

Final project report

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Executive summary

This deliverable gives an overview of the work done and the achievements made during the KITS project. We will describe the instructional and the knowledge management aspects of KM Quest™, which is the training system that was developed. This deliverable summarises how these aspects are implemented into the KM Quest™ learning environment and how the learning environment was evaluated. Finally, we describe the project's efforts in disseminating and exploiting KM Quest™.

The KITS (Knowledge Management Interactive Training System) project had two main starting points. First, the project built on psychological and pedagogical developments in learning and instruction that are based on a shift from “instructivistic” approaches towards “constructivist” approaches. Second, the project saw a need for better training of people working in the emerging field of knowledge management. Based on these two starting points, that are described in Chapter 1, several assumptions were made that formed the basis of the development of KM Quest™.

The instructional aspects of KM Quest™ are described in Chapter 2. The simulation game is situated in the context of a fictitious large product leadership organisation “Coltec”, a manufacturer of adhesives, coatings etcetera. An underlying business model is used to generate dynamic information about the behaviour of a large set of business (process) and knowledge (process) variables. The simulation game is played by three players who all (together) have the same role of (one) knowledge manager and who collaboratively have the task to improve the efficacy of the knowledge household of the company. However, this is not an aim in itself but is related to objectives for the (management of the) company in general. Players play their role for three consecutive years in the life span of the company.

Basically, in the game, players can inspect the status of business process indicators and knowledge process indicators (in three general domains), ask for additional information, install a measurement system, and implement knowledge management interventions to (try to) change the behaviour of the business simulation. To trigger activities from the players and to make sure that players are confronted with different types of knowledge management problems, at the beginning of each quarter players are confronted with an (unexpected) event that could affect the knowledge household of the company. Players have to decide if and how they want to react on these events. Events are generated from a pool of 50 events.

It was decided to divide the learning scenario into two main phases: a training phase and a playing phase. Two additional phases are added: one to introduce the learning environment, and one for reflection and debriefing. The main instructional measures that are implemented in the environment are: development of problem solving strategies (KM model), just-in-time information presentation, collaboration, articulation/explicitation, feedback, scaffolding, monitoring and reflection, debriefing and visualisation. With regard to collaboration issues special attention is given to the use of shared worksheets, and workspace (and activity) awareness. Visualisation of the variables in the business model is based on an analysis of the properties and scales of the indicators. A broad range of visualisations is defined including bar charts, line graphs, numbers, pie charts, icons etc. Colour is widely used to support the interpretation of the information.

The business simulation is further outlined in Chapter 3. The simulation is driven by the business model, which consists of a set of variables representing the crucial features of an organisation that are relevant for learning knowledge management. The set of variables is carved up in layers of which two reflect general business concerns and two others focus on

knowledge domains and knowledge processes. In order to constrain the set of variables an approach is chosen which sees the organisation as a product leadership organisation. The behaviour of business model variables is influenced by events that occur at the start of every period/cycle in the game. These events are selected randomly from a list of enabled events.

The knowledge management model is the normative model that prescribes 'good' knowledge management practice. As a procedure, it consists of a sequence of phases and steps, with decision points and results. When following the phases and steps, the learner has access to the variables included in the business model.

The basic architecture and technical choices underlying the KM Quest™ system are described in Chapter 4. To realise the features of KM Quest™ a basic choice has been made for a JavaScript at the client side and an xml/asp approach at the server side. The user only needs a standard Internet Explorer to play the KM Quest™ game. The core of the KM Quest™ system is represented by a set of server-side procedures that manage all the rules and the data required by the different phases of the game. On the same server also the data storages which contains all the static and the dynamic variables related to the KM Quest™ environment (BM and KM variables, event list, action list, etc), as well as all the players' and teams' info and the archive with the log of the collaboration actions (chat, forum, templates, etc) are located.

The evaluation of the KITS learning environment, that is described in Chapter 5, followed three main directions. The first aim was to investigate the usability of the learning environment. The second goal of the evaluation was an investigation the learning effects of the environment. Thirdly, the acceptability of the learning environment was assessed. Although acceptability is a broad concept, in this study it was formulated as the extent to which the learning environment is sufficiently situated for users to learn about principles and practices in the field of knowledge management and to what extent the environment is suitable for company-use.

In the development of the final learning environment, two prototypes were identified, P1 and P2. P1 did not contain the complete functionality of the final learning environment and its evaluation would lead to an improved system. P2 was close to the final prototype learning environment and results of the second evaluation period could only lead to minor adaptations of the system. In this view, it was logical to perform the various evaluation studies in the following way:

- P1: Usability testing and a study into the learning process
- P2: Study into the learning results of players

In the evaluation of Prototype 1, 32 teams enrolled in the evaluation of which 14 student teams and 18 managers teams. In the second evaluation 43 teams started the evaluation with 5 managers teams and 38 student teams. Results of the evaluation are summarised in Chapter 5.

Chapter 6, finally, gives a brief account of the exploitation opportunities for KM Quest™. The first focus in exploitation will be an open enrolment web-based game with a gradual extension to corporate licence and tailor-made web-based games.

1. Introduction

The KITS (Knowledge Management Interactive Training System) project had two main starting points. First, the project built on psychological and pedagogical developments in learning and instruction that are based on a shift from “instructivistic” approaches towards “constructivist” approaches. Second, the project saw a need for better training of people working in the emerging field of knowledge management. Based on these two starting points several assumptions were made that formed the basis of the development of the KITS learning environment (KM Quest™). In this introduction we will shortly outline these assumptions that will be further elaborated in this deliverable that forms a short overview of the achievements in the project. The current deliverable, and thus the overview, is based on and uses several other, both public and internal to the project, deliverables. These deliverables are:

- D10: Evaluation report on using first prototype of the KITS learning environment
- D12: Final models and visualisation
- D13: Final specifications of instructional envelope
- D14: Final evaluation report on limited use of final KITS learning environment prototype
- D16: Consolidation report
- D18: Report on exploitation and dissemination
- D22: Evaluation plan

1.1 *Approaches in instructional design*

In the field of instructional design there has been, during the last decade, a shift from “instructivistic” approaches towards “constructivist” approaches. Instructivistic theories assume that formal concepts and systems can be transmitted to students by giving them formal descriptions in combination with the presentation of examples. Constructivistic approaches emphasise the idea of an active, experiencing student in a situation where knowledge is not transmitted to the student, but constructed through activity or social interaction. Well-designed instruction should offer experiences to learners that enable them to construct useful cognitive schemata and which allow them to understand a new domain. For instance, situated cognition (Brown, Collins, & Duguid, 1987) emphasise the importance of learning in context, because the context becomes an important part of the knowledge associated with that learning. In the related ‘cognitive apprenticeship approach’ (Collins, Brown, & Newman, 1989), it is argued that instruction should focus on realistic real-world problem solving rather than the transmission of pre-structured pieces of knowledge. The role of an instructor or instructional materials is then to coach and support the learner while these problems are solved. In addition to this, new approaches also include collaborative learning as an important means to foster knowledge exchange and construction (Koschmann, 1996). Van Merriënboer (1997) states that constructivistic and instructivistic approaches need not be seen as distinct alternatives, but merely as two aspects of instruction that can, and often should, complement each other.

In designing the KM Quest™ learning environment we have included the new approaches mentioned and have merged them with more traditional aspects.

1.2 Knowledge management, an ill-structured domain

Knowledge management (KM) is a domain that recently has received increasing attention. This is partly due to the awareness that advanced economies will rely increasingly on their ability to create and deploy knowledge for competitive advantage. Knowledge management can be defined as the achievement of the organisation's goals by making the factor knowledge productive (Beijerse, 2000). Knowledge as a factor of production has some properties unlike other resources in organisations. Wiig, de Hoog, and van der Spek (1997) listed some of the most important characteristics that set knowledge apart from other resources like for instance raw materials, goods etceteras: Knowledge

- is intangible and difficult to measure;
- is volatile, that is, it can 'disappear' overnight;
- is, most of the time, embodied in agents with wills;
- is not 'consumed' in a process, it sometimes increases through use;
- has wide ranging impacts in organisations (e.g. 'knowledge is power');
- cannot be bought on the market at any time, if often has long lead times;
- is 'non-rival', it can be used by different processes at the same time.

So Wiig, de Hoog, and van der Spek (1997) conclude that "knowledge management should focus on these unique properties of knowledge and come up with a set of methods, tools and techniques that helps in tackling problems that arise from these and other properties (p. 16)".

However, this is easier said than done. Especially at the level of individual companies the systematic and effective management of knowledge assets is still far from perfect. Effective Knowledge Management is related to the development of new knowledge, consolidation of knowledge already acquired, distribution of knowledge in the organisation, combining the knowledge available and ensuring that the best knowledge is being used (Wiig, de Hoog, & van der Spek, 1997).

Typical problems in the domain are: What knowledge is crucial to reach the organisation's goals? Is the knowledge that is necessary in certain processes available at the right moment, at the right place in the right format? If not, should knowledge be acquired, or developed, or should knowledge transfer and sharing between departments be supported? How can people be motivated to share knowledge, and use new or already existing knowledge? People faced with these kinds of knowledge management problems often do not handle these problems in a systematic way and therefore often do not choose the right activities and solutions (Christoph, van der Tang, & de Hoog, 2001). Many knowledge management activities are more guided by available (IT) solutions than a thorough understanding of nature of the relations between initial problem (or opportunity) statement and the organisational solution or measure that serves its purpose well. This seems to be partly due to the fact that a coherent and well-supported methodology for knowledge management is lacking (Wiig, de Hoog, & van der Spek, 1997), and partly due to the fact the problems in this area are multi-faceted, complex, and without univocal outcomes.

Many problems in the domain of knowledge management can be categorised as ill-structured problems. This means that the starting situation is often not well defined and further study and deduction is needed, that the problem solving procedures do not have an algorithmic character, and that there may be outcomes that cannot be univocally judged.

1.3 Strategies for learning knowledge management

Several authors have claimed that training to solve ill-structured problems requires different instructional settings than training to solve well-structured problems (e.g. Jonassen, 1997). Hong, Jonassen, and McGee (2002) found that solving ill-structured problems in a simulation called on different skills than well-structured problems, including metacognition and argumentation. Jonassen and Kwon (2001) showed that communication patterns in teams differed when solving well-structured and ill-structured problems.

Instructional designs for well-structured problems are rooted in information-processing theory while instructional designs for ill-structured problems necessarily share assumptions with constructivism and situated cognition. Important elements of instructional design for ill-structured problems according to Jonassen are the use of cases that are placed in a context, and that have problem constraints instead of clear or obvious solutions. Other important elements are the support of knowledge base and argument construction, and assessment based on process and product criteria. These elements are characteristic for student centred learning environments in which problem based learning is an important element. Contemporary conceptions of these environments recommend instructional strategies such as authentic cases, simulations, modelling, coaching and scaffolding to support implicit problem solving outcomes (Jonassen, 2000). In addition to this collaborative learning can play an important role (Koschmann, 1996)

1.3.1 Use of simulations and games

Games, simulations, and case studies have an important role in education and training because they can be used to put learning into a real context. Furthermore, they are constructivistic environments in which students are invited to actively solve problems. Games and simulations provide students with a framework of rules and roles through which they can learn interactively through a live experience. They can tackle situations they might not be prepared to risk in reality and they can experiment with new ideas and strategies. They involve individual and group interpretations of given information, the capacity to suspend disbelief and a willingness to play with the components of a situation in making new patterns and generating new problems (Jacques, 1995).

Games have played a role in instructional situations already for quite some while. The first field in which such applications took place was military training (see Hays & Singer, 1989). The next field in which important developments took place was business management training, where the use of games, simulations and case studies as vehicles for developing decision-making skills was introduced in the mid-1950s (Ellington & Earl, 1998, p. 5)".

Business games since then have been very popular. Carson (1969) states that these games generally fall into two classifications: general management or total enterprise games, and functional games.

"General management games are designed to teach decision making at the top management level where all major functional areas of the total enterprise are involved in achieving fundamental organisational objectives, such as maximum profit, return on investment, or attainment of certain sales levels or a certain share of the market. Generalised games of this type are designed to teach objective decision making through experimentation, evaluation, and modification (Carson, 1969, p. 40)".

"Functional games are intended to teach specific skills in a particular management area such as marketing, production, inventory control, finance or some other. They are aimed at teaching better decision making at the middle and lower levels of management.

In these games, instead of trying to maximise attainment of some organisational goal, the players are usually working to minimise costs through efficient operation. Teams normally do not compete with one another in a market, but try to get the highest possible score relative to a perfect operation (Carson, 1969, p. 40).”

Although a wide variety of management games have been developed, they share several general features. Hays and Singer (1989) mention the following features:

- They allow the presentation of feedback of the results of players’ actions.
- The environment represented in management games is expressed in logical or mathematical relations. Some of these relations are known to the players as rules while others are only vaguely qualified and become known during play.
- They allow interaction between the players (sometimes representing different functional areas within a company) and the environment.
- They provide a simplified view of reality. These simplifications are due to the desire to make the games manageable and sometimes because our understanding of the world is lacking.

