Applying Serious Games for Supporting Idea Generation in Collaborative Innovation Processes

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Abstract
The ideation process – often called the fuzzy front-end to innovation – is one of the most crucial steps when starting industrial- and especially collaborative – innovation processes. There are numerous creativity techniques like brainstorming to be used in this early phase. This paper introduces another approach based on Serious Gaming. A game to structure the ideation process – refQuest – has been developed and is briefly described. Two early evaluations have been performed at the University of Bremen in order to verify that the approach supports idea generation in a structured approach and to get an overview on strengths and weaknesses for further enhancements. The approach used for this early evaluation of the refQuest game prototype was based on three different types of input: the observation and the exchange of information between the facilitator and the player, questionnaires comprising questions on the functionality, the utility and the usability of the software as well as questions dealing with the idea generation process, and direct observations during the game.

Keywords
Computer games, Serious games, Idea generation, Innovation, Creativity

1 Introduction
The ability to maintain and develop competitiveness of the European manufacturing industry is essential for the prosperity of the EU. This competitiveness is highly dependent on the ability of the European manufacturing industry to innovate. Therefore, in order to achieve continuous innovation and thus create persistent competitive advantage, there is a need to increase capacity for carrying out open-ended and nonlinear problem solving involving a wide participation of people in knowledge-rich environments. Companies are well aware of this issue and have implemented strong innovation processes which are often driven by a stage-gate model. Common to nearly all of these innovation processes is the black box in the beginning of the process called idea generation.

Additionally, harder competition and more complex products that demand more specialised knowledge have led to more collaboration between enterprises. In order to support the innovation of complex products, it is therefore important to focus on collaborative innovation procedures. The innovation process comprises several steps, but the output is always dependent on the input, the generation of ideas. It is therefore worth looking at how it is possible to support idea generation in a collaborative working setting.

2 Relation to Existing Work
Ideation, which is the generation of ideas, is the most crucial step in the early stage of innovation projects. This phase is often called the “fuzzy front-end of innovation”. Even though this stadium of an innovation project is loosely structured, the generation of good and realisable ideas is mandatory for the overall success of the project.
Figure 1 shows that before entering the well-known stage-gate-process of development, prototyping, manufacturing, and marketing and sales the ideation is beforehand. This is the early stage of innovation, where the potential to gain creativity boost is located.

Figure 1: The Innovation Process (Rothwell 1992)

Good ideas are often the result of the creativity of a single person or of a group of collaborating persons. The best known method to support creativity in group settings is brainstorming, but the corresponding literature reveals a large number of other methods to stimulate creativity such as Morphological Analysis (Zwicky, 1969), 635 Method (Rhorbach, 1969), or Synectics (Gordon, 1961). Analysing how innovation “arise” shows that the process is mainly carried out in small discrete steps with or without a given timeframe. Most of the product innovations in Europe are not about generating a complete new product, but about improving product characteristics, or adding new features and/or services to an existing product. The success or fail of such an innovation process, is not only dependent on its ability to meet the market requirements to lowest possible development costs but also highly dependent on the time to market. Therefore it is necessary to look on those processes being esp. critical or time consuming for the outcome. The idea generation is such a process; only a few ideas will ever be developed to a prototype, and only a few of the prototypes will be final product. This process might often appear quite frustrating, as most of the ideas ends up as “ware” (Hesmer et al. 2007).

The idea generation process seems to have many similarities with processes based on serious games. The application of computerised and non-computerised games for educational and vocational training has shown positive impacts during the last decades (e.g. Schwesig et al, 2005). Encouraged by the similarities, it seems interesting to investigate, if the use of games in the idea generation will lead to better results in a shorter time than typical methods like brainstorming.

Because of its fuzzy nature, where details and even goals are not defined exactly the early stage innovation can not take place in a linear process. Iterations are the nature of the related workflows. Traditional project management is all about linearity. But, in the early stage of innovation one rarely has a well-defined problem, and so iterations between problem, solution and possibilities are needed (e.g. Simon 1973).

3 Research Approach

The ideation process, in this case the disruptive idea generation, which is the most difficult one, is described to be the process of discovering what to make, for whom, understand why to make it and define the success criteria including the development of insights for answering these strategic questions (Rhea, 2005).

Analysing most used methods supporting ideation as well as the processes carried out and looking at paradigms used for education, it seems to be obvious that constructivism has a lot of
similarities with the ideation process. Constructivism sees learning as construction of learning out of experience (e.g. Kolb 1984). Constructivism sees the learner as an active agent, not a passive processing unit, and it sees knowledge as personal and subjective construction, not internalisation of external rules. This is an important distinction between the cognitive learning theories and constructivism. There is no truth “out there”; no knowledge exits independently of the knower, which is also true for the process of innovation.

