given grades from 1 to 5. The average of the pretest answers was 3.5. In other words, this topic was somewhat familiar to the students, though several of the answers were quite uncertain and fuzzy, mixing up the concepts in question. In the post test the average for this question was 4.00, showing an improvement of 14.3 %. Again there were indications that students were either frustrated in answering the question or that they could express themselves more exactly. The following Table 6.4 shows some of the best examples of how the answers have become more compact and less explanatory.

Table 6.4: Some answer examples to question 4.

Pre test answer	**Post test answer**
Generally speaking, the faster the cash flows, the more profitable the operations. If [you] buy something which you can't sell, there won't be any profit. There's a policy in selling "with little profit but selling more". In my mind, it's the same as profitability. Cash income is what you get for whatever you sell, and cash payments is whatever you pay out to get the products ready to sell.	Generally speaking, the faster the cash flows, the more profit you are making. But still it depends on the situation. Not really, if we take loans (on accounting as cash income), that's not profit.
If its incoming cash flow is always bigger = in the long run I can't see why the company wouldn't be profitable.	If it is long term yes!
Cash flow is incomes and payments, i.e. how money "flows through" a company. Profitability is profit, which the company gets.	Cash flow shows how money flows within a company at the present moment. In the long run cash flow should be positive so that the company can make profit. In other words, the "Net present value" of cash flow should be positive so that the company can make profit.
In order to make profit we also have to cover all other expenses the company has. [Original answer in Swedish]	Cash flow is money coming in to and going out from the company. Profitability is whether the company and investors have received any profits from their investments. [Answer in English]

In the first example of Table 6.4, the student has in her pre test answer a somewhat invalid view of how profit is generated. She connects the speed of cash flow to profitability, which is the false assumption we were expecting when planning the question. She does not mention margin (income from a product minus expenses consumed to create the product) at all. In the post test answer she still misses the margin aspect but the view about cash flow has expanded.

In the second example of Table 6.4, the student answer has become more secure about the subject matter (see the questioning nuance in the pre test answer and the exclamation mark in the post test answer).

In the third example of Table 6.4, the pre test answer is clearly quite insecure about the profit part. In the post test answer the profit part is quite nicely expressed.

In the fourth example of Table 6.4, the answer has become sharper, but the concept of profitability still remains unexplained (maybe he is trying to veil his ignorance) and shows no definite knowledge about the creation of profitability.

Question 5 in the test was: "*Which individual market features can a company scan in order to sense its competitors' actions?*" The aim of this question was to get an understanding of how well the students understand the role of their competitors in their own company's position. Thus, we wanted to see how the students interpret the turbulence of the environment caused by other companies within the same industry.

The pre and post test answers were given grades from 0 to 3. The average of the pretest answers was 1.38. In the posttest the average for this question was 1.44, showing an improvement of 4.5%. In general, the students' answers concentrated on simple concrete facts like competitor prices, terms of payment and terms of delivery. Very few (either in pre or post test) included less concrete aspects like the following pre/post pair of answers: "*Variation of products, competition, prices/differences in prices*." / "*Price, position, market shares, threats, weaknesses, market targets and areas, customer relations*." Obviously this question was difficult for the students and the reason for this may be that competitor analyses were not dealt with during the classes although the home assignments included a lot of tasks (e.g. SWOT analysis) belonging to this area.

Question 6 in the test was: "*Attached you can find some financial statements. According to the figures in these statements, calculate: a) Profit-%; b) Return on Investment (ROI)*". The aim of this question was to find out how well the students knew some very basic financial figures and whether gaming could improve this knowledge.

The answers were given grades from 0 to 1. We were quite astonished that even calculating the very simple figure of Profit-% produced difficulties. In the pre test less than half (average of grades 0.44 = 44%) of the students could give the right numerical value or the right verbal definition for Profit-%. In the post test the average of the grades was 0.50, meaning that exactly half of the 16 students returning the test could calculate or explain the figure right, indicating an increase in the average of 14.2%.

In the case of ROI the results were even more disappointing. The answers were given grades from 0 to 2. In the pre test only one student could perfectly explain ROI but in the post test even he created an invalid explanation. The average of grades was 0.31 both in the pre and post tests.

During the course we did not explain how to calculate these figures. The figures were, however, explained in the course compendium and these figures were very regularly used when analyzing and comparing the game competitive situation. Still the students did not bother to find out the exact formulas for these two very central financial figures. Another thing is that these students all studied some business science and in that sense the financial basic concepts should be very clear to them.

The following conclusions can be drawn from the test questions analyzed above. We can say that in the experimental design it is utterly important to design the pre and post tests so that altered student motivation does not affect the way they answer the test questions. Thus, especially with the post test, it is important that the students do not regard the test to be a heavy burden and something that is only a repetition of old questions. This is where we clearly failed as the results were heavily affected by the students' reluctance to answer the questions properly. This also shows in the summarized averages of pre and post tests, which increased only from 12.7 to 13.9 points (max. 21), as described in Nurmi and Lainema (2003), quoted below in Appendix E.

Our results also suggest that gaming without lectures about subject matter or assignments on them is not enough to produce maximal learning results. The students have to be actively exposed to the learning topics to take full advantage of the gaming environment. It seems that mere gaming does not put the students to a situation where they really should test and examine their mental models. Without suitable challenges the participants' gaming may become mere ‘video game shooting’ rather than a serious learning effort. Thus, the teacher has to ensure that the students really undergo their mental models about the learning topics and their defective mental models are fixed through experiences during the gaming.

Results from this experience show that a game can, together with the business context learning themes, be used as an effective language learning tool. The language learning can happen without any investment into the language itself, thus, this learning may happen automatically. This learning is something we did not expect beforehand, although it now seems quite natural.

As there were obvious problems with the test we have, after this session, used less heavy knowledge tests. After this, the only time when we used a similar type of knowledge test is described in Appendix E.

Appendix D, Sessions 16, 18, 23; October and November 2001, June 2002

The application of this knowledge test is reported in Paper 3.

Appendix E, Session 22; March 2002

This knowledge test was used (before and after the game session) in the game session which has been described in Nurmi and Lainema (2003). The tests and the training session structure were both planned in cooperation between Sami Nurmi and Timo Lainema. The test included one concept mapping task and three tasks to be answered verbally. Besides of these individual tasks there was one group task which included solving a manufacturing problem by calculating the bottlenecks of production material flows.

We will first discuss the group task of the test (task 5 in Appendix E). This test proved to be quite easy for the participants. The pre-game test answers were already on a very good level, both in the novice and intermediate experts groups. We could not make a difference between the two groups.

The test problem description includes two different bottlenecks. First, the production of Scanners does not equal the demand (10 short per week). Secondly, the automatic raw material order for the present production level is too big for Electronics (100 units per week) and short on Sensors (50 units per week). On the other hand, if the production of Scanners is raised to equal the demand (10 units more to be produced per week), then the automatic raw material order for the raised production level is only 50 Electronics units per week too big and 70 units per week short on Sensors.

Figures 6.7 and 6.8 represent a typical pre-post test answer pair of one group (of intermediate experts). In figure 6.7 the students have found a right verbal answer to the problem: "*The auto order for Sensors is too small compared to the produced amount and there is too much Electronics in the inventory. There is more demand for Scanners than can be produced. The raw material inventory should be increased to increase the production to equal the demand*." Thus, the students understood the problem and found solutions that aim at the right direction. However, there are no exact recommendations on the valid values for production and orders. This might be only because they did not bother to give the right figures as an answer (but you can see the figures being calculated and in the boxes in the problem figure).

In Figure 6.8 the same group of students solve the problem in a similar way but now they also provide numerical values and exact actions as a solution: "*If Scanners are produced 60/week then 50 more Electronics and 20 more Sensors are needed. Thus, we need to order 50 less Electronics per week and 70 more Sensors per week. The total weekly order should be 550 Electronics and 170 Sensors. To balance the situation the capacity of the machines will be increased or more machines will be bought.*" Thus, the solution is exact and the students also propose actions to correct the unbalance between demand and supply.

Most of the pre and post test answers were similar to the one described here. The students could solve the problem also in the pre-game phase. On the other hand, some were reluctant to answer the test questions again, as one group gave the following as an answer to the post-game test: "*The same as the last time*". For us this test presents a typical factual problem. Thus, the students do not need any higher order business skills to solve the problem. The task was a simple calculation problem which did not call for special business knowledge or higher order mental skills. In that sense the task was not planned well enough but we – of course – understood that this test is not valid to reveal such learning as is possible to achieve through simulation and gaming exercises.

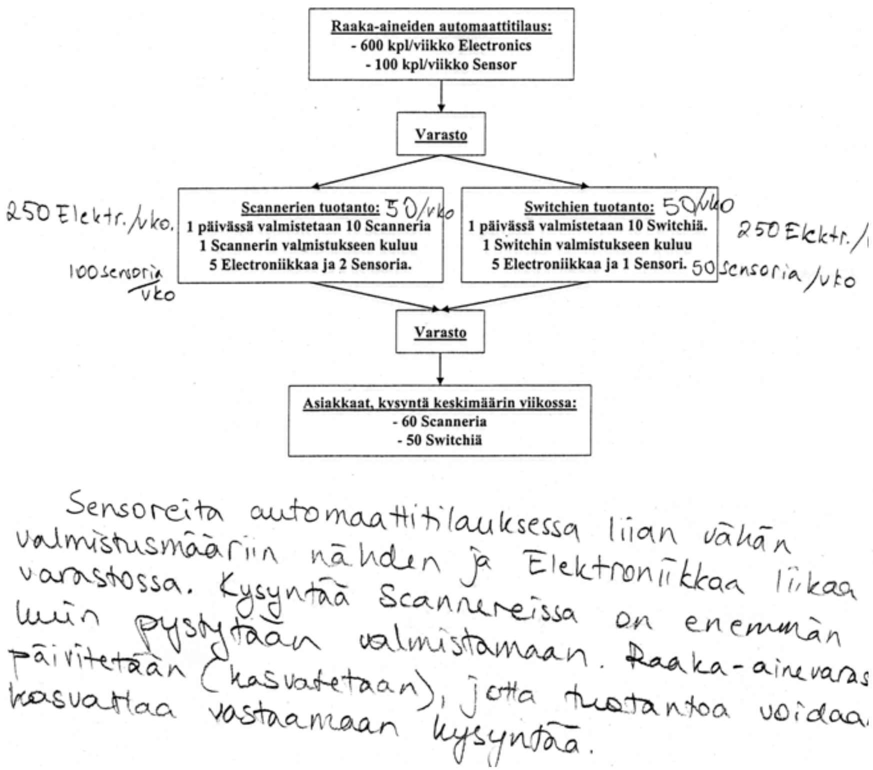


Figure 6.7: An example of a student group pre test answer (Realgame session 22, March 2002).

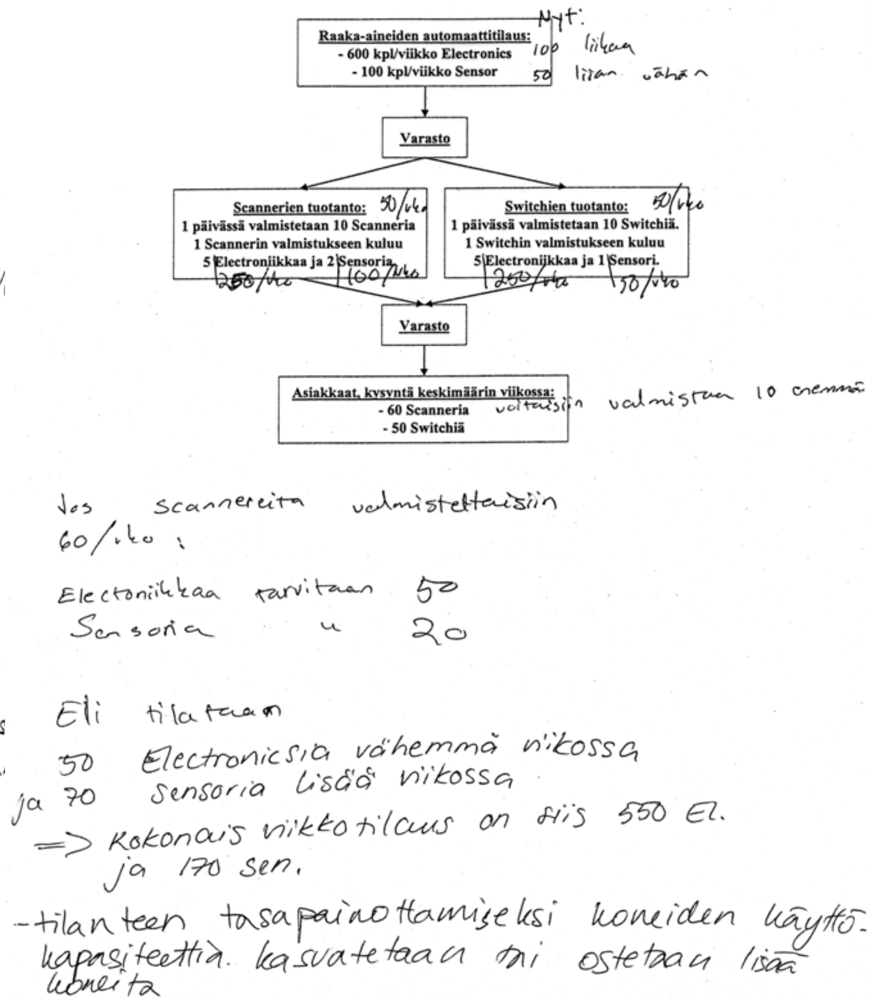


Figure 6.8: An example of a student group post test answer (Realgame session 22, March 2002).

The first task in the knowledge test of Appendix E was to draw a concept map describing the factors influencing the cash flow of a manufacturing company (both positive and negative factors). Once again we faced very similar problems as with the concept mapping task of Appendix C.

The rest of the tasks in this test were questions to be answered verbally (in written form). The maximum grade for each question (tasks 2, 3, 4a and 4b) was 4 points. Thus, the maximum amount of points from all of the 3 tasks was 16 points. As one of the researchers is an expert in Education – not so much in business sciences – the researchers prepared together example answers to the questions. Then, with the support of these examples, the researchers independently graded each of the student answers, both in the pre and post tests. After this, the researchers met and compared the points they had given. If there was a difference between the researchers' grades, the answer in question was looked at together and given a jointly decided grade. Then these pre and post game total grades were compared, as described in Nurmi and Lainema (2003), quoted below:

OVERVIEW OF THE CURRENT RESEARCH

At the moment we have conducted two separate studies with DBG [Dynamic Business Game, i.e. Realgame]. *The first one* [Session 17, Appendices B and C] *was arranged with 19 students of business administration, and the course lasted 24 hours in addition to several home assignments. The second one was given to 28 students of business studies and educational sciences (14 of both). During this 20 hours course we were able to compare the working and learning of intermediate experts and novices. We have now collected a large amount of both quantitative and qualitative data. The purpose of the researchers was to understand the actual collaborative learning and working processes when using the simulation, and to find out what the effects of the simulation course are on students' substance knowledge and attitudes towards ICT, team work and business studies.*

PRELIMINARY RESULTS AND DISCUSSION

These preliminary results are only based on the effects of working with the simulation, and feedback and experiences from the students. When reviewing the students' scores on pre and post test questions in Study 1, the effects of playing were significant, but the overall increase in score was quite modest, the average scores increased only from 12.7 to 13.9 points (max. 21)(table 1).

Table 1: Effects of simulation course on the scores on pre and post tests of substance knowledge in Study 1.

Repeated measures T-Test

test scores	***mean***	***N***	***st. dev.***	***t-value***	***df.***	***sig. (p-value)***
pre test score	*12.69*	*16*	*3.301*			
post test score	*13.88*	*16*	*3.243*	*-3.230*	*15*	*0.006***

**** p<.001 **p<.01 *p<.05 (max. 21 points)*

We were not quite satisfied with our first test questions, which dealt too much with factual knowledge, and the content of our problem solving tasks didn't match well the issues students had to face while working with the simulation. It seems that by its very nature the results of simulation work are so qualitatively different from the mere acquisition of new factual knowledge that those effects cannot be detected by traditional knowledge tests (c.f. Swaak & de Jong, 1996). Swaak et al. (1998) conclude that it is not clear how the effects of learning from simulation are to be measured. Further they infer that simulation working produces intuitive (or implicit or tacit) knowledge, which tends to be difficult to verbalize and to measure. As a consequence in Study 2 we changed our test questions more towards problem solving and knowledge applying tasks as well as concept mapping assignments.

In Study 2 simulation working has greater and statistically more significant impact on test scores (see table 2). The overall mean scores increased from 8.8 to 11.1 points (max. 16). When reviewing the differences between novices and intermediate experts it can be seen that simulation working had different effects on their test scores, although both groups improved significantly. In short, the interaction effect of the level of expertise and simulation_working was significant in MANOVA (table 3). Students of economics had much higher scores in the pre test than novices, but as a consequence of simulation working the mean development of scores was greater with novices (see figure1). However, intermediate experts still outperformed novices, but the gap was narrowed.

*Table 2***:** *Effects of simulation course on the scores of pre and post tests of substance knowledge in Study 2.*

Repeated measures T-Tests

		mean	***N***	***st. dev.***	***T-value***	***df.***	***sig. (p-value)***
All	*pre test*	*8.79*	*28*	*2.672*			
	post test	*11.07*	*28*	*2.243*	*-5.518*	*27*	*0.000****
int. Experts	*pre test*	*10.43*	*14*	*1.910*			
	post test	*11.79*	*14*	*2.155*	*-2.924*	*13*	*0.012**
novices	*pre test*	*7.14*	*14*	*2.316*			
	post test	*10.36*	*14*	*2.170*	*-5.323*	*13*	*0.000****

**** p<.001 **p<.01 *p<.05 (max. 16 points)*

Table 3: *Effects of simulation working on the scores of pre and post tests between novices and intermediate experts.*

Repeated measures analysis of variance (MANOVA)

Effect	***Type III sum of squares***	***df.***	***mean square***	***F***	***sig. (p-value)***
time	*73.143*	*1*	*73.143*	*36.027*	*0.000****
*time * expertise*	*12.071*	*1*	*12.071*	*5.946*	*0.022**
Error (time)	*52.786*	*26*	*2.030*		

**** p<.001* ***p<.01* **p<.05*

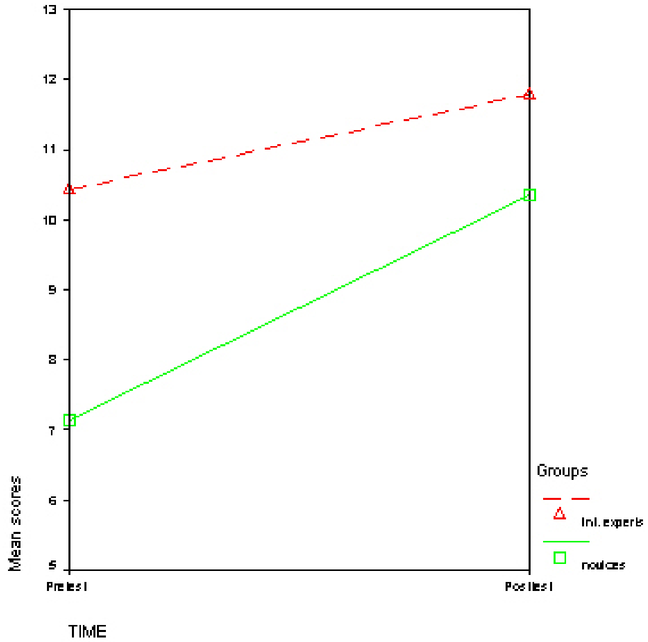


Figure 1: *Scores of pre and post test*

We also asked participating students to reflect on their experiences and give feedback from simulation working. According to these comments several conclusion can be made. First of all, all the respondents regarded DBG as authentic. They thought that the questions and problems they were dealing with during the game could also be faced in the real working-life of any manufacturing company. Participating students evaluated that DBG represent authentic and complex business processes in a realistic way. For example students said that "What made this playing feel so real was that you had to take care of so many things simultaneously to get the firm to do well" *and* "I realized that an enterprise is always a risk. You can't be sure that even reasoned decisions will lead to anything but a loss." *Secondly, the simulation was regarded as very engaging and working with it was experienced as meaningful and interesting. Especially the real-time element of the game was seen as a very important feature which affects authenticity and engagement, because real-time processing* "makes it possible to see the consequences of one's own decisions and actions*",* "…shows how important it is to make your decisions as quick as possible and before your competitors*", and* "…forces to observe the market situation, analyze the actions of other companies and revise your strategy*". Thirdly, participants especially assessed the collaboration around the simulation as very fruitful and useful. They said that the simulation could function as a shared frame of reference, which allows talking about difficult issues even without the correct concepts: "*Our team work succeeded well, and we were all aiming at getting our company to show a profit. I could say that the working was very intensive during the whole course, and the game inspired our discussion*". Students also saw DBG as very motivating teaching and learning method for business education, and based on their opinions it can be said that simulation could maintain task related orientation during the whole course. When asking students to reflect what the most important thing they have learned during the simulation course was, the majority stated that it was acquiring the consistent conception of business processes as a whole. They said that they could now understand how many different factors affect the success of a business company:* "…the most important thing that I have learned is how different parts of a company interact and what kind of things you have to take into consideration in such a company as this… you could see the flow of the whole process of the product from the raw materials to the end product and the different procedures in between*". In all, the overall responses about the whole course were very positive without an exception.*

In conclusion we state that simulation working can be regarded as authentic and very engaging as well as meaningful and motivating for students, and it could facilitate the development of a deeper understanding about realistic business processes as a whole. However, our qualitative analyses about the small groups' working processes are not done yet, and they will shed new light on many of our research questions and conclusions in the future.

Appendix F, Session 26; October 2002

This questionnaire represents the direction towards which we have started to move lately. As we have mentioned, the closed part of our questionnaires only helps to assess the game functionality from the human-computer interaction point of view. More important knowledge from the participants can be attained through the use of open ended questions but especially using methods like video recording and interviews. The results of the use of this questionnaire remain still unanalyzed.

Appendix G, Session 24; September 2002

This questionnaire represents the latest version of the "standard" game questionnaire. As can be seen, the closed part (which is used to ensure that the game is regarded technically functional by the participants) has remained fixed from the very beginning of the project. The open ended questions are modified according to the purpose of the training.

Appendix H, Sessions 25 & 28; October 2002

This appendix represents the unsuccessful knowledge test used in Alpha game sessions (see Paper 4). The conceptual map drawing task proved to be much too time consuming for the business people. Especially in the pre test answers they almost totally neglected this test, many by just answering: "The same as in the pre test". This made the use of this test as an analysis tool impossible.

The second and third task in the test proved to be too complex to analyze. The researchers should have tested this combination test beforehand to check that some sensible results could be deducted from the answers. However, this was not done and the test was carried out in the real training situation. The problem with the analysis was that we could not find any patterns in the answers (may be the sample was too small). Also the participants' motivation to spend time on answering the tests was weak.

We will be running two new training sessions with our case company Alpha during autumn 2003 but the unsuccessful knowledge test represented here will most probably not be used, not even any modified version of it. Instead, we will put more emphasis on video analyses and participants' interviews, as described in Paper 4.

6.4 Verification

After having presented positive participant evaluations of Realgame, we continue with the artefact verification. Guidance for verifying artefacts can be found from the domain of business sciences. A construction that is considered adequate in narrow technical terms does not necessarily work in practice. The actual usefulness of a managerial construction is never proved before a practical test is passed (Kasanen et al., 1993). In Järvinen's (1999) design science research process model the last phase is the construction evaluation phase. We have gone one step further here when assessing the verification of our artefact.

Paper 4 includes results that give some support to the verification of the construction. But an earlier verification test was arranged already in 1999 in case company Gamma, when, for the first time, the researcher regarded the game model as ready for presentation. In September 1999 twelve employees took part in this session. The game was planned to be a network game but the computer class in Gamma was equipped with Windows 95 which could not handle the network operations of the game and the computers ran a stand-alone version of the game (each company model has its own local market, thus no competition between the companies). Actually, during the game the participants did think that they were playing against each other. The truth about this was revealed after the game, before the questionnaires were delivered. The demonstrative game was more a test for the material processes of the game than a test of the overall holistic business structure of the game. The funding, sales and reporting features of the game were still developed quite a lot after this session. After the session a questionnaire was given to the participants. 10 questionnaires were returned. First six questions were answered in a numerical scale from 1 to 5 (1 for very poor/bad to 5 for very well/good). The frequencies of the answers to these six questions are represented in Table 6.5.

Table 6.5: The frequencies of the first six questions in the questionnaire of the industrial partner's demonstrative game training session (Likert scale from 1= Poor to 5= Excellent; N= 10).

Question	1	2	3	4	5
1. How well did the game represent the materials process of our business unit?			1	8	1
2. How well did the game represent the real business environment of our unit?			5	5	
3. How well did the game reveal the significance of separate tasks and functions to the goals of the holistic business unit?			1	7	2
4. How well did the game represent the bottlenecks in the activities of our unit?		2	3	3	2
5. How well did the game represent the sequential dependencies of functions in our unit?			1	8	1
6. Was the game training session a pleasant experience?				5	5

Some open-ended questions were asked in the questionnaire, too. The answers describe well the potential of the game:

- *The game is production focused, which is good for us. Familiar everyday activities. Sales – production – purchases (sectors).*

- *For all personnel groups – when well implemented teaches to understand at least something from every sector.*
- *The whole process was seen concretely.*
- *Everything that was included in the game software worked well and appropriately. It is hardly possible to include changing factors in the game, such as operating reliability, human aspects, communal influences,… Theory is theory; practice is practice; a machine is a machine; a human being is a human being. But not a bad experience. An interesting game, which certainly can be tailored for different focus groups as convenient packages. Cooperation worked all right in the game. This is something that should be invested in also in the future so that people would learn cooperation as something voluntary as well as desirable.*

The verbal answers to the open-ended questions reflect a positive attitude to the game as a training tool. The small amount of criticism concerned technical problems, not the basic idea and presumptions of the game. The answers to the training session questionnaire give strong support to the usability and acceptability of the game construction. Later questionnaires from other company in-house training sessions have given even better results (e.g. Papers 3 and 4). The most interesting results concerning the verification of the artefact come from the last company in-house training, described in Paper 4. Although artefact verification is not directly dealt with in Paper 4, some conclusions can be drawn from that research:

- The continuous processing element of the artefact represents how different business processes elaborate, emerge and link together.
- The artefact represents information flows and demands, sequential dependencies in operations and a holistic view of a business organization very well.
- The participants clearly regard the gaming experience as useful.

The usability of the construction can be demonstrated through the implementation of the solution (Kasanen et al., 1993). Kasanen et al. divide construction market tests based on the concept of innovation diffusion into three phases. In this taxonomy constructions are viewed as products competing in the market of solution ideas:

1. Weak market test: A manager responsible for the financial results of his or her business unit has been willing to apply the construction in question in actual decision-making.
2. Semi-strong market test: The construction has become widely adopted by companies.

3. Strong market test: Business units applying the construction systematically have produced better financial results than those which are not using it.