In KITS we use the following general description of games: Games are (competitive) situated (learning) environments based on a set of rules and/or an underlying model, in which, under certain constraints, some goal state must be reached. Games are situated in a specific context that makes them (more or less) realistic, appealing and motivating for the players. Important elements that are related to the situatedness of games are validity/fidelity, complexity, risk, uncertainty, surprise, unexpected events, role-play, access to information, and the representation form of the game (Leemkuil, de Jong, & Ootes, 2000).

1.3.2 Instructional support

Much of the work on the evaluation of games has been anecdotal, descriptive or judgmental, but there are some indications that they are effective and are superior to case studies in producing knowledge gains, especially in the area of strategic management (Wolfe, 1997). However, there is general consensus that learning with interactive environments such as games, simulations, and adventures is not effective when no instructional measures or support are added. Miller, Lehman, and Koedinger (1999, p. 306) for example stated that “the learning outcomes achieved through micro world interaction depends largely on the surrounding instructional activities that structure the way students use and interact with micro worlds”. Some years before, Knotts, and Keys (1997) in the context of learning from games asserted that “Early research in business gaming and experiential learning destroyed the notion that games were self teaching. Instructor guidance is critical and must be applied during crucial states in the game development to insure that learning closure takes place. Students must be guided, prompted, motivated, and sometimes forced to learn from experiences (p. 387)”. Also, de Jong and van Joolingen (1998, p. 181) after reviewing a large number of studies on learning from simulations concluded, “The general conclusion that emerges from these studies is that there is no clear and univocal outcome in favour of simulations. An explanation why simulation based learning does not improve learning results can be found in the intrinsic problems that learners may have with discovery learning.” These problems are related to processes like: hypothesis generation, design of experiments, interpretation of data, and regulation of learning. After analysing a large number of studies de Jong and van Joolingen concluded that adding instructional support to simulations might help to improve the situation.

Instructional supports include the following elements that are listed by Alessi (2000): explaining or demonstrating the phenomenon or procedure; giving hints and prompts before student actions; giving feedback following student actions; providing a coach, advice, or help system; providing dictionaries and glossaries; providing user controls not needed in a non-instructional simulation; and giving summary feedback or a debriefing.

“All of these types of support may be increased or faded across time, or they may be based on user performance, user choice, or instructor choice. The amount and design of instructional support will be a function of the instructional philosophy (discovery or expository) and the degree of model transparency that is dictated by that philosophy (Alessi, 2000, p. 191)”.

1.3.3 Collaborative learning

From a constructivistic perspective, collaborative learning can be seen as one of the methods to promote knowledge base and argument construction. Collaboration with other students provokes activity, makes learning more realistic and stimulates motivation (Veerman & Veldhuis-Diermanse, 2001). In collaborative learning settings learners are “forced” to share perspectives, experiences, insights, and understandings. This can help learners to come up with new ideas, to debug their ideas, and to notice the complexities of concepts and skills. Barrows (in Kolodner & Nagel, 1999) points to the fact that if collaborative learning is done well, learners can solve much more complex problems and come to far more sophisticated understandings than they could do on their own. Collaborative learning needs to be distinguished from co-operative learning. Examples of co-operative learning groups are those in which students help each other while still maintaining their own worksheet, and groups in which each student does a different part of the group task. In contrast with co-operative learning groups, in collaborative peer workgroup students try to reach a common goal and share both tools and activities (van Boxtel, 2000).

1.4 Assumptions

The information presented in the previous sections leads to a set of assumptions that are on the basis of the development of the learning environment that will be described:

- Learning is an active process in which knowledge is gained and constructed, and in which problem solving takes a central position.
- Knowledge is context based (“situated”).
- Games, simulations, and case studies have an important role in education and training in putting learning in a context.
- Learning with interactive environments such as games, simulations, and adventures is not effective when no instructional measures or support are added.
- Problems in the domain of knowledge management are not clear-cut, complex, and without univocal outcomes. Therefore, the problems in this domain can be categorised as ill-structured problems.
- Explication, reflection, and argumentation are important processes when solving “ill-structured problems”.
- Collaborating with others can enhance the processes mentioned above because learners in a collaborative learning situation are forced to explicate and formalise knowledge that otherwise would stay implicit and intuitive.

In the next chapter we will outline how these assumptions have been concretised in the KM Quest™ learning environment.

2. KM Quest™ - instructional aspects

2.1 Introduction

The simulation game (KM Quest™) that was developed is based on a case based learning situation in which teams of players had to react upon unexpected events that are related to a company description that was given to the learners (De Hoog et. al., 1999). In this situation there was no feedback mechanism incorporated (players did not get information about the effectiveness of their actions), and no instructional support was given to the learners.

To transform the case description into a collaborative and constructive Internet based learning environment the case description was enriched with several tools and components that will be shortly described below.

A *business model* is implemented to simulate the behaviour of a large set of business and knowledge (process) indicators of the company, and to enable new situations to arise as a consequence of decisions taken by the learners (see Chapter 3 and KITS deliverable D12). In principle, the business model should be seen as a learning relevant representation of an organisation and its environment, and not as a necessarily valid representation of an actual organisation. The business model consists of a set of variables representing the crucial features of an organisation that are relevant for learning knowledge management. The set of variables is carved up into four layers of which two reflect general business concerns and two others are focused on knowledge domains and knowledge processes. These last two generally are not incorporated in general business simulations.

- Organisational effectiveness variable reflect the competitive characteristics of the company like market share, profit, level of sales and so on.
- Business process related variables reflect the quality of internal processes and “how well” work is done within the company. Examples are “production level” and “average time it takes to bring a new product to the market”.
- Knowledge related variables reflect the level of competence in the relevant knowledge domains (marketing, research & development, and production)
- Knowledge process related variables reflect the properties of processes involving knowledge in relevant domains, like speed of knowledge gaining, effectiveness of knowledge transfer.

Elements of games are introduced to make the environment more appealing and give it validity. This was done by implementing constraints (limited resources), roles and goals, and uncertainty and surprise (unexpected events, see description given below)

It was decided to use an Internet-based environment because of several reasons. The main one being that the primary target group of the simulation game consists of managers given responsibility for implementing knowledge management in their companies. These managers, in most cases, have a very tight schedule and do not have many colleagues with the same task in their own company. By using an Internet based environment the opportunity of remote participation is offered (Dasgupta & Garson, 1999). This means that players can collaborate with people outside their company without having to be available at the same place and time. The only thing player’s need is an Internet connection and a web browser.

To support *collaboration and communication at a distance* tools are implemented like a chat box, monitoring facilities, shared worksheets, a voting tool, and embedded forums. These

tools support synchronous as well as asynchronous communication and collaboration between team members.

To support the players in solving knowledge management problems, several elements were implemented that should enhance the learning process. Main element is the introduction of a *knowledge management model* that describes a systematic approach to solving knowledge management problems. This approach is based on a prescriptive view of how knowledge management should be done. It consists of four distinct phases (focus, organise, implement and monitor) that are subdivided into smaller steps. These steps indicate the activities and actions a knowledge manager should do in order to come up with the best fitting knowledge management solution for problems in an organisation. Actually, although the model consists of a limited set of steps, there are choice points, each leading to different pathways in the (focus phase of the) model. These pathways are based on different types of knowledge management problems that one can encounter.

2.2 Learning goals, target group and learning strategy

The simulation game is made for senior managers who are keen to learn more about knowledge management because they think it might solve existing and/or future problems for their organisation, or other managers given responsibility for implementing knowledge management in their companies. A second target group consists of students at universities and business schools that want to know more about knowledge management.

The learning goals can be subdivided into goals that have to do with the procedure to follow when performing knowledge management (KM strategic knowledge) and knowledge that is used in the procedure (KM conceptual knowledge). After having completed all phases in the learning scenario (see next chapter), learners:

- Are able to recognise a KM problem or opportunity;
- Are able to specify which phases can be distinguished in solving knowledge management (KM) problems;
- Can perform the steps in the different phases in the knowledge management model;
- Are aware that KM problems, opportunities and solutions can be highly situational;
- Are able to relate KM work to business output through established performance indicators;
- Are able to assess the KM situation and advise/implement appropriate interventions;
- Are able to monitor and evaluate the consequences of interventions.

Two types of learning strategies are used to reach the learning goals. Expository and experiential learning will be used to teach the KM strategic knowledge (KM model) and discovery learning is used to “teach” conceptual knowledge.

2.3 Short description of the core of the simulation game

The simulation game is situated in the context of a fictitious large product leadership organisation “Coltec”, a manufacturer of adhesives, coatings etcetera. Starting point is a (case) description of that company. In this case description static information about Coltec is given. An underlying business model is used to generate dynamic information about the behaviour of a large set of business (process) and knowledge (process) variables.

“Coltec is a manufacturer of adhesives, coatings, headquartered in Utrecht, The Netherlands. Coltec was established in 1968. Initially, Coltec operated in the market of custom formulated adhesives and coatings. During this period the company developed a unique competence in the development and manufacturing of coatings and adhesives for extreme temperatures. Based on this competence, Coltec developed in the seventies a series of standardised products for the industrial market. In 1981 Coltec was acquired by the Namco Group, a leading USA-based consortium in the chemical industry. In the eighties, Coltec extended its activities to include consumer products (do it yourself glues etc.). Within the Namco Group Coltec operates as an independent company. It develops manufactures and sells its own products. Since the acquisition by Namco, Coltec has steadily extended its range of products. In 2000, Coltec offers 250 different products, ranging from high performance adhesives used in space engineering to DIY products. Coltec currently operates in 23 countries in Europe and the Middle East. It has production plants in 12 European countries, and it employs 5000 people. The total expenses for operating are 3 billion Euros, other non-operating expenses include depreciation and interest on loans.....”

Coltec operates in a high-tech, steadily growing market. The market is characterised by short product life cycles. Coltec has an average market share of about 27% of the European market, but almost no market share elsewhere. There are few new entrants in the market, but the number of competitors is growing, mainly because more and more American adhesives manufacturers are beginning to operate in Europe. Coltec is planning to extend its activities to other parts of the world, but has not yet decided on a strategy to do so.”

When entering the game the players get a description of their role in the Coltec Company:

“The board of directors of the company has recognised that knowledge is a key asset. To develop a better understanding of the role of knowledge in the organisation, and the ways it should be managed, a special knowledge management task force has been put together. Your team is this special task force.

Your task is to initiate specific activities that improve the efficacy of the knowledge household of the company. You are expected to propose both pro-active and re-active actions.”

2.3.1 Role and goals

The simulation game is played by three players who all have the same role of knowledge manager and who collaboratively have the task to improve the efficacy of the knowledge household of the company. However, this is not an aim in itself but is related to objectives for the (management of the) company in general. The general goal of the game is to optimise the level of a set of general organisational effectiveness variables: market share, profit, and the customer satisfaction index. These variables are at the top level of the business model (that is used to simulate the behaviour of the company). Players play their role for three consecutive years in the life span of the company. Players interact with the game through an interface that represents a virtual office (see Figure 1).



Figure 1. *Virtual office interface*

As already mentioned, in functional management games teams normally do not compete with one another in a market, but try to get the highest possible score relative to a perfect operation (Carson, 1969). This is also the case in the game described here.

2.3.2 *What players can do*

Basically, in the game, players can inspect the status of business process indicators and knowledge process indicators (in three general domains), ask for additional information, use a measurement system, and choose knowledge management interventions to (try to) change the behaviour of the business simulation. Most of the indicators are characterised by a decay factor. This means that the value of the indicators decreases over time when no interventions are implemented. The interventions can be chosen from a predefined pool of 60 interventions. At some moments in time certain interventions will not be available. This depends on the things players have done in the past.

Changes in the status of the business indicators will only be computed at the end of each quarter. There is no time limit to playing the game. Teams set their own pace. When players think they know enough to solve the problem they indicate that they agree with the proposed interventions (by using a voting tool). After they have reached agreement the game proceeds to the end of the quarter and the business simulation will calculate new values for each of the business indicators. The game ends after the players have indicated that they agree with the content of the yearly report in the first quarter of the fourth year in the life span of the company. In this quarter no new events are presented.

2.3.3 Unexpected events

To trigger activities from the players and to make sure that players are confronted with different types of knowledge management problems, at the beginning of each quarter players are confronted with an (unexpected) event that could affect the knowledge household of the company. Players have to decide if and how they want to react on these events. Events are generated from a pool of 50 events. Different types of events can be distinguished based on two dimensions: the locus of the event (internal or external), and the effect of the event (direct, delayed, no effect). Effects can be positive or negative.

Which event is selected can depend on several elements: the events presented in the previous quarters, the interventions taken by the players, and/or the value of certain business indicators. When the triggering conditions of more than one event are met, one event from this set will be randomly generated.

Players can interact with the environment and with each other by using tools and resources that are presented in an Internet environment, based on a “virtual office metaphor” (see Figure 1). Clicking on a specific element in the “office” will open a window with additional resources or tools. For instance, clicking on the newspaper will display the description of the event that has occurred. The simplified organisation chart at the whiteboard gives access to the case description with static information about Coltec. The icons next to the chart give access to a visualisation system that can display the (current and old) values of a set of 65 indicators in the business model (using different types of visualisations). The books on the lower bookshelves give access to additional information about knowledge management, the indicators in the business model, types of visualisations, and the interventions that can be implemented. The books at the shelf above contain “historic” data about the player’s own behaviour in the game. Clicking on the phone gives access to a chat facility. The laptop computer gives access to process worksheets related to the different steps in the four phases of the Knowledge management model.