3.1 Research Concept

One advantage of games is that they are motivating, which could reduce the frustration in an idea generation process. Players are presented with information that they need to interpret and interact with. Games can easily contain multiple and contradictory knowledge structures. They can be used to promote discussion and re-framing of the knowledge gathered in the ideation process. Games built around a constructivist view on knowledge creation and learning can for example have competing, parallel views of incidents. Games focus players’ attention and good games tend to strengthen concentration and agency. Often, games are hard work but offer engagement by providing challenge and struggle. At the same time, games provide incentives to change existing culture, routines and behaviour. Serious games have been shown to have a beneficial effect in training e.g. in surgeons (Stone, 2005). Additionally, the game develops explicit routines for team-based ideation work, together with a technological infrastructure that allows for communication about, and experimentation with more or less finished ideas, early stage innovations and concepts not yet implemented. These game elements are all elements which would bring a process based idea generation further.

The objective of a game for idea generation would therefore be to make the work routine of generating ideas more effective. The outcome of the game intends to be initial ideas, but could also be broader and imply “options”, e.g. ideas for solutions for specific problems. The game should support the idea generation in a structured way. It is meant to be played in a workshop setting, but it is also playable in a distributed environment.

After analysing different gaming approaches and different available games and compared these with the user requirements, it was decided upon, that we need some sort of game engine, so that the player can get an individual adapted end user scenario. Only in that way, it can be guaranteed that the player will develop ideas which can be used in a productive way. A gaming engine allows for the generation of different games and levels of games without having the need of re-programming. This is the reason for separating the engine from the underlying model. The engine reads and executes game models providing an advanced user interface for the players.

The architecture of the simulation game consists of an underlying business model, a simulation engine and a user interface, which allows to examine the model elements and to apply game specific actions. These parts are described below (see Figure 2):

- Business Model: The underlying business model provides all modelled entities as a formal basis for the implementation of the simulation game.
- Simulation Engine: The engine works on the underlying model and simulates time and costs, which are the main variables influenced by the players in taking specific actions. The simulation engine can be seen as the central control unit of the game.
- User Interface: The user interface allows to browse the overall and personal information in the game and to apply game specific actions.

The business model enables the definition of the simulation engine. The user interface allows data input from players as well as displaying game relevant information.

Structure of the game, process driven i.e. it simulates the processes mainly running in a working environment of engineers. It is a collaborative game, since this is the main working situation.
The game stimulates the idea generation by looking at a given problem from different perspective. For each round, the perspective a game have will change. Also the team may change. The process can be naturally prolonged indefinitely and the outcome of the game depends on the length of the game. The outcome could be a product idea, value proposition, user need, central question or area of strategic interest. In the game frame, a number of ideation groups, representing different innovation perspectives, work together to develop and reformulate the central “guiding problem” – the challenge or opportunity for the organisation.
performance indicators for the idea generation, it is possible to measure the quality performance, the time and the costs within the game, because this is a necessary element in order to achieve the competing effect which often works as a motivation factor in games.

3.2 Implementation

Figure 3 shows the user interface of the refQuest game. The concept has been explained in (Baalsrud Hauge et al. 2007).

As an example a fictive telecommunications products manufacturer is considered. The innovation topic of this example is to develop a new kind of mobile phone for a specific target group: disabled and elderly persons. Six persons from the manufacturer are divided into two groups to generate ideas on the innovation topic. The process each of the groups has to follow is shown in Figure 3. In the first step each group decides the perspective on the topic. Examples for different perspectives are: production centric, end-user driven or technology oriented. In the second step, each player generates individual ideas and stores them in an idea documentation template. During the third step the players exchange on their individual ideas and define some in the group commonly agreed ideas. In the fourth step the three groups present their ideas to each other in order to be ready to assess the generated ideas in step five. The sixth step is finally to complete the idea generation process and to save the results for further processing. While the players are running through the process steps, some performance indicators concerning time costs and quality are updated accordingly.

![Figure 4: The refQuest Monitoring User Interface in a Web browser](image)

A facilitator is watching and supervising the groups of players. The facilitator can observe the results of the players (the content of documents and actions applied by players) and intervene by setting some disruptive events, which should influence the direction of thinking of some of the group members (see Figure 4). The facilitator is also able to monitor all messages which have been sent between the players.

3.3 Early Evaluation Methodology

Even though the refQuest game is mainly developed to support idea generation in the industry, the first main test and evaluation of the software were done by master students in production and
The refQuest game has up to now only been used twice. The main objectives of the early evaluation were:

- To evaluate whether the game supports idea generation and creativity methods in general.
- To evaluate whether the game supports a structured approach of idea generation.
- To find weakness and lacks in the game and the gaming concept at an early stage, so that the next version can be improved.

The approach used for this early evaluation of the refQuest game prototype was based on three different types of input:

- The observation and the exchange of information between the facilitator and the player.
- Questionnaires comprising questions on the functionality, the utility and the usability of the software as well as questions dealing with the idea generation process.
- Observations done during the game.