Kasanen et al. (1993) find that if a working solution is produced to a management accounting problem of a firm, it is likely that this solution applies to other firms of the same type. We agree with this in the case of the new artefact. As the artefact is developed in cooperation with an industrial partner, it is likely that the artefact can be applied or configured to describe other manufacturing companies, too. In fact, this has already been tested in practical training sessions (like the case in Paper 4 and the Section 7.7 concerning artefact configurability).

The applicability of the Kasanen et al. (1993) construction market tests is somewhat problematic in the case of the game construction. The weak market test has been passed with several companies; out of four companies which have used the artefact in production use, three will use the artefact in their future development programs. All the four universities that have used the artefact in teaching are still applying it as a part of their future undergraduate education or on courses offered to their business customers. To our mind, this clearly fulfills the weak market test and also hints that the artefact has potential to pass the semi-strong market test (the artefact will become widely adopted by organizations).

To clearly pass the semi-strong market test the artefact and the service provided through the use of it should be vendible. As the artefact creates more a training service than a diffusible training product, the semi-strong and the strong market tests are more or less interpretative and even hypothetical in this case. However, the semi-strong market test can be thought to have been passed now that the game construction has been used consecutively in several different organizations. For example, one of our case organizations has now used the artefact four times and new sessions are to come.

The strong market test is not necessarily applicable to educational constructions (if to any construction) as the interconnection between the use of a learning product and organizational performance is quite impossible to show in practice due to myriads of intervening variables, except in very rare cases.

We tend to notice that the actual usefulness of the artefact is proved with the practical tests. Besides of this test carried out in September 1999, several similar training sessions have been carried out since. Some of the results from these sessions are reported in the papers of this thesis.

7 ARCHITECTURE, CONCEPTUAL DESIGN AND THEORIZING

In this chapter we will connect the different parts of the thesis together to provide a comprehensive image of the artefact of the thesis – Realgame. For those not interested in the technical aspect of the artefact this chapter may prove to be quite uninteresting. Those readers are recommended to continue reading from Section 7.8, *Elaboration on the Process and Time Argument*.

The first phase (licentiate thesis) of this research entailed the construction of a continuously processed business game. The research problems in this phase concerned mainly how to solve some technical problems. As mentioned earlier in this work, the research problem of the first phase (licentiate thesis) was determined as follows:

Is it possible to construct a business game model in which:

(a) The business model works in an interactive, real-time processed connection with the markets.

(b) The business model (internal business model) and the market model (external business model) are customized according to the requirements of the training event.

(c) The business model demonstrates the total business concept. This includes the main functions of a general manufacturing organization and its most significant stakeholders.

In this chapter we will now introduce what is the outcome of the construction process and how the concrete goals set above for the artefact have been achieved. We hope to be able to illustrate that with present programming tools and operating systems it has been possible to construct a real-time processed business game that differs from the main stream of business games by the way it is operated and processed.

As illustrated in Section 5.1, experiential learning is the traditional view of learning used to argue for business gaming. Learning takes place through direct experience. In business gaming the participants act as decision-makers and see the consequences of their decisions. Thus, in this chapter we will describe how Realgame is build upon the experiential learning theory. Some words are also said about how the use of Realgame might facilitate organizational learning.

In this thesis we have further provided general ideas supporting the construction of Realgame. These arguments have been introduced in Chapter 3. These arguments refer to (1) a holistic view, (2) introduction of process and time, and (3) inclusion of decision-making levels. In this chapter we will also explain how these requirements are implemented in Realgame.

We will then return to a topic introduced in Chapter 5, complexity and discuss how Realgame – in our mind – forms a learning environment with high complexity.

We also would like to note that Chapter 2 includes the design methodology used when designing and constructing the artefact. Figure 7.1 illustrates the contextual framework of this chapter. The design methodology in Chapter 2 forms the visible frame around Figure 7.1, binding together all the separate chapters and papers.

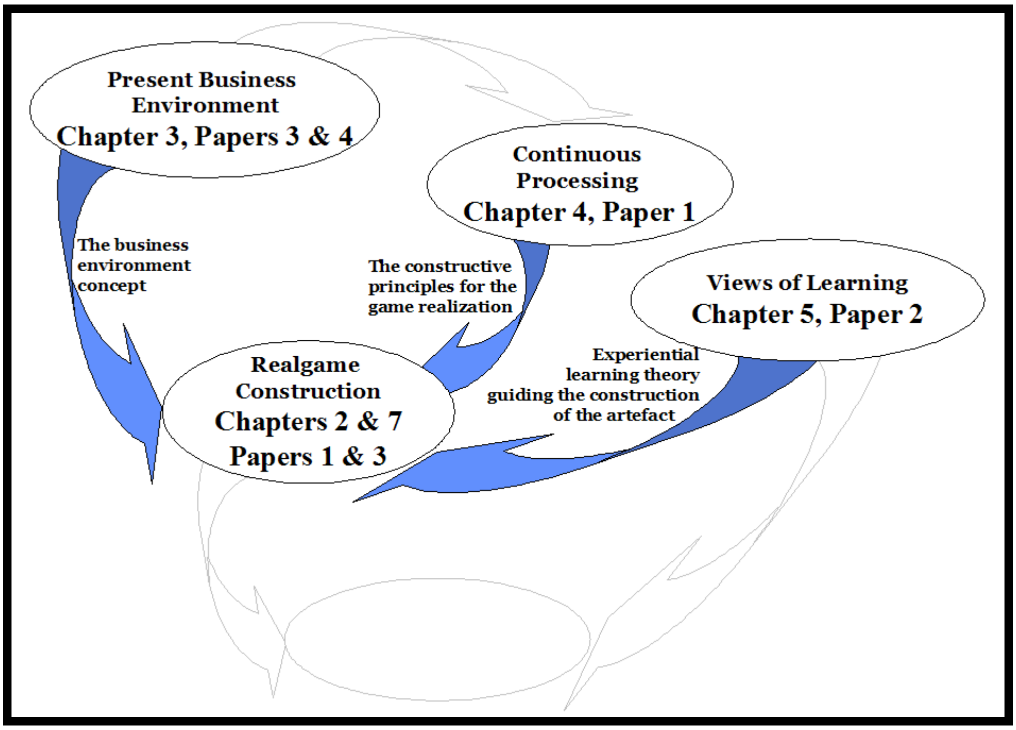


Figure 7.1: The contextual framework of Chapter 7.

After presenting all topics concerned with designing Realgame, we will discuss the role of debriefing in Realgame training sessions and how to assess the learning that takes place in Realgame training sessions. Finally, we introduce some participant comments supporting the issues and arguments used in this chapter.

The sections within this chapter relate to the following aspects:

- **Sections 7.1 – 7.3**: Introduction of the context of use of the game and technical architecture.

- **Section 7.4** and indirectly also **Section 7.6**: Realization of *real-time processing*; research problem (a) in the licentiate thesis.
- **Section 7.5** and indirectly also **Section 7.6**: *Total business concept*; research problem (c) in the licentiate thesis, and argument (1) of Chapter 3.
- **Section 7.7**: *Customization*; research problem (b) in the licentiate thesis.
- **Section 7.8**: More elaboration on the *process and time* argument (2) of Chapter 3.
- **Section 7.9**: *Decision-making levels* argument (3) of Chapter 3.
- **Section 7.10**: How Realgame is based on experiential learning and how it could be applied when aiming at organizational learning.
- **Section 7.11**: How Realgame forms an environment of high complexity and how this possibly enhances the learning experience.
- **Section 7.12**: Debriefing in Realgame training sessions, assessment of learning, and participant comments on Realgame.

7.1 Context of Use of the Gaming Environment

Before proceeding, we will introduce the context of use of the gaming environment. In Realgame 6-8 companies compete against each other, with the market suppliers and the banking business being connected to all the companies (teams of participants).The essential idea of the game is to position the participants in a role where they have to manage a manufacturing business. This should be carried out in a profitable manner to keep the company alive. The companies are in continuous information exchange with their customers, suppliers, and indirectly with their competitors. The game company represents a total enterprise model of a manufacturing company in which decisions from one functional area interact with those made in other areas of the company. The game can be both industry-specific and generic, depending on whether the game model is configured/tailored for the case organization or not configured.

The intended audience of the game varies. The game is suitable for participants from middle management position to foremen of production, and to business students. As the game clock speed and game complexity are variable, these parameters can be adjusted according to the competencies of the audience. The participants adopt roles of decision-makers. They have to make decisions on production, supplies, sales, marketing, investments, transport, and so on. Below we will further clarify the managerial role of the participants through representing game decision-making screen copies. The goals of the game can be varied, depending on the aims of the training. These may include efficient production, profitability, optimizing inventories, maintaining economical self-sufficiency, and so on.

As the game is complex, running a game training requires at least eight hours. Preferably the game session should last one and a half or two days to obtain all the benefits. The required time depends of course on the selected complexity of the game model and the speed of the game clock. The participants, after having learned the rules of the game, are mostly free to manage their companies. Thus, the facilitator intervenes only if the participants wish to have additional guidance.

7.2 Realgame as an Information System

Any information system can be thought of as comprising an infrastructure and the systems which make use of that infrastructure (Land, 1992). In Realgame the infrastructure consists of the following artifacts (following Land's classification):

- **The organizational structure**: game participants under the guidance of the game supervisor.
- **Communication channels**: computer applications using network data interchange.
- **Facilities**: TCP/IP computer network, market server computer, plus the technical network components.
- **Apparatus**: the workstation computers running each of the participating company decision-making applications.
- **Software tools**: both the company decision-making and the market server application, the database engine supporting both of these applications, and the Windows operating system.
- **Training, advisory and help facilities** provided to support the information systems activities of the user community: the game supervisor operating the market application, guiding the participants and conducting the briefing and de-briefing of the game session.

Land (1992) states that most information systems have three major information sources: (a) the real world itself, (b) the designed information system – an artifact, and (c) an informal information system. *Realgame is not a typical information system in that sense that it does not directly include the real world itself as a major information source*. The designed information system may be configured according to a real world organization but during the game session the participants can access the real world only through the informal information system, that is, through the knowledge of the other participants about the real world. This situation refers to the factor of the range of channels used for conveying messages or signals to the user (one of four generic factors Land mentions).

As Land (1992) notes, in practice most information users operate as a part of one or more groups. These groups may work in a cooperative manner, sharing information in order to carry out tasks or solve problems. This is also the case with Realgame. However, Realgame is *not a group decision support system* in that sense that it does not have specific characteristics to support the work of a group. In other words, the game can be used by a single user as well as by a group of users, although the educational situation is expected to be more fruitful for a group of decision-makers discussing different decision alternatives within a group (but also between the groups during the debriefing sessions).

Land (1992) argues that *an information system is a social system*, which has information technology embedded in it. This can be also said about Realgame. On the other hand it could also be argued that Realgame is firstly information technology and then the social system has been gathered around it. However, the *training session is firstly and definitely a social system* and it must also be borne in mind that learning through gaming is partly or even strongly a social process. Land expresses that the designers of the formal part of a system have to be aware of the contribution made by the other half, and seek to provide links which enable the information user to make the most effective use of all components of the information system.

Land (1992) furthermore notes that *even the most rigidly defined systems will be used by its users in ways which were neither planned for nor anticipated by its designers*. In the case of Realgame the more ways the users find to exploit the game system the better. The participants are encouraged to interpret and collect the available extensive data in ways that best serve their decision-making needs. In fact, this kind of process of creating one's own procedures to interpret game organization data to receive a holistic picture of the organization and its environment is highly recommended.

7.3 The Game Development Environment and Game Structure

The documentation of the game construction in this chapter is mainly descriptive. The actual technical documentation is not included in this chapter. The main purpose of this descriptive approach is to introduce the nature of real-time/continuous processing to the reader.

As mentioned earlier, in Realgame 6-8 companies compete against each other. This game has been programmed with a Rapid Application Development (RAD) tool (Delphi) in Windows environment. Delphi enables the use of databases and supports user-defined inherited objects. Both of these resources are seen as essential for the creation of Realgame. Databases are needed in order to record all the detailed business transactions taking place during the game run. The transaction specific representation mode of Realgame is characteristic of it and this specificity can be seen in all of the processes of the game. The object-oriented development environment has been a major requirement for the work to be successful. Without the object oriented development environment it would have been considerably more difficult to construct a truly configurable business game.

Selecting Windows as the platform ensured that it would be possible to implement the game to the computers of any company, thus allowing in-house business game training in companies and, thus, high portability. In the beginning of the project the operating system in use was Windows 3.1 but very early in the project the 32 bit Windows environment had to be selected because of resource demands. Both the company application and the market application of the game are Windows based applications programmed in Delphi. Delphi was selected as the researcher had previously carried out programming projects with Delphi. Afterwards it can be concluded that the selection of Delphi as the development tool was successful because:

- Delphi allows rapid application development (RAD). This means that Delphi's programming environment and the language itself provide properties and tools which significantly speed up the application development work compared to traditional third generation programming languages.
- Delphi includes easy-to-use embedded support to the use of databases. Databases are the only data storage method of the new business game construction.
- Delphi allows user defined objects. Furthermore, it was the only RAD tool at the time of the start of the project to allow the user to develop their own objects through inheritance from standard source objects.
- Delphi compiles true executable code (EXE code), which can be run from the Windows operating system without the need of a code interpreter.

Realgame is not client/server based. The main reason for this is the light installation process of Delphi Standard in any computer class. Delphi C/S demands a much more complicated installation process than Delphi Standard. The ease of the installation process is an important aspect as the training is usually carried out on the premises of the organization whose employees are to be trained. This advantage from the light installation process has become very evident, as the game has now been installed in more than 10 different computer classes in Finland and also abroad. Normally the game installation process takes less than one hour and no microcomputer expertise support is needed.

By using simple file copying routines the network usage of the game has proven to be relatively reliable: short or even longer network failures do not cause any errors in the game execution. Simple file copying makes it also possible to run the game applications in environments with fewer resources than would be needed with the use of client/server technology.

7.3.1 Realgame Technical Architecture

The game works in a TCP/IP network environment (Figure 7.2). A critical area for the cooperation of the game applications is the transfer of data between the market application (MAP) and the company decision-making applications (CAP). As CAPs are continuously in connection to the MAP (and visa versa) the local computer network has to operate reliably.

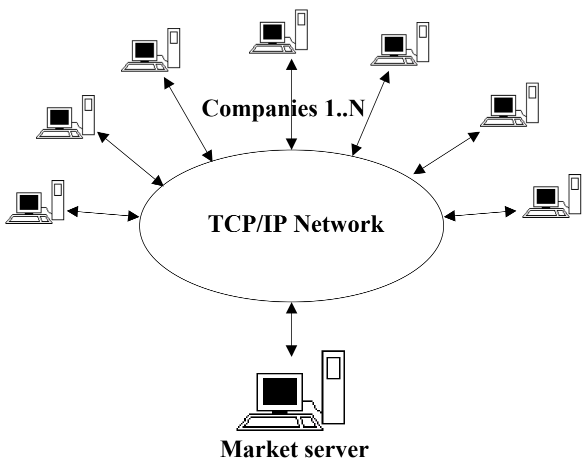


Figure 7.2: The game construction's general network structure.

The number of companies in the game is not restricted by the game application itself. However, the maximum number of simultaneously competing companies in a game session depends on the resources of the hardware environment and the Windows operating system in use. A standard Windows NT workstation allows a maximum of 10 workstations to be mapped simultaneously to it. Thus, using a Windows NT workstation as a market server computer, there can be the maximum of 10 competing companies in one game. In practice we have allowed a maximum of 8 participating companies as Windows file sharing has proven to be somewhat unpredictable.

In the present version of the game the most restricting component for the game configuration is the speed of the MAP computer and its ability to handle the locking and releasing of the Market database alias subdirectories (Figure 7.3, subdirectories 1...X...N). How well locking and releasing is handled depends on the Market server computer's processor clock speed and the type of Market server operating system. The network usage of the game construction requires at least a Windows NT operating system for the server, the clients can be Windows 97 workstations.

As client/server technology in data processing is not used, the different game applications can not access the same computer directories simultaneously. Thus, data processing has not been centralized but each application component of the game processes its own data locally. Local processing demands continuous data transfer between the MAP and CAPs. The data transfer from the market server computer to the company computers goes as follows:

- the market application processes the market events and transactions of one processing cycle and saves this data to the databases in the Market database alias (directory)
- the MAP locks each company specific Market alias subdirectory to be used exclusively, thus preventing CAPs from accessing the tables while it is accessing the subdirectories
- the MAP copies the databases needed in CAPs from the Market database alias directory to the company specific subdirectories
- the Market application releases the locks on the company specific Market alias subdirectories, thus allowing CAPs to access these subdirectories
- CAPs access the company specific Market alias subdirectories and copy the databases to their own Local database alias directories.

The data transfer from the companies to the market application goes as described above with the only exceptions that data is transferred to the opposite direction and the locking is done by the company application.

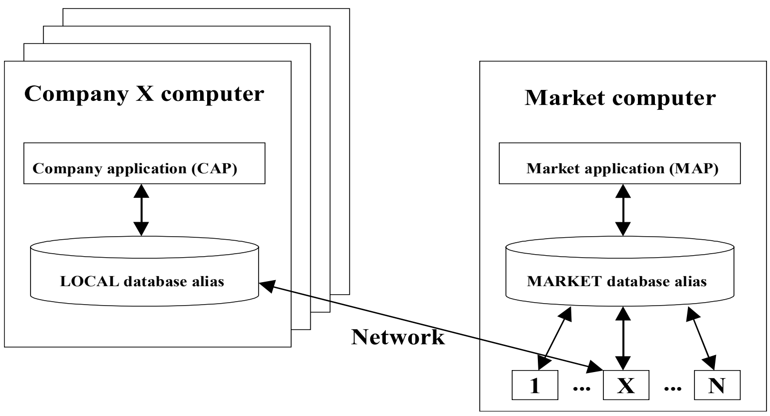


Figure 7.3: The game construction's general data transfer structure.

7.3.2 The Company Application (CAP)

The CAP includes several processes managed by the game participants. These processes are represented in the form of game computer screen copies in this chapter. Several of the company internal processes are also automatic and triggered by the game internal clock. The operation of the game clock is managed in the MAP but as the clock proceeds the time is transferred to each CAP, too. Thus, if the game internal time has proceeded, the CAPs will execute the company internal processes (such as the production of goods within the manufacturing process).

The separate tasks in the CAP are all defined and saved as their own windows consisting of their own definitions and program code procedures. Altogether there are 32 independent window units plus one component (object) unit. The total number of program code in these units is some 17.000 lines. This code includes only pure data processing procedures (plus, of course, comments within the code, and variable and type definitions) as each window's layout properties are saved in separate Delphi form files. These separate form files can contain up to 650 lines of property definitions of objects encapsulated in these windows.

The data of CAP transactions and operations is saved in database tables. First of all, this is because Delphi offers easy to use functions to manipulate data in databases. Secondly, relational databases offer a natural data structure to maintain transactional data. In the game construction the transactional databases are analogical to any enterprise software databases: the data is mainly structured according to the same normalization rules. Thirdly, databases provide database table indexes, which in many ways speed up the data processing and retrieval of the saved data compared to e.g. binary file routines. The database used in the game construction is Paradox database version 7.0, which comes with Delphi.

Figure 7.4 (next page) represents the Realgame interface. The *Clock* window tells the player what time (game internal time) it is, what production shift is active, what day of the week it is, and what date it is. The game internal time proceeds with the same pace as the market program is proceeding. Thus, the company clock proceeds only when the market time proceeds first.

The *On-line cash* window tells the players the amount of cash they have available in any moment. The cash amount is always in real-time and is updated after every cash payment and cash income. The menu items of the company application are shown in Figure 7.5.

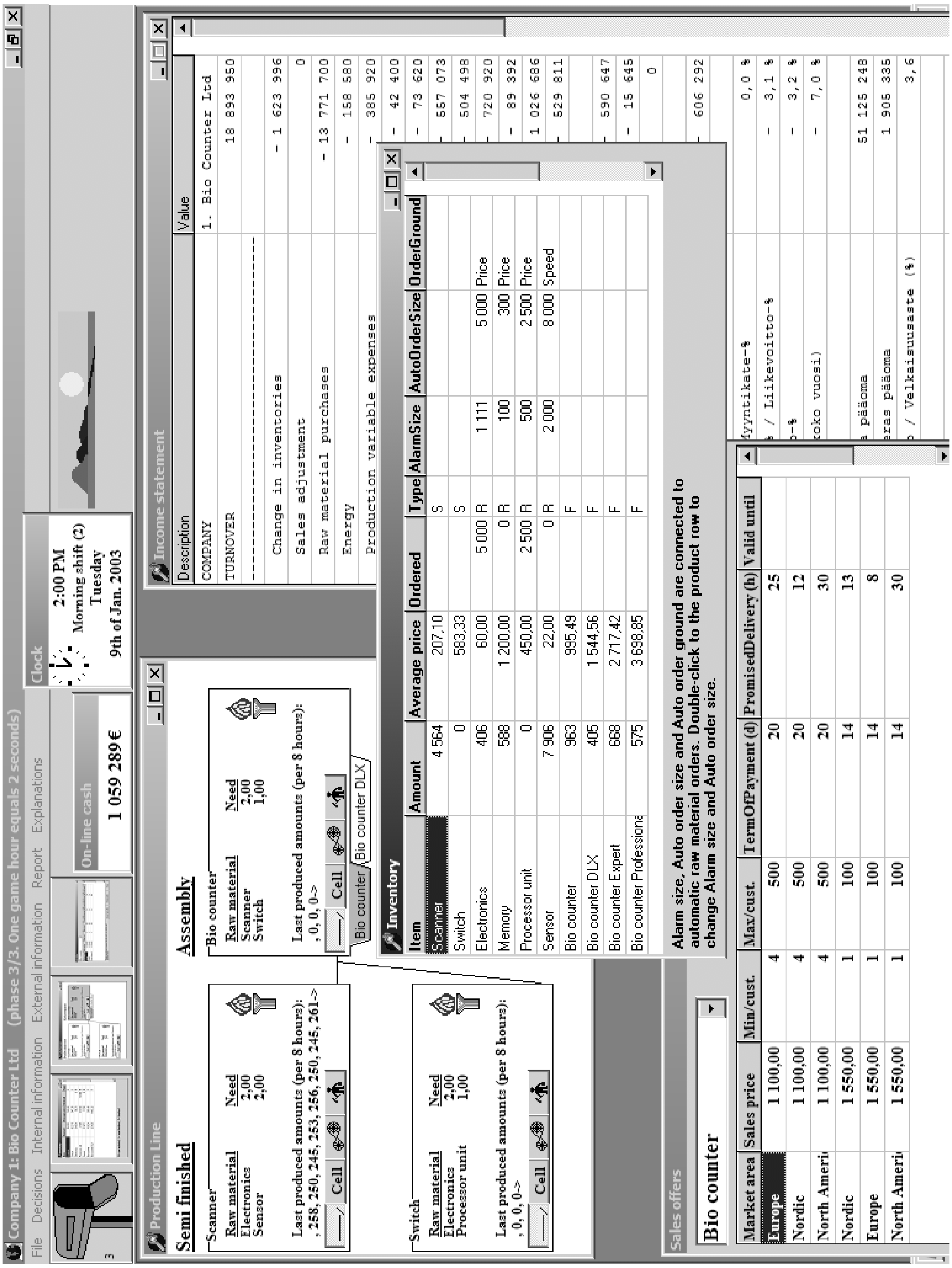


Figure 7.4: Realgame interface.

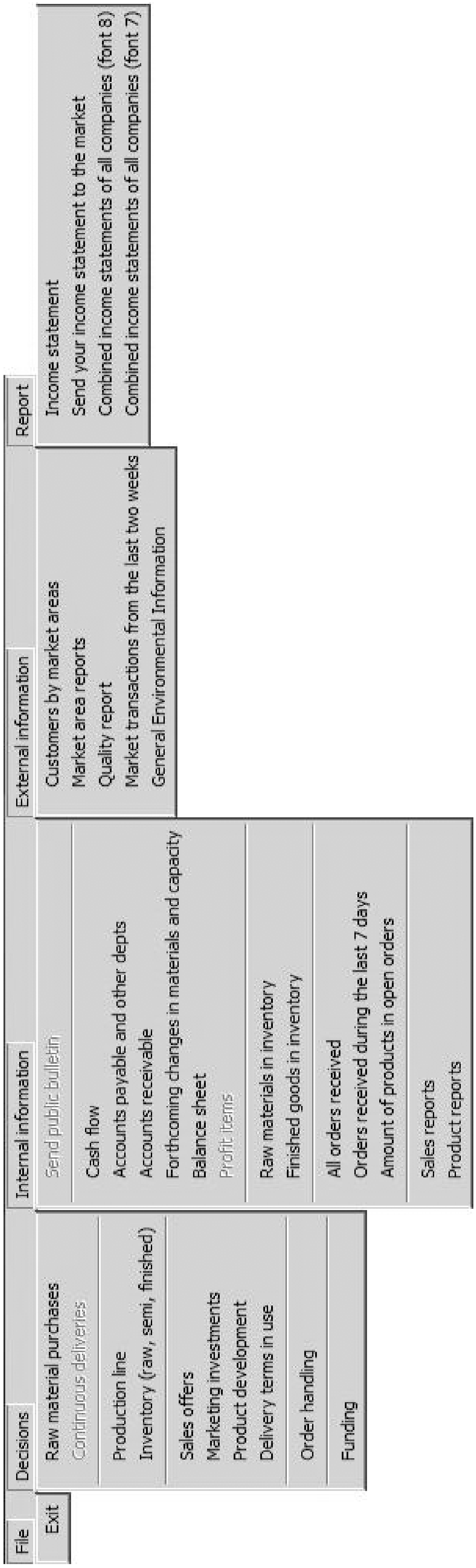


Figure 7.5: The menu items of the company application.

7.3.3 *The Market Application (MAP)*

The MAP interface is shown in Figure 7.6.

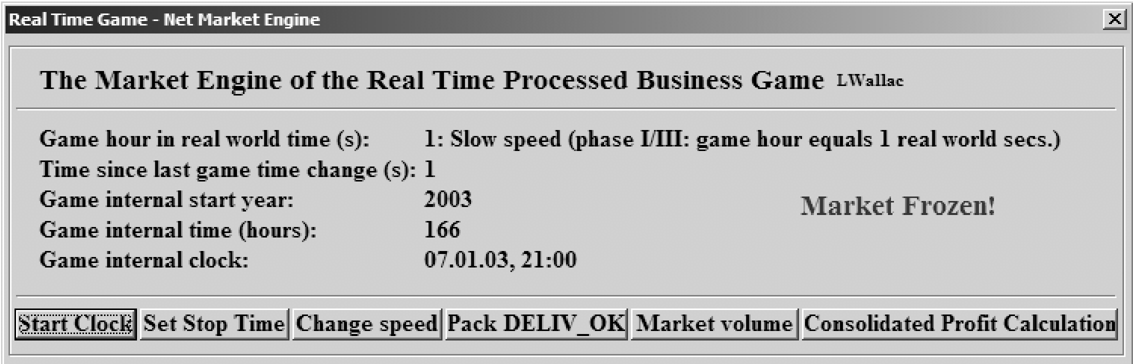


Figure 7.6: The user interface of MAP.