2.3.4 Constraints

The implementation of interventions involves costs. Players receive a limited budget that they can use to implement interventions.

Other constraints to the actions of the players are: It is not possible to reorganise the structure of Coltec, or to inspect indicators at the level of specific departments, products or persons. Nor is it possible to implement interventions at these levels.

These constraints are introduced because of practical reasons. Reorganising the company would mean that the relations between variables within the business model would have to be changed, which is very difficult. Furthermore, the static information about the company would be “outdated”. The business model comprises about 200 variables (of which 65 are visible for the players). Adding additional variables at the levels of specific departments, products, or persons, would make the model even more complex than it already is. In the current version it is only possible to inspect the status of general business indicators and knowledge process indicators in three global domains: research & development, marketing & sales, and production.

2.3.5 End of the game

The game ends after the players have indicated that they have implemented the last intervention(s) in the fourth quarter of the third year in the life span of the company and have

filled in the third yearly report. At that moment the business model will calculate new values and the players can monitor the consequences of the last set of interventions that they implemented.

2.4 Four phased learning scenario

In the learning environment a shift is made from an environment, which is initially based on modelling, coaching, scaffolding (and fading) to an environment where these processes are less important and where the learners collaborate without guidance. In the latter phase the main instructional measures are just-in-time information presentation articulation, reflection and exploration.

It was decided to divide the learning scenario into two main phases: a training phase and a playing phase. Two additional phases are added: one to introduce the learning environment, and one for reflection and debriefing.

2.4.1 Introduction

In the introduction the main elements of the learning environment and simulation game are introduced as well as some basic information about knowledge management and about collaboration.

2.4.2 Training phase

The training phase is used to develop (shared) knowledge that forms the basic knowledge base needed to play the simulation game and to collaborate with other team members. To develop this knowledge an expository approach is used. This means that information is presented to the learners and at certain points in time tools or “assignments” are introduced. People can go through this phase individually.

Modelling in this phase is done by presenting the main phases and the choice points and sub-steps in the different pathways in the *knowledge management model* to the players step-by-step (Figure 2), and by giving them examples.

Coaching and scaffolding is done by structuring the environment and limiting the freedom of choice of the players, and by giving them immediate feedback on their behaviour. Furthermore, this is done by giving them process worksheets (see Figure 3) that are based on the knowledge management model, and by presenting prompts and hints about what to do and how to do it. Freedom of choice is gradually increased.

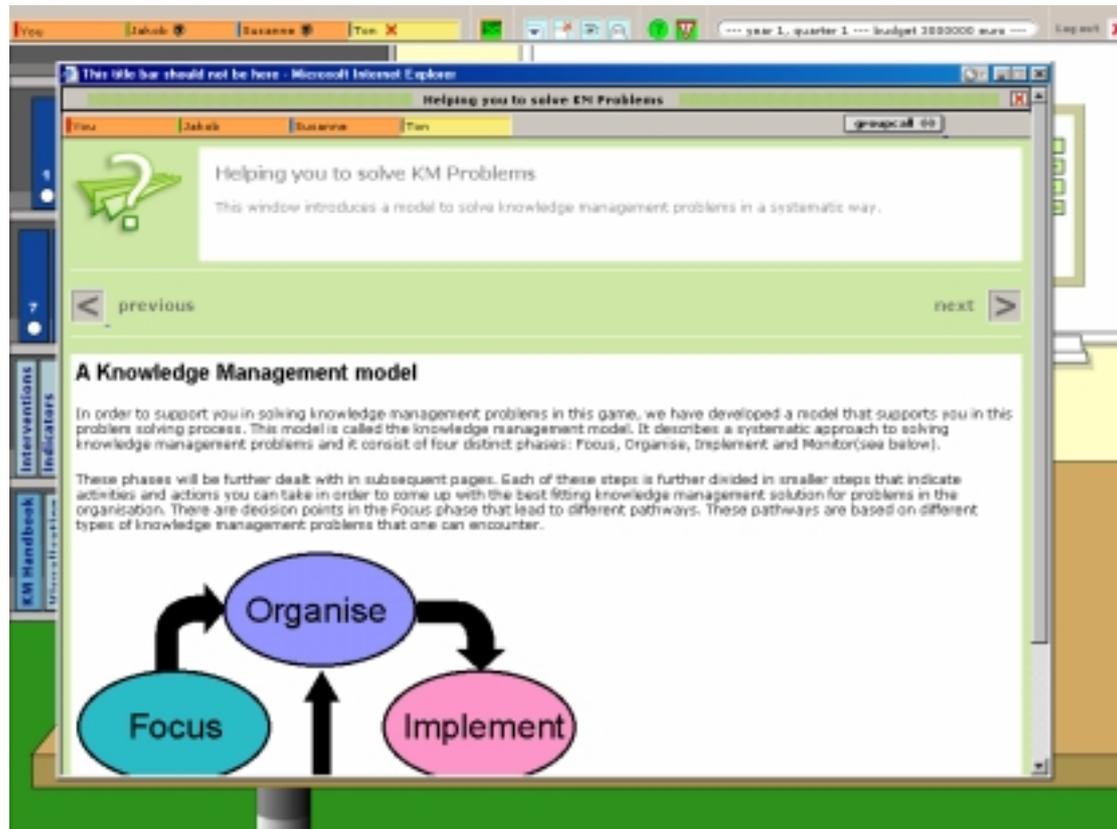


Figure 2. Example of a KM Quest™ training page

2.4.3 *Playing phase*

In the *playing phase* the players actually play the simulation game collaboratively for three years in the life span of the company, using all the resources and tool that are available. Players have the freedom to explore the environment and to choose their own way of problem solving and collaboration.

At the beginning of this phase the indicators in the business model are reset to the initial level and the players start again at day 1 in the first quarter of the first year. Freedom of choice is at its maximum.

2.4.4 *Reflection and debriefing phase*

A problem related to simulation games is its game like character. Students are very easily inclined to play it as a game only. During the simulation “intuitive knowledge” (see Swaak & de Jong, 1996) is acquired about the “rules of the game” and the strategies players have used. By having students reflect on what they do and experience, they can make this knowledge more explicit.

Petranek (2000) states that several authors in the simulation and gaming field stress the value of oral debriefing. Written debriefing, however, is rarely used. “The major hurdle is the time needed to write and evaluate the writing. However, the benefits far outweigh the costs. With written debriefing, participants can reflect about their behaviour, facilitators can assess

individual learning, and students can privately communicate with their professor (Petranek, 2000, p. 108)”.

For these reasons a debriefing phase is present after the game is played.

2.5 Implementation of instructional support

2.5.1 Development of problem solving strategies

In the *training phase* the knowledge management model is introduced and practised, step-by-step. This phase is used to develop (shared) knowledge that forms the basic knowledge base needed to play the game and to collaborate with other team members. An expository approach is used. This means that information is presented to the learners and at certain points in time tools or “assignments” are introduced. Assignments have to do with using process worksheets that are related to the different steps in the knowledge management model. These process worksheets contain elements like (open) text fields, check boxes, and drop-down menus (to indicate choices) that are used to structure the problem solving process, and to make (implicit) ideas explicit.

To be sure that every player (in potential) will have the same information base, the information will be presented in a fixed order. Players will probably differ in the extent to which they already possess this knowledge. Because of these differences in prior knowledge, it was decided to make this phase an individual one. This means that learners can go through it at their own pace and are not “forced” to keep pace with the other team members.

2.5.2 Process worksheets

Although the knowledge management model indicates the steps that could be followed when solving a knowledge management problem, it does not give any clues/indications which specific activities should be performed (in the learning environment) in each step. To provide the learners with this information process worksheets were implemented (Figure 3). These process worksheets guide the learners through the steps in the knowledge management model. To do this they contain several elements:

- Clues on what to do and how to it.
- Tools to structure the process and make the results of the activities explicit.

Every quarter the team gets a new set of worksheets. The content of the old ones is saved and is available for inspection later on in the game. This means that players can always monitor their behaviour during the game, and have the opportunity to reflect on it (see 2.5.7).

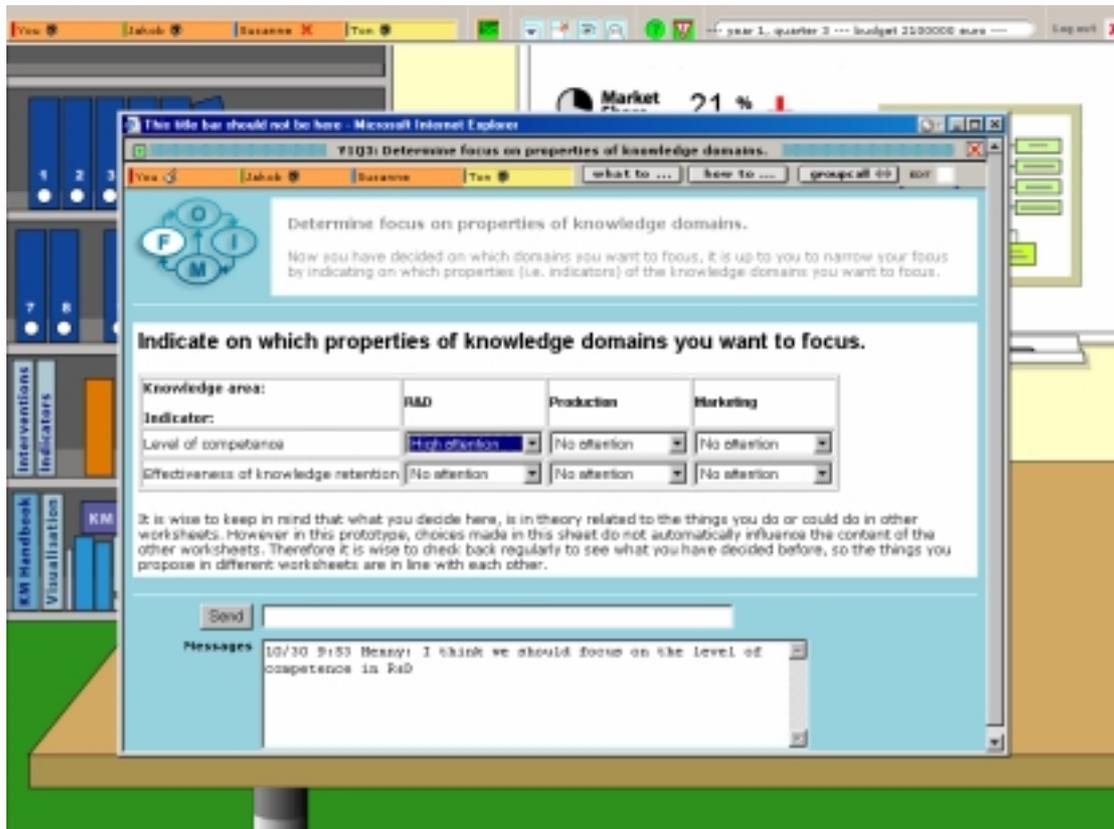


Figure 3. Example of a process worksheet

2.5.3 Just in time information presentation

Information and tools should be easily accessible at the time players need them. This principle is used to structure the information in several ways.

Information that is directly related to a step in the knowledge management model can be accessed by using links that are presented in the process worksheets. Two types of links are used:

- What (to do). This contains information about what the learner is expected to do in a certain step and why, or what the result of a step could be, and of the relationship (and dependencies) with other steps.
- How (to do it). This contains information about how to proceed to complete the activities related to this step (and worksheet), what to think about when performing these activities, and how these activities are to be performed outside the KM Quest™ environment.

Information that is more general and can be of use at anytime during the process, is available by using resources that are placed in the virtual office like books on a bookshelf, the organigram, etcetera.

2.5.4 Feedback

Feedback is a critical event in instruction. It should give learners the opportunity to assess the appropriateness of their actions during practice. In the KM Quest™ environment feedback is based on several sources:

- The behaviour of the underlying business model
- The normative knowledge management model
- Pre canned conceptual knowledge about knowledge management that is based on the experiences from KM experts and is coupled to certain events.
- An advisor functionality in the system.
- A human tutor.

Feedback based from the business model

In the learning environment it is possible to get intrinsic feedback from the business model at the end of each quarter. Players have the possibility to see/monitor the status of (a large set of) indicators (and their history) in the business model. The values (and trends) of the business and knowledge (process) indicators give them feedback on the quality of their actions.

Feedback based on the knowledge management model

During the training phase players get direct feedback after having completed certain steps in the knowledge management model. During the playing phase no feedback based on this model is available in the system.

Feedback based on conceptual knowledge

Every event is characterised by a description of the knowledge domains they refer to and the knowledge processes that are important. Based on this information a list of suitable objectives will be formulated and a list of interventions that are suitable or not suitable. This information is used to give pre-canned feedback to the players, after a quarter in the play has been finished.

Feedback based on advisor functionality in the system

Furthermore, pre-canned feedback is available that indicates that there is a problem and that indicates what one can do (list of proper interventions) about it when the value of some indicators gets below a (fixed) threshold value or when there is a certain (fixed) discrepancy between the desired value and the current value of an indicator that is related to the objectives the players have set during the game (Figure 4).