4 Initial Results

A main difference of using games in the support of ideation instead of more traditional methods like brainstorming etc. is that games in themselves should be motivating and to some extent make fun. Another difference is that games always have a competing element, which mostly makes it interesting to play.

The tables below show that the first impression of the game is quite good and that the players do think it will support the ideation. The questions were answered by the test persons on a scale having seven steps within a range of two opposite estimations. The numbers in the table describe the percentage of the sample who selected that specific column.

However, after analysing the comments on the questionnaire as well as combining these with the oral feedback and the observation done during the game, it becomes clear that even though the first evaluation of the game shows that the game supports the idea generation, there are several minor elements which need to be improved. The use of events, momentarily set by the facilitator had a positive and motivating aspect at the game, since it could be applied if the motivation seemed to decrease as well as in order to help to find a solution. But in this first version it was only possible to set predefined events. The comments showed that it probably would be better if the events could be set on a fly. It was also shown that the competing element was too low for the tester. This could be solved by playing the game with several groups in parallel so that they can compete against each other. The refQuest game is implemented as a browser game. Players and the facilitator just need an up-to-date web browser to play the game.

Furthermore, this initial evaluation also shows that in order to the process steps of the game as well as the functionality need to be better documented and made available during the game. This is especially necessary as long as the player play the generic game, in which they do not recognise the processes and the working environment from their daily work. An implementation in different business environment requires an adaptable game framework so that the game reflects the running processes in each company. This will improve the “productivity” of the game as well as improve the efficiency because the players will know the environment. At the moment the game may only be changed by first carrying out a business process analysis and then change the scripts. This is very time consuming both for the potential company as well as for the game designer and the programmers. For the future it is intended to build an authoring tool which allows an author to manage the game objects without assistance from the programmer. It will still require a deep analysis of running processes.

The game is designed to be used in a workshop setting, i.e. the players are available at the same time. This works in quite many companies quite well, but analysing the process of idea
generation shows that the processes itself is discrete. Future versions provide the option to play the game either in a workshop setting in a given timeframe, and then with time limitation in each step or as a more integrated version which allows each player to carry out the steps when he has time and he only organises small discussions when he needs to carry out a task with someone else. The limitation will then be that the facilitator is available. The first step in order to integrate the game into the working environment will be to connect the DB of the game with the ones of the companies.

During the game … | --- | -- | - | 0 | + | ++ | +++ | During the game …
-----------------|-----|-----|-----|----|----|-----|-----|-------------------|-----|-----|-----|----|----|-----|-----|
I did not fell motivated | 20  | 60  | 20  | I was very motivated
I did not feel comfortable | 20  | 60  | 20  | I did feel comfortable
I did not have enough time | 20  | 80  | 20  | I did have enough time
Were the tasks to be solved hardly understandable | 20  | 60  | 20  | The tasks to be solved easily understandable
Was the structure of the game difficult to understand | 60  | 20  | 20  | The structure of the game was well understandable

Table 1: Results from early evaluation of the refQuest game

The game is … | --- | -- | - | 0 | + | ++ | +++ | The game is …
-----------------|-----|-----|-----|----|----|-----|-----|-------------------|-----|-----|-----|----|----|-----|-----|
Too short | 80  | 20  | Too long
Unrealistic | 20  | 40  | 40  | Realistic
Not useful for my profession | 40  | 60  | Useful for my profession
Can not be integrated in my daily working routines | 60  | 40  | Is surely possible to integrate in my daily working routines
Will not support my daily work | 20  | 40  | 20  | 20  | Supports my daily work

Table 2: Results from early evaluation of the refQuest game

Furthermore, the experience in using the demonstration game and other games based upon the same game engine has shown a need for non-linear processes, as well as to have more generalised, tasked design process steps. But this is a quite essential change of the concepts behind the gaming engine.

5 Conclusion and future work

The current version of the game includes a user scenario which is understandable for almost everyone and is therefore suitable for using the game for prototype discussions as well as for a pre-evaluation of the game. An implementation in different business environments requires an adaptable game framework so that the game reflects the running processes in each company. This will improve the “productivity” of the game as well as the efficiency because the players will know the environment.

The initial evaluation also shows that for an optimal support of the ideation process, a more generic gaming concept is needed. Interruptive idea generation in other contexts may need other types of process steps (currently only actions and documents are available). Therefore, we plan to implement a generic process step structure, which allows including plug-in modules.
Another planned enhancement concerns cyclic processes. Currently, the players are running through a linear process. The inclusion of cycles would allow further refinement and re-thinking of ideas. The cycles should be manageable by the players themselves or by the facilitator of the workshop.

The version planning of the *refQuest* game foresees three major updates implementing the enhancements mentioned above. These are scheduled for June 2008, November 2008 and June 2009.

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**References**


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