The execution of the MAP program code is straightforward. A Timer object in the MAP triggers the procedure including all the market routines. This is done in a batch-processed manner: the code is executed from the beginning to the end and then the MAP waits for the Timer to activate anew. In all, the MAP includes some 3,000 lines of Delphi programming code just to handle each game clock loop plus some 200 lines of window object definitions in a separate form file. In short, the processes the MAP executes in every game clock loop are the following:

- If the clock is on, the time increases with one hour.
- Reads all the decisions and other transactional information (offers, deliveries, market investments, R&D investments) of the participating companies.
- Browses through customers in each market and reads their demands. For every customer whose purchases are acute, browses through which company's offering (price, terms of payment and delivery, marketing investments, company image, and product quality) is most suitable and makes an order.
- Copies updated market information tables (market messages, time, new orders, general customer information, available delivery methods, company market images, environmental variables) to each company.

For the game administrator, the use of the MAP is quite simple. After the MAP is started the only thing the administrator has to do is either to stop or to start the execution of the MAP clock (the Stop Clock/Start Clock button in Figure 7.6). The clock is stopped when the administrator needs the attention of the game participants to be focused on something else than the game, e.g.

when some educational aspects of business decision-making are discussed together with all the participants.

If the administrator wants to change some environmental variables of the game this can be done easily by starting the Database Desktop application and accessing the needed database tables directly. This can only be done during the game if the MAP clock is stopped.

7.4 The Management of the Game Internal Time

In the new business game construction real-time/continuous processing has been the major guiding principle. This continuous nature of the learning tool is a relatively novel concept in the field of business gaming (see Lainema and Makkonen, 2003, for more information).

We argue that for the present business environment to be described more realistically, the influence and importance of time should be embedded in the business game to reflect the cause-relationships in the business environment. Besides of this, the new business game construction (Realgame) described in this thesis includes a holistic view of business (all major business functions and stakeholders), and represents this to the game participants in the form of integrated management decision-making. Furthermore, the construction includes the ability to configure the business game according to different business environments.

The time argument means that the connection between players, supply market, customers and capital market needs to be interactively processed. The role of time in simulating time-bound business processes and decision-making is essential, as well as the communication between the companies and different stakeholders. What is suggested here is a real-time or continuously processed business game. Decision-making, and results from the decisions made, should occur in an interactive on-line mode, as they do in the real-world environment. In a continuously processed business game different business events and processes take place continuously and simultaneously, and often at a varying frequency. The participants steering the company view all the market events and internal processes on-line. Whatever happens can be seen without a delay and action can take place instantly – providing the participants realize the need to do so. Thus, the game emulates the real world processes of business environments with the major exception that the internal simulation time is accelerated compared to the real world. In managing this kind of environment, the participants' ability to perceive processes and causal dependencies is essential.

According to the terms introduced by Thavikulwat (1996), Realgame is scaled flexibly (participants can select when to print reports), synchronized (all game participants are bound to the same period lengths), and clock-driven (the game time advances in concert with the computer's internal clock). Furthermore, Realgame is interactive in both the respects Chiesl (1990) mentions (first, continuous interaction between the game and the players; secondly, players interact with other participants). In continuous game processing the functions are executed in a continuous and iterative manner. Different steps can be enacted simultaneously or separately. Different iterative decision loops may occur at the same pace or at a different pace. It may be impossible for the decision-maker to decide beforehand what actions to take at particular moments. The process is never ending, with any easing off in decision-making resulting almost certainly in trouble. Furthermore, the participants are part of the game processes. This means that they see the changes in their environment evolve on-line. We feel that this is a major difference if we compare continuous processing to batch-processing: the participants are an organic part of the business processes and are able to witness and see them, and – most of all – are able to interact continuously with this process. As Huckfeldt et al. (1982) have noted, the models employed should not be judged on the extent to which they replicate a social process, but rather on the extent to which they help us understand a social process. Continuous processing makes the learning environment business processes transparent and according to constructivist learning principles (see e.g. Lainema, 2003a) this is useful from the learning point of view.

The impact of time in real-time and batch-processed business game decision-making in some business operations and processes is described in Table 7.1. The examples in the table illustrate just some of the differences between batch-processed games and real-time processed games.

Table 7.1: Some examples of differences on how the participant decision-making may be treated differently between real-time and batch-processed business simulation games.

Operation / Process	**Batch-processing**	**Real-time processing**
Reacting to opportunities or threats in the market	The speed at which the participants react to opportunities does not have a realistic significance, because all the companies deliver their decisions (or at least their decisions are processed) at the same moment. The fastest decision-maker does not benefit from fast decision-making. E.g. no company has any advantage of adapting early to customer needs.	The true nature of decision speed is represented, because a faster decision maker always responds first to any external events. For example, the company that fastest adapts to changing customer needs can gain new market share.
Response to misleading production plans	A misleading production plan cannot be straightened until the decisions for the next season are being made.	A misleading production plan can be straightened as soon as it is discovered.
The advantage of faster product development	In some cases the speed of the product development process does not have any significance. E.g. consider two companies (A and B) developing similar novel products. Company A develops the new product during the season in half of the duration of the season. Company B develops the new product during the season but it takes the whole length of the season. In this case company A has minimal – or no – advantage of being faster in the development process.	The company being faster in development processes earns all the benefit it deserves from being faster. E.g. it can benefit from being the only provider of the novel product by demanding higher prices.

Actually, Realgame does not operate in true real-time processing. True real-time processing would mean that each and every independent game object (e.g., a customer or a supplier) would have its own internal Timer object, which would activate independently of everything else in the game, and process all object specific tasks and processes. Very early in the development of the game, this kind of true real-time processing was tested but proved to be impossible to use. This was due to the Windows operating system, which allows only a limited number of active Timer objects to be used at a time. True real-time would have needed hundreds or even thousands of game internal Timer objects and this is not at all realizable in a Windows environment, as the operating system's resources run out with no more than some tens of timer objects. However, the processing is continuous in the sense that:

- the game time is clock-driven – the smallest increment of time being one hour,
- the participants are not tied to making decisions at specified points of time but can make them whenever they choose,
- the decisions made at each point of time can be single decisions or several decisions but no decision batches are required,
- the participants may choose to run reports included in the game at any point of time, and

- the participants see the internal and external business processes evolving, e.g. hour by hour, depending on the game parameters (explained below).

The clock speed in Realgame varies in three phases. The first phase is usually the slowest one and the third phase the fastest, although the speed is not fixed in any of the phases. In the beginning of the game the duration of one Realgame hour might be, for example, 30 real world seconds. In the second phase, the game might proceed with the speed of 15 real world seconds equaling one game hour, and in the third phase one real world second might equal one Realgame hour. These different processing speeds are parameters of the game, and may vary between different game sessions.

The MAP controls the advancing of the game internal time. The MAP uses the time specific configuration the game administrator has defined in the CLOCK database table. The CLOCK table is also copied during each MAP processing cycle to CAPs to be used to guide the time handling in CAPs and to ensure that CAPs advance in the same phase as the MAP.

The speed of the game time has three phases. The first phase is the slowest one and the third phase is the fastest. In the beginning of the game the duration of one game hour might be e.g. 30 seconds. This means that the MAP executes the events of one game hour every 30 seconds.

The motivation to use different game speed phases in the game arises from the need to train different kinds of business skills. The first (and slowest) game speed allows rehearsing short-term game company internal operations. These concern mainly operational decisions like raw material purchases, delivering, finding an optimal production capacity for production cells, and so on. As the speed is relatively slow the players have the possibility to see properly the material flows in the game but do not need to search frequently for external funding, invest on marketing operations, and so on. The first phase is also suitable for examining the dependencies between different materials transactions, accounts payable and receivable, and cash flow. This phase, as well as the other phases, allows the participants to communicate about the decisions and to build a management team.

In the second phase the aim is to rehearse more tactical – mid-range – decision-making. Before turning on the second phase the players should have familiarized themselves with the production function. The second phase involves more decision-making concerning overall material chain management. In the first phase it might be difficult to get a holistic view of the material processes, as the game speed is too slow for that. This should be acquired in the second phase. Some first phase decisions are automated in the second phase in order not to block the decision-making capacity of the players. For example, the delivery process is automated in the second phase (an alternative for this would be a decision by the participants to invest in an information system producing automatic deliveries). As the second phase is usually considerably faster than the first phase the participants should be able to see a more holistic view of the dependencies between the functions taking part in the materials processes.

Accelerating the clock to get a grip on tactical (and later strategic) decision-making is not in contradiction with management practice and theory. To create tactical and strategic plans the participants need to be given time to analyze the situation and create the plans. This time is achieved by stopping the game clock. Then, when enough time has been given for planning, the plans are implemented and the clock is turned on again. As the game time is accelerated, the participants can now see the longer span effects of their decisions within an understandable time span. It is essential that the clock time is accelerated; otherwise it is not possible for the participants to understand cause-relationships. If the clock is kept slow throughout the game, the participants might never see the outcomes of their longer span decisions or they might forget what they planned in the first place before they saw the results. Accelerating the clock has been proven necessary in practice; otherwise the game training objectives could only be operational.

The third phase of the game is the long-term strategic decision-making level of the game. The speed of the game should be as fast as the MAP computer allows. At the best it has been possible to execute the game internal hours once in a real-world second but the MAP is not tuned up to be as fast as possible yet. Thus, in the future it will be possible to reduce the speed of the MAP third phase execution to fractions of a second on average. As the speed of the game increases during the game – depending on the computer capacity in use – the transaction processing of both the MAP and CAP will become too heavy for the computers to handle within the given cycle time. This is why the CAP can be set to process several hours during one cycle. For example, four game hours can be processed during one CAP processing loop.

To allow game speeds fast enough for game sessions where several game years can be simulated during one day, the speed of the MAP must also be accelerated in the same way (however this has not been done at the time of writing). For example, to be able to simulate three game years in one day training the execution of one hour must not take more than 0.833 seconds (the training time: 6 h x 60 min x 60 s, divided by the simulated game hours: 3 years x 12 months x 30 days x 24 h). The speed of the MAP to execute one game hour depends highly on the number of participating companies and customers on the markets. Even with a relatively limited game configuration (some 8 competing companies and three customer markets, each including less than 20 customers) and a Pentium II/366 MHz computer MAP game hour processing takes some 1.5 seconds. Thus, to allow several years to be executed in a one-day training event the processing method of CAPs must be applied in the MAP also.

7.5 The Total Business Concept

As noted in Chapter 3, the changing nature of work in some industries demands flexibility, responsiveness and an ability to understand the organizations as entities where different organizational parts (functions, tasks, people) work together in synthesis with their environment to reach a common goal. Thus, we argued for giving a holistic view of the operations of a manufacturing organization. If workers are to become adept at making informed decisions, they need to know the outcomes of their decisions; the cause-effect relationships of their decisions and outcomes. Understanding how individual contribution links into the overall goals and ability to deal with novel situations demands from the learning tools/methods/contents above all the ability to deliver a holistic view of organizational and environmental functioning. This is something that we have tried to include in the artefact business environment.

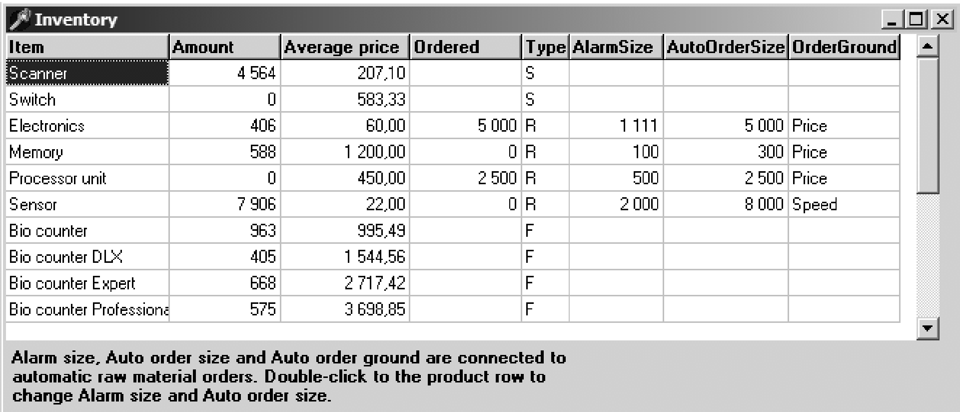
The artefact of the thesis aims at giving a holistic view by introducing typical business functions/tasks of a manufacturing (as stated in the original first phase research problem) organization. These main functions/tasks are, for example, manufacturing, purchases, inventory management, funding, marketing, sales, capacity investments, supply channel management, and so on. The screen copies of Section 7.6 should give the reader a fairly good view of these tasks to be managed during the game sessions.

7.6 The Business Processes in the Game

When describing the business processes of the artefact we apply the four *principal types of economic utility*, which add value to a product (or service). The classification we are using is introduced in Coyle et al. (1996). The principal types of economic utility are: *form, time, place,* and *possession*. Generally, manufacturing activities provide form utility, logistics activities time and place utility, and marketing activities possession utility.

Form utility refers to the value added to goods through a manufacturing, production, or assembly process. E.g. this utility results when raw materials are combined to make finished products. This utility represents a change in product form that adds value to the product. Different material processing functions of the CAP together create the body of the CAP. Other business functions are more or less constructed upon the materials processing functions and support them. Following screen copies (Figures 7.7-7.17) from the CAP represent the form utility processes in Realgame. The following screen copies are from several different game sessions. Thus, the configuration (e.g. currency and interface language) and internal time vary between different screen copies.

During the game the production function uses the raw materials in the company inventory (*Store*) (Figure 7.7). This inventory window includes finished goods, semi-finished goods and raw materials. As seen in Figure 7.7 the company has run out of Electronics raw material.



Item	Amount	Average price	Ordered	Type	AlarmSize	AutoOrderSize	OrderGround
Scanner	4 564	207,10		S			
Switch	0	583,33		S			
Electronics	406	60,00	5 000	R	1 111	5 000	Price
Memory	588	1 200,00	0	R	100	300	Price
Processor unit	0	450,00	2 500	R	500	2 500	Price
Sensor	7 906	22,00	0	R	2 000	8 000	Speed
Bio counter	963	995,49		F			
Bio counter DLX	405	1 544,56		F			
Bio counter Expert	668	2 717,42		F			
Bio counter Professiona	575	3 698,85		F			

Figure 7.7: The store window.

The materials process starts with *Raw materials purchases* (Figure 7.8). In the third phase of the game the raw material purchases will be done automatically by the CAP. However, in the beginning of the game the participants themselves have to take care of purchases. The *Raw material purchases* window includes two tables. From the table on the left the players select which raw material they want to order. After selecting the raw material the table on the right will show the different suppliers of the selected raw material and their terms of delivery. Furthermore, each of these suppliers has a restricted inventory of each raw material. As the suppliers are common to all competing companies a certain raw material may become scarce. The raw material inventories of the suppliers are renewed in time but in some occasions the demand of raw materials may be greater than the renewal speed.

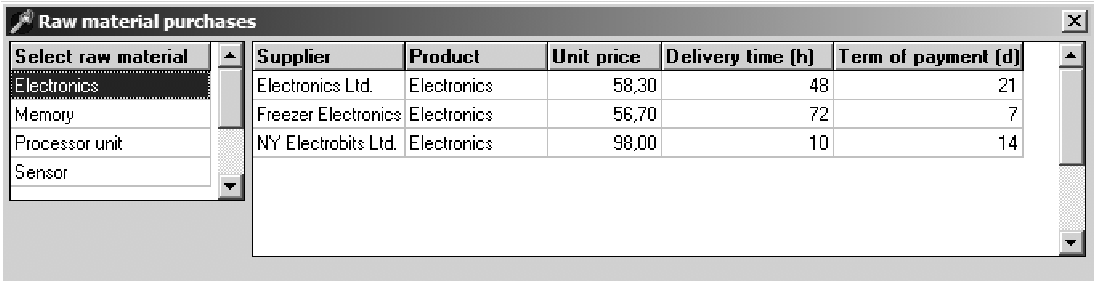


Figure 7.8: The raw material purchases window.

When the player has decided from whom to order he/she selects the *Buy* button. What follows is represented in Figures 7.9 and 7.10.

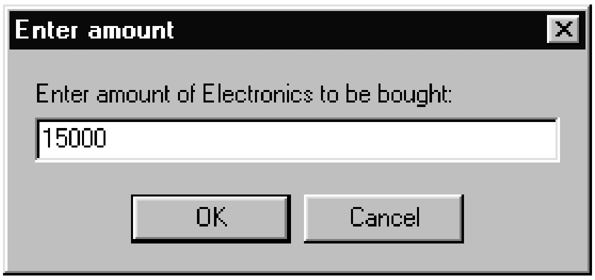


Figure 7.9: Entering the amount of raw materials to order.

Figure 7.10: Confirming the order.

From this point forward only selected dialogs of the company application are presented as screen copies. Figures 7.9 and 7.10 show the principle in which the interaction between the game and the players is operated.

As the game describes time depended interactions within a manufacturing company most events and operations take certain time to materialize. E.g. the raw material ordered does not arrive at our inventory before the delivery time has passed. During this time the delivery can however be seen in the *Future capacity and material changes* window (Figure 7.11).

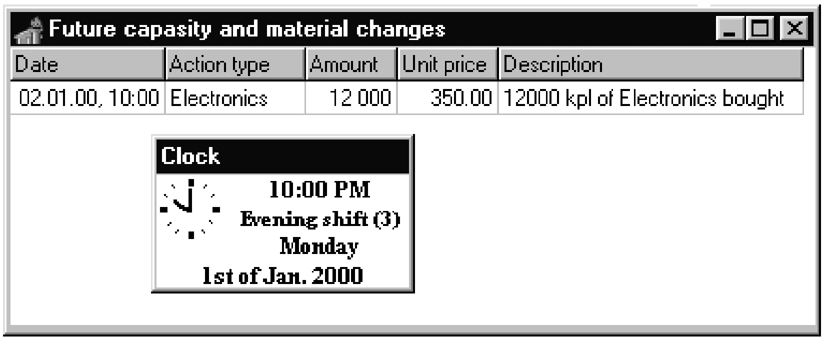
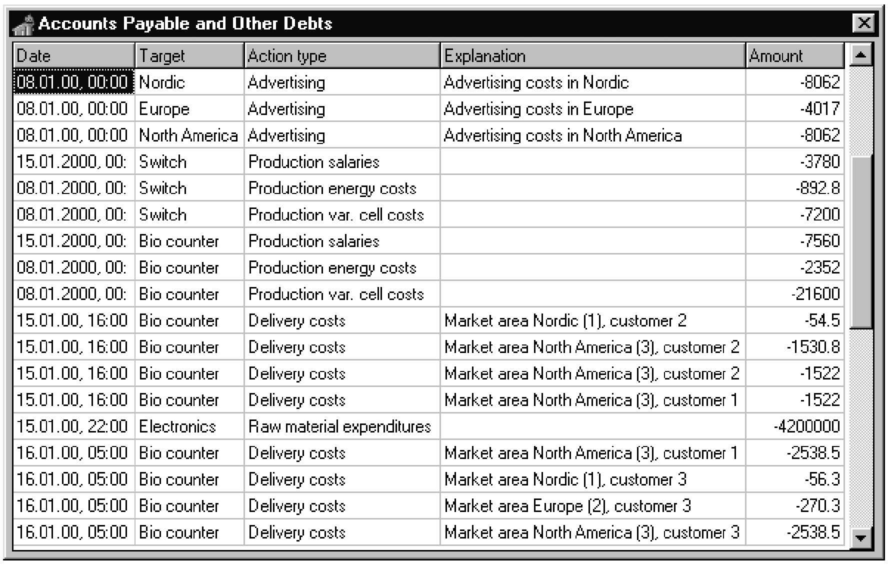


Figure 7.11: The future capacity and material changes window.

At the point of ordering the raw material we also become debtors to the supplier. The debt is entered to the *Accounts payable and other debts* table (Figure 7.12). The debt will be paid automatically by the CAP by the due to date and time. From Figure 7.12 can also be seen that the information included in the table is transaction specific information.



Accounts Payable and Other Debts

Date	Target	Action type	Explanation	Amount
08.01.00, 00:00	Nordic	Advertising	Advertising costs in Nordic	-8062
08.01.00, 00:00	Europe	Advertising	Advertising costs in Europe	-4017
08.01.00, 00:00	North America	Advertising	Advertising costs in North America	-8062
15.01.2000, 00:	Switch	Production salaries		-3780
08.01.2000, 00:	Switch	Production energy costs		-892.8
08.01.2000, 00:	Switch	Production var. cell costs		-7200
15.01.2000, 00:	Bio counter	Production salaries		-7560
08.01.2000, 00:	Bio counter	Production energy costs		-2352
08.01.2000, 00:	Bio counter	Production var. cell costs		-21600
15.01.00, 16:00	Bio counter	Delivery costs	Market area Nordic (1), customer 2	-54.5
15.01.00, 16:00	Bio counter	Delivery costs	Market area North America (3), customer 2	-1530.8
15.01.00, 16:00	Bio counter	Delivery costs	Market area North America (3), customer 2	-1522
15.01.00, 16:00	Bio counter	Delivery costs	Market area North America (3), customer 1	-1522
15.01.00, 22:00	Electronics	Raw material expenditures		-4200000
16.01.00, 05:00	Bio counter	Delivery costs	Market area North America (3), customer 1	-2538.5
16.01.00, 05:00	Bio counter	Delivery costs	Market area Nordic (1), customer 3	-56.3
16.01.00, 05:00	Bio counter	Delivery costs	Market area Europe (2), customer 3	-270.3
16.01.00, 05:00	Bio counter	Delivery costs	Market area North America (3), customer 3	-2538.5

Figure 7.12: The accounts payable and other debts window.

After the delivery time has passed the raw material appears in our inventory represented earlier (Figure 7.7).

The raw materials are consumed in the company manufacturing function (Figure 7.13). The production line of the company consists of a configurable amount of production phases (maximum amount of phases is five, two in the example) and cells (maximum nine per production phase, two in the first phase in the example). The flow of materials proceeds from the inventory to the first phase production cells, then the semi-finished products are transferred to the inventory, then the second phase cells take their materials from the inventory, and so on. The inventory always functions as a transfer container for the materials on their way through the production. Also the finished products end up in the inventory before they are delivered to the customers.

In the production line example of Figure 7.13 the first phase of production consists of cells producing Scanners and Switches. In the second phase there is just one cell producing Bio counters, which is the final product in this model.

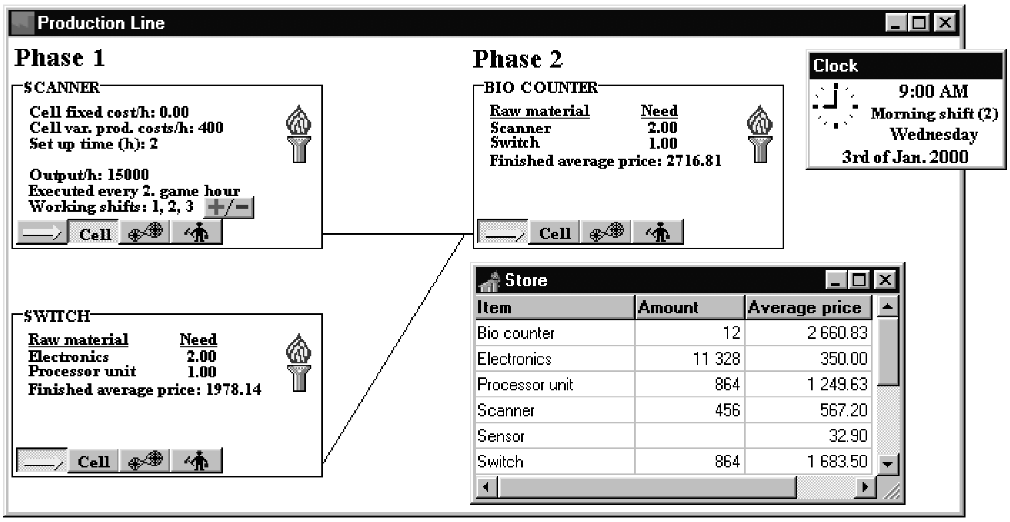


Figure 7.13: The production window, the clock window and the store window.

Each of the production cells consists of four pages of cell information representing production cell specific information and capacity decisions. These pages are selected from the buttons (yellow arrow, Cell, wheels, and worker buttons) in the cells. From the production window the players can also turn the production cells on and off.

In Figure 7.14 the players have selected the Workers button of the Scanner cell. Now the players may either choose to hire new workers or sack old workers. In both cases there will be a delay before the workers quit or start working. Quite the same can also be done with production machines. In Figure 7.15 the player has selected the Machines button of the Scanner cell. Again there will be a certain delay in getting the machines bought for production.

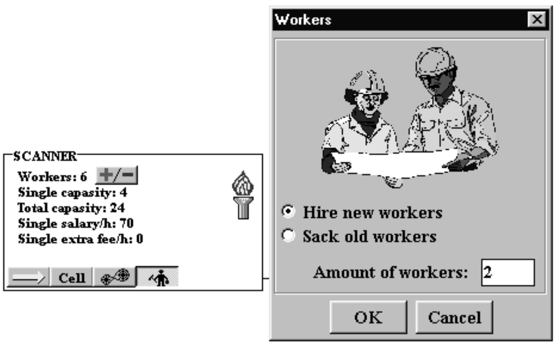


Figure 7.14: Hiring or sacking workers.

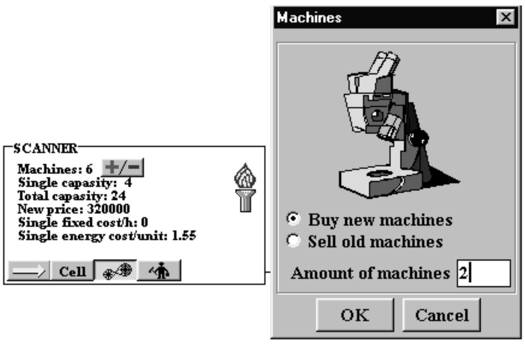


Figure 7.15: Buying and selling of machines.

Also the changes in worker and machine capacity and the delays these changes need to materialize can be seen from the *Future capacity and material changes* window (Figure 7.16).

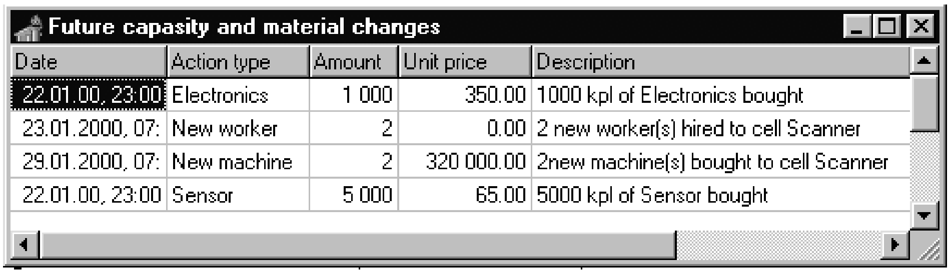


Figure 7.16: The future capacity and material changes window.

Last decision concerning production deals with the working shifts used in each cell. Figure 7.17 shows how the shifts can be turned on and off (the player has selected the Working shift button from the Scanner cell).