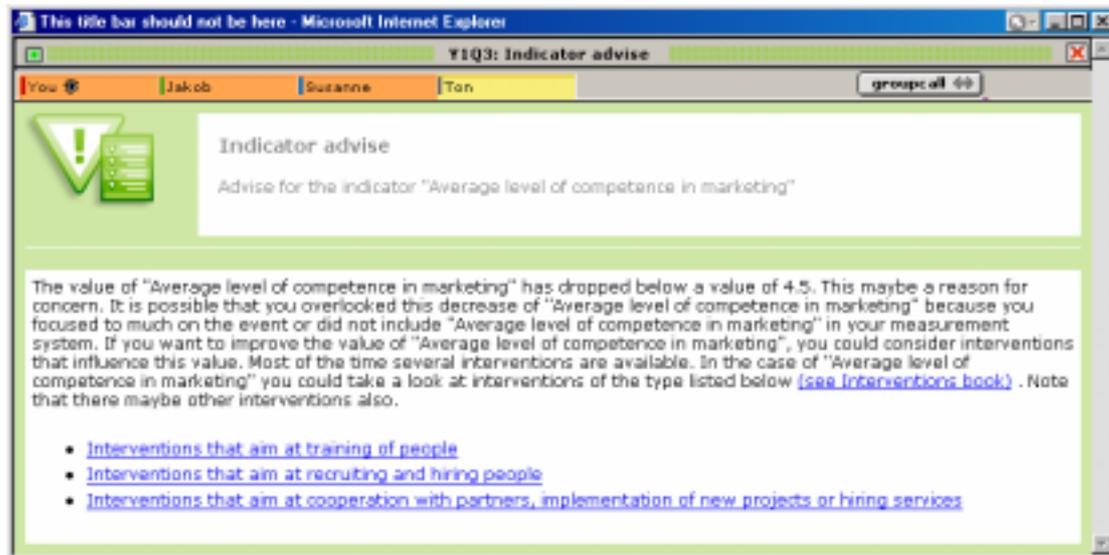


Figure 4. Example of feedback from the advisor functionality

Feedback given by a tutor

It is possible that a tutor logs on to the environment as a fourth (non-playing) team member. This person is a kind of non-playing group member that can observe the behaviour of the players, can inspect the worksheets they have filled, and can participate in chats. This tutor can give the players additional feedback about the steps they have taken and the interventions they have chosen.

2.5.5 Scaffolding

Scaffolding is used in the training phase. At the start of the training phase freedom of choice is limited. When a player enters the environment in the training phase a layer is opened automatically. A layer is a kind of hidden window that appears in front of the virtual desk of the knowledge manager (after a certain action has been taken). Each layer in this phase contains a back and forward button to move to another (predefined) layer. These buttons will not be displayed in the actual “Playing phase”. When the player presses the next button the layer will close and a new layer will be opened. When the player presses the previous button the layer will close and the previous layer will be opened.

The content of the books with additional (background) information that are on the bookshelf in the virtual office (e.g. KM handbook, Interventions book, etc.) can be accessed by links that are not part of the “next/previous” sequence. This means that by clicking on the link to these information sources a new layer will open that will display additional information.

2.5.6 Reflection

In the KM Quest™ environment players are triggered to reflect on their actions in a number of ways:

One of the steps in the knowledge management model is “Monitor”. In this step the players are supposed to monitor changes in the business (model) and to draw conclusions from what they see in relation to the goals and objectives they have set.

At the end of each year the knowledge management team has to write a report to the “general management team”. In that document they indicate which problems they faced in the year before, which actions they performed, which interventions they implemented (with which objectives), which results were accomplished (until that moment) or are foreseen in the coming period. And, not the least important, why certain assumptions, interventions were (not) right, and which lessons they learned from it. A worksheet for this document is available.

After the players have finished the simulation game, a debriefing session will be planned in which they can look back at the three reflection reports they made. Players can discuss choices and actions in relationship to their final score, and to the goals they set themselves during the game. As stated above an external tutor is appointed to each team.

2.5.7 Monitoring/history facilities

To be able to monitor their own behaviour and to reflect on it the behaviour of the teams in the KM Quest™ environment is logged by the system. Information from this log file is available at any moment for inspection. This means the teams have the opportunity to go back in time without having the opportunity to reverse activities and/or actions that they have chosen. They are able to inspect:

- Which events have happened
- The content of the worksheets they filled in a certain quarter
- Which interventions they took,

2.5.8 Collaboration and communication

According to Gutwin and Greenberg (1999) teamwork involves several activities: for example group members must communicate, organise joint action, provide assistance, co-ordinate activities, divide labour and monitor each others work. To be able to collaborate with other team members in the KM Quest™ environment several tools are available that support these activities. These tools support synchronous as well as asynchronous collaboration. This means that players can collaborate with people (outside their own company) without having to be available at the same place and time.

In principle it is possible for team members to play the game completely asynchronously. This means that they never are logged on at the same moment in time. In practice, however it is handy to build in synchronous playing moments, to speed up the gaming process.

In the *asynchronous* mode players have a great degree of freedom to act as they please. They can gather (buy) information, fill in and/or change the content of process worksheets, set objectives, propose interventions, etcetera. However, to actually implement interventions, they need the approval of the other team members. Players can give their approval by using a voting tool (see 2.5.8.4) that is added to the implementation worksheet.

In the *synchronous* mode synchronicity does *not* mean that the screen is shared and everybody sees the same things and has the same options. So the layout can be different for each player. This means that players each can seek their own way of working. They can open tools and resources without the others seeing these on their screen.

There is a limitation however, when a window contains editable text fields, checkboxes or other elements where input is needed. In that case (because of practical reasons) only one player can edit these at a time. Players have to take control over the editing process by pressing an icon in the top of the specific window. When one player is in control, the others

cannot interfere in the editing process. The others can see who is in control and they can see directly (with a small time delay) what the “editor” is doing. When the first player releases control over the window, the others can take over.

In the sections below the tools that are implemented to facilitate communication and collaboration using the Internet are described.

2.5.8.1 Communication

Two types of tools for communication are implemented. These tools support synchronous as well as asynchronous communication:

- A general chat facility to communicate with team members about every issue that is considered to be important (task related as well as non-task related). Clicking on the telephone that is on the desk will open the general chat facility.
- Topic related chat facilities to communicate about predetermined issues. The topic related chat can only be accessed by means of a worksheet. The topic of discussion is determined by the tasks/activities that are related to every step in the knowledge management model. The content of the topic related chat is saved together with content of the worksheet, so it is always clear what the topic of discussion is.

The topic related chats function as a kind of forum. A real forum meant for asynchronous communication is not implemented in the environment because the groups that have to collaborate are small and therefore the necessity of a forum with discussion threads and branches is questioned. Furthermore introducing such a facility would enhance the complexity of the collaboration process. It was decided to limit the number of different tools and try to support different modes of communication with the same tools.

To be able to use the chat facility and to exchange information with players, who are not logged in on a certain moment in time, the content of the chatbox is not cleared after each session (as is mostly the case in chat systems, for instance in MS NetMeeting).

- The content is saved and available for inspection in a next session.
- At certain fixed points in time, after a quarter (or a year) is finished, the general chatbox is cleaned. The content will then be available by means of the history files.
- The content of the topic related chat is cleaned after each quarter, because players get a new set of worksheets each quarter. The content of the topic related chat is saved together with the content of the worksheet it belongs to.

Other issues concerning the chat facilities:

- New messages are put on the top of the listing, so players do not have to scroll to see the latest entries.
- The name of the player and entry date are displayed together with the content of the message, so it is clear who posted a message and when.
- Different background colours are used for different users, so it can be easily detected who posted a message.
- Clicking on the chat icon in the status bar will make the chat layer will come in front of the screen when it is hidden or (partly) covered by other layers.
- When players wants to be sure the other players notice the new message they can use the “Group call” icon (see next section) that is also displayed in the chat window.

2.5.8.2 *Workspace awareness*

To make players aware of each other's presence in the learning environment several elements will be implemented.

Who is where?

The status bar on the top of the screen shows the real names of the players and of the tutor. An icon behind the name indicates whether a player is logged on to the system.

- When a team member is not logged on to the system a cross is displayed behind the name.



- When an eye appears behind the name of a player, that player is logged on to the system



When players have opened a window they can see which other players has also opened that window by looking at the names of the player that are displayed in the top bar of the each window.

- When an eye appears behind the name, the player has opened that specific window. However, this does not mean that that specific window is on top. It could be (partly) hidden.
- If the content of the window can be edited, players can see who is in control of the editing process. The eye is replaced by an editing icon. 

Group call

If a player has opened a window and wants the other players to open that window also, the player can press the "Group call icon" that is in the top of the window (see Figure 5).

- Pressing the group call icon will cause a pop-up window to appear on the screen of the other players displaying a message like "You are invited to join (name of player) in the window (short title of the window). Do you accept?" together with two buttons "OK" and "Cancel".
 - Pressing the OK option will open the specific window directly.
 - Pressing the Cancel option will make the pop up window disappear.

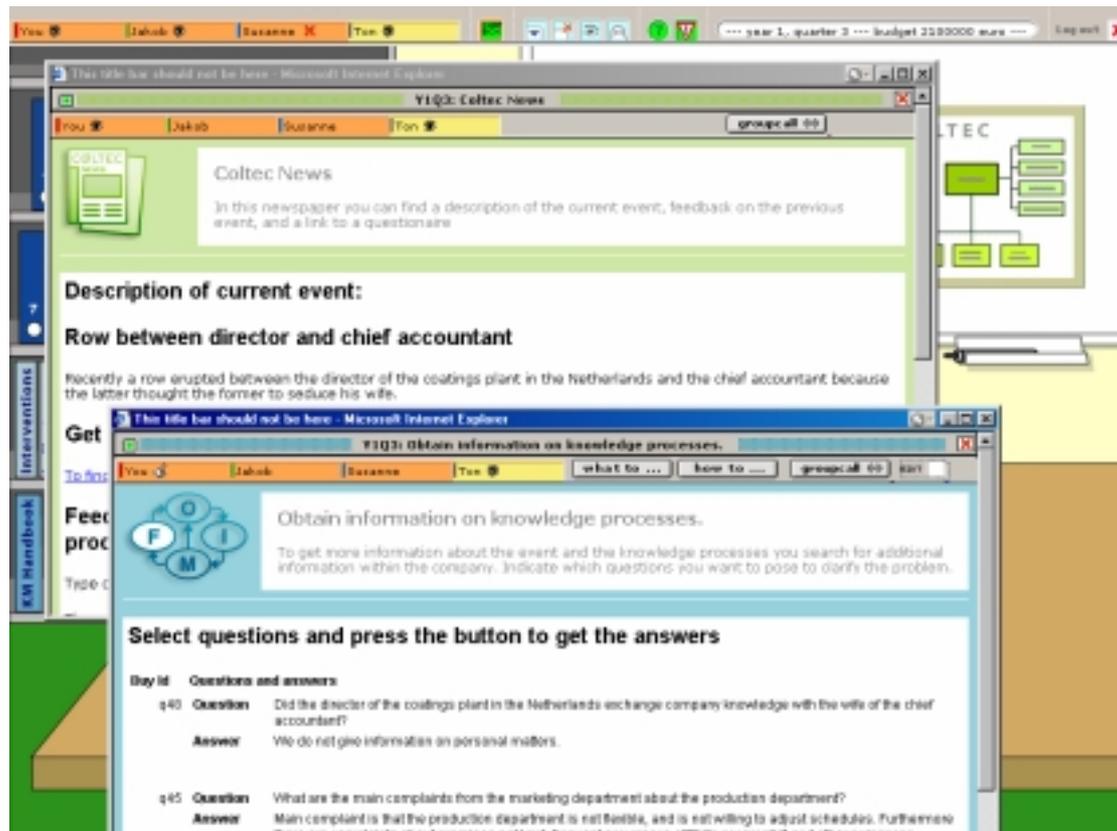


Figure 5. Example of screen with several windows open.

Editing shared worksheets

When a worksheet contains editable text fields, checkboxes or other elements where input is needed (because of practical reasons) only one player can edit these at a time (except for the topic related chat).

- Players have to take control over the editing process by pressing an editing icon (pencil) in the top of the specific window (see Figure 5).
- When one player is in control, the others cannot interfere in the editing process.
 - The editing icon is disabled (as is indicated by a cross through the pencil).
 - However, the others can see who is in control (because there is a pencil displayed behind the player's name) and they can see directly (with a small time delay) what the "editor" is doing.
 - When the editor releases control over the window (by pressing the editing icon again), the others can take over.
- When the others want to comment on the things that the editor is doing they can use the topic related chat facility that is on the bottom of the window.

2.5.8.3 Activity awareness (and workflow)

To keep track of the things that have been done so far in a certain quarter players can use the file that refers to that quarter. When players enter the learning environment after a period of

absence they can get up to date information here about the activities that have been performed so far..

Worksheet	Last change	
	By	When
Focus phase		
Determine focus on knowledge domains.	Jakob	27/10/02 14:58
Determine focus on properties of knowledge domains.	Jakob	28/10/02 22:26
Inspect and discuss event.	Jakob	29/10/02 08:49
Determine desired KPI values for marketing domain.	Henry	27/10/02 12:46
Determine desired KPI values for production domain.	Susanne	28/10/02 04:15
Determine desired KPI values for research and development domain.	Susanne	29/10/02 01:44
Obtain information on knowledge processes.	Henry	28/10/02 16:43
Where do we focus on?	Jakob	27/10/02 03:20
Organise phase		
Select interventions to reach your goals	Jakob	27/10/02 00:28
Inspect current knowledge infrastructure (KPI) and its contribution to your goals	Henry	29/10/02 15:00
Monitor phase		
Monitor changes in the KPI in the production domain	Susanne	27/10/02 07:12

Figure 6. Example of screen with an overview of changes

2.5.8.4 Voting mechanism

In the learning environment the three players have to reach agreement concerning a lot of issues, like: “What kind of problem are we facing?”, “Which objectives do we set?”, “Which interventions do we want to implement?”, “Which indicators do we include in the measurement system?”.

Limited number of voting issues

Formally each player should for each issue explicitly express this agreement by using a kind of voting mechanism. However this would make playing the game troublesome and annoying. Therefore it is decided to limit the number of moments where explicit voting is used.

- Players have to express agreement in the implementation worksheet about the interventions that are going to be implemented. If the three players have not agreed (yet) with the proposed interventions, the simulation game will not proceed to the next quarter and changes in the business indicators will not be computed. As long as a third player has not expressed his agreement the set of interventions can still be changed. If a third player has voted “yes” the proposed interventions automatically will be implemented, the

business model will calculate new values, and a new quarter will start (with a new event), except at the end of the year (see below).

- When a third player has expressed agreement a system message is displayed that the system is computing new values and that a new quarter has started.
- To stimulate the players to reflect on their own behaviour they have to write a yearly report (see 2.5.6). Players have to express agreement with the content of this report in the associated worksheet (in the Monitor phase).

Tutor can vote for other players

The fourth (non-playing) team member, the external tutor, has the option to vote instead of (one of) the players. This option is build into the system to prevent the game gets stuck when one of the players decides to stop, or is temporarily not able to play because of illness.

2.5.9 Visualisations

The business model consists of a large set of indicators. To help the players with interpreting the values of the indicators and with seeing trends in the data, several types of visualisation will be implemented (see De Hoog et. al. KITS Deliverable D12). Visualisation aims to support players to achieve a deeper understanding and intends to support the detection of patterns of information. The goal of information visualisation is to ease understanding, promote a deeper level of understanding of the data under investigation, and foster new insight into underlying processes (Gartner et al, 2002).

In KM Quest™ we use various type of charts: pie, bar, stacked-bar, line, and pictorial; diagrams, and combination of textual information. These types of chart, diagram and textual information are well known to the players as they can be found in many financial reports in the business sector. Representing data into a chart yields positive effects in understanding quantitative information, however it requires careful design because each type of chart may give different types of understanding (Wileman, 1993).

A specific type of visualisation is the Knowledge Map. Figure 7 represents the three knowledge domains displayed in three squares. The square is divided into 5 sections as knowledge has 5 processes: gain, development, retention, utilisation, and transfer. The Knowledge Map contains two important elements: colour changing from red to green representing a poor to good level of effectiveness of knowledge processes variables, and text information representing speed of knowledge processes variable in 5 levels:

- S=VS means very fast
- S=F means fast
- S=M means medium
- S=S means slow
- S=VS means very slow.

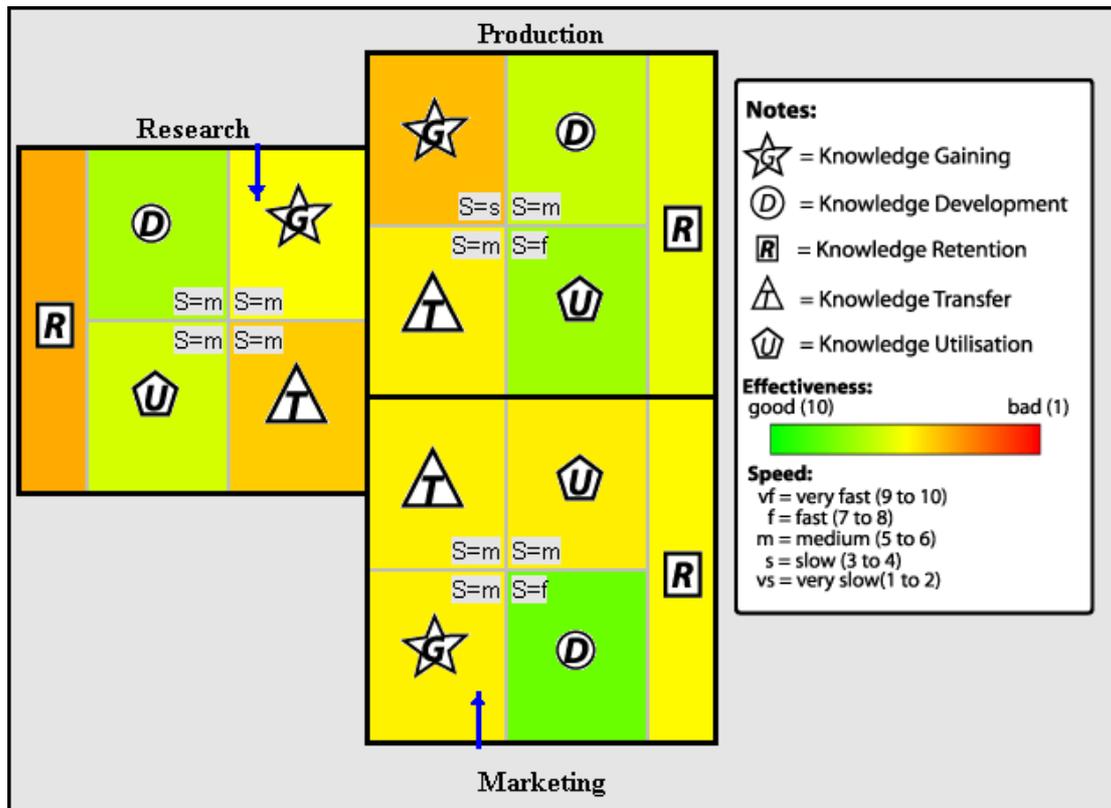


Figure 7. Example of the knowledge map

2.6 Navigation

In the sections above already some issues concerning navigation have been dealt with. In this section additional issues will be clarified.

2.6.1 Quick navigation buttons

When players have different windows open these will (partly) overlap each other, and this will also make the virtual office invisible. To help the players to navigate in this situation some buttons have been added to the status bar:

- An icon that makes that all windows that are open will be closed.
- An icon that makes that all windows that are open will be temporarily hidden. This will make it easy to open a new one without having to close (or move) all the others.
- An icon that makes all hidden windows will appear again.
- Clicking on the chat icon in the status bar makes that the chat layer will come in front of the screen when it is hidden or (partly) covered by other layers.

2.6.2 Backgrounds and icons

To make it easy for the players to see what kind of windows they have opened, the different types of windows will have a different background.

- The background of the worksheets that are related to the phases in the KM model will have the same colour as the circles on the screen of the computer.
- The windows related to the books and chat will have a different background, than the worksheets (most of the time green).

2.6.3 Fixed dimensions

When a window is opened it will have a fixed dimension. Different windows will not be opened in the same place on the screen so that a new one does *not* totally overlap an old one.

2.6.4 Moving windows

Windows can be moved to another place on the screen by clicking in the top part of the window (and keeping the mouse pressed). Horizontal scrolling of the windows is avoided as much as possible.

3. KM Quest™ – Knowledge management

3.1 Introduction

In the KM Quest™ game learners interact with a runnable model of a simulated company. The basis for this running model is what we have called the “business model”. In addition to traditional elements of a business model our model also contains specific knowledge management related elements. Next to the business model we have a so-called knowledge management model which is a normative model that guides the user through the different steps of the knowledge management process. In this knowledge management process the user finally decides to perform one or more specific knowledge management interventions. These interventions have an effect on the variables in the business model. These effects are shown to the learner. Users are also presented with events. Events are unpredictable incidents that happen inside and outside an organisation and on which users have to react.

Next we will further discuss these KM components of the KM Quest™ game.

3.2 The business model

3.2.1 Type of organisation

As it is not feasible to create a model that covers every imaginable organisation, a decision was made about the type of organisation that would drive the modelling work. We took the classification proposed by Treacy and Wiersema (1995) as the starting point. Though far from being the one agreed upon by everyone, it at least gives some criteria by which strategic differences between organisations can be defined at a fairly high level of abstraction. Treacy and Wiersema distinguish three main strategic orientations for a company, which can be used to identify core areas for knowledge management:

- *Operational excellence*: the company competes mainly in terms of costs, it tries to streamline processes in such a way that, while keeping the required quality, the costs of operating are minimised.
- *Product leadership*: the company competes by bringing to the market speedily, innovative products. This implies short product life cycles and innovative research and development.
- *Customer intimacy*: the company competes by trying to become a partner for a limited number of other companies through providing customised solutions.

When compared, it turned out that the *product leadership organisation* was probably best suited for taking as a defining characteristic of the organisation to be modelled. The emphasis on processes in operational excellence requires sophisticated process modelling in order to show the effect of cost cutting logistic interventions. For customer intimacy quite some information concerning the customer environment had to be included, possible even how interventions in one organisation will influence the behaviour of other organisations. This was seen as too complex to handle. The product leadership type is somewhat easier to model, because it does not need to handle complicated production processes or customer

relationships, but focuses on products as entities and more or less abstract processes to generate them.

3.2.2 Case used

The initial idea for a knowledge management game was based on the so-called Coltec case (see de Hoog et al., 1999). This case was also widely used during the requirements gathering phase of the KITS project (see Haldane, 2000). Though some thoughts were given to alternatives, it was decided to use this case also as the reference case for the KM Quest™ learning environment, because substantial experience with this game was obtained that could be re-used for modelling purposes. The case fits also in the product leadership type of organisation. In order to avoid confusion, the case was re-written somewhat, in particular omitting the detailed product information, because the business model would become too complex if behaviour had to be specified at the level of each product category. A more extensive description of the case was given in Section 2.3.



3.2.3 Variables

The set of variables includes business variables that characterise the organisational effectiveness and business processes, and knowledge management variables, which represent knowledge and knowledge processes and their properties.

Business and knowledge management variables are ordered in four layers of which the first two layers are general business ones, and the third and fourth layer comprise knowledge management indicators (i.e., relevant from the knowledge management perspective):

- *organisational effectiveness variables*: these variables represent the relation between the organisation and its environment;
- *business process related variables*: these variables reflect the ways things are done and how well they are done inside the organisation;
- *knowledge-related variables*: these variables represent the relevant knowledge domains in the organisation and several of their relevant properties;
- *knowledge-process-related variables*: these reflect the properties of the core knowledge processes in the organisation.

The set of business and knowledge management variables thus represents a four-level model.

In addition the model had to deal with internal and external events and interventions taken by the knowledge manager. All events that happen *within* an organisation and which effect knowledge, influence the knowledge processes. As an example to illustrate internal events and knowledge management interventions we consider the following case: a key-researcher leaves the company (internal event, which influences the knowledge process property 'effectiveness of knowledge retention' in the organisation, and the knowledge property 'average level of competence in the company'). As a result of this event the company loses knowledge. To re-gain this knowledge, a knowledge manager could appoint a new person by choosing appropriate items from the list of knowledge management interventions, but this could also be accompanied by preventive interventions, e.g., 'install a bonus/reward system'. These interventions influence the knowledge processes and knowledge domain properties in the company as well as employee satisfaction.

Thus, in the model the changes of lower level variables lead to certain changes in the higher level variables. Each knowledge management intervention or internal event provides different inputs for lower level variables (knowledge processes related variables). These, from their side, also influence the ‘state’ of knowledge in the organisation. The state of knowledge in the organisation is represented by knowledge related variables, and determines the business processes: ‘how well is the knowledge applied?’ And at the end, business processes variables are connected to the organisational effectiveness variables.

As an illustration of this sequence we can refer to the knowledge management intervention: ‘appointing a high-class expert with new knowledge in the research area’. This intervention gives an input to the change of knowledge-processes variables, which characterise processes of gaining knowledge in the organisation. On the next level, new (gained) knowledge changes the knowledge-related variable (average level of competence in R&D). The level of competence influences the business processes. The higher the level of competence in the company, the better the business processes are going. The effective business processes determine the organisational effectiveness, which is represented by organisational effectiveness variables (e.g., increase in profit). The four layered model of business and knowledge management variables, as well as the links with internal and external events and knowledge management interventions is presented in Figure 8.