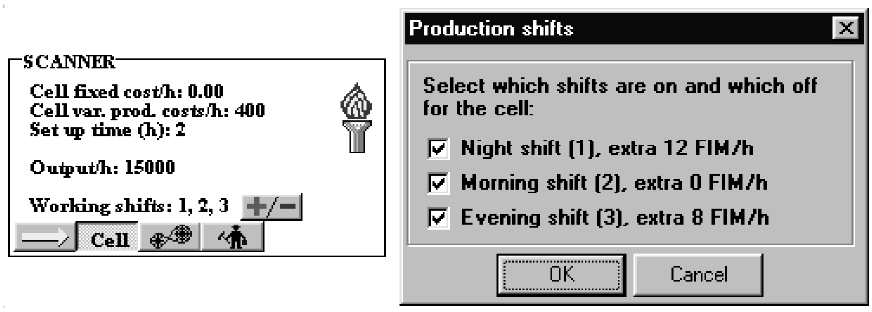


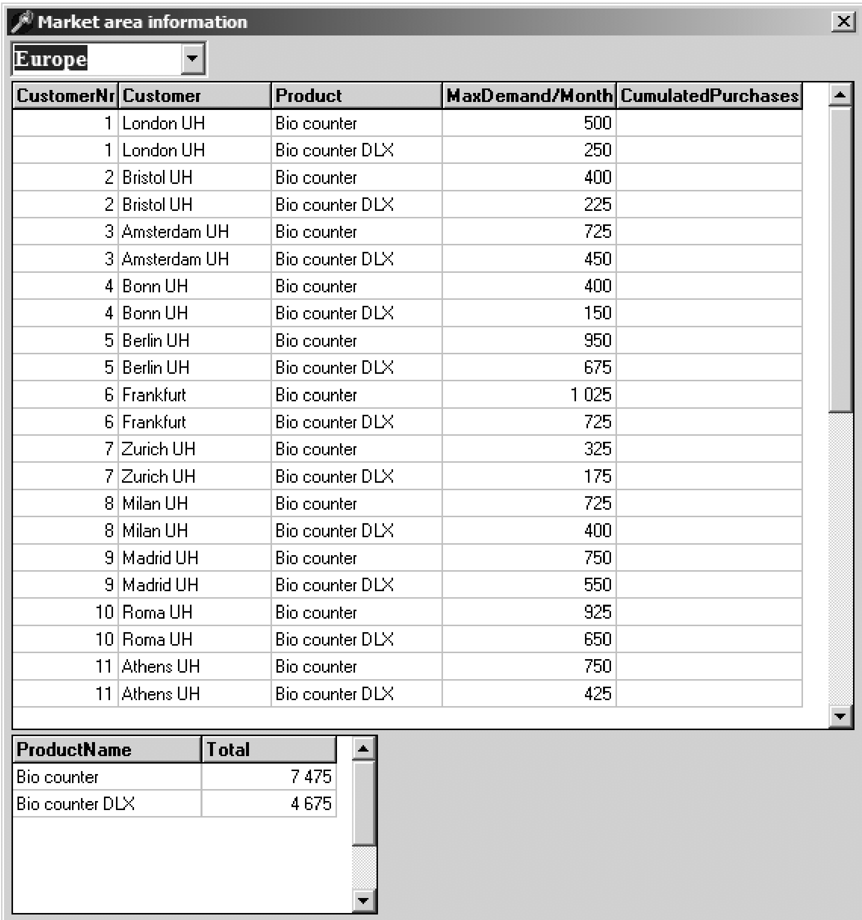
Figure 7.17: Selecting shifts in a production cell.

As the materials have been processed through the production line the final products appear in the inventory and are ready to be sold/delivered.

We have now introduced most of the form utility functions of Realgame. The next economic utility is *possession utility* (Coyle et al., 1996). Possession utility is primarily created through the basic marketing activities related to the promotion of products (or services). Coyle at al. define promotion as the effort – through direct and indirect contact with the customer – to increase the desire to possess a good (or to benefit from a service).

The customers in each market in any Realgame configuration can be seen in the *Market area information* window (Figure 7.18). From the selection box above the table the user can select any of the markets in the game. After the player selects an area the larger table shows the customers in the selected market. By viewing the customers the player can estimate the demand potential of the market. This information is calculated also in the smaller table at the bottom of the window. The maximum demand per month in the table tells the maximum demand per customer per product per one month. This is not necessarily the demand that will materialize in the game (e.g. offered products are not good enough for the customers) but it will give the players an estimate of the size of each market area. The cumulated purchases column informs the players the customer specific materialized purchases accumulated from the beginning of the game.

The customers in the game are passive in that sense that they wait passively for offers from the companies taking part in the game.


Market area information

Europe

CustomerNr	Customer	Product	MaxDemand/Month	CumulatedPurchases
1	London UH	Bio counter	500	
1	London UH	Bio counter DLX	250	
2	Bristol UH	Bio counter	400	
2	Bristol UH	Bio counter DLX	225	
3	Amsterdam UH	Bio counter	725	
3	Amsterdam UH	Bio counter DLX	450	
4	Bonn UH	Bio counter	400	
4	Bonn UH	Bio counter DLX	150	
5	Berlin UH	Bio counter	950	
5	Berlin UH	Bio counter DLX	675	
6	Frankfurt	Bio counter	1 025	
6	Frankfurt	Bio counter DLX	725	
7	Zurich UH	Bio counter	325	
7	Zurich UH	Bio counter DLX	175	
8	Milan UH	Bio counter	725	
8	Milan UH	Bio counter DLX	400	
9	Madrid UH	Bio counter	750	
9	Madrid UH	Bio counter DLX	550	
10	Roma UH	Bio counter	925	
10	Roma UH	Bio counter DLX	650	
11	Athens UH	Bio counter	750	
11	Athens UH	Bio counter DLX	425	

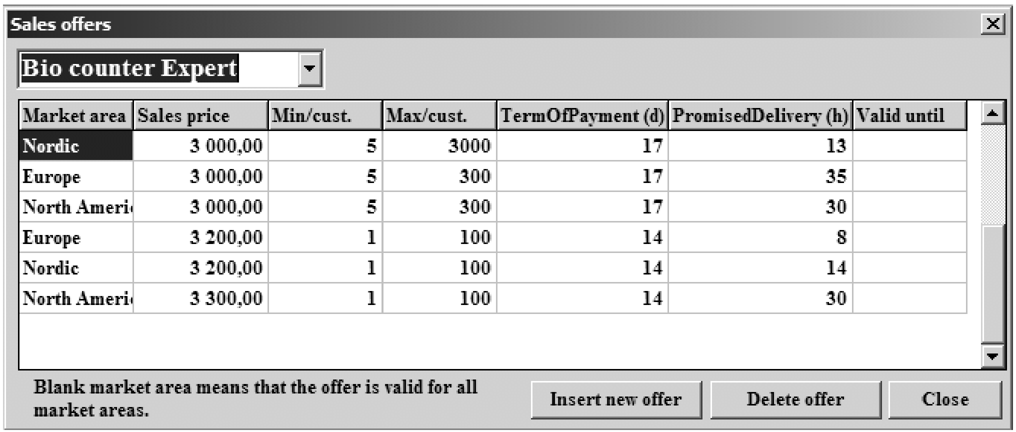
ProductName	Total
Bio counter	7 475
Bio counter DLX	4 675

Figure 7.18: The market area information window.

The customer buying decision is based on several facts. The customer purchase decision depends (in the current version of the game) on the game company:

- product sales price,
- the term of payment the company is offering,
- the delivery time the company is promising,
- the amount of marketing investments,
- product quality.

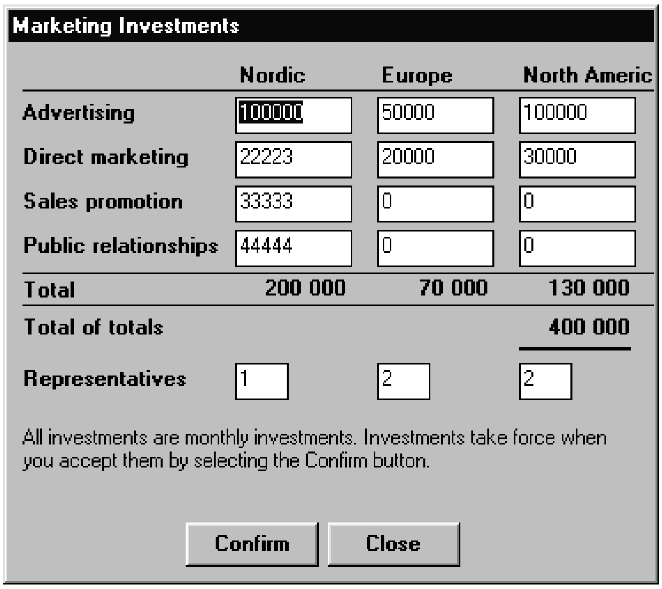
Sales offers (including sales prices, maximum amounts of products that are offered for one customer per one transaction, term of payment, promised delivery time, and the offer valid until date) are maintained in the *Sales offers* window (Figure 7.19). The offers are either market specific or common to all markets.



Market area	Sales price	Min/cust.	Max/cust.	TermOfPayment (d)	PromisedDelivery (h)	Valid until
Nordic	3 000,00	5	3000	17	13	
Europe	3 000,00	5	300	17	35	
North Ameri	3 000,00	5	300	17	30	
Europe	3 200,00	1	100	14	8	
Nordic	3 200,00	1	100	14	14	
North Ameri	3 300,00	1	100	14	30	

Figure 7.19: The sales offers window.

The rest of the factors affecting the sales potential of the company are determined in the *Marketing investments* window (Figure 7.20) and R&D window (Figure 7.21). Marketing investments are market specific. The monetary figures are amounts per month.



	Nordic	Europe	North Americ
Advertising	100000	50000	100000
Direct marketing	22223	20000	30000
Sales promotion	33333	0	0
Public relationships	44444	0	0
Total	200 000	70 000	130 000
Total of totals			400 000
Representatives	1	2	2

Figure 7.20: The marketing investments window.

Product development takes place also as a monetary investment (Figure 7.21). The participants can select a Product quality report which covers the product qualities of all companies (Figure 7.22).

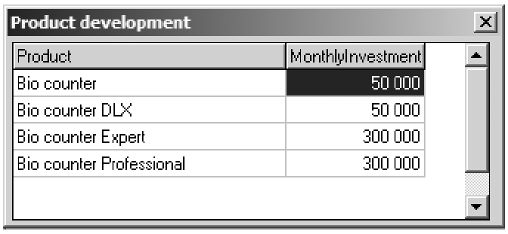


Figure 7.21: The product Development window.

Figure 7.22: Part of the Product quality window.

As the customers order from a company, the company receives an order. The *Handling of the open orders* window (Figure 7.23) tells the players who has ordered, when the order took place, what are the sales terms our company has promised to the customer, and the time of delivery (according to the offer). An essential feature in this window is that the information is transaction specific. Transaction specific information is seldom explicit in batch-processed business games because the algorithms in a batch-processed game are executed in a batch producing aggregate information about the transactions. Continuous processing produces explicit information about single transactions.

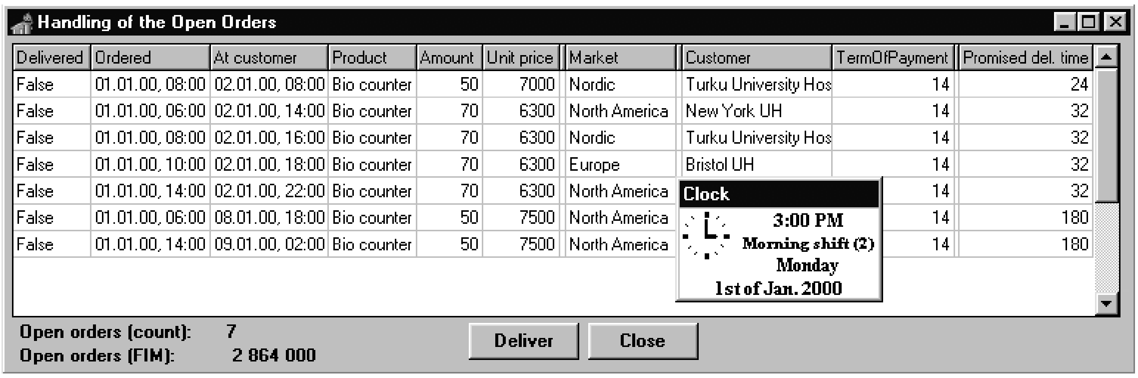


Figure 7.23: The handling of the open orders window.

The last two economic utilities (Coyle et al., 1996) are time utility and place utility. *Time utility* can be created through proper inventory maintenance. Not only must goods (and services) be available where customers need them, but they must also be at that point *when* customers demand them, i.e. economic value to goods (or services) by having them at demand point at a specific time. For example, having advertised products available for customers at precisely the time promised in the offer can create time utility. In Realgame time utility is always present as all the transactions and operations are bound to the flow of time (e.g. customers expecting the goods to be delivered within the promised delivery time).

Place utility is provided by moving goods from production to points where demand exists. Extending physical boundaries adds economic value to the goods. In Realgame place utility is created through transportation. The next screen copies demonstrate Realgame functions that are related to time and place utilities.

Realgame can proceed at three different speeds. We will now describe how the handling of open orders will be done when the game proceeds at the slowest speed (phase 1/3). In phases 2 and 3 the game handles open orders automatically, that is, orders are delivered automatically and invoices sent to the customer whenever there are enough products in the inventory. However, in the slowest speed mode the players themselves have to take care of delivering the orders: first they click the order to be delivered and then select the Deliver button. They will get the *Confirm delivery* window on the screen (Figure 7.24).

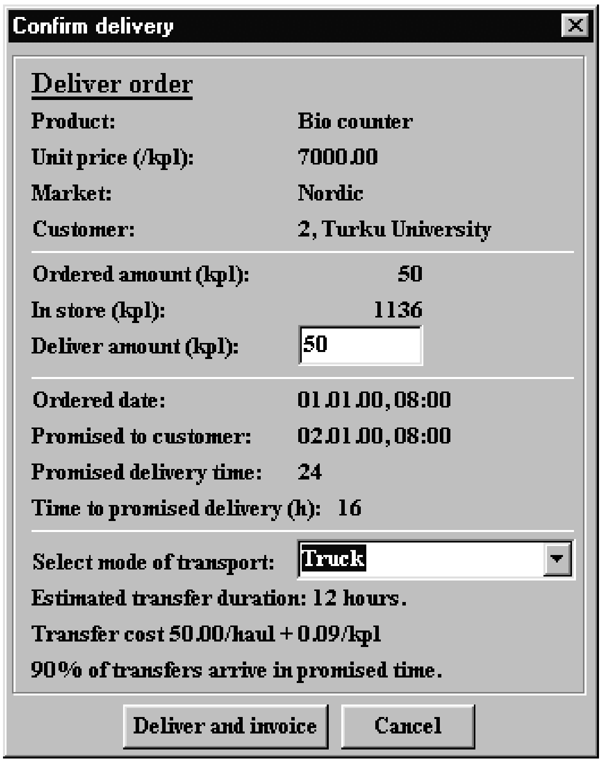
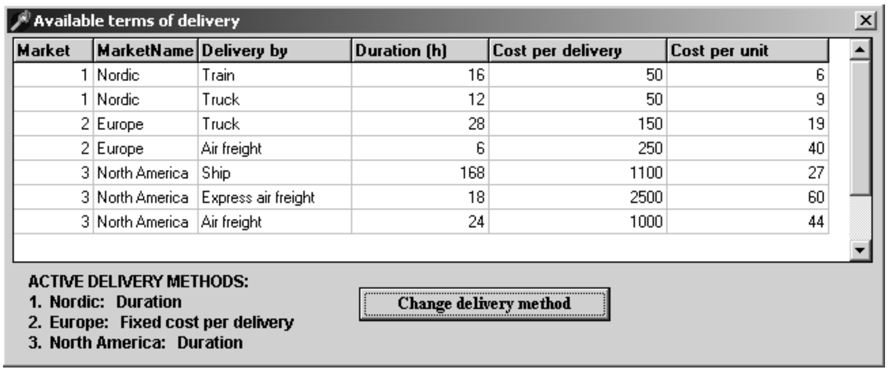


Figure 7.24: The confirm delivery window.

In the Confirm delivery window the players decide which amount of the product to be delivered and with what mode of transport to deliver. The different transport modes differ from each other by transport duration and cost. The delivery departs to the customer when the players select the Deliver and invoice button.

If the game is in the second or third phase then the deliveries will be done automatically by the CAP. However, the mode of transport selected by the CAP is still based on a decision by the players. The players may choose between the possible delivery modes in the *Available terms of delivery* window (Figure 7.25). As the game delivers automatically it selects the transport mode according to the user chosen auto-delivery mode.



Market	MarketName	Delivery by	Duration (h)	Cost per delivery	Cost per unit
1	Nordic	Train	16	50	6
1	Nordic	Truck	12	50	9
2	Europe	Truck	28	150	19
2	Europe	Air freight	6	250	40
3	North America	Ship	168	1100	27
3	North America	Express air freight	18	2500	60
3	North America	Air freight	24	1000	44

Figure 7.25: The terms of delivery in use window.

We have now described the four principal types of economic utility in Realgame, which add value to a product or service. The rest of the game functions are *support functions*, which do not create economic utility but are necessary for managing the company towards the desired direction. These support functions are related to *monetary flows, accounting procedures, and creating decision support* (reports) for managing the company. We will briefly introduce some of these functions.

As the order is delivered to the customer the customer becomes our debtor. The *Accounts receivable* window shows the players who their debtors are and how much the debtors owe them (Figure 7.26). Furthermore, the window tells when the debts are to be paid to the companies. Once again, the participants see transaction specific information.

Accounts Receivable

Date	Target	Action type	Explanation	Amount
16.01.00, 05:00	Bio counter	Sales earnings	Market area Nordic (1), customer 4	441000
16.01.00, 05:00	Bio counter	Sales earnings	Market area Europe (2), customer 4	441000
16.01.00, 05:00	Bio counter	Sales earnings	Market area North America (3), customer 3	375000
16.01.00, 07:00	Bio counter	Sales earnings	Market area North America (3), customer 4	441000
16.01.00, 07:00	Bio counter	Sales earnings	Market area North America (3), customer 4	375000
16.01.00, 09:00	Bio counter	Sales earnings	Market area Nordic (1), customer 5	350000
16.01.00, 11:00	Bio counter	Sales earnings	Market area Nordic (1), customer 5	441000
16.01.00, 13:00	Bio counter	Sales earnings	Market area Europe (2), customer 5	441000

Figure 7.26: The accounts receivable window.

If the players do not succeed in delivering the orders in time the deliveries may be late at the customer's. Customers will inform the companies about this with a message to the Bulletin board (Figure 7.27).

Bulletin Board

01.01.00, 16:00: New orders received.
01.01.00, 18:00: New orders received.
01.01.00, 22:00: New orders received.
02.01.00, 00:00: New orders received.
02.01.00, 02:00: New orders received.
02.01.00, 17:00: customer 3 from market 1 informs us about a delivery (Bio counter) late for 0 days and 1 hours!
02.01.00, 17:00: customer 2 from market 1 informs us about a delivery (Bio counter) late for 0 days and 1 hours!

Figure 7.27: Customers informing company about late deliveries.

As time passes the debts of the customers will automatically be paid to our cash (*On-line cash* window) and to the *Cash flow* window (Figure 7.28).

Cash flow

Date	TargetObject	Brand	Sum
15.01.00, 16:00	Bio counter	Sales earnings	375 000
15.01.00, 16:00	Bio counter	Sales earnings	375 000
22.01.00, 19:00	Bio counter	Delivery costs	- 270
22.01.00, 19:00	Bio counter	Delivery costs	- 55
15.01.00, 22:00	Electronics	Raw material expenditures	-4 200 000
16.01.00, 05:00	Bio counter	Sales earnings	441 000
16.01.00, 05:00	Bio counter	Sales earnings	350 000
16.01.00, 05:00	Bio counter	Sales earnings	441 000
16.01.00, 05:00	Bio counter	Sales earnings	441 000
16.01.00, 05:00	Bio counter	Sales earnings	350 000
16.01.00, 05:00	Bio counter	Sales earnings	441 000
16.01.00, 17:00	Bio counter	Sales earnings	350 000
16.01.00, 19:00	Bio counter	Sales earnings	455 000
16.01.00, 19:00	Bank loan	Loan withdrawal, Merita	300 000
16.01.00, 23:00	Bio counter	Sales earnings	375 000
17.01.00, 03:00	Sensor	Raw material expenditures	- 650 000
17.01.00, 11:00	Bio counter	Sales earnings	350 000

Figure 7.28: The cash flow window.

While the game time passes, the companies may face cash deficit. If the companies do not collect the incomes fast enough from the sales they have to withdraw loans. Loan withdrawals are made in the *Funding* window (Figure 7.29).

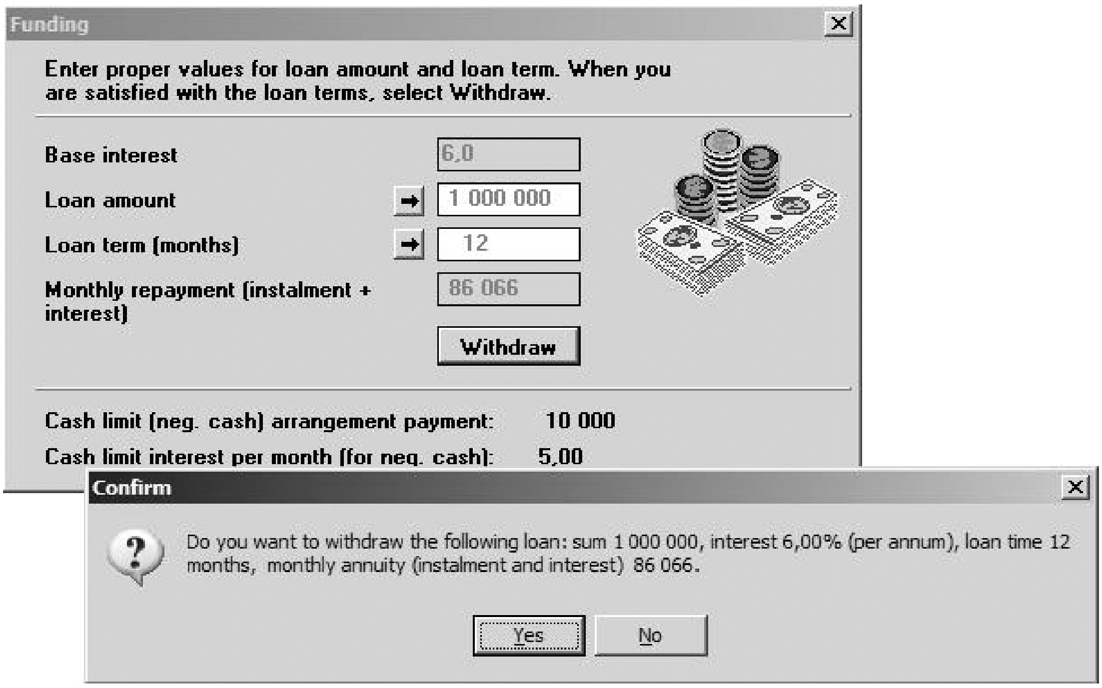


Figure 7.29: The Funding window.

The CAP also updates the balance figures (Figure 7.30) in real-time. Of course, this does not mean those accounting entries which are dealt with when the accounts are closed (for example, calculating the end value of machinery balance sheet value makes sense only at the end of the financial period when the value of depreciation is calculated).

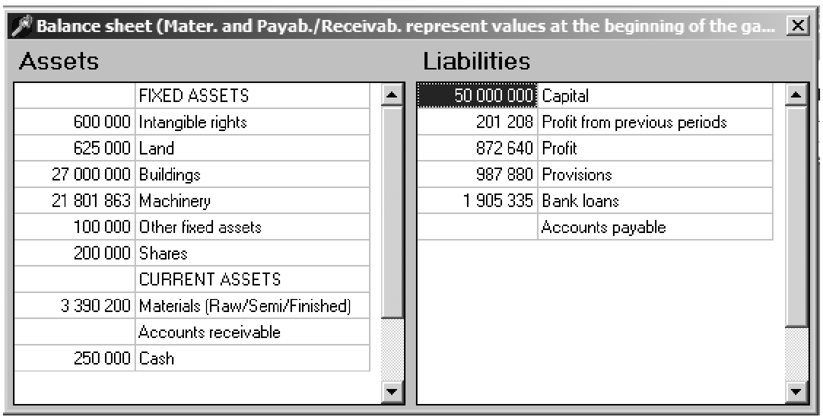
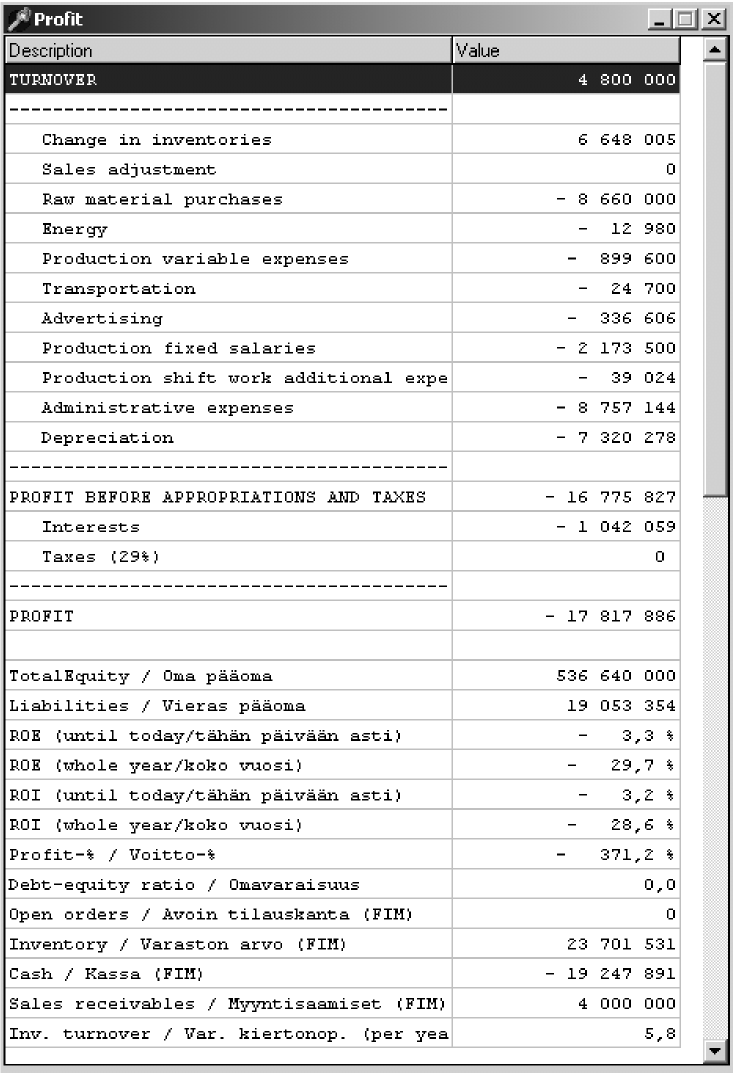


Figure 7.30: The balance sheet window.

The CAP also includes a possibility to calculate the profit on-line (Figure 7.31). This calculation can be selected from the menu and the CAP calculates the financial statement according to the events materialized during the period (realized so far).