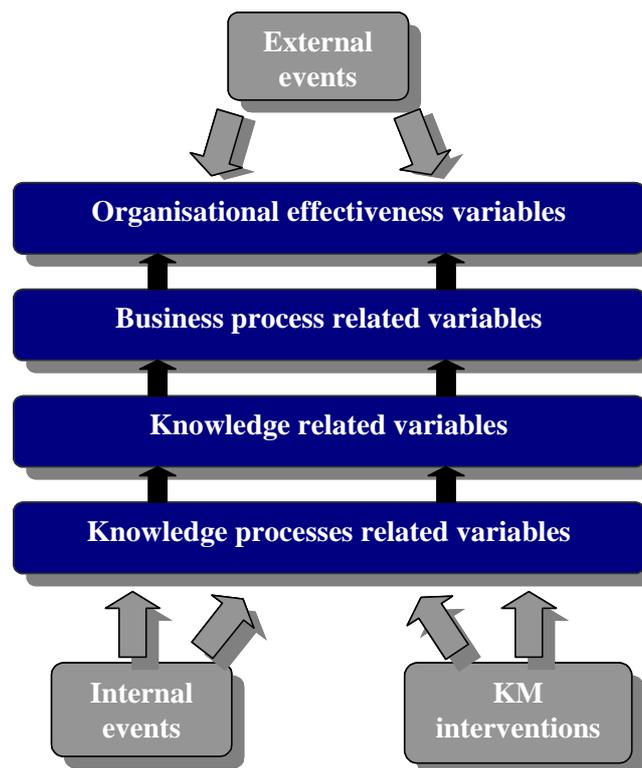


Figure 8. Basic model of business model variables

3.3 Events

Events are things that happen unexpectedly in the KM Quest™ learning environment. Their goal is to create unpredictability for the learner which to some extent reflect reality, which in

turn should contribute to the attainment of the learning goals. The choice of events is not entirely free. Apart from links to learning goals they are also constrained by:

- The possibility to link them to variables in the business model on which they have to impinge
- The presence of interventions to remedy their effects in a meaningful way

In addition some additional desirable properties can be listed:

- The link with interventions should not be too straightforward
- Several of them should be contentious, i.e. generate disagreements between players
- Some should entice players to come up with wrong/ineffective interventions
- Events should reflect the notion of bottlenecks and barriers in the KM model

The main distinction is between external and internal events. Sources of external events can come from areas of *government* (legislation, subsidies), *competition* (products, processes, campaigns, take-overs), *market* (fashions, application areas), *scientific* (new stuff, properties of old stuff), and *natural* (disasters, shortages). Sources of internal events can come from *conflicts* (between departments, between people, labour conflicts, between hierarchical layers), *personnel turnover* (experts leave for age, expert leave for dissatisfaction, experts are headhunted), *carelessness* (lost stuff, lab mistakes), *breakdowns* (computer, production), *higher management initiatives* (merging departments, strategic alliances, fashion based initiatives, labour control).

For each 'source' one or more events were generated. This list was subsequently pruned by using the criteria mentioned in the beginning of this section. In addition several events were included that don't require knowledge management interventions. This was done to bring across to learners that not everything that happens is in the scope of knowledge management. This resulted in a list of 50 events. Examples of Knowledge Management related events are:

Event 1. Joep Janssen, a brilliant student from the chemistry department of the Technical University of Delft is performing research for Coltec in order to graduate. He is a member of the famous research group of Dr. Zing that is currently investigating a new formula for heat resistant membranes for the space engineering industry. NASA has indicated that they are very interested in the research results. One evening while Joep is working late in the laboratory, a huge explosion occurs in the laboratory that causes the death of Joep and it destroys all the research results.

Event 2. The marketing director is pregnant and due to unforeseen complications in her pregnancy, she has to take up maternity leave earlier than expected. Unfortunately, this coincides with a major launch of Ecoplast (a new product) that she is heavily involved in.

An example of a non Knowledge Management related event is:

Last week, a chemical spill at a cloth dyeing factory in Paderborn in Germany, a town where Coltec's abrasives production unit is located, has injured 90 people after they inhaled toxic fumes.

This disaster led to many protests of the local community against any kind of chemical industry in the city area. Activists who chained themselves to the entrance barricaded Coltec's abrasives unit.

The city government invited the managers of Coltec as well as other industrials for a meeting about the situation and would like to discuss to move chemical plants from the city area. The meeting is scheduled within two months from now.

3.4 Knowledge management model

The knowledge management model consists of several steps of which the most general are: Focus, Organise, Implement, and Monitor. Each of these is briefly characterised in the next

subsections. The overall model is shown in Figure 9. In Figure 9 there are square boxes at three levels:

- Level 1: the main phases of the KM model
- Level 2: groupings of steps that belong together in a phase
- Level 3 actual steps in the KM model

The steps at level 3 are the actual steps the learners have to master. All these steps are supported in the KM Quest™ learning environment and described in some detail below.

The parallelogram-like shape represents a decision point from where several roads can be followed. The solid arrows indicate preferred pathways through the model. The dashed arrow stands for a “jump” between groups of steps. Together with the steps at level 3, the learner has to understand and master the path(s) through the model as a way to proceed in a well defined and coherent manner, when dealing with knowledge management problems in an organisation.

3.4.1 *The Focus phase*

The Focus phase aims at providing the knowledge management initiatives with the necessary contextual information about objectives and current performance of the organisation. As knowledge management is not a goal in itself, any knowledge management effort should be linked to objectives that are relevant to the organisation: the Focus phase precisely aims at establishing a link between organisational objectives and knowledge management objectives. In the Focus phase, the organisation under consideration asks itself the following questions:



1. What is our current performance and what should our future performance be?
2. How will events influence the future performance
3. What are the knowledge processes and domains we are going to focus in the next cycle, taking the answers on 1. into account

In order to be able to answer the first question, some sort of measurement system should be inspected to obtain current values of indicators for performance. Furthermore, in order to set a norm for future performance, discussions with higher management in organisations are to be held.

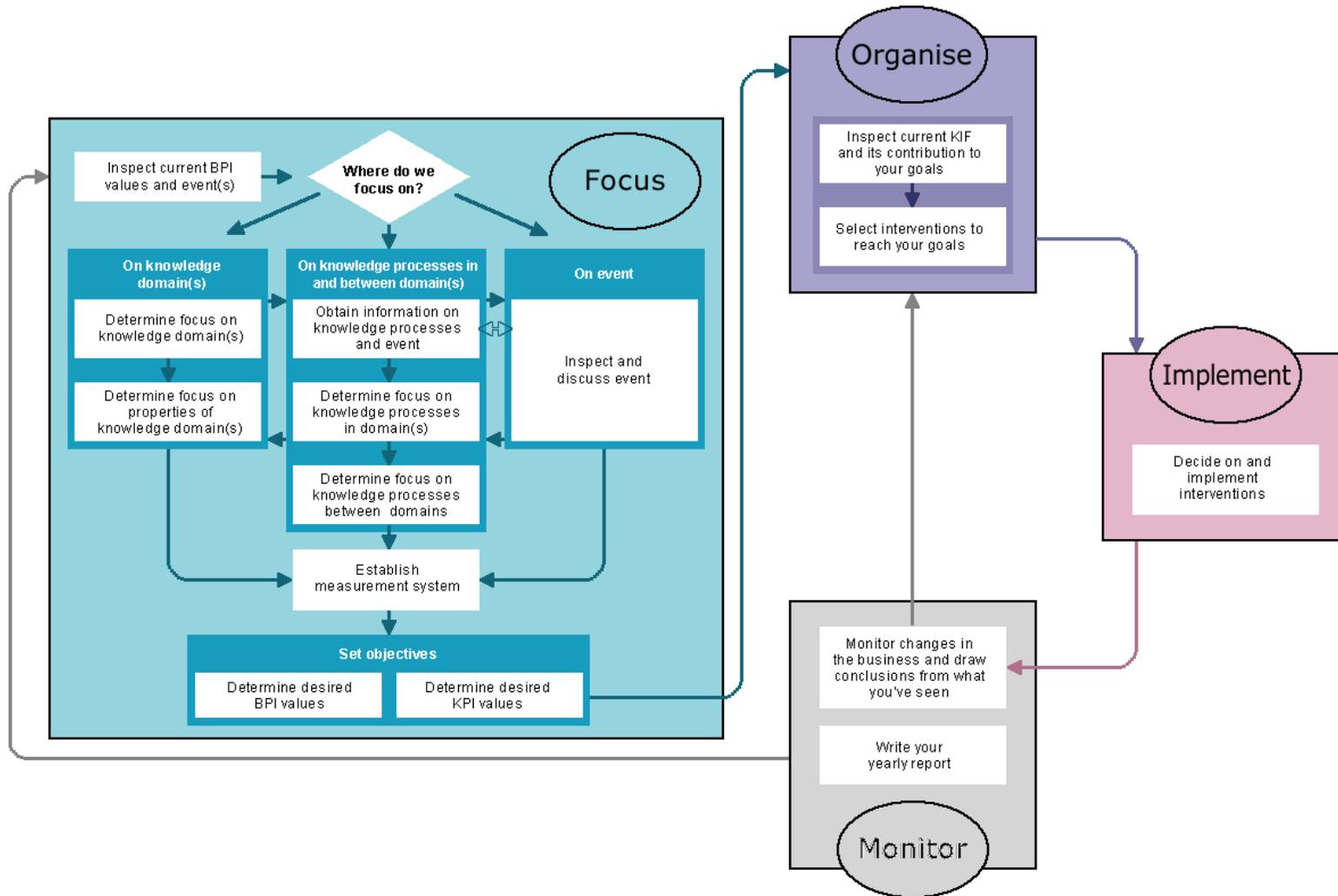


Figure 9. The knowledge management model

3.4.2 *The Organise phase*

In the Organise phase, the knowledge management model looks into the current situation with respect to structures and resources in an organisation (the knowledge infrastructure of an organisation). More important, this inventory of the current situation should result in an assessment of how the current knowledge infrastructure influences key properties of knowledge domains and processes that are identified as relevant in the Focus phase.



From this inventory of the current situation, and the ambitions set in the Focus phase, a coherent set of interventions is determined. Although these generally differ along many dimensions (e.g. material costs, labour costs, prerequisites, implementation time, adherence to company standards, etc), the most important dimension is their ability to effect changes in the properties of knowledge domains and processes.

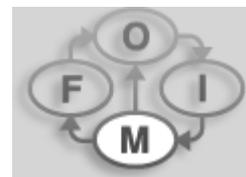
3.4.3 *The Implement phase*

During the Implement phase the chosen interventions are incorporated into an implementation plan. This plan consists of a set of measures and projects to make sure that the interventions are really taking place. As the successful implementation of interventions is guaranteed in KM Quest™, this phase is of less importance in the game than in reality.



3.4.4 *The Monitor phase*

In the Monitor phase, the knowledge management model inspects the state of the business model, and a discrepancy analysis is carried out in order to establish a clear picture of the gap between ambitions and current project status. Any re-planning of interventions may be initiated here, and feedback loops may occur to any of the previous (sub)phases, depending on scope and severity of the outcomes of the Organise phase



4. Implementation

With KM Quest™, basically, a type of business game has been realised. There are widely available versions of business games all over the world, so an interesting question is: what makes KM Quest™ different from the others? In Chapters 2 and 3 we have discussed the KM and instructional characteristics of KM Quest™, here we concentrate on the KM Quest™ specific technical features:

- Web architecture, no need of special client software installation, just standard Internet Explorer DOM1 browser;
- Widely expandable with zero maintenance time;
- History feature which records all open and modified templates;
- Collaborative tools like chat and template calling which permits remote handshaking of info and makes like all the players are in the same room;
- Communication fault tolerance which detects remote player drops;
- Collaborative voting to take a decision together;
- The use of XML model database simplifies the restyling of the entire graphic interface;
- Application variables, another use of XML, to store internal application status.

4.1 A deeper look into the main features.

4.1.1 Web architecture, no need of special client software installation, just standard Internet Explorer DOM1 browser

During the design phase we could have opted for standard 2 or 3 tier client-server architecture but this implies the need of writing client software and server software, the need of a more accurate versioning of software that is too much costly for a prototype. Another draw-back is that changes in the layout graphics would not have been easy as it is now. Now, all style sheets reside on the server, thus, with a minimal impact we could completely redraw the layout. With web-based architecture we can distribute the application to much more players and when the server load is not enough to drive all connected clients we can just upgrade web server at more computing power and using a more suitable database server like Microsoft SQL Server.

4.1.2 Widely expandable with zero maintenance time

This feature comes directly from the web architecture design. The number of connected clients depends only by the computational power of the used web server and db server. At now, a db server like Microsoft Access is the minimum requirement because of the low traffic of data between web server and db server but with higher number of connected teams the DB server, it should not be capable to serve all queries. The porting effort of modifying internal query to make those compatible to the new db server would be minimal because of attention paid during the coding phase to write the simplest possible and most portable query.

4.1.3 History feature which records all open and modified templates

The history feature saves all opened templates that have been modified during the game. The changeable template is a template that has a “lock” button that takes the lock and enables the player to modify the writeable part of a template preventing all other players to modify the same template.

A template with no lock function is a simple visualisation template, can not be modified and thus doesn't need to be saved.

When a player opens, on his or her desktop, a book of previously closed quarter appears a list of modified templates during that quarter, by selecting a template, it opens displaying his latest status when it was written in that quarter.

4.1.4 Collaborative tools like chat and template calling which permits remote handshaking of info and makes that all the players appear to be in the same room

Because of his web architecture, we can make a team with players far from each other. When they discuss about a decision to be taken in the game, they need to share their opinions using a general chat template accessible directly from the desktop or a more specific forum function laying in the bottom of each template so to discuss about that template. If someone opens a template and wants to share an idea with his team mates, he can call other players to open his template and start a discussion about his idea. It could use a “Template Call” function of that template. In this case, at the next polling time, a dialog box appears on top of each player's desktop showing a message asking the player to open a specific template, if the player answer “yes” that template opens on his desktop without force him to open a set of templates prior to open the target template.

4.1.5 Communication fault tolerance which detects remote player drops

The nature of the http communication protocol does not provides continuous handshaking between client and server, so it is not possible to determine if a client is dropped or if the remote player does not need to make action in the game like if were an observer simply watching the game. To prevent this situation we defined the so-called phantom detection feature. If a player poller does not refresh his execution time for long time then is throw out of the game and all the memory structure are released otherwise if he tries to re-log in and his last refresh time is acceptable then no memory is released and the player re-enters the game at the point were the other players are.

4.1.6 Chart tool for studying all main business variable.

Directly on the player's desktop there is a whiteboard, by clicking on it a set of templates is opened that is useful to display a set of histograms of the main business variables whose values are frozen during quarter changes. So, at quarter N we can read all values that a certain variable has had for each quarter previous to the quarter N. This feature has been achieved by the visualisation server called each time a player requests a specific set of visualisation variables named Visualisation Package.

How to obtain a histogram? Each time a player opens a template which displays a histogram then an xml sheet is built in real-time with the information about the package needed and other arguments which will be passed to the Visualisation Server which builds immediately a gif picture with the right graphic and sends web server the url where this real-time-formed

web page can be reached, the web server acquires the web page and encapsulates it in the requiring template.

4.1.7 Collaborative voting to take a decision together

Like all the business games, the manager, or, in this case a team of managers, have to take one or more interventions each change of quarter. If the manager is a single player, there is no need to vote for a decision but if team is composed by more members, all players must share the action to take. After each member has voted “YES” about the interventions, then this decision is submitted to the Business Model Server in XML format, it analyse the current status of the game plus the corrective action taken by the team and recalculate the new status of the system by changing his system variables values. This new status will be submitted to the team and the quarter will be incremented by one.

4.1.8 The use of XML model database simplifies the restyling of the entire graphic interface.

The revolutionary idea of the XML approach is that by simply changing the saved XML sheet and XSL style sheet we could completely change the external and the internal behaviour of the game. Each template has an entry in a database table, in this row there are defined attribute like absence/presence of buttons but, the most important, there is a field which contains the XML sheet which would be rendered by using the relative XSL style sheet. The final result is a HTML page or better, a DHTML page which will be encapsulated in a layer draggable on the desktop of the user.

4.1.9 Application variables, another use of XML to store internal application status.

XML has been also used to store both temporary structures and global structures to speed up the execution time and for the best logical ordering of similar information necessary to store run-time system variables. In fact, to minimize database queries, we decided to keep in the server application memory all frequently accessed variables so to make less slow db accesses. In these XML structures several types of information is stored such as: all the players and teams connected, refresh time for each player, opened templates and if a template is locked by a player then all changes in template status are also stored on the same XML structure. The reason is because a player may frequently change every field in the template before definitively releasing it, so only the final changes are committed to DB when the player unlock his template or close it leaving locked or drop his web connection for an undetermined reason. Now that the changes are finally stored on DB, each player opening the same template will see changes made by the previous player.

This global application area is also used to keep all visible info like game budget and quarter number up-to-date. It also serves the updating of two important flag variables that are needed to control the system during the quarter changing and it keeps track of possible failures and provides a restore algorithm in case of a communication failure with the BM server.

4.2 The general KM Quest™ configuration

Because of the web nature of the software the KITS (KM Quest™) system it is not a merely client-server architecture. It has only one characteristic of a traditional web site, namely the need of a browser. The other features make it seems like a full client-server application or

more. By use of JavaScript/xml/asp we have tried to achieve a right compromise of speed and data transfer load because all code running on client has been written on JavaScript and only the needed procedures are loaded on the client, and more, the server takes charge of providing, for each client, the necessary code and graphics for rendering his desktop and every open windows on it.

There is no "SUBMIT" button at the client and all the data communication has been achieved in full duplex mode by using two communication channels for sending/receiving data to/from the server. By using an event-driven architecture, each command, each typed text, each action taken by the player is immediately sent to the server which makes all necessary changes on system variables, database tables and prepares portions of code which will be sent to the client and executed on it at the next predefined execution time. This is achieved by using a script JavaScript like a batch script, executed on the client but built on the server which instructs the client to refresh the graphics layer, open a new template, close the other and so on. The script then re-launches itself after a predefined number of milliseconds (the refresh time) with the new task assigned from server. With this technique every client sees the new state of the system each X milliseconds including all messages from other players like chat messages and template calls.

Although the KITS system, and therefore KM Quest™, appears to the user as a single coherent system, the implementation comprises three servers:

KITS server This is the server that learners logon to. It uses DHTML to provide the core functionality of KM Quest™, such as interacting with the KM Model, exchanging ideas with other learners and issuing KM interventions.

BM server Underlying KM Quest™ is a Business Model (BM of a fictitious company. The BM server computes successive states of the variables in this model based on user actions (KM interventions) and external events.

Viz server The variable values in the BM, i.e. the state of the company at some point in time, are visualised using graphs and charts. The Viz server generates these visualisations based on the state of the BM.

The three servers could, obviously, be integrated into a single system. During the design of the overall KITS system it was decided that the servers best be viewed as physically separate servers for a number of reasons. First of all, the KITS server and the BM/Viz servers have been developed at different locations (TNO Italy and UvA Amsterdam respectively) and using different programming platforms (Microsoft ASP and SWI-Prolog under Linux respectively). Physically distributing the servers made independent development possible. A second advantage of the separation of functionality is that BM and Viz servers can be used for completely different purposes than originally envisaged, for example the two servers could be used as part of a Management Information System. An obvious consequence of the design is that the servers must establish a clear mechanism for interoperability.

5. Evaluation

5.1 *Goals of the evaluation*

The evaluation of the KITS learning environment followed three main directions. The first aim was to investigate the usability of the learning environment. Any application, whether intended for instructional purposes or for performing automated tasks should be user friendly in the sense that users should be able to work with it, users should be able to understand the environment, and should be motivated and supported in order to reach their goals. The second goal of the evaluation aimed at investigating the learning effects of the environment. Questions such as how are learners playing the game?, what strategies do they perform?, and why and what do they learn from it? will be answered. Thirdly, the acceptability of the learning environment was assessed. Although acceptability is a broad concept, in this study it was formulated as the extent to which the learning environment is sufficiently situated for users to learn about principles and practices in the field of knowledge management and to what extent the environment is suitable for company-use.

Concerning the study into the learning effects it is important to notice that this research will not adopt a strategy of comparing traditional or conventional knowledge management courses with the KM Quest™ learning environment. Reasons for this are:

- Existing conventional courses are not comparable to the KM Quest™ environment in terms of learning goals
- When comparing different types of instruction in a non-laboratory settings, many confounding factors play a role that make it extremely difficult to interpret the learning results or learning process characteristics in terms of cause and effect.
- Logistically it is not possible to develop a conventional KM Quest™ course and organise it along the interactive learning environment

5.2 *Two-phase evaluation: P1 and P2*

In the development of the final learning environment, two prototypes were identified, P1 and P2. P1 did not contain the complete functionality of the final learning environment and its evaluation would lead to an improved system. P2 was close to the final prototype learning environment and results of the second evaluation period could only lead to minor adaptations of the system. In this view, it was logical to perform the various evaluation studies in the following way:

- P1: Usability testing and a study into the learning process
- P2: Study into the learning results of players

One important aspect of an interactive learning environment is the user friendliness of the system both in terms of the user interface design and the functionality provided. This study was performed on P1, as it allowed for sufficient time to feed back the results to the development team. Moreover, the usability study took place before the study into the learning process features was executed. In this way major problems that occurred with the first prototype could be repaired. In addition, on P1 a study into the features of the learning process took place. This study focused on questions such as how are users playing the game and to what extent the instructional envelope supported them in achieving their learning goals.

Included in this study, results will be achieved into the features of the communication that takes place and how users are working with the collaboration tools.

As it seems not fair to look into the learning results of users when playing with a system that is not yet fully functional, the learning assessment was performed with P2.

As it is of great importance for the exploitation and marketing of the learning environment during and after the project, the acceptability study started already during the first evaluation session and continued throughout the project. The acceptability study focused on the extent to which the case material, events, and business model are appropriate for the target group and what features of the system lead to an implementation of the learning environment in the organisational context of the potential customer.

5.3 The evaluation of the first Prototype

5.3.1 Usability measurements of P1

The first and foremost topic that the evaluation addresses for the KITS environment is the usability. Usability is conceived as the detection of mistakes and errors and problems in the interaction between the user and the application. In order to gain a thorough understanding of the KITS environment and in order to achieve the learning goals, the user interface should be designed in such a way that players can easily learn how to use the system and are able to efficiently and enjoyably perform their tasks and learn about KM.

The usability of KM Quest™ as a concept was measured by using various instruments. First of all, an electronic questionnaire was developed that consists of several dimensions the players can judge KM Quest™ on. Each of the dimensions is further specified in specific aspects of the system. Participants gave a score on a rating scale and were able to include their comments when assessing the environment. This electronic questionnaire was used by the potential customers ((senior) managers) of KM Quest™ to give their opinion. In addition, various groups of student teams had to develop their own framework for assessing the usability of the game. This resulted in having additional remarks and comments upon the functionality of the game. Finally interviews had been performed to gain more insight in how the participants perceived playing the game. The results of the evaluation of prototype 1 are described in Section 5.3.6.

5.3.2 Learner behaviour measurements of P1

The second topic of research for prototype 1 concerns the actual behaviour of the players in the game and their learning process and results. In this study, the behaviour of the players was captured by the system in several log files that gave insight in:

- What events have been played;
- What activities players have perform in terms of the instructional envelope;
- What activities players have performed in terms of the KM model;
- What interventions have been chosen;
- What the performance of the business model is;
- What players have discussed about

5.3.3 *Acceptability measurements of P1*

Third topic of interest for the KITS learning environment is the acceptability of the game.

Acceptability here is defined as:

- To what extent is the normative knowledge management model suitable for training KM theoretical background knowledge and principles
- To what extent is the business model sufficiently realistic for the potential target group
- To what extent does the instructional envelope support the effective and efficient achievement of learning results
- To what extent can the learning environment be implemented in the organisational context of future users
- Technical problems encountered

These issues were all investigated by means of an electronic questionnaire that the players (managers) of the game had to fill in. Results concerning the acceptability of prototype 1 of KM Quest™ can be found in Section 5.3.6.3.

5.3.4 *Setting*

For the evaluation of prototype 1 the playing of the game was organised in two different scenarios. One scenario that the teams could choose was the full time mode. In this scenario teams played the game over a period of two days with team members being located (ideally) in different rooms, so no face-to-face contact was possible and the game was entirely played over the Internet. In this scenario team members were on-line all the time. The coordinator of the teams introduced the game plenary and led a training session before the start of the game either virtually or in a face-to-face kick-off meeting.

The other scenario was the multiple week scenario in which teams could play the game over a period of four weeks. The introduction and training for the game were performed by distributing PowerPoint files that addressed specific introduction and training issues. Then, teams started playing the game and could log on the system at any time and any place.

5.3.5 *Teams*

In total, over 30 teams had been scheduled to play the game. In Table 1 an overview is given of those teams and their background.

No. of Teams	Originating from
7 teams	ARANEA (both in The Netherlands and Belgium)
4 teams	EADS (both in Toulouse and Paris)
1 team	Ecole Centrale Paris; coordinated by EADS
3 teams	Coordinated by ECLO
5	Coordinated by the University of Twente (team 48: Russian Management students, team 49: Russian Management students, team 50 and 51: players originating from various backgrounds, team 52: Players from Quaker Chemicals Group)
9	Coordinated by the University of Amsterdam, students following a course

Table 1. Overview of teams participated in the first evaluation.

5.3.6 Results of the first prototype evaluation

5.3.6.1 Usability results of P1

In the KITS evaluation we have regarded Usability research as the detection of mistakes, errors, and problems in the interaction between the user and the application. The managers rated the overall ease of use of the elements in the environment as not sufficient. Especially the communication tools were rated as difficult to work with. The instructional support, KM model and process worksheets, and the case and event description were valued as easier to use. The players experienced difficulties navigating through the different elements of the environment. Especially, navigation with regards to the communication elements was difficult. The different elements of screen design (text, icons, graphics and colour) were judged to add only marginally to the functionality of the game. The colours that were used received the lowest rating. Overall, the respondents judged the consistency of the environment as being moderate. Most of them could find the information needed but had some problems finding the right place. Data showed that compatibility of the information in the system with the understanding of the players could be improved. The media integration was rated as not sufficient for the game. Main issue for this dimension is that communication and collaboration is not sufficiently supported by the system. There seems to be a discrepancy between the expectation of the players and the behaviour of the game. However, not so many comments have been added in order to get a clear picture of what the ideas and expectations of the players were in relation to the actual behaviour of the game. Rating scores for the various aspects of the system indicated that the aesthetics dimension is considered as moderate. For communication aspects respondents considered the aesthetics dimension as insufficient.