Profit

Description	Value
TURNOVER	4 800 000
--	
Change in inventories	6 648 005
Sales adjustment	0
Raw material purchases	- 8 660 000
Energy	- 12 980
Production variable expenses	- 899 600
Transportation	- 24 700
Advertising	- 336 606
Production fixed salaries	- 2 173 500
Production shift work additional expe	- 39 024
Administrative expenses	- 8 757 144
Depreciation	- 7 320 278
--	
PROFIT BEFORE APPROPRIATIONS AND TAXES	- 16 775 827
Interests	- 1 042 059
Taxes (29%)	0
--	
PROFIT	- 17 817 886
TotalEquity / Oma pääoma	536 640 000
Liabilities / Vieras pääoma	19 053 354
ROE (until today/tähän päivään asti)	- 3,3 %
ROE (whole year/koko vuosi)	- 29,7 %
ROI (until today/tähän päivään asti)	- 3,2 %
ROI (whole year/koko vuosi)	- 28,6 %
Profit-% / Voitto-%	- 371,2 %
Debt-equity ratio / Omavaraisuus	0,0
Open orders / Avoin tilauskanta (FIM)	0
Inventory / Varaston arvo (FIM)	23 701 531
Cash / Kassa (FIM)	- 19 247 891
Sales receivables / Myyntisaamiset (FIM)	4 000 000
Inv. turnover / Var. kiertonop. (per yea	5,8

Figure 7.31: The profit window.

Besides of standard financial statement the game offers diverse reporting possibilities. First, the reports describing each company’s sales efficiency can be seen in Figure 7.32. The different reports describing market events and positions can be seen in Figure 7.33. These reports are produced on-line (they will report the situation with a delay of a day or some days). Available reports of each company’s efficiency in the materials functions can be seen in Figure 7.34.

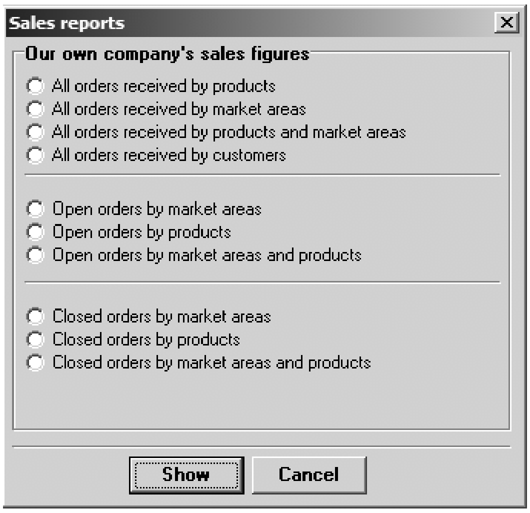


Figure 7.32: The sales reports window.

Figure 7.33: The market reports selection window.

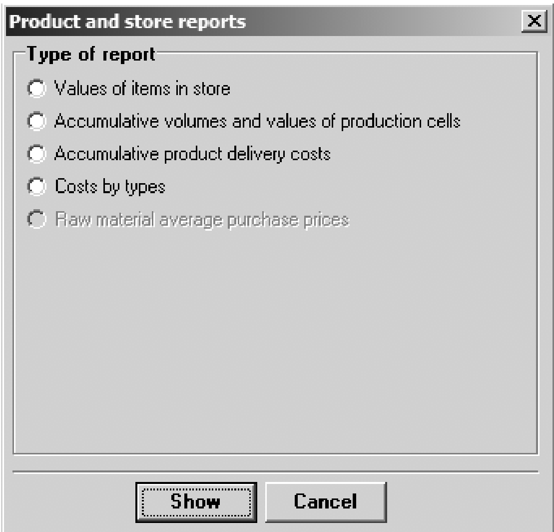


Figure 7.34: The product and store reports window.

7.7 Business and Market Model Customization

Another construction principle represented in this chapter is the configurability of the learning tool. This is a property that is seldom effectively implemented in business games. The argumentation for the configurability of a learning environment and preliminary learning outcomes from it are presented in Paper 4.

The configurability of Realgame concerns all the functions of the game. In this chapter we will clarify the meaning of configuration and how it will affect the user interface.

The configuration information is always saved and maintained in database tables. Maintaining the game configuration information is simple: the operator just opens the table including the configuration information with the Database Desktop and edits the information in the table.

7.7.1 Configuring the Supply Function

The configuration of the market raw material suppliers is performed in a single Paradox table, which is maintained in the market server. The table layout and some example data are shown in Figure 7.35. Besides of the fields in Figure 7.35 the raw material renewal speed can be configured for each supplier/raw-material.

Table : Supstore.db

Supstore	Name	Product	Store	UnitPrice	DeliveryTime	TermOfPayment
1	Electronics Ltd.	Electronics	1 000 000.00	350.00	12	14
2	Electronics Ltd.	Processor unit	1 000 000.00	2 480.00	24	14
3	Electronics Ltd.	Sensor	1 000 000.00	65.00	12	14
4	Freezer Electronics	Electronics	1 000 000.00	340.00	24	7
5	Freezer Electronics	Sensor	1 000 000.00	60.00	24	16
6	NY Electrobits Ltd.	Electronics	1 000 000.00	360.00	10	14
7	NY Electrobits Ltd.	Sensor	1 000 000.00	59.00	28	10
8	Y2K ComplianceLtd	Processor unit	1 000 000.00	2 600.00	12	14

Figure 7.35: The SUPSTORE database table.

7.7.2 Configuring the Production Structure of Companies

The options to configure the production line structure of the companies are:

- Determine the number of successive production cell phases and the number of parallel cells in each production phase.
- Determine the internal structure of each production cell.
- Determine which cells form a 'meta-cell': a group of cells in which only one cell at a time can be the active cell. This structure means that the meta-cell includes several parallel production recipes of which one at a time can be in use.

7.7.3 Configuring the Overall Production Line Cell Structure

The company production line can include from 1 to 5 successive production phases. Each of these phases can consist from 1 to 9 parallel production cells. Figures 7.36 to 7.38 show some examples of the configuration of the manufacturing function. The first one is the game generic version (generic version used mainly to teach university students), the second one is a model configured for a glass manufacturer, and the third one is a production model for a high-tech instruments manufacturer.

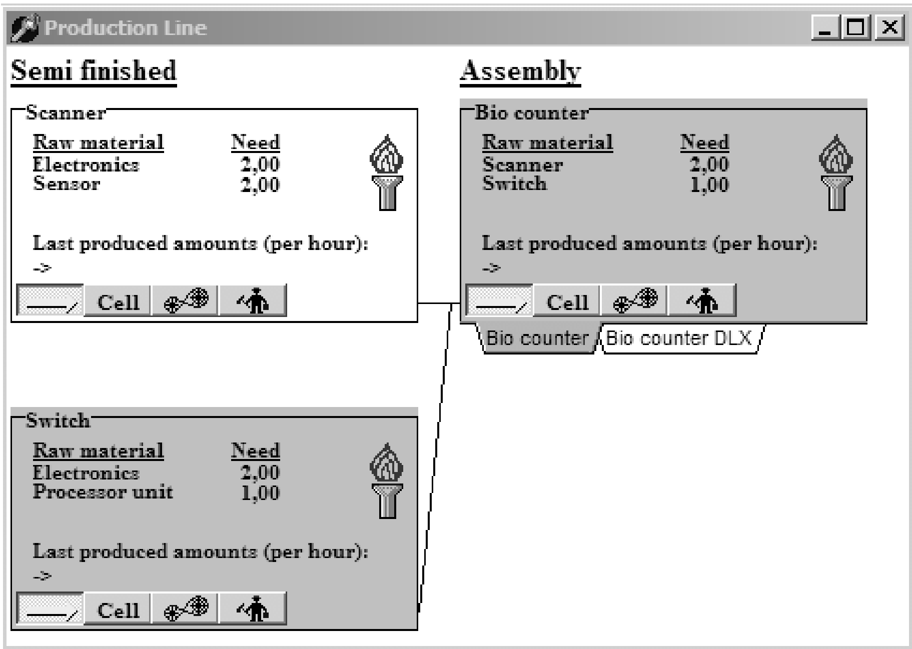


Figure 7.36: The Production line window in the game generic version.

Figure 7.37: The Production line window of a glass manufacturer configuration.

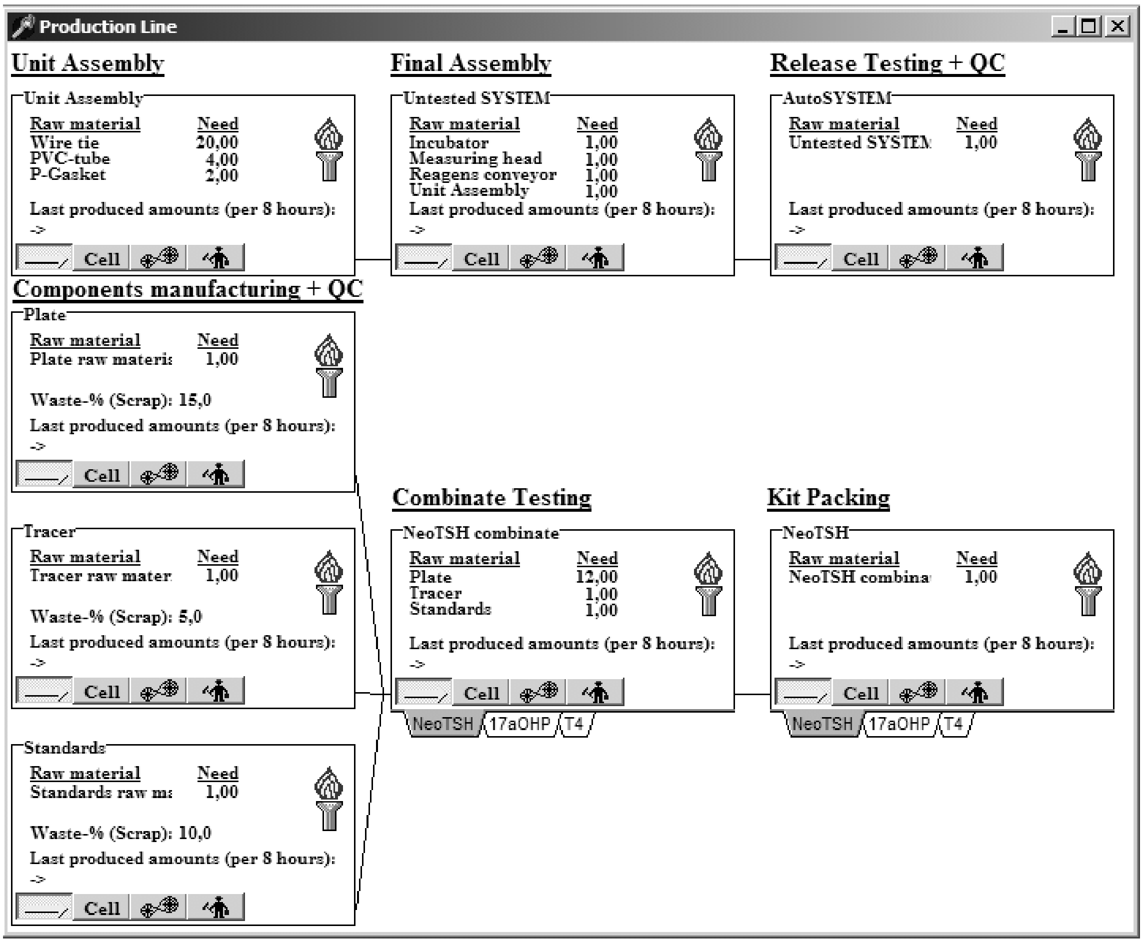


Figure 7.38: The Production line window of a configuration for a manufacturer of high-tech analysis systems.

The simplest possible configuration of the production line consists of a single production cell and the most complex one of 45 cells (5 phases times 9 cells). However, the present computer clock speeds limit the maximum number of cells. The number of production cells is one of the most significant factors affecting the processing time of one company application processing cycle.

7.7.4 Configuring the Internal Structure of Each Production Cell

The properties and functioning of a production cell is defined in a programmer defined Delphi object type. This object is inherited from Delphi standard objects. This object is the only significant programmer-defined object in the game construction (though some database table rows, like customers in a market table, are often manipulated like objects). Other objects in the game applications are standard Delphi objects. The cell object consists of some

2,500 lines of program code. Each of the production cells in the production line window has its own table file. For example all the numerical information in Figure 7.39 for the Scanner cell is saved in the cell's configuration database table.

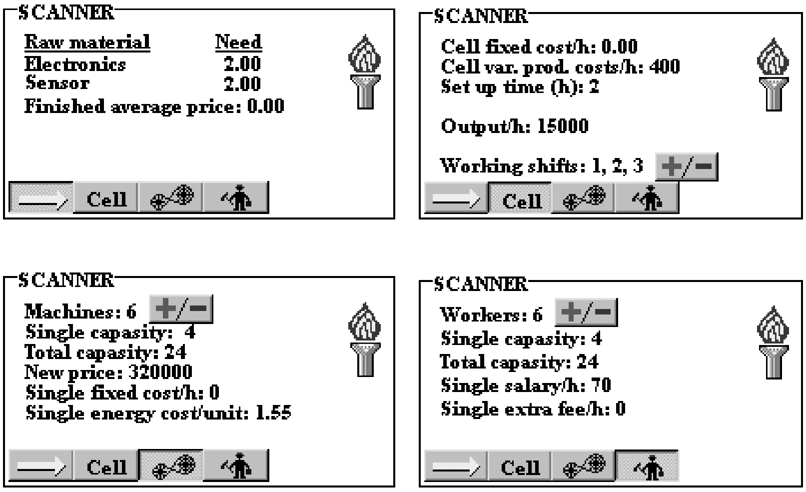


Figure 7.39: Four different views to a production cell. All the numerical cell info is saved as parameters in a database table.

7.7.5 Configuring a Production Meta-cell

In some cases the production cells need to have several alternative production recipes. Figure 7.40 represents a production meta-cell actually consisting of three separate production cells belonging to the same production cell group. Each of these three recipes can be turned on and at the same time as the recipe that has been on so far is turned off.

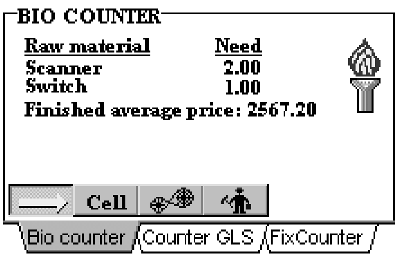


Figure 7.40: A production meta-cell consisting of three separate production cells.

7.7.6 Configuring the Customer Markets

The market structure of the game can be configured in two levels. First, the administrator can decide how many markets to be included in a game. This is done by entering the possible markets to the MARKETS database in Figure 7.41.

Table : MARKETS.DB

MARKETS	MarketNr	MarketOn	MarketName
1	1	True	Nordic
2	2	True	Europe
3	3	True	Nort-America
4	4	False	Asia
5	5	False	
6	6	False	
7	7	False	

Figure 7.41: The MARKETS database table.

Column 'MarketOn' specifies whether the customers in the market area are active or not. During the game it is possible to activate new market areas (by changing the value of 'MarketOn' from False to True) or even to create totally new market areas by appending new records to the table. The number of market areas is in practice limited only by computer processing capacity. New markets are created by the game operator, either at the beginning of the game or during the game. This can be done by inserting new market areas in the table.

Secondly, the market area customers are defined in market specific customer tables (MARKET1, MARKET2, MARKET3,... MARKETN). Figure 7.42 describes the customer structure of market area 3, North America. The table rows are customer and product specific.

Table : MARKET3.DB

MARKET3	CustomerNr	ProductName	CustomerName	LastPurchaseTime	AvgVolumePerMonthIfGetIn
1	1	Bio counter	New York UH	-78,00	200,00
2	1	Bio counter DLX	New York UH	-78,00	175,00
3	2	Bio counter	Boston UH	-70,00	275,00
4	2	Bio counter DLX	Boston UH	-70,00	325,00
5	3	Bio counter	New Yersey UH	-62,00	425,00
6	3	Bio counter DLX	New Yersey UH	-62,00	300,00
7	4	Bio counter	Philadelphia UH	-54,00	300,00
8	4	Bio counter DLX	Philadelphia UH	-54,00	400,00
9	5	Bio counter	Pittsburgh UH	-46,00	425,00
10	6	Bio counter	Buffalo UH	-38,00	375,00

Table : MARKET3.DB

HoursBetweenPurchases	MinGetInValue	CumulatedPurchase	WeightPrice	WeightTechr	WeightAdvertising
84,00	0,00	0,00	70	100	80
84,00	0,00	0,00	70	100	80
84,00	0,00	0,00	70	100	100
84,00	0,00	0,00	70	100	100
84,00	0,00	0,00	100	100	60
84,00	0,00	0,00	100	100	60
84,00	0,00	0,00	30	100	50
84,00	0,00	0,00	30	100	50
84,00	0,00	0,00	100	100	100
84,00	0,00	0,00	70	100	30

Table : MARKET3.DB

WeightSalesPromotion	WeightTermOfPayment	WeightTermOfDelivery
80	100	50
80	100	50
100	20	20
100	20	20
100	80	50
100	80	50
100	80	100
100	80	100
100	80	50
100	20	20

Figure 7.42: The MARKET3 database table.

The number of customers in each market area is theoretically limited only by computer database storage capacity. However, the processing of customer purchases is clearly the most time-consuming calculation task of the MAP. This means that increasing the number of customers will slow down MAP execution fast and thus slow down the game internal time. In practice this means that if the game clock is set too fast for the calculation processes, the game will proceed as fast as the calculation processes allow. At present day computer clock speeds this situation is possible when one game hour is set to equal two seconds or less.

7.7.7 Configuring the Game Environmental Parameters

The game environment is configured in the ENVIRONM database table. The content of the ENVIRONM table is described in Lainema (2003c). To give examples, the table contains parameters such as the game interface language, the basic hourly salary of a production worker, the length (days) of salary pay period, number of markets in use in the game, how many companies can theoretically sell to one customer at a time, how much the companies will pay (one time cost) if the cash balance becomes negative, fixed administrative expenses per month, administrative costs per production machine per month, base interest (rate) for loans, and so on.

7.7.8 Configuring the Market Specific Delivery Methods

The market area specific delivery methods and their costs are defined in the DELIWAYS database table (Figure 7.43).

Table : C:\datat\...\DELIWAYS.DB

DELIWAYS	DeliveryName	DestinationMarket	DeliveryDuration	FixedCostPerDelivery	DeliveryCostPerUnit	CertaintyOfArrivingInTime	MaxHoursLate
1	Truck	1	12	50,00	9,00	90	4
2	Train	1	16	50,00	6,00	90	4
3	Truck	2	28	150,00	19,00	90	4
4	Air freight	2	6	250,00	40,00	90	4
5	Air freight	3	24	1 000,00	44,00	90	6
6	Ship	3	168	1 100,00	27,00	90	8
7	Express air freight	3	18	2 500,00	60,00	90	4
8	Ship	4	224	900,00	32,00	90	4
9	Air freight	4	72	3 000,00	52,00	90	4

Figure 7.43: The DELIWAYS database table.

7.8 Elaboration on the Process and Time Argument

In this section we will explain more concretely the process and time aspect of Realgame. Our 'PROCESS AND TIME' proposition from Chapter 3 was: The batch-processing decision-making process is a budgeting process, where the top level corporate decision-makers make the decisions on behalf of the whole organization. In continuous processing the participants are part of the business process which evolves as the time proceeds. The dynamics between different organizational tasks and functions is explicit (in the form of processes).

When explaining process and time in Realgame we refer to Section 7.4 (*The Management of the Game Internal Time*) and Section 7.6 (*The Business Processes in the Game*) as our view of processes is based on the their flow and evolution as time passes. Table 7.2 replicates the characteristics of continuous processing from Table 3.4 and explains how these characteristics are show in Realgame.

Table 7.2: The characteristics of continuous processing in Realgame.

Characteristics of continuous processing	How shown in Realgame
Close to an open system view: best understood as ongoing processes rather than as a collection of parts.	The order and structure of participant operations and decisions according to which the game should be played is not fixed. *Events take place continuously and some of them in an unexpected order*. For example, the participants are not able to know in advance when customer orders take place. Furthermore, several processes are ongoing at the same time, each evolving according to its own phase: each customer transaction from order to delivery and payment; material flows from suppliers through manufacturing to delivery; product quality development/erosion as a dimension of time, cash flow development as a function of almost all the tasks taking place throughout the game company internal and also external environment, and so on.
Decentralized decision-making, also on the operational decision-making level, close to the actual action.	When started from the first game phase, the game represents decision-making on the very operational, transaction specific level (meaning handling single customer transactions; not aggregate): ordering raw materials, answering to customer orders, sending deliveries, selecting delivery methods, turning on/off production tasks/cells, and so on. These are tasks which often are missing in a batch-game and at least the decisions are made on a very aggregate level, which does not represent the operational level.
Continuous; the view is continuously evolving representing the process nature of business operations, on a transaction specific level.	Instead of momentary states at the end of fixed decision-making periods, continuous processing presents the flow and evolution of processes from the very first step to the last one, not missing intermediate phases. For example, the players can witness how their raw material purchases – as a function of time – are transported from the supplier to the inventory, are taken from the inventory to be used in production, are transformed while flowing through production cells to more developed semi- and final products, and end up in the inventory waiting to be delivered to the customers.
Process, bottom-up.	Business processes (materials handling processes but also processes which deal with sales, product development, monetary transactions, and so on) form the core business activity. Aggregate information can be produced based on the processes (from bottom to the upper levels), but the participants are always able to return to the transactional level of information.
From short to mid-term (sometimes also long-term) decision-making.	As Realgame functioning is based on the transactional level processes, the simulation internal time cannot be very fast, at least not in the beginning of the game. Both because of the speed and the transactional level, this means that the game is suitable for studying especially short and mid-term business operations. By halting the game clock regularly the participants are able to shape tactical and strategic level plans and decisions.
Process -> Outcomes.	As the game builds on processes and the transactional level of operations, the participants are able to see the chain from decisions/events to their outcomes. Thus, this connection is transparent or visible, not a black box as in batch-games. However, to be able to form a conceptual map of the game processes the game participants need to observe the game events and conclude the actual structure of the processes. This demands pattern recognition from the participants.
More potential for double-loop learning?	The transparent nature of Realgame might facilitate double-loop learning more than batch-games, because the participants see the cause-effect chains in actions. Thus, these chains are not hidden and in that sense it is not as easy for the participants to form wrong mental models about the relationships between business decisions and their outcomes. This is connected with what Machuca (2000) states about batch-processed games. In batch-games the assumed learning is attained through a system of trial and error in which the player does not really know the origin of the results obtained, although he or she bases his or her decisions on these (the symptoms of the problem). This is because a batch-game is a black box, not allowing observation of the true transactions, but an aggregate approximation of them.

Again referring to Chapter 3, from the temporal point of view batch-processing offers a cyclical process which normally has a constant pace. Referring to Ancona et al.'s (2001) temporal classifications, batch-processing corresponds to repeated activity mapping of Figure 3.4. Continuous processing, as time bound processes, is also able to represent all the other activities described in Figure 3.3 (as described in Section 3.4). Our own interpretation of the time aspect is described in Figures 7.44 and 7.45. Figure 7.44 describes the batch-processing process. Each black square representing a task – an aggregate level of a task in this question (like planning a raw material purchase budget for a period). During the decision-making period the participants plan an aggregate level decision for each of these functions/tasks. Then these decisions are fed into the simulation model. During the simulation, these aggregate figures affect each other and as a result, the simulation model gives out some end values to be used during the next decision-period.

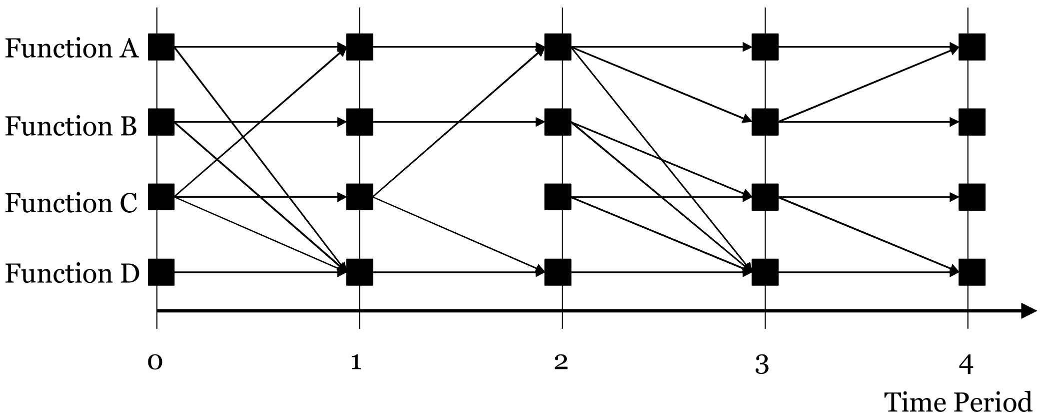


Figure 7.44: Participant decision-making tasks (aggregate level of tasks) in batch-processed games: one decision during each period within one decision-making task.

Figure 7.45 describes decision-making in a continuous game (compare to Figure 3.3). When the game is on, decisions are made continuously. These decisions are possible on the atomic, transaction specific level. Furthermore, there may be several simultaneous similar kinds of decisions. For example, the player continuously scans the raw material inventory. Whenever any of the raw materials inventory values needs supplement, a raw material order is made. These single, basic level decisions trigger other events or decisions. For example, a raw material order triggers a payment after the payment time (thus, the order is marked in the accounts payable and later this leads to a cash flow transaction) and an inventory value increase after the transport time. (Note that Figure 7.45 is an exaggeration in that sense that in practice in Realgame not that many tasks can be executed simultaneously as the game interface does not allow very many windows to be open simultaneously. Another point is that there can also be simultaneous tasks executed automatically by the game application.)

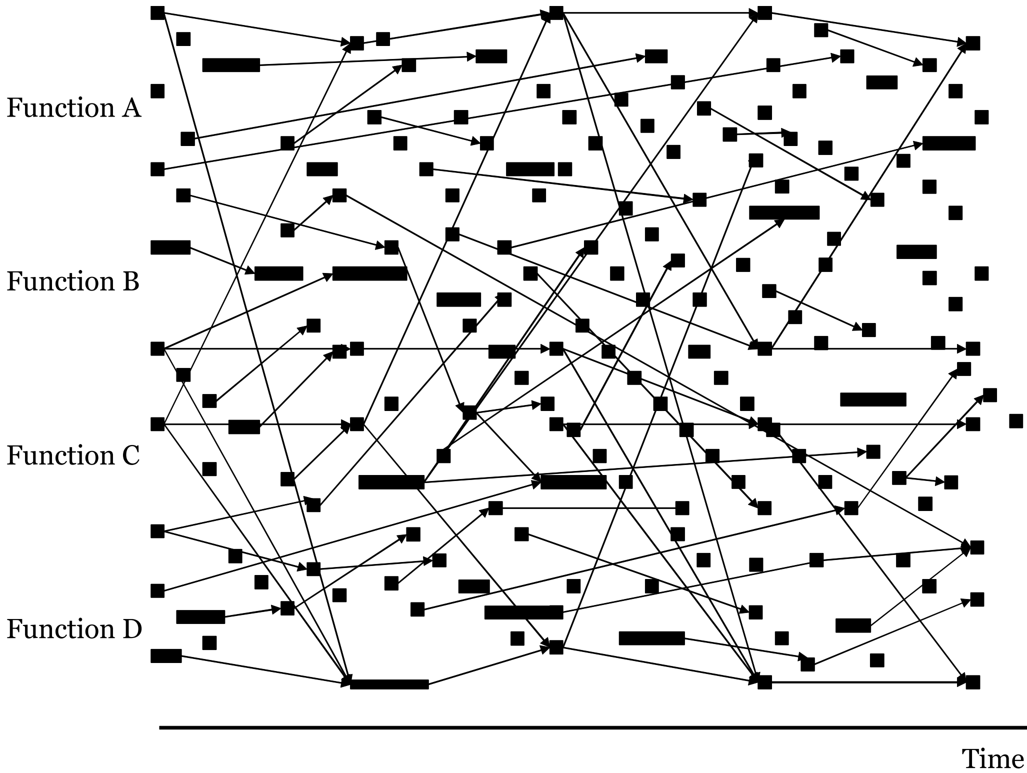


Figure 7.45: Participant decision-making tasks (transaction level tasks) in a continuous game: possibly several separate decisions on each functional decision-making level executed continuously during the game run.

From the 'PROCESS AND TIME' point of view, the main difference between the two modes is that in the continuous model reveals the process nature of business operation, explaining in a transparent form each particular phase within a certain business process. We will further analyze the difference between the two modes (and Figures 7.44 and 7.45) later in Section 7.11, *Complexity in Realgame*.

As a fact of minor importance, note, however, that Realgame is not a pure continuously processed game, but a batch-game where the batches are executed in one game hour cycles. As described earlier, this is because of technical convenience: present day computers do not allow the use of enough timer objectives needed in true continuous processing. Thus, the difference between Realgame and batch-games is the resolution level of business activities.

7.9 Decision-Making Levels Argument

The 'DECISION-MAKING LEVELS' proposition from Chapter 3 goes as follows: We aim at giving the participants a view of business functioning at the operational level which lays the foundation for higher level tactical and strategic decision-making. We are offering a bottom-up view on business activities instead of just a top-down view of business activities. In the business game this means different phases or levels of decision-making and different game clock speeds. This topic is already explained in Paper 1 but we will discuss the topic in more detail here.

A Realgame session has three phases. The first phase is the slowest one and the third phase is the fastest one. The clock speed in each game phase is a parameter and may be changed during the game run. The motivation to use different game speed phases in the game arises from the need to train different kinds of business skills (from operational/ structural decisions of the slow game speed to strategic/unstructured decisions of the fastest game speed) with the game. The slowest game phase allows the rehearsal of short-term game company internal operations. During the first phase, the decisions are made on the most atomic management level. The screen copies of Section 7.6 describe this level. As the speed is relatively slow the players have the possibility to properly see and experience the dependencies between different materials transactions, accounts payable and receivable, and cash flow.

When there is a need to see the causes from different decisions within a longer time span (tactical decision-making), the clock speed needs to be increased to make the link between the decision and the outcome, separated in time, visible (this might sound contradictory from the managerial point of view, but the link needs to be explicated). Without speeding up the clock speed the playing would remain on the operational decision-levels preventing the participants to see the longer term effects of their decisions. For example, marketing, product development and pricing decisions have a varying but long delay (from weeks to several months) between the decision and the outcomes. Without speeding up the game speed the participants might never during a game session see the consequences of their marketing activities as the game on a slow speed might run only a few months of game internal market time. However, speeding up the clock and automating the functions should not be done before the participants have understood the operational level logic of the game company operations. This is something that the game operator has to be well aware of. Speeding up the clock too early would lead to participant frustration and possibly distorted understanding of the operations.

Then, without automating any game decision tasks, accelerating the clock would soon make playing impossible as there would be too many tasks to be taken care of within the given time. In conclusion, to see consequences of actions the game clock speed needs to be accelerated during a training session. As the game speed is accelerated, some decisions need to be automated. This necessity became very obvious during the very first game sessions when there was no task automation in effect yet. During these first game sessions the clock speed needed to be kept on a moderately slow level in order not to make the participants totally exhausted. We want to emphasize that what is explained above has been well experimented (during the more than 30 arranged game sessions) and there is no doubt that the chosen approach of automating tasks and changing from a decision-making level to another works in an appropriate manner.

This is why customer orders are automated in the second phase. This simple action considerably eases the participant decision-making as incoming orders are by far the most common business transaction that has to be taken care of. Thus, after the second phase has started (by the game operator decision in the MAP) the participants do not any more have to deliver manually each incoming order in the window described in Figure 7.23 (The handling of the open orders window; thus, the task described in Figure 7.24 – The confirm delivery window – is not needed any more). All orders will now be delivered automatically if there only are enough finished goods in the inventory. If there are not enough goods available, the order will be delivered as soon as there are enough finished goods.

Linked to this automatic delivery mechanism the players also have to decide which delivery method to use for each customer market (Figure 7.25: The terms of delivery in use window). Again linked to the selected delivery method and its speed is the promised delivery time in Figure 7.19 (The sales offers window).

The second phase involves more decision-making concerning smooth overall material chain management. As the second phase is considerably faster than the first phase the participants should be able to see a more holistic view of the dependencies between the functions taking part in the materials processes. The third phase of the game is the long-term 'strategic' decision-making level of the game. In this phase one game hour might take, for example, one real world second. The participants are no longer occupied with operational decision-making but need to concentrate on more strategic decisions, i.e. they have to follow competitor actions and market drifts.

As the game clock speed is again increased in the third phase, the most laborious task of the second phase – raw material purchases – needs to be automated (to prevent the participants from going to pieces because there are too many tasks to be carried out in a limited amount of time). When the game operator changes the game from the second to the third phase, the Inventory window will show some new columns (compare the second and third phase Inventory windows in Figures 7.46 and 7.47) into which the players can enter reorder points ("alarm size") for raw materials (and also deciding how much will be ordered at the reorder point and according to which terms: fastest, cheapest, with the longest payment time).

Inventory

Item	Amount	Average price	Ordered	Type
17aOHP combinate	1 000	490,00		S
NeoTSH combinate	462	428,70		S
Plate	5 725	27,29		S
Scrap	592	33,36		S
Standards	507	35,49		S
T4 combinate	1 000	481,00		S
Tracer	520	31,40		S
Unit Assembly	12	11 007,80		S
Untested SYSTEM	12	23 063,67		S
Incubator	198	650,00		R
Measuring head	248	2 322,00		R
P-Gasket	196	27,00		R
PVC-tube	192	2,10		R
Plate raw materials	19 171	12,50	0	R
Reagens conveyor	148	310,00		R
Standards raw material	4 481	8,50	0	R
Tracer raw materials	4 484	5,50	0	R
Wire tie	960	0,22		R
17aOHP	2 500	550,00		F
AutoSYSTEM	32	31 926,25		F
NeoTSH	2 818	544,11		F
T4	2 500	522,00		F

R= raw material; S= semi finished; F= finished

Figure 7.46: The Inventory window in the game first and second phase.

Inventory

Item	Amount	Average price	Ordered	Type	AlarmSize	AutoOrderSize	OrderGround
17aOHP combinate	1 000	490,00		S			
NeoTSH combinate	208	532,90		S			
Plate	3 269	31,02		S			
Scrap	2 378	33,38		S			
Standards	366	50,33		S			
T4 combinate	1 000	481,00		S			
Tracer	428	43,87		S			
Unit Assembly	11	11 550,72		S			
Untested SYSTEM	11	25 138,56		S			
Incubator	192	650,00		R	50	100	Price
Measuring head	242	2 322,00		R	50	100	Price
P-Gasket	184	27,00		R	100	150	Price
PVC-tube	168	2,10	300	R	200	300	Price
Plate raw materials	8 230	12,50	30 000	R	20 000	30 000	Speed
Reagens conveyor	142	310,00		R	50	100	Price
Standards raw material	3 531	8,50	0	R	2 500	3 500	Speed
Tracer raw materials	3 522	5,50	0	R	2 500	3 500	Speed
Wire tie	840	0,22	1 500	R	1 000	1 500	Speed
17aOHP	2 500	550,00		F			
AutoSYSTEM	37	33 053,25		F			
NeoTSH	3 620	547,39		F			
T4	2 500	522,00		F			

Alarm size, Auto order size and Auto order ground are connected to automatic raw material orders. Double-click to the product row to change Alarm size and Auto order size.

Figure 7.47: The Inventory window in the game third phase.

Having explained all the above, we want to clarify that the purpose of using the different game phases emerges from the need to clarify the operational level business functioning and to link that to the higher levels of organizational functioning and decision-making. In our mind, the chosen structure enables the participants to see first the single trees of a forest and then gradually move further off the single trees and to see groups of trees and ultimately the whole forest. We have not developed any rules for when to move from one game phase to another, or what the exact clock speed during each game phase should be. The suitable speed and moment to change the phase depend on the length of the game, participant knowledge level, and the game learning themes that should be introduced. Thus, the degree of the transparency of the model may change or depend on learner progress.

These different decision-making phases also follow the path from structured to unstructured decision situations (as the most structured non-automated decision-making task is automated). Thus, in the first phase even the most simple, structured decisions have to be made by the players. Once the game participants have developed skills to handle them, this decision-making is given to the computer to be taken care of, setting participant decision-making capacity to be used for more complicated, unstructured problems, such as analyzing market competitive situation, analyzing the shifts in customer demand, calculating long term investment alternatives, and so on.

But also as the game proceeds from one phase to another, the game clock speed increases. This means that the participants are able to develop a more holistic view with a longer time span than when the game environment proceeds slower, as it is possible to see more clearly the outcomes of decisions (the delays between when decisions are made and their impact will shorten). The faster game clock speed also means that managing the whole structure becomes more difficult as the complexity increases (number of events per real world time increases). This is discussed in Section 7.11, *Complexity in Realgame*.

As a last comment on decision-making levels, we refer to Loewenstein's (1994) model of curiosity which is based on the notion of manageable gaps in one's knowledge. Motivation tends to increase as an individual realizes that a gap exists between the current knowledge level and a desired knowledge state. Furthermore, Loewenstein notes that the key to understanding curiosity seeking lies in recognizing that the process of satisfying curiosity is itself pleasurable. Thus, students should find learning fun because closing manageable gaps is pleasurable. However, the key is the term manageable. To stimulate curiosity, it is necessary to make students aware of manageable gaps in their knowledge. Gaps that are too great discourage learning. Students who consider the new learning level to be unattainable will be deterred from attempting to gain the new level. Similarly, when gaps are too small, learners are apathetic to the challenge. The different decision-making phases and the adjustable clock speed in Realgame seem to offer very effective tools to create manageable gaps in the learning environment, which further increase participant motivation.

7.10 Realgame Playing as Experiential Learning

Experiential learning is the traditional view of learning used to argue about business gaming (see Chapter 5). In business gaming the participants act as decision-makers and see the consequences of their decisions. Business gaming represents learning which is based on multiple circular cause-effect relationships and in which time is accelerated so that the link between a decision and its outcomes becomes explicit. In Realgame this includes intricacies of time delays and spatial scattering of decisions. The participants face here-and-now concrete experience and learning is based on feedback processes. This process is well illustrated in Figure 5.8. (*The impact on learning using virtual world*; Isaacs and Senge, 1992).

Then, how does Realgame fit into this picture? There probably is no doubt that Realgame is an experiential learning environment: it provides experience and feedback. It has been designed to become an experiential learning environment right from the beginning of the research project.

Realgame, however, is radically different from conventional business games in respect of the nature of this experiential cycle and in respect of what kind of experiences it provides. First, during the game execution the cycle of experience in Realgame does not include clear *separate* phases of Concrete experience, Reflective observations, Abstract conceptualization, and Active experimentation, but there are several cycles taking place simultaneously. In a conventional business game there is a more clear experiential cycle in the form of separate phases of Mental models, Strategy and decision-making, Virtual world (the business game model), and Outcomes and evaluation (Figure 5.8). Each of these phases mainly takes place separately from each other, although mental modeling, strategy and decision-making become intertwined during the process (Figure 7.48). In Realgame there are several experience cycles going on at the same time (Figure 7.49). For example, while the players have sent new sales offers to the market (i.e. phase Decision-making; have not yet received any information about the reception of those offers) they may at the same moment be experiencing the results of an old marketing investment (i.e. Outcomes and evaluation). This may be one reason for the observation that the participants immerse very deeply in Realgame playing (see the discussion in the Alpha case in Paper 4), according to our experience and interpretation more deeply than they usually do in conventional business gaming.

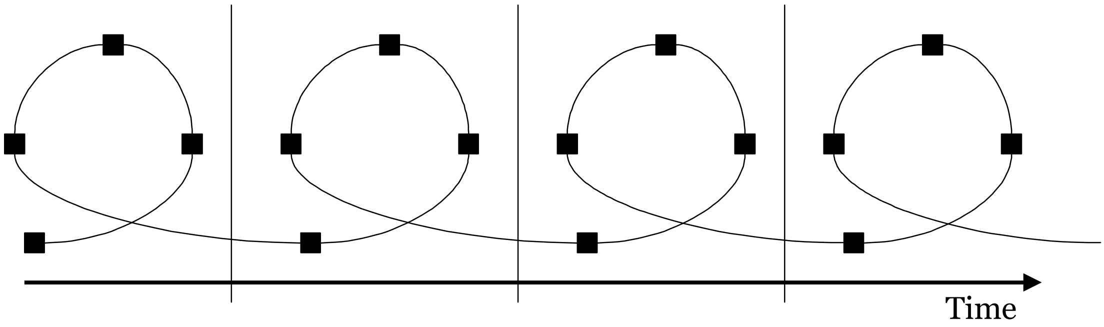


Figure 7.48: The experiential learning cycle in a batch-processed game.

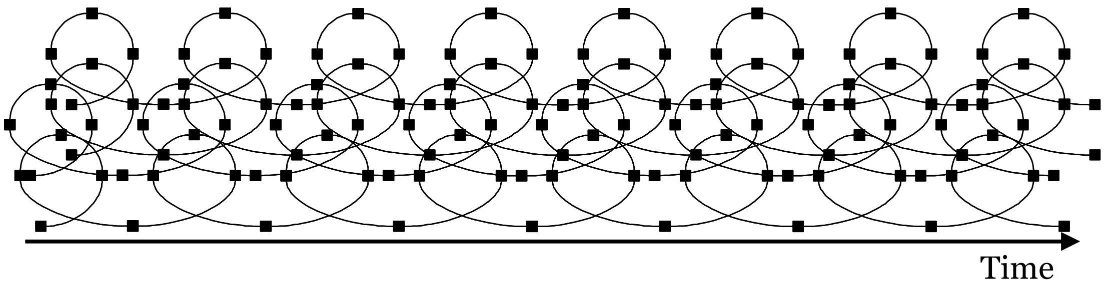


Figure 7.49: The experiential learning cycle in a continuously processed game.

Second, the flow of these experiential cycles is independent, thus, time flows independently of how the participants of the game act during the game (in Figure 7.48, the cycles are paced according to the decision periods; in Figure 7.49 the cycles are mainly dependent on the flow of time). Time is conceived as *clock time* and time determines or influences the behavior of the participants (Lee and Liebenau, 1999). If differences in human time orientations may cause organizational integration to be problematic (as Lee and Liebenau suggest) then this might also be the case of the Realgame experience compared to batch-gaming. The greater the time pressure, the more vigorous the search for alternatives becomes, and selective perception is the most acute where time pressure is the highest. This certainly would suggest that the learning experience is very different between the two modes.

As we noted in Chapter 3, in batch games time is probably not regarded in the clock time sense but more as a concept of social time (Lee and Liebenau, 1999). In batch-games time is probably experienced more as *event time* which is an opposite of clock time. Event time flows unevenly and discontinuously, and contains varying levels of contingency. As we suggested in Chapter 3, this seem to indicate that continuous processing and batch-processing also provide a different kind of learning experience.

Re-referring to Lee (1999; Chapter 3), it is quite obvious that batch-processed and continuously processed games differ from each other in respect of the six dimensions of temporality of business processes (Table 3.5):

- *Duration dimension*: Continuous processing probably gives generally less time to be spent to complete tasks and activities, making the experience more time urgent and maybe also forcing the time horizon of the participants to be shorter. This is not a direction without problems as it will cause problems on the higher levels of decision-making. This is also the reason why Realgame execution has to be halted every now and then during the training sessions to give the participants an opportunity to thoroughly analyze the situation and properly create new plans to be implemented on a mid- and long term basis.
- *Temporal location*: In continuous gaming events and tasks take place both simultaneously and in succession, thus, there is no clear temporal structure of events and decision-making as often is quite clearly in batch games.
- *Sequence*: In continuous gaming the sequence of activities is more complex, as already described in Section 7.8 (*Elaboration on the Process and Time Argument*) and will further be discussed in Section 7.11 (*Complexity in Realgame*). Batch-processing gives the participants a possibility to adapt to a slightly more monochronic way of working, where tasks are performed more in a manner of one task at a time, although functional management tasks are integrated on a general (strategic) level to one set of decisions. In continuous processing the work is more polychronic, demanding attention to be given to several tasks in parallel. Thus, the game events, resources and information are managed continuously; their flow is not intermittent like in batch-processing.
- *Deadline*: In continuous gaming the nature of deadlines differs from the deadlines in batch games. In batch games the only deadline is the deadline for the whole decision batch, defined by the game operator. In continuous gaming the deadlines are clock bound and set partly by the decision makers (for example, in the sales orders the players promise a certain delivery time for their customers and are then bound to deliver their goods according to this) and partly by the environment (the customers may order when ever they decide and then the players need to answer to this in time). This is a key difference between batch- and continuous processing.

- *Cycle*: In batch games the periodic regularity in which work is completed is clear; it is the period of simulating one cycle from decisions to results. In Realgame the cycles, again, are simultaneous, successive, their frequency may be very fast, and they are not necessarily regular. Again, this is a key difference between batch- and continuous processing.
- *Rhythm*: In continuous processing the alternation in the intensity of being busy may vary considerably. In batch-gaming the intensity is probably more stable.

Another issue concerns Realgame as part of an *organization's learning process*. Here we do not see that much difference between the two processing modes. Whatever the processing method, the role of the learning environment in Kim's framework (Figure 5.6) is the same. An experiential learning environment should function as a shared frame of reference where participants can test their mental models, to see relationships between various business decisions and potential outcomes. The insights gained from experience with these activities may be transferred to an organization when participants face situations that remind them of similar challenges faced in the simulation. Experiential environments should foster shared understanding of complex organizational processes and systems.

However, Realgame's configurability offers a potential additional useful feature to be taken advance of in organizational settings. Configuring a learning environment to resemble the case organizations real environment should be advantageous at least in that sense that the participants coming from different departments of the organization may find a common language more easily than when game "produces and sells X's and Y's". However, this is a feature that can also be implemented in batch-games. Here we refer to the results suggested in Paper 4. Some of the results from the paper hint that configuring Realgame would be beneficial for learning. However, the configuration should be planned carefully, not to try to create a detailed realistic model but a model with a reasonable level of resemblance to the actual environment. Naturally, how configuration should be carried out depends on the nature of the game, the context of the game use, the intended audience, and the subject matter to be taught.

The last comment on the learning aspect refers to the role an experiential learning environment should have in the larger learning context. Marsick and Watkins (1990; referred in Section 5.2) give recommendations for building learning modules around experience modules. People should work on projects that are real, preferably in teams in an environment outside their immediate work group so that they can question taken-for-granted norms and protocols, and so they are not constrained by habitual status, power, or other interpersonal patterns. The three main components of experiential (action) learning should be: a project (experience), seminars in which participants reflect on both content (the problem) and process (learning skills), and back-home experience. All three segments run parallel. Learning is a long-term developmental process requiring that some portions of the formal classroom activity be devoted to reflection in groups on the experience so that lessons can be drawn that are more generic than the specific project. These aspects apply equally both to batch- and continuous processing.

7.11 Complexity in Realgame

Complexity is not a research topic in our studies. However, complexity is an issue, which regularly pops up in the game participants' comments when they describe the game environment. Complexity is almost always mentioned in a positive manner. We believe that complexity is a topic more relevant in the context of Realgame than in the context of traditional business games. This originates from both Realgame’s transaction specific level of information and the continuous nature of the game. What this means will be discussed in this section.

Today organizations are routinely viewed as dynamic systems of adaptation and evolution that contain multiple parts which interact with one another and the environment. Systems thinking teaches us that what we label cause and effect are but temporary states in a web of interactions whose second- and third-order consequences come often back to haunt us. Members of learning organizations will have to envision dynamic conceptions of time/space where B leads to A or both are contingent on C. This is a relational picture that does not translate neatly into words (Mirvis, 1996). Kim (1993) argues that most efforts at mapping mental models result in static representations of phenomena which are usually highly dynamic and nonlinear. In this section we discuss why the artefact of the thesis might be somewhat different from conventional business games from the point of view of complexity.

As explained in Subsection 5.2.2, Senge (1990) divides complexity into two types: detail complexity (e.g., many variables included in a decision situation; Aulin’s, 1989, subjective complexity) and dynamic complexity (situations where cause and effect are subtle, and where the effects of interventions are not obvious over time; Aulin’s, 1989, objective complexity). Dynamic complexity can be found in situations where the same action has dramatically different effects in the short and the long run. According to Aulin’s (1989) classification, Realgame is a *continuous dynamical system which includes causality* with no rest state to be reached in a finite number of steps. This kind of dynamical system includes *dynamic complexity* (situations where cause and effect are subtle, and where the effects of interventions over time and space are not obvious) (Senge, 1990). But Realgame may include also detail complexity. We will first discuss the detail complexity issue.

The level of *detail complexity* in Realgame depends on two factors: *the specific game configuration in use* and *game clock speed*. Through configuration the game model detail complexity can be altered considerably. Consider, for example, the differences in the game production layout structures between Figures 7.36 and 7.38. Besides the production layout structure complexity can be increased by increasing the number of: market areas; customers; raw materials needed in the production (compare Figures 7.7 and 7.46); finished products produced; workers and machinery needed in each production cell; available transport methods; and so on. Even a very complex model – in respect of the number of details – can be easy to manage if the clock speed is slow. Thus, a back side of this same detail complexity is the clock speed. The faster the clock speed becomes, the more difficult it becomes to manage the details.

Here we would like to note that this combination of details and speed needs to be kept within manageable gaps mentioned in Section 7.9 (Loewenstein, 1994), to give the participants the possibility of attaining new learning levels. Just to mention one example of Realgame detail complexity, a Realgame company typically after simulating some half a year of business operations may have around 5,000 rows of cash transactions in the cash flow table (Figure 7.28). Because of this huge amount of detailed cash events information the participants may face problems analyzing the reasons for the present cash situation.

As discussed earlier, most cases in policy resistance arise from *dynamic complexity*, the behavior of systems that arises from the interactions of the agents over time (Sterman, 2001). Where the world is dynamic, evolving, and interconnected, we tend to make decisions using mental models that are static, narrow, and reductionist. The elements of dynamic complexity that are the most problematic are feedback, time delays, and non-linearity. We believe that to improve our ability to learn about and manage complex systems, we need tools capable of capturing the feedback processes and time delays which are sources of dynamic complexity. A learning tool must enable us to understand how these structures create a system's dynamics.

Dynamic complexity can be found in situations where the same action has dramatically different effects in the short run and the long run. Senge (1990) mentions that the real leverage in most management situations lies in understanding dynamic complexity, not detail complexity. Examples of dynamic complexity mentioned are: balancing market growth and capacity expansion; developing a profitable mix of price; improving quality; lowering total costs; and satisfying customers in a sustainable manner.

In Realgame, dynamic complexity arises from the characteristics of the game illustrated already in Figure 7.45. Dynamic complexity usually exists also in conventional business games but its nature is different from that found in Realgame. In batch games the results of different situations/actions/events is calculated based on aggregate values. The simulation model uses the decision budget values as input and calculates the results from these based on some simple – though hidden – algorithms. Both the input and output are on an aggregate level. Single transactions are "hidden" within the aggregate values. The result is that normally the imaginary transactions – if visible at all – represent an average transaction. Thus, the model is not able to illustrate exceptional transactions which may have a significant and interesting role in a continuous model.

In Realgame all the aggregate values are based on "real", existing, atomic level transactions. This means that the participants are able to drill down to the atomic level of events and analyze each transaction separately (analogically to present data warehousing techniques). This makes it possible to see reasons, for example, in difficulties in delivering or selling certain products during a certain time limit to specific customer in a certain market are. Examples of this transaction specific kind of information are represented in Figures 7.11, 7.12, 7.16, 7.23, 7.24, 7.26, 7.27, and 7.28. All these are examples which cannot be met in batch games.

This characteristic of Realgame also makes the relationships between cause and effect less mechanical than in batch games. In batch games stochastic elements are based on simulation model arithmetic, but in Realgame the players themselves may cause stochastic behavior, like when they "forget" to order raw materials, change the production cell to produce the product in demand, or deliver customer order in the order back log. Thus, the continuous transaction specific nature of Realgame gives a new dimension in respect of change elements in the game environment.

To illustrate what we mean, we will discuss one example of business activities, sales promotion investments. In batch-gaming the game participants invest in sales promotion, the simulation is run, and then the participants are expected to analyze and make conclusions about the effect of the investment on their sales (upper part of Figure 7.50). This sounds like quite a simple procedure, though, of course, matters are not quite this simple as there are many intervening decisions and the results are often very difficult to link to the sales promotion investments. However, the process is basically of the type of input-process-output-analyze.

In continuous processing, the process of investing and analyzing sales promotion is not at all straightforward. This is because of the continuous nature of events taking place. For example, companies may launch sales promotion campaigns of different scales at different times. This kind of situation is much more complex than the one in batch-processing and becomes quite impossible to be analyzed thoroughly in the given time. The lower part of Figure 7.50 illustrates the operation in question in continuous processing. Different companies launch their campaigns at different times, with different frequencies and with different sums (the length of the bar illustrating the amount of money invested). In the reports of the game the participants can mostly see the aggregate scale of each company's investment but not at all as easily the point of time and the dispersion of the investments. Considering all this and the fact that new investments normally do not take effect immediately, analyzing the different components and drawing exact conclusions from the whole structure is not possible. All that can be concluded is an approximation of the situation. For example, consider the situation in Figure 7.50 between companies 6 and N. Both of them have invested an equal amount but the investment of company 6 has had more time to take effect. Looking only at financial reports of the companies at the end of the time scale does not reveal a difference between the companies. Still, in general the investment of company 6 would have been more effective by the end of the time scale (but probably this effect ends before the effect of N's investment).