5.3.6.2 Learner behaviour results of P1

Over thirty teams have played KITS and for each of the teams the activities in the system have been registered. Results give insight in to what extent process worksheets of both the KM model and the various support facilities have been used, what quarter in the game was reached and what players have discussed about. The overall picture shows that the managers' teams spent 9.7% on chatting, 32.4% of their time on activities that do not include using the KM model and the remaining 57.9% on using the KM model for finding a solution for events. All managers teams seem to use the KM model quite a lot. We see that most of the teams (over 50%) have played only one quarter. This means that these teams have accessed the game and have consulted the various worksheets and effectuated the first set of interventions for the first event. It is rather a large percentage of teams that have obviously for some reason decided not to continue with the game after having finished the first quarter in the game. In terms of what the players have said, approximately 60% of the discussion is domain related, that is, applies to knowledge management. The remaining 30% is equally distributed to discussion concerning the use of the environment (tool) and regulating the group process. Over 25% of the teams have however finished playing the first year in the life of Coltec. The remainder of the teams have ended in the second or third year in the life of Coltec. One team actually played the complete three years of the game.

5.3.6.3 Acceptability results of P1

The degree of reality and acceptability or validity of the context of a simulation game is an important element that could facilitate learning or hinder learning and transfer of learning to take place. The KITS case description and business model are tailored to a product leadership type of organisation. Respondents indicate that they sometimes experience difficulties to match the type of organisation and interventions they can apply (to change the behaviour of the organisation as simulated by the business model) to their own organisation. Furthermore, they have problems in assessing the effects of the events and interventions based on the business indicators in the business model. They also wonder if the events are adequate for learning how to solve knowledge management problems. Although players see the value of having a knowledge management model to help them solve knowledge management problems, they also indicate that the model is explicit and comprises many steps (working through the model every cycle takes much time). Furthermore, the value of some of the steps (for instance determination of the impact of knowledge domains) was questioned, and sometimes the difference between steps was not intelligible. Basically, the respondents are positive about the ideas of using process worksheets, and of giving additional information by means of examples and “What to do?” and “How to do it?” links. Although sometimes the distinction between these last two was not clear, and the texts that were used were seen as too scientific. However, they also indicate that there are too many worksheets and, that they were disappointed that the support given by the worksheets was mainly in structuring the process and there were no cases in which actions taken in a specific worksheet have impact on the content of other worksheets. In general people indicate the game could be more challenging and competitive. Some think it is too complex and that playing it takes too much time. Players agree that having three players in a team is enough, and find it motivating to play the game with a team. However, they do not directly see that playing the game in a team improves learning, and they do not experience enough difference in knowledge management expertise in their team to benefit from. The players do not agree that the tools implemented enable good communication and collaboration.

5.4 Evaluation of the second prototype

5.4.1 Participants and setting of the second prototype

The evaluation of the second prototype was scheduled for September – October 2002. Due to implementation issues the second prototype was available only from mid-October 2002 and in practice the evaluation ran until mid-December 2002. Several profit and non-profit organisations participated in this study and the choice of the participants is based on the description of target groups of KM Quest™ as described in D3 (Dissemination and Use plan). The primary target group of KM Quest™ is divided into three subgroups: those who manage knowledge resources in an organisational setting or those who are going to do that as an explicit part of their organisation role. Higher education students who are preparing for these roles. And individuals that wish to enter the professional field of knowledge management as a switch in their own career.

In order to recruit participants that match the primary target group of KM Quest™, existing contacts that were made during the evaluation of prototype I have been contacted. Unfortunately, most of these contacts (please see D10) switched jobs and in addition, due to competitive restrictions regarding the use of KM Quest™ none of the external contacts could be included in the evaluation of the second prototype. As for the internal prospective

participants each of the partners involved in the evaluation has recruited teams to play KM Quest™. In Table 2 an overview is given of the recruited teams. In addition, the identification of target subgroup is included in the table.

Partner	Coordinating teams from	Target group
ECLO	1 team from chamber of commerce, Munich (Germany)	Managers of knowledge resources in organisational settings
Cibit	1 team from internal contacts (The Netherlands)	Managers of knowledge resources in organisational settings
EADS	3 teams from within EADS (France)	Managers of knowledge resources in organisational settings
UT	24 teams from the University of Nijmegen (The Netherlands)	Higher education students
UVA	14 teams from the business school Maastricht (The Netherlands)	Higher education students

Table 2. Overview of recruited teams for the evaluation of prototype 2.

5.4.2 Learner behaviour measurements of P2

In order to investigate the learning results of the players of KM Quest™, a questionnaire has been developed that aims at measuring this. This questionnaire is based upon the learning goals formulated for KM Quest™. The learning goals of KM Quest™ are twofold (see D13) and include both strategic and conceptual knowledge. After players have completed all phases in the game, learners:

- Are able to recognise a KM problem or opportunity
- Are able to specify which phases can be distinguished in solving KM problems
- Can perform the steps in the different phases in the KM model
- Are aware that KM problems, opportunities and solutions can be highly situational
- Are able to relate KM work to business output through established performance indicators
- Are able to assess the KM situation and advise and implement appropriate interventions
- Are able to monitor and evaluate the consequences of interventions.

In order to measure conceptual knowledge, two questions are included in the questionnaire. In order to assess strategic knowledge (which is much more difficult to measure, see e.g. Swaak 1998) players are introduced to a case that is equivalent to Coltec, namely HollandSky, a small travel agency.

5.4.3 Acceptability measurements of P2

In order to investigate the acceptability of KM Quest™, a questionnaire has been developed that we call the 'Learning environment questionnaire' (LE Q). This questionnaire is based upon the one used during evaluation cycle 1.

5.4.4 Validity of the BM

In order to investigate validity of the business model that simulates the behaviour of Coltec a questionnaire has been developed. The questionnaire was designed specially to evaluate elements of the business model and the validity level of those elements.

The validity level of the elements was evaluated according to the three aspects:

Plausibility – model or its components can/should be in the game

Acceptability – model or its components can be found in companies

Credibility – model or its components exist in Product leadership companies in reality.

5.4.5 Results of the second prototype evaluation

The results of the managers' teams are reported separately from the students. Three teams from EADS, one from Cibit and one team from ECLLO have participated. Players are quite positive concerning the learning environment and the business model, but it is hard to compare managers' teams as they show a diverse picture of quarter reached in the game.

Twelve student teams from the University of Nijmegen have reached the finish line. Teams used different strategies: some teams paid more attention to the marketing domain, whereas other teams focussed on other knowledge domains. Some teams considered KM Quest to be a management game, not realising it concerns *knowledge* management. Students are positive about the learning environment and the business model, however, they experience a lack of 'history' functionality and the communication and collaboration of the environment should be improved. The behaviour of the business model is felt to be adequately realistic.

Nine student teams from the polytechnic in Maastricht have reached the finish line. Students from Maastricht do not show a significant learning result after having played KM Quest, which can be explained by the fact that the number of missing values in the post test is by far higher than in the pre test. Students are less positive about the learning environment and business model than the students from Nijmegen or the managers' teams. Overall, the teams perform relatively well and maintain an efficient household of Coltec, only one teams ends far below the initial situation.

6. Exploitation and dissemination

This chapter briefly outlines the exploitation and dissemination of KM Quest™. The, non public, exploitation plans are described in Deliverable D18. Based on the characteristics and features of KM Quest™, for external commercial exploitation, the following products are defined:

- Open-enrolment web-based KM game
This is the basic product. KM Quest™ made available through an internet host and uses an automated enrolment facility to register customers. For a fixed fee the customer gets a password to play the game once. KM Quest is used as a pure e-learning product with of-the-shelf content;
- Add-on to existing KM courses
This product is very close to the Open-enrolment web game. The main difference is that it is used in a blended environment, players will be playing in groups of three and specific train-the-trainer material is given to the course runner;
- Corporate licence
A corporate license to run the KM game on a corporate intranet. The corporate license will include a yearly update and a train-the-trainer programme;
- Tailor-made web-based KM games
either for in-house gaming or for specific sectors in the industry.

6.1 Target groups

6.1.1 Primary target group

The primary target group of KM Quest™ is divided into 3 subgroups:

1. KM professionals: those who manage knowledge resources in an organisational setting (both profit and non-profit) or those who are going to do that as an explicit part of their organisational role. This primary target group consists of individuals who have roles such as:
 - a. Chief Knowledge Officers;
 - b. Chief Learning Officers;
 - c. Knowledge managers;
 - d. Content managers;
 - e. Knowledge facilitators;
 - f. Knowledge analysts;
 - g. Knowledge coordinators.
2. Higher education students who are preparing for these roles, during e.g. bachelors or masters programs for Business Administration, Information Management, Marketing and Communication, Library Science, etc.
3. Individuals that wish to enter the professional field of knowledge management as a switch in their own career. For reasons of convenience, we will dub this group with term 'profession switcher'

6.1.2 Secondary target group

Those who can influence the behaviour and circumstances of individuals in the primary target group populate the secondary target group. Currently, the following subgroups are discerned:

1. Professionals in knowledge-intensive organisations. These individuals do not hold a responsibility for managing knowledge resources, but may have an interest in becoming acquainted with the principles of knowledge management, and may influence the overall opinion towards knowledge management in an organisation. In general, middle management, project managers and staff personnel relating to quality management and HRD populate this group.
2. Opinion makers. These are the individuals who influence the opinion of the individuals in the primary target group. This group is populated by e.g. gurus, the press, consultancies who favour particular KM methodologies, but also institutions that can endorse training courses with a formal certification.
3. Decision makers. These are the individuals who actually make a purchasing decision and/or a decision to go forward with knowledge management within an organisation.

6.2 Roll-out sequence and prioritisation

Priority	KM Quest™ product	Requirements *)
First	Open enrolment	100%, EUG, GH, [SP]
Second	Add-on to courses	100%, EUG, GH, [Demo]
Third	Corporate licences	100%, EUG, [GH], IG, TS, Demo, [GRG]
Fourth	Tailor made	100%, EUG, [GH], IG, TS, Demo

*) explanation of the abbreviations:

EUG End-user guide (currently available as on-line training)

GRG Game runner guide

IG Installation guide

100% KM Quest™ is complete and working properly (currently under review)

TS Technical support, helpdesk

GH Game Hosting

Demo Demo version of the game

SP Single player version of the game

Based on the requirements and the level of effort involved to realise these requirement, first priority is given to marketing KM Quest™ as a Open-enrolment web-based game. The second step in commercial roll-out would be Add-on to courses. These two products have almost the same requirements and can therefore be sold in parallel. Our estimations of the target group however lead to the decision to start marketing with the Open-enrolment product.

It should however be noted that the path towards corporate licensing and even tailor-made versions of KM Quest™ is evolutionary rather than revolutionary. This implies that effort and money put into the Open-enrolment product is also well spent with regards to the more advanced products.

6.3 Marketing

The foreseen marketing effort is also focussed on the first priority product: the Open-enrolment web-based game. Exact marketing planning will be made with the post-project exploitation organisation. We envision four spear heads in our campaign.

6.3.1 Approach 1 – KM specific internet campaign

Directly aiming at that part of the primary target group: the KM-professionals. Within that group we focus at persons that are already using Internet in their educational needs or those that are intending to do so. This means that the campaign needs to be completely web-based, using banners on prominent English-spoken KM focussed websites, such as KM world, KM magazine, and KM journal.

6.3.2 Approach 2 – Getting into corporations' education guides

This approach aims at the large corporation based potential users, mainly using their own infrastructure in finding adequate training and education. Through our networks access can be gained to education responsible persons in a number of these larger organisations, such as banks, industry etcetera. This approach will also be the basis for the assessment of the market potential for the Corporate license product.

6.3.3 Approach 3 – Developing track record through consortium network

Developing references, white papers and articles for KM Quest that can be used in all other marketing approaches will be set-up via the consortium network. 'Friendly' customers will be asked to play KM Quest™ and, in return, will give evaluations and references for the game. In itself this approach could also lead to a spreading build-up of corporate customers.

6.3.4 Approach 4 – Getting into major players content catalogues

For this to work we have identified new marketing partners who can contribute to successful exploitation. Following the launch of the open enrolment course further investigations as to the use of this potential marketing channel will be undertaken.

6.4 Dissemination

The dissemination activities performed by the consortium during the project include 27 presentations / meetings and 7 scientific articles.

Dissemination of the work of the KITS project should be done for two main purposes:

- In order to enable other European organisations to profit from the knowledge that in during the KITS project was developed
- In order to ensure that the game produced by KITS will be commercially successful.

The focus of dissemination activities, their nature and the efforts invested in them has to changed during the project. Starting with activities aimed at dissemination of general information, the project will later, when more and more results are available, change the nature of the dissemination activities to more focused ones: dissemination of specific technical and knowledge management knowledge, the product itself etc, to better targeted audience, namely potential clients and partners.

Conclusions that can be drawn regarding the goals of dissemination activities of the KITS project are:

- The public, Europe's enterprises, workers and consumers, should receive general information about KITS in order to be able to decide whether each individual or organisation can profit of it and, at the same time, in order to confirm Europe's position as a leading force
- The knowledge and technology developed during the project that may contribute to other European organisations should be available to them. At the same time the position of the KITS consortium should be kept in tact in order to realise a sustainable growth for its partners.

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