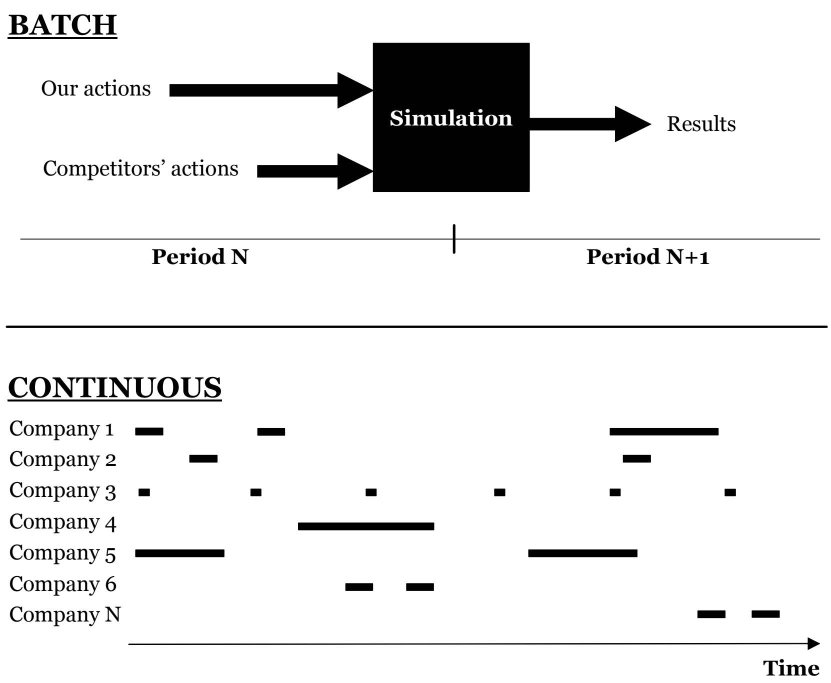


Figure 7.50: The characteristics of competitive investments in batch-processing and continuous processing.

Sales promotion activities are not the only type of activity functioning the way we described in continuous processing. Actually all time dependent activities affecting the competitive situation have the very same characteristics, e.g. offers (when an offer is launched) and product development.

Senge (1990) argues that besides of seeing interrelationships rather than linear cause-effect chains, there is another issue essential for systems thinking (described more in detail in Paper 1 of this thesis). Also, seeing processes of change rather than snapshots is important. Here batch and continuous processing are very different. In batch processing the participants can see only a static view of the state of their company after each simulated period (see Figure 7.48 describing the periodic structure of a batch game). In continuous processing the view to the business model is transparent (see Paper 1).

The above discussion on continuous processing and dynamic complexity adds realism to the gaming experience. But the value of continuous processing and dynamic complexity for the learning experience is still vague. However, the inclusion of these elements in the learning environment should be in line with the new views on learning which encourage the use of complex learning environments by arguing that students cannot be expected to learn to deal with complexity unless they have an opportunity to do so (Cognition and Technology Group at Vanderbilt University, 1992).

We have to further comment one more aspect of batch gaming. Actually, Realgame is a batch game, but the batches are executed once an hour in simulation time. Thus, we could also think Realgame as a highly accelerated batch game where one decision period lasts one hour simulation internal time. Following this reasoning, we could argue that batch gaming would produce similar learning experience as Realgame if only a batch game’s cyclical input-process-output cycle was accelerated considerable. However, this is not the case, as in Realgame the events still take place on the transactional level.

As a conclusion about the dynamic complexity in Realgame we can comment that though the basic nature of dynamic complexity between batch and continuous games is the same (cause and effect are separated in time and place), in Realgame the number of causes and effects is much higher and are influenced more by participant actions. How useful this is from the point of view of helping participants to discover trigger points separated in time and place, remains to be studied in the future.

7.12 Debriefing and Assessment of Learning

As already mentioned in Chapter 6, a thorough assessment and evaluation of the ability of our artefact to facilitate learning is beyond the scope of this thesis. Debriefing and assessment in the form of evaluation and follow up studies will take place in the future. This future research will deal with questions like "How do participants construct and test knowledge from the flow of data and information available during a session?" The purpose of this section is to give some preliminary comments on Realgame debriefing and learning assessment.

In Subsection 4.2.3 we already introduced the purpose of debriefing. For example, Thiagarajan (1995) lists six phases of debriefing, including such topics as what do the participants think happened during the gaming, what the participants think they have learned, how does the experience relate to the real world, and so on. The participants should be encouraged to generate and test different hypotheses and come up with general principles based on their experiences from the game and to offer evidence to support or to reject the principles. The participants need to articulate their perception of what was learned, and the instructor needs to put things into a broader perspective (Gentry, 1990). The process feedback is much more valuable than outcome feedback.

Debriefing is a part of a larger gaming context. Klabbers (2001b) states that a game session encompasses two cycles: the macro- and micro-cycle, which together give shape to the learning cycle (Figure 7.51). The macro-cycle refers to the overall game session. It includes such tasks/phases as handing out manuals, allocating participant responsibilities, the actual game (shaping the micro cycle), stepping out of the game situation, debriefing as a reflection on the process and game experiences, and debriefing as an arrangement of concepts and relationships (contextualizing the lessons learned).

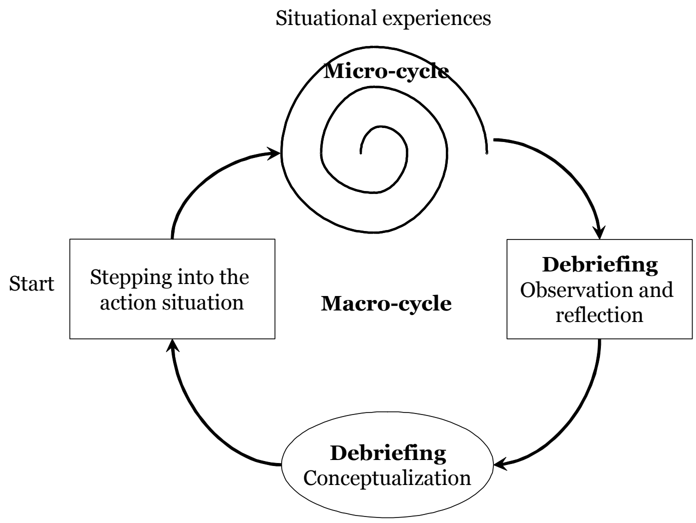


Figure 7.51: Learning cycle of a game session (Klabbers, 2001b).

During the game and especially during the debriefing, the participants are invited to reflect on their actions (mutual problem solving, making decisions, interacting with fellow players). Such reflection-in-action is a precondition for learning and understanding. Assessing a game from the point of view of individual and peer assessment should take place right after the session. Impact assessment, however, is not straightforward. One reason why it is difficult to assess games relates to the complexity of the learning situation. Participants deal simultaneously with problem framing, meta-cognitive competence, emotional skills, communication skills, attitudes toward competition, decision-making, and process management skills (Klabbers, 2001b).

In Realgame in-house company training, the macro-cycle presented in Figure 7.51 includes in general the following tasks/phases:

1. *Start*: Before the training session, the participants receive a description of the training task they are going to face. This description is delivered about one week before the actual training days. The description is not exhaustive as its purpose is to motivate the participants, not to frighten them. The description illustrates the nature of the business learning environment and the competitive nature of the setting but it does not include detailed gaming instructions as such information would not be read by the busy participants in any case. The start phase also includes a guide to the use of the game application interface at the beginning of the actual training day (approximately one hour).
2. *The gaming micro-cycle*: this phase includes the playing of the game, as described in the game screen copies of Chapter 7. The company in-house training sessions normally last one and a half days (12

hours). Besides the actual doing (playing), the game clock is halted every now and then (depending on the need to clarify the game development; usually after every 1.5 to 2 hours of gaming). During the game pauses the operator may use the game workbook as additional learning material. The workbook includes learning topics related to the game conceptual requirements (described in Chapter 3: planning business operations, tactics and strategy, within the main organizational functional areas, like materials process, pricing, market analysis, accounting; the time aspect of decision-making is organically embedded in the learning environment). The complexity aspect of Realgame was not one of the aspects that was taken into account in the original contextual game design. This is why the debriefing has not dealt with complexity so far. Complexity, however, is inherently present in Realgame and will thus be taken into account in future Realgame training sessions.

3. *Debriefing*: Debriefing is an integral part of Realgame. Debriefing takes place already during the game as the game is halted and different problems are discussed collectively. The most important part of debriefing takes place immediately after the game session. During this the participants' experiences are examined and discussed. Through this examination the experience should be turned into learning. The debriefing part of the cycle is problematic in company in-house training as business organizations are usually not aware of the importance of the debriefing phase. Thus, it is sometimes difficult to allocate enough time to debriefing. Usually the debriefing session has taken one hour, but in a normal in-house training session of one and a half days it would be preferable to use around two hours for this phase. During the debriefing the participants share their experiences and are encouraged to evaluate critically the viewpoints of other participants. The game operator serves as a leader in the discussion by introducing relevant learning topics. What these learning topics are depends on the theme of the game session (usually this theme is agreed with the case organization well in advance before the training sessions). Normally the learning topics deal with the aspects taken into account in the Realgame conceptual requirements (Chapter 3).

Referring to Figures 7.48 and 7.49, we note that batch games and continuous games are different from the point of view of the structure of the experiential learning cycle. Based on the participant comments we are convinced that as a learning experience Realgame is different from batch games. Several participants in Realgame training sessions have stated that continuous processing in Realgame is an important factor and makes the game different from other business games (see e.g. comments in Paper 4). If this is true, then does this mean that the nature of debriefing might also be different? At this phase of the research we do not want to take any clear stand on this. One might argue that at least the complexity in Realgame means that “more than average” time should be devoted to debriefing. The high complexity of the processes in the game should mean that clarifying their structure demands more time than when using conventional games. But this is not necessarily the case. According to our experience, the transactional/operational first phase of gaming prepares the participants very well for the increased complexity of the game in the second and third phase. Thus, as the basic operational level is clarified thoroughly, it might make it easier for the participants later on to concentrate and take over the more demanding and more complex issues of gaming.

When assessing Realgame, we have in this thesis made the underlying assumptions about organizational characteristics explicit and then clarified the specifications of the game design. These two together frame the learning environment. During the debriefing the participants feed back their experiences in a form that should be compatible with the design characteristics. This is critical when we want to assess the learning environment. The assessment of Realgame is still preliminary. These preliminary results are presented in Papers 1, 3 and 4. The preliminary results are encouraging and there are strong clues that the artefact produces valid learning regarding the aspects taken into account in the contextual design. However, we want to remind the reader that assessing learning in games is a difficult task (see, for example, Burns et al., 1990, discussed in Subsection 4.2.5). We also want to repeat again what Gosenpud (1990) has found (see Subsection 4.2.5): The learner often learns things not intended by the designer, and often this unintended learning is more valuable because it is relevant to the learner. Evaluation, defined by the designer, may miss the real worth of the experiential experience because what is valuable for the learner is defined by the learner and may have nothing to do with the designer’s intention. In addition, in experiential learning intended outcomes are often vague since the focus of learning is usually on very complex, abstract phenomena.

One aspect speaking for the learning potential of Realgame is the fact that according to our observations Realgame teams often act like team members in a Synergistic learning mode (Kasl et al., 1997). Although we have not used the Kasl et al. framework in Paper 4 of the thesis, many of the learning conditions and processes of Synergistic learning were present in the Alpha case (referring to the video observations and interviews during the study of Paper 4). The findings which suggested Synergistic learning were:

- The participants valued team work as an enriching modus operandi,
- ideas were freely and openly expressed; members saw the potential payoff of all contributions, even when they might at first have seemed irrelevant,
- the teams became boundary-less as information was sought and given freely,
- experimentation was frequent and bold; it was both individual and collective,
- members sought out views that may have been disconfirming or challenging.

Unfortunately, in this study we have not yet analyzed why it seems that Realgame includes the potential to achieve Synergistic learning. Neither have we found any research discussing this topic. This issue clearly includes potential for future studies.

8 THE PAPERS OF THIS THESIS

In this chapter we will summarize the purpose of each of the original articles included in this thesis. The papers are placed in a logical order, which essentially also follows the temporal order of the papers (in a pure temporal order Paper 4 should come before Paper 3). Although most of the papers are only recently published or under review, the work leading to these papers has been active during the last five to six years.

PAPER 1

Lainema and Makkonen (2003). Applying Constructivist Approach to Educational Business Games: Case REALGAME. *Simulation & Gaming: An Interdisciplinary Journal of Theory, Practice and Research*, Vol. 34, No. 1, pp. 131-149.

The paper represents the researcher's present line of thinking about real-time/continuously processed business learning environments. This paper includes the core processing method thinking which is the basis for the rest of the papers. Thus, Paper 2 lays the technological assumptions on which the rest of the work rests.

This paper briefly evaluates business games in the light of constructivism and on the basis of this learning principle introduces Realgame, a new computer-based business game. The purpose of this construction is to give the business game participants a realistic view of business processes and, thus, enhance participant business process perception. The paper argues that business processes should be taught by providing a natural representation of the real world and a case-based learning environment, which fosters reflective practice. The paper argues for the use of techniques that support continuously processed gaming simulations which are based on computer network technologies. The results from Realgame use are preliminary, but an argument is made that continuous processing reveals the natural complexity and process nature of business operations. Thus, continuous processing is found to present authentic tasks rather than abstract instructions.

This paper is co-authored with Pekka Makkonen who was the main responsible for the part of the paper which discusses constructivism (chapter *Implications of Constructivism for Instructional Design*).

PAPER 2

Lainema (2003a). Implications of Constructivism for Computer-Based Learning. In the Proceedings of European Conference on Information Systems (ECIS) 2003, *New Paradigms in Organizations, Markets and Society*, June 19-21, Naples, Italy, CD-ROM. The paper was selected as one of the best paper nominees in the conference.

The paper introduces a learning principle – constructivism which is used to argue continuous processing. The paper represents an attempt to go back to the original texts in the reference discipline (education) to gain genuine appreciation of the arguments being proposed, although the presentation forum is an IS conference. This paper serves as an introduction to constructivism and can be referred to when reading Paper 4.

Constructivism has gained popularity recently, but it is not a completely new learning paradigm. Much of the work within Information Systems Science (IS), and especially within e-learning, uses constructivism as a reference 'discipline' but few of the works done within IS discuss thoroughly what the basic assumptions and implications of Constructivism are. As a result, the technology has driven the applications, with theory only vaguely or superficially applied. The paper argues that constructivism provides one theoretical approach to the use of computer-based systems, and, as such, deserves careful consideration.

PAPER 3

Lainema (2003b). Reinforcing Information Systems Students' Perception on Business Processes. Submitted to the *Journal of Information Technology Education*.

The paper argues why we need business process training for IS professionals and introduces some findings on how Realgame has been received in company training sessions. The paper includes the clearest argumentation for the relevance of business process based learning environments in the Information Systems science curriculum in this thesis, but the actual process learning results are more convincingly represented in Paper 4.

The paper argues that the constantly changing business environment has forced many organizations to move away from focusing on individual tasks and functions to focusing on more integrated and coordinated ways of work. On the basis of the evidence from some business school and especially Information Systems education literature the author points out the need to teach the cross-functional nature of business operations. Also some findings from the use of Realgame as a dynamic and realistic business process learning environment in company in-house training sessions are presented (introducing characteristics of a comparative case study; Cunningham, 1997). The applicability of the learning environment in university settings is argued. The findings speak for the use of learning tools that represent authentic tasks rather than abstractive instructions.

PAPER 4

Lainema and Nurmi (2003b). Applying an Authentic, Dynamic Learning Environment in Real World Business. Submitted to *Computers and Education, An International Journal*.

This paper includes the heaviest findings on the effectiveness of Realgame training. This paper describes a configured training session in two in-house training sessions. By the level of research methods and instruments and the depth of the empirical study this paper is the most mature one of the thesis. Paper 4 also introduces a single intensive case study (Cunningham, 1997) providing a vivid and powerful description of events and ways of working taking place during Realgame training.

The main focus of this paper is on describing how authenticity can be applied to computer-based learning environments. Two company in-house training sessions – where Realgame was used – are described. In these sessions the Realgame environment was first configured to describe the real-world environment of the case company. The authors conclude that real-time processing and the interactivity of the learning tool are important additions if we want to be able to represent authentically the process nature of business organizations. Realgame was found to be a very useful tool to be used in these in-house training sessions. The rationale for the game's usefulness comes both from the participants' positive feedback and interviews with them. The participants' regarded Realgame training as a very rewarding and interesting experience. Realgame seemed to be able to introduce the complex nature and interdependencies of the functioning of the business to the participants, that is to say the process view of business. Realgame inspired intense interaction and collaboration between the participants.

This paper was co-authored with Sami Nurmi. Timo, however, was responsible for writing most of the new text in the paper, and disentangling and analyzing the data. Timo also searched for the case company and made the agreements with it. The research instruments where again jointly developed and the experience from the earlier experiments (for example from the one described in Paper 4) were all taken on board. The conclusions were formed jointly.

9 CONTRIBUTION, CONCLUSIONS AND FUTURE RESEARCH

9.1 Results of the Study

Knowing how we know is the ultimate human accomplishment.
Duffy and Cunningham (1996)

One of the most demanding things one has to learn when entering the academic community and tradition is to refrain from presenting your own opinions before you have rigorous evidence supporting your arguments. This is also a challenge for this work: is the evidence presented here objectively strong enough to support our original arguments and can we thus say that the work carried out during the project has been successful, according to academic criteria? What makes this aim even more difficult is the nature of the research topic: learning business concepts and interdependencies. This topic differs radically from factual learning, which by nature is easier to discover.

Although not dealing with constructive research, Yin (1989) illustratively represents concerns about scientific research (and especially case research), current also in constructive research and in the assessment of its results:

1. The lack of rigor: has the researcher allowed equivocal evidence or biased views to influence the direction of the findings and conclusions?
2. Provides very little basis for scientific generalization: How can you generalize from a single case?
3. Takes too long and results in massive, unreadable documents.
4. Good case studies are difficult to do: Investigator's ability.

We have been aware of all the concerns and we believe we have succeeded in avoiding at least some of the problems. But still, all the above points remain ultimately to be estimated by an outside observer of this thesis. To facilitate this, the documents in this thesis include material from all the research phases of the research project. The qualitative methods in this research project were more significant than the quantitative methods in evaluating the acceptability of the artefact. The role of the surveys (questionnaires used during the game sessions) was merely to provide an additional, but less significant, source of evidence.

Table 9.1 represents the study design tests by Yin (1989) to be used to maintain validity in research (again from the case research field, but applicable especially when forming evaluation instruments in constructivist studies). Tactics used in this research are in italics.

Table 9.1: Case study tactics for four design tests (Yin, 1989; tactics we have used in this research in italics).

Tests	Study tactics	Phase of Research in which occurs
Construct validity (correct operational measures)	*Use multiple sources of evidence.* *Establish chain of evidence.* Have key informants review draft study report.	Data collection Data collection Composition
Internal validity (establishing causal relationships)	Do pattern matching. *Do explanation-building.* Do time-series analysis.	Data analysis Data analysis Data analysis
External validity (establishing the domain of generalizability)	*Use replication (multiple cases).*	Research design
Reliability (demonstrating that the study can be repeated)	*Use study protocol.* *Develop study data base.*	Data collection Data collection

Our research questions in this work were:

Do business game participants consider the continuous processing element of the new business simulation game beneficial?

Minor research questions stemming from the main problem were:

a) *Does the use of the artefact increase the engagement and meaningfulness of the work during the training situation? Thus, does the use of the artefact affect the participants' gaming experiences and working processes in a meaningful way?*
b) *What are the effects of configuring Realgame on the participants' gaming experiences and working processes? Does configuration increase the feeling of realism?*

The papers of the thesis and the discussion in this chapter aim at answering the questions: “Why did it work?” and “How did it work?” The "why" question (theorizing) is answered in the form of arguing for continuously processed learning environments. The "how" question (justifying) is answered especially in Paper 4 and in this chapter.

We feel that there are some undisputed contributions in this work. March and Smith (1995) state that significant difficulties in design science result from the fact that artefact performance is related to the environment in which it operates. The artefact must be evaluated, but the evaluation criteria themselves must also be determined for the artefact in a particular environment. March and Smith require that after an artefact’s performance has been evaluated, it is important to determine why and how the artefact worked within its environment. Thus, we theorize and then justify theories about those artefacts. We have also discussed these issues earlier in this work and in the papers of this thesis.

Building the first of any set of constructs is deemed to be research (March and Smith, 1995). The research contribution lies in the novelty of the artefact and in the persuasiveness of the claims that it is effective. Progress is achieved in design science when existing technologies are replaced by more effective ones. If the artefact is novel then actual performance evaluation is not required at all. Our contribution lies clearly in this area. *The work represents an artefact that includes features that have not previously been introduced* in any learning environment produced in academia in the world. Our literature review on this topic is quite unambiguous. Business games that would include pure continuous processing have not been constructed before. This probably also applies to the commercial side. But how significant is this new feature? This question still remains partly unanswered. There is some speculative literature about the effects of continuous processing which emphasize its possibilities, but as this is new research ground there is no prior research on the topic. We feel that Papers 3 and especially 4 of this thesis include some evidence of the applicability of continuous processing in training. However, future research has to be done within this topic. Still, we feel that Paper 4 includes some potential to become an important paper in this narrow area. Also Paper 1, which represents the idea of continuous processing in business gaming, is in our mind the clearest presentation of the topic in academic media so far.

Another new feature of the artefact is its configurability. To our knowledge there are no other educational business games which would include these diverse possibilities of configuring the training tool for the environment of the case organization. How important this is remains to be studied in the future, though Paper 4 gives us some hints that *configurability increases the adaptability of the learning environment in training situations*. The configuration aspect of the artefact received both positive and negative opinions. On one hand, the configuration shortened the time required for familiarization with the game and made it easier to understand the functioning of the game environment. On the other hand configuration caused some troubles, because the game model didn't resemble the case organization's real world environment at 100 % precision. We would like to emphasize that this topic offers an interesting future research area to be carried out in cooperation with real world business organizations. But we have to understand that real world resemblance is not a means to an end but a possibility to increase participant motivation. A computer model can never accurately represent the real world. Our objective is to repeat the Alpha type of research with Alpha or some other business organizations with slightly modified research questions and instruments.

Another contribution of the research is *the narrative of the research project*. This contribution should be interesting to anyone considering beginning similar constructive research. The amount of constructive research within business sciences seems to be increasing and this should partly increase the topicality of the work. The work describes both the misfortunes and successes of the work and tries to give an unembellished picture of the project.

The work also *links together some current views on technology based learning*. On the business gaming side, the experiential learning theory has been the dominant theory since at least the early 1970's. Our view is that the constructivist view of learning expands the otherwise very suitable experiential learning theory when we construct, evaluate and study the effects of computer based learning environments. Constructivism has some explanation power not included in experientialism. This concerns especially the cooperative social aspect of learning and knowledge creation, and cognitive phenomenon during the learning events. The aspects of constructivism that support business gaming type of learning well are, e.g. (applied from Cognition and Technology Group at Vanderbilt University, 1992, and Duffy and Cunningham, 1996):

- Support for dynamic environments: the problems to be communicated can be complex and interconnected supporting the formation of rich mental models.
- Represents a meaningful context for problem solving: Knowledge is context dependent, so learning should occur in contexts to which it is relevant.
- Problem complexity. Students cannot be expected to learn to deal with complexity unless they have an opportunity to do so.
- Links across the curriculum.

- Learning is an inherently social-dialogical activity. Knowledge, and thereby learning, is a social, communicative, and discursive process, inexorably grounded in talk. The way in which an individual comes to manifest the effective behavior of a community is to speak with the voice of that community.

The above list is not – in our mind – in conflict with the principles of experientialism but supplements it, bringing new explanation power into studying 'action learning'. Based on observations and interviews from our research we can conclude that *the artefact of the thesis provides a very intense and meaningful learning environment and context*. The artefact seems to maintain task-orientation well over long periods of training. *The continuous processing element helps participants to see how the different business processes elaborate, emerge and are linked together*, thus facilitating the formation of rich mental models, linking across different business studies, and representing the complexity of business operations.

According to Järvinen (1999) the researcher could ask whether the new artefact better differentiates and/or describes the phenomenon – to which this construct refers to – from other phenomena than any other conceivable construct. We are quite convinced that *continuous processing represents business processes and real world complexity more authentically than batch-processing*. Our results clearly give support for this hypothesis. The results give more support for this hypothesis than for any other of our hypotheses. The artefact represents information flows and demands, sequential dependencies in operations and a holistic view of a business organization very well.

The researcher might also ask what the potential benefits of the new construction are in use (Järvinen, 1999). When discussing March and Smith's (1995) term instantiation, Järvinen states that a new instantiation can support the users' learning and understanding when they use the new artefact. Thus, is working with the artefact beneficial for learning? We have noticed that what is learned through playing the game is not easy to recognize. The game participants clearly regard the gaming experience as useful, but they have difficulties in expressing what the concrete benefit from the session was. According to the participants' interviews and questionnaire answers *the game helped them to construct a holistic view of the functioning of a manufacturing company, and to see the interdependencies between different business operations*. In other words, the game introduced a process view of business to the participants.

As the last improvement to March and Smith's work, Järvinen states that instead of experimenting once with the artefact, a longer period of experimentation should be conducted, as many implications of a certain artefact will appear during the long use the artefact. We very much agree with this. Though we already have some findings we consider valuable (especially in Paper 4), we are quite sure that the most significant results of this research will emerge within the next few years. In future, we are going to open up more possibilities for participants to experience meaningful decision-making problems which can be regarded to be relevant in the real world environment.

As a conclusion from the research results from the game participants' interviews and questionnaire answers we state that the major research question (or the assumption underlying it) has been strengthened. *Continuous processing in the artefact seems to be beneficial for learning and it facilitates the development of holistic understanding about business processes*. We are convinced also that *the use of the artefact increases the engagement and meaningfulness of the work during the training situation*. At the same time we have to note that *we do not have unambiguous results as to whether the configuration of the artefact increases the feeling of realism*.

9.2 Limitations of the Study

"There are three stages in your reintegration" said O'Brien.
"There is learning, there is understanding, and there is acceptance."
Orwell[24] (1949)

So don't ask me no questions and I won't tell you no lies.
Rossington and Van Zant [25](1974)

The thread of the work is long – both longitudinally and including many phases (see Figure 2.2) – and there is an obvious danger that some phase or phases are not discussed thoroughly enough. This danger is especially relevant in those areas which are new for the researcher. In this thesis the major concern in this area is whether the discussion about the learning principles is of the quality and depth required.

Another potential problem in this work is that – though having had many Realgame training sessions – we still have relatively few cases where our ***latest*** research instruments have been in use. On the other hand, in the Alpha case (Paper 4) we used a very wide collection of research instruments and

[24] Orwell, George (1949). Nineteen Eighty-Four.
[25] Song *Don't Ask Me No Questions* from *Second Helping*.

analyzed the data from two different perspectives (two researchers). We also feel that the findings from case Alpha were quite interesting, and although some of the research should be replicated, some of the results are of interest already at this stage.

An obvious potential problem in this research might be the researcher's lack of knowledge about the work that has already been done in the field of simulation gaming. As Wolfe and Crookall (1998) put it, to create a cumulative literature of simulation gaming (not to mention achieving an non-contradictory scientific tradition), a researcher who knows his/her own discipline's literature well must also learn and build on the literature of the simulation gaming field if they are to push the field forward. On the other hand, we hope to have replaced some of this possible lack with the properties Wolfe and Crookall call meaningful educational research (p. 17):

> *Those who make significant research contributions do so in an environment of high activity and exposure with frequent interactions and contact with the real world rather than initially operating in solitude and isolation. The genesis of ideas that motivate significant research comes from the simultaneous convergence of several activities of interests. Intuition plays a significant role. Rather than being guided by logical, esoteric analysis, significant research is often guided by what "seemed to be right," by a hazy-yet-enthusiastic sense of moving in the right direction.*

Another thing is that the existing simulation gaming discussion may be of less importance to this study as the research has been of the straight evaluative kind (assessing whether a teaching method has been effective or not).

The research so far covers the initial assessment of the artefact. The basic question is whether the artefact enacts business processes adequately. Judgment on this is based on evidence gathered through different questionnaires and interviews in the thesis. However, the theories presented in this thesis have not yet been tested in the strict sense. Some might think that this would require a comparative study between continuous and batch-processed games, but we do not quite believe this. For us, continuous processed games and batch-processed games represent such qualitatively different learning environments as well as different learning topics that comparing the two methods does not make much sense. However, the value of continuous processing as a learning facilitator remains still untested, in a rigid scientific sense. How to do this is not quite clear to us yet, but we feel that continuing along the path that has been opened in Paper 4 provides a starting point for this work.

As Gosenpud (1990) argues, a theory-based evaluation study might reveal more useful findings, e.g. why is a given teaching method more effective, or what is it about it that makes it effective? We feel that our research tends to be more like the latter kind of research. We also feel that we have been able to carry out meaningful educational research in an environment of high activity and exposure with frequent interactions and contact with the real world rather than initially operating in solitude and isolation.

9.3 Future Research

...to stubbornly go where no man has gone before.
Adapted from Roddenberry[26] (1966)

Isaacs and Senge (1992) mention directions of computer-based learning environment (CBLE) research, to enable CBLEs to be used both to discover more completely the nature of the manager's theories-in-use concerning complex situations, and as tools to produce changes in these theories-in-use. We consider all of these directions relevant to our research:

- To examine what people take away from computer based learning environments (CBLEs) and attempt to put into practice in their working environments.
- To study the extent and nature of changes in theories-in-use altered in work settings.
- What is the range and type of errors in learning behavior of which people are aware before and after the CBLE?
- What new behaviors are CBLEs able to produce?

The main research objective in the future should be the learning which takes place while playing the game. This is a topic that has not yet been exhaustively studied, as it is vast as a research topic. Also, it seems to take some time to find suitable research instruments and arrange feasible research sessions. In the future, we are probably going to continue research similar to the one described in Paper 4, in cooperation with researchers from the discipline of Education. What also needs more research is the confirmation of the findings of Paper 4. In discussions with the Department of Education (University of Turku) one tool that has been mentioned as a possible research instrument is a descriptive system of analysis for investigating the dynamics of peer group interaction (see Kumpulainen and Mutanen, 1999).

[26] Roddenberry, Gene (1966). Preamble, TV series *Star Trek*.

The continuous nature of Realgame also seems to cause very deep immersion from the part of the game participants. What is interesting in this immersion is that it lasts over long periods of time, without much – if any – disturbance from the environment external to the game. This is one topic that – besides the actual learning – might be interesting to study: why is this immersion so deep and is it beneficial for learning?

Another interesting and central topic for Realgame research should be studying the effects of tailoring the game environment. The results from the game tailoring in case Alpha (Paper 4) were partly contradictory. Thus, more research should be done to study whether tailoring the game environment according to the case company's environment is beneficial for learning or not. This topic is especially interesting for Realgame research as Realgame's configurability is much wider and deeper than the configurability of conventional (batch) games. It also seems that companies in general are very interested in taking part in cooperation to create configured game models.

Actually, we see many other potential research trends for Realgame. Many of these might have relevance to behavioral research. For example, why does it seem to be so that a gaming environment includes the potential of achieving immediate Synergistic learning (Kasl et al., 1997) though normally team learning evolves through the Fragmented and Pooled learning modes to the Synergistic mode. Of course, this research topic is not restricted to the use of Realgame, but can be studied with other gaming tools, too.

Another research topic comes from the area of research on time. Lee and Liebenau (1999) argue that in the category of temporality where time is regarded as an independent variable (see Subsection 3.2.2) and as clock time (see Section 3.4), especially the study of time in different cultures deserves greater effort from scholars in organizational studies as well as those in international business and management. This would require cooperation with a researcher working within these disciplines but it is also an interesting research topic. In general, Realgame – compared to batch games – includes a totally different platform for research interested in the influence of time pressure on human decision-making.

Though demanding, these suggestions give us plenty of challenge to be answered in the future. As a final remark we want to comment on the difficulty of gaming impact assessment. As already discussed in Subsection 4.2.5 and Section 6.3, the quality of a simulation gaming tool as a learning facilitator is very difficult to verify. The potential problems are: how can we isolate the impact of the simulation gaming tool from other intervening factors; should we study the effect of simulation gaming on the individual, team or organizational level; what is the point of time when the effect of the learning tool should be measured (immediately after the session, a day after, a month after)? In this research we have gradually developed our research instruments. This development can be seen when one looks at the different questionnaires and tests used during the research project (Appendices A-H). We have gradually moved from simple questionnaires towards less rigid and more free-form methods, like video recording and interviews. At the moment we believe that methods like these include the best potential to reveal the actual learning potential of simulation and gaming tools. Paper 4 of the thesis represents and discusses the latest impact assessment procedure we have used in our studies. What is introduced in Paper 4 provides a foundation for our future impact assessment studies.

9.4 Applying the Results in Practice

Our main research contribution – the constructed artefact – is proven to generate a successful learning environment. How then to apply the results of the thesis in practice? First of all, considering the participants' learning and attitude, continuous processing quite clearly functions in a positive way. Reinforcement to this claim can be found in the video gaming industry; network gaming, where participants are online, connected to the gaming environment, are becoming the industry standard. Most new versions of present best selling video games include network gaming features. Thus, online gaming is becoming a standard feature. This is a challenge for business games, too. If the business gaming community is not going to adapt to this trend, its learning environments are in danger of getting an outdated image. This certainly applies to several types of business games (like marketing & sales and operations management oriented games), but maybe not necessarily to all (like games having only a strategy development emphasis). Nevertheless, the business gaming community should have a more experimental and curious attitude towards new application possibilities. *Continuous processing clearly represents one respectable possibility to take the gaming discipline further*.

Considering the above, our synthesis of the requirements for creating learning tools that (1) represent a holistic view of business operations, (2) include process and time, and (3) give the possibility to understand the scale of decisions based on a bottom-up view, forms *a framework that might be taken advantage of when considering alternative game processing methods*.

Finally, the results of this study – to our mind – quite clearly show that there is a lot to be improved in the field of company in-house training courses. Our experience is that people responsible for organizing internal education in companies as well as people responsible for higher education in educational institutes have a restricted view of what the characteristics of successful game based training are. People responsible for organizing training do not have sufficient skills to evaluate what the commercial game training companies are offering and training decisions are probably made on the basis of wrong arguments. Thus, there is a demand for *research that defines the nature of game based training that could help the decision-makers to evaluate the game training supply*. Some of our results are such that they can be used to clarify both the requirements and the structure of successful game-based training. For us, there are clear suggestions in our results that the interactivity of the learning environment, the authenticity of the learning tasks and the continuous nature of problem-solving tasks are important ingredients in a learning situation. These are topics that might be interesting to personnel development in business organizations.

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well i did my time in that rodeo
fool that i am i'd do it all over again
George[27] (1975)

Make it or break it
To open that door
To a new understanding
For man in his glory
Or then just forsake it
And worry no more.
Pembroke[28] (1974)

[27] Song *Mercenary Territory* from *The Last Record Album*.
[28] Song *Maestro Mercy* from *Being*.

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APPENDIX A: REALGAME QUESTIONNAIRE, GAMMA 1999 (SESSION 2)

1. Have you played any business games before?
2. Please give a grade on the following game properties. In other words, how well did the game illustrate the theme in question?

0 = I do not know/can't say
1 = poor
2 = quite poor
3 = satisfactory
4 = good
5 = excellent

Business function or theme that was described in the game, or some other game characteristic	Grade
Purchases	
Manufacturing	
Inventory management	
Offering	
Order management	
Marketing	
Funding	
The importance of time in decision-making	
Representing a holistic view of a company	
Representing sequential dependencies in operations	
Representing the importance of information demands and flows	
Enjoyability of playing	
Fluency of gaming	
Game's ability to give feedback on decisions	
Level of realism in the game	
Ease of use of the game interface	

6. Please comment on the potential of Realgame as a training tool.
7. Which Realgame parts should be further developed?
8. In your mind, does Realgame include potential in explicating (making clear) the flow of business processes? If so, describe briefly which are the processes that have the most potential to be explicated.

Thank you for your help!

APPENDIX B: REALGAME QUESTIONNAIRE FROM A REALGAME UNIVERSITY COURSE, AUTUMN 2001 (SESSION 17)

Åbo Akademi, Information Systems

4060, Dynamic Business Game, Autumn 2001

Experiences and thoughts from the Business game course

1. Evaluate the business game according to the theme below. How good was the game in representing the given issues?

Purchase process	**Poor 1 2 3 4 5 6 7 Excellent**
Manufacturing	**Poor 1 2 3 4 5 6 7 Excellent**
Inventory management	**Poor 1 2 3 4 5 6 7 Excellent**
Bidding	**Poor 1 2 3 4 5 6 7 Excellent**
Order management	**Poor 1 2 3 4 5 6 7 Excellent**
Marketing	**Poor 1 2 3 4 5 6 7 Excellent**
Management of funding	**Poor 1 2 3 4 5 6 7 Excellent**
The importance of time in decision-making	**Poor 1 2 3 4 5 6 7 Excellent**
Representing a holistic view of a company	**Poor 1 2 3 4 5 6 7 Excellent**
Representing sequential dependencies in operations	**Poor 1 2 3 4 5 6 7 Excellent**
Representing the importance of information demands and flows	**Poor 1 2 3 4 5 6 7 Excellent**
Enjoyability of playing	**Poor 1 2 3 4 5 6 7 Excellent**
Fluency of gaming	**Poor 1 2 3 4 5 6 7 Excellent**
Game's ability to give feedback on decisions	**Poor 1 2 3 4 5 6 7 Excellent**
Level of realism in the game	**Poor 1 2 3 4 5 6 7 Excellent**
Ease of use of the game interface	**Poor 1 2 3 4 5 6 7 Excellent**
Game processes' correspondence to reality	**Poor 1 2 3 4 5 6 7 Excellent**
How realistic was the uncertainty in the game	**Poor 1 2 3 4 5 6 7 Excellent**

Game was too complex	**Disagree 1 2 3 4 5 6 7 Agree**
The game gave enough feedback during the playing	**Disagree 1 2 3 4 5 6 7 Agree**
It was easy to find information in the game	**Disagree 1 2 3 4 5 6 7 Agree**
The time used for play was too short	**Disagree 1 2 3 4 5 6 7 Agree**

2. Did the game help you to get a holistic (to see the whole structure) view of business processes? Why/why not?
3. What do you feel you have learned during the course? What was the most important thing you have learned?
4. How useful do you think the Realgame is in teaching business processes (e.g. compared to traditional teaching methods; lectures, seminar working etc.)?
5. Was the working of your group successful? Would you have succeeded better alone?

Thank you for your answers!

APPENDIX C: REALGAME KNOWLEDGE LEVEL TEST (PRE AND POST TEST) FROM A REALGAME UNIVERSITY COURSE, AUTUMN 2001 (SESSION 17)

Åbo Akademi, Information Systems

4060, Dynamic Business Game, Autumn 2001

Knowledge level test

The test is just to measure your knowledge on the topics the course will cover. This test and your answers will not affect in any way the rating of your performance.

You may answer in English, Swedish or Finnish (whichever you feel you can best express yourself in).

Please answer the following questions.

1. Use a flowchart to describe the phases of the delivery process in a manufacturing company (we). Start from the customer order and draw phases until the customer pays its invoice to our bank account. Draw some 5 to 15 main “functions/routines/tasks”. An example of a flowchart is shown on the class screen.

2. How can a company ease its tight cash situation by changing the terms of payment available?

3. What kind of characteristics can be found in an efficient materials process of a manufacturing company (purchases – inventories – production – inventories – deliveries)? I.e. what are the crucial elements that have to be managed in order for the process to be efficient and economical?

4. What is the relation between cash flow and profitability? E.g. is positive cash flow (cash incomes greater that cash payments) the same as profitability? Explain your opinion.

5. Which individual market features can a company scan in order to sense its competitors’ actions?

6. Attached you can find some financial statements. According to the figures in these statements, calculate:
   - Profit-%
   - Return on Investment (ROI)

APPENDIX C CONTINUED

PROFIT CALCULATION

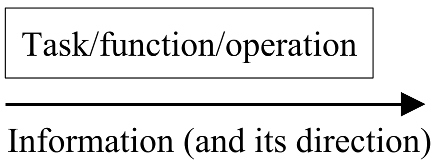
Turnover	31.000.000
Variable costs	-20.500.000
Fixed costs	-6.300.000
Operating profit	**4.200.000**
Financial income & expenses	-350.000
Profit before tax	**3.850.000**
Tax	-1.000.000
Net Profit	**2.850.000**

BALANCE SHEET

Assets	
Fixed assets	
Property, plant, equipment	10.150.000
Current assets	
Inventories	250.000
Receivables	550.000
Bank and cash	600.000
Total Assets	**11.550.000**
Liabilities & Shareholder's Equity	
Shareholders' equity	
Share capital	6.000.000
Retained earnings	2.500.000
Long-term liabilities (interest-bearing)	2.400.000
Current liabilities	
Account payable	650.000
Total Liabil. & Shareh. E.	**11.000.000**

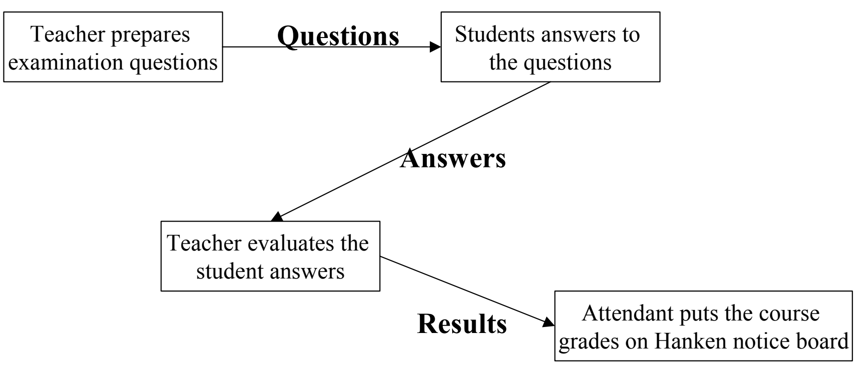
USING FLOWCHARTING TECHNIQUE

Basic symbols:



Usually the direction of flow is from left to right and from up to down.

An example:



APPENDIX D: REALGAME QUESTIONNAIRE USED IN THE SESSIONS OF PAPER 3 (SESSIONS 16, 18 and 23)

1. Work experience, years?
2. Education: Business / Technical / Natural science / Other: ___________
3. Have you played business games before?
4. Please give a grade to Realgame in respect of the following game properties/functions. In other words, how well did the game describe the property in question?

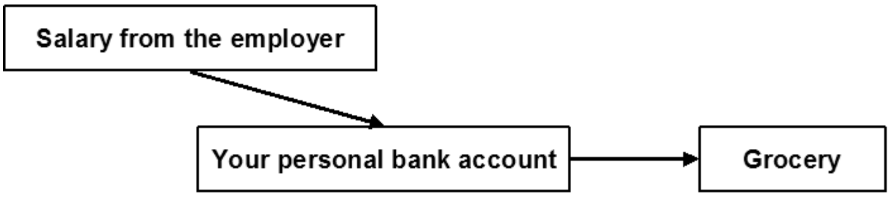
Purchase process	**Poor 1 2 3 4 5 6 7 Excellent**
Manufacturing	**Poor 1 2 3 4 5 6 7 Excellent**
Inventory management	**Poor 1 2 3 4 5 6 7 Excellent**
Bidding	**Poor 1 2 3 4 5 6 7 Excellent**
Order management	**Poor 1 2 3 4 5 6 7 Excellent**
Marketing	**Poor 1 2 3 4 5 6 7 Excellent**
Management of funding	**Poor 1 2 3 4 5 6 7 Excellent**
The importance of time in decision-making	**Poor 1 2 3 4 5 6 7 Excellent**
Representing a holistic view of a company	**Poor 1 2 3 4 5 6 7 Excellent**
Representing sequential dependencies in operations	**Poor 1 2 3 4 5 6 7 Excellent**
Representing the importance of information demands and flows	**Poor 1 2 3 4 5 6 7 Excellent**
Enjoyability of playing	**Poor 1 2 3 4 5 6 7 Excellent**
Fluency of gaming	**Poor 1 2 3 4 5 6 7 Excellent**
Game's ability to give feedback on decisions	**Poor 1 2 3 4 5 6 7 Excellent**
Level of realism in the game	**Poor 1 2 3 4 5 6 7 Excellent**
Ease of use of the game interface	**Poor 1 2 3 4 5 6 7 Excellent**
Game process correspondence to reality	**Poor 1 2 3 4 5 6 7 Excellent**
How realistic was the uncertainty in the game	**Poor 1 2 3 4 5 6 7 Excellent**

Game was too complex	**Disagree 1 2 3 4 5 6 7 Agree**
The game gave enough feedback during the playing	**Disagree 1 2 3 4 5 6 7 Agree**
It was easy to find information in the game	**Disagree 1 2 3 4 5 6 7 Agree**
The time used for playing was too short	**Disagree 1 2 3 4 5 6 7 Agree**

5. Did the game help you to form a consistent holistic view of the business of a manufacturing company and the factors influencing to it?
6. What did you learn during gaming? What do you feel was the most important thing you learned?
7. Was the continuous nature of the game a significant factor if you consider learning and understanding?

APPENDIX E: KNOWLEDGE TEST (PRE AND POST TEST) BUSINESS STUDENTS VS. EDUCATION STUDENTS, MARCH 2002 (SESSION 22)

1. Draw a concept map of the factors influencing the cash flow of a manufacturing company (both positive and negative factors). You can use your own drawing symbols or arrows to describe, for example, information/materials/monetary flows, and boxes to describe events/tasks (below an example of using the symbols).

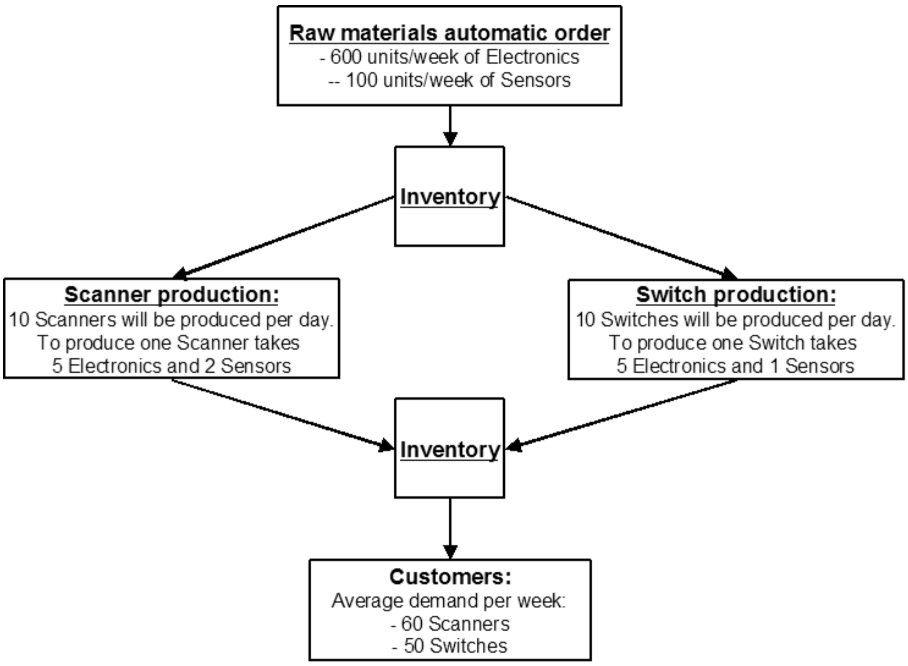


You have max. 15 minutes for the first task! Draw your concept map here…

2. How can a company have an effect on its tight cash situation (meaning a situation when incoming cash is not enough to cover the outgoing payments)?
3. What is the relation between cash flow and profit? Explain your opinion briefly.
4. Explain in your own words the following financial terms:
   - Profit %
   - ROI (Return on Investment)

ANSWER THE LAST QUESTION IN GROUPS!

5. The figure below describes a company's materials process (5 day working week). Analyze according to the numerical information in the figure what problems the process includes and what the effects of these problems are? What should be done to correct the situation?



APPENDIX F: UNIVERSITY COURSE QUESTIONNAIRE, AUTUMN 2002 (SESSION 26)

Åbo Akademi, INVESTMENT PLANNING, Autumn 2002, Business game

1. Class (number of years studied)?
2. Main subject of studies?
3. Have you played any business games before?
4. If you have, what was the name of the game (the name of the game you best remember)?
5. If Realgame clarified the run of business processes describe briefly which processes were clarified.
6. Did the game make you think about investments in the machinery? Did the homework help in this respect? How did you find the homework?
7. How much did your strategy change when you had played one full session? Did you understand (feel) that it is hard to plan strategies with non-complete information, comments?
8. Do you think that a business game like this is helpful in connection with a course in investment planning? If so, did the game add something extra that you think would not have been possible if some other teaching method had been used?
9. How should the real-time game be further developed?
10. What do you feel you have learned during the training? What do you think was the most important thing you learned?
11. Your general comments on the use of the real-time game?

Thank you for your help!

APPENDIX G: REALGAME QUESTIONNAIRE, IN-HOUSE TRAINING, TAMPERE UNIVERSITY OF TECHNOLOGY, SEPTEMBER 2002 (SESSION 24)

1. Work experience, years: __________
2. Education: Business / Technical / Natural science / Other: ___________
3. Have you played business games before? Yes / No
4. Please give a grade to Realgame in respect of the following game properties/functions. In other words, how well did the game describe the property in question?

Purchase process	**Poor 1 2 3 4 5 6 7 Excellent**
Manufacturing	**Poor 1 2 3 4 5 6 7 Excellent**
Inventory management	**Poor 1 2 3 4 5 6 7 Excellent**
Bidding	**Poor 1 2 3 4 5 6 7 Excellent**
Order management	**Poor 1 2 3 4 5 6 7 Excellent**
Marketing	**Poor 1 2 3 4 5 6 7 Excellent**
Management of funding	**Poor 1 2 3 4 5 6 7 Excellent**
The importance of time in decision-making	**Poor 1 2 3 4 5 6 7 Excellent**
Representing a holistic view of a company	**Poor 1 2 3 4 5 6 7 Excellent**
Representing sequential dependencies in operations	**Poor 1 2 3 4 5 6 7 Excellent**
Representing the importance of information demands and flows	**Poor 1 2 3 4 5 6 7 Excellent**
Enjoyability of playing	**Poor 1 2 3 4 5 6 7 Excellent**
Fluency of gaming	**Poor 1 2 3 4 5 6 7 Excellent**
Game's ability to give feedback on decisions	**Poor 1 2 3 4 5 6 7 Excellent**
Level of realism in the game	**Poor 1 2 3 4 5 6 7 Excellent**
Ease of use of the game interface	**Poor 1 2 3 4 5 6 7 Excellent**
Game process correspondence to reality	**Poor 1 2 3 4 5 6 7 Excellent**
How realistic was the uncertainty in the game	**Poor 1 2 3 4 5 6 7 Excellent**

Game was too complex	**Disagree 1 2 3 4 5 6 7 Agree**
The game gave enough feedback during the playing	**Disagree 1 2 3 4 5 6 7 Agree**
It was easy to find information in the game	**Disagree 1 2 3 4 5 6 7 Agree**
The time used for playing was too short	**Disagree 1 2 3 4 5 6 7 Agree**

5. Did the game help you to get a holistic (to see the whole structure) view of business processes?
6. Did the game represent the characteristics of the real world environment? Which characteristics?
7. Did the game represent realistically the role of time in decision-making? Give reasons for your opinion.
8. What do you feel you have learned during the training? What do you think was the most important thing you learned?
9. As Realgame is continuously (real-time) processed it demands that the participants follow market events and update their strategies continuously. Do you feel that this continuous surveillance was an important feature of the game from the point of view of learning and understanding? Why?

APPENDIX H: REALGAME PRE AND POST TEST, CASE ALPHA OF PAPER 4, OCTOBER 2002 (SESSIONS 25 AND 28)

Please answer before the training.
Bring the completed questionnaire with you to the training.

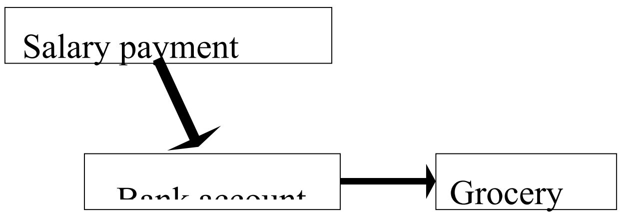
Name: ________________________________

Work experience, years: ________ **Work experience at *Alpha*, years**: ________

Education: _____________________ **Main subject**: ______________________

Have you played business games before?

1. Draw a conceptual map (your mental model/perception/käsitekartta/ mielikuva) of the factors influencing the cash flow of a manufacturing company (both positive and negative factors). You can use whatever symbols you want to describe the relevant tasks/events (below an example of using the symbols).



DO NOT USE MORE THAN 7-8 MINUTES ON THIS TASK! Draw in the space below:

APPENDIX H CONTINUED

2. Your factory warehouse is completely full. If your sales do not increase considerably next month, you will run out of warehouse floor space. As well as increasing your warehousing costs, your profitability will decrease as your sales income will not be sufficient to cover the costs. **Which of the following measures would you select to solve this problem (you may select several)?**

Production volume:

	Maintain production volume
	Decrease production volume
	Increase production volume

Selling price:

	Drop selling price
	Maintain selling price
	Raise selling price

Sales terms:

	Promise to deliver faster

	Give the customer more time to pay
	Keep to the old term of payment

Other:

	Launch a marketing campaign
	Invest in R&D
	Lay off production workers
	Sell production machinery
	Other: ___________________________

3. As a result of your decisions in the previous question what will happen to the following factors?

a) Unit profit?
b) Demand of your products?
c) Total profitability?
d) Your future capability to answer to shifts in the demand?
e) Your image as a manufacturer and supplier?
f) Cash flow?

Thank you!

Included in the original thesis publication are the following journal/conference articles:

PAPER 1

Lainema and Makkonen (2003). Applying Constructivist Approach to Educational Business Games: Case REALGAME. *Simulation & Gaming: An Interdisciplinary Journal of Theory, Practice and Research*, Vol. 34, No. 1, pp. 131-149.

PAPER 2

Lainema (2003a). Implications of Constructivism for Computer-Based Learning. In Ciborra, Mercurio, De Marco, Martinez, and Carignani (eds.) the Proceedings of European Conference on Information Systems (ECIS) 2003, *New Paradigms in Organizations, Markets and Society*, June 19-21, Naples, Italy.

PAPER 3

Lainema (2003b). **Reinforcing Information Systems Students' Perception on Business Processes**. Forthcoming, *Journal of Information Technology Education*.

PAPER 4

Lainema and Nurmi (2003b). **Applying an Authentic, Dynamic Learning Environment in Real World Business**. Submitted to *Computers and Education, An International Journal*.