Innovation in Software Development
-
Comparing Theory and Practice

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Title:

Innovation in Software Development – Comparing Theory and Practice

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Participants:

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Abstract:

With a textual analysis of the literature on innovative software development and empirical data depicting innovative software development in action, this project strives to answer the three research questions;

1. Is the theoretical data in accordance with the empirical data?
2. Is the idea development process innovative?
3. Based on an analysis of the PayWay PSA, does the development process utilized by the group lead to innovative software?

The research shows that while the model proposed on basis of the textual analysis might not completely comply with the findings in the empirical data, a step towards breaking down the barriers in understanding and defining the concepts of innovation and creativity has been made. Furthermore, this project contributes to the combined literature by proposing a model that has the potential of providing a step towards modeling innovative software development processes as well as tools that, if utilized, might prove to enhance innovative and creative abilities in software developers.

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1. Introduction

As in many other industries, when working in the field of information systems it is important to gain the creative and innovative advantage. Even though this is acknowledged by the media, researchers in the field do not seem to think of it as a problem. When regarding the literature in the field, it is apparent that the IS industry is particularly lacking in comparison to other fields [Cougar96]. With this situation in mind, one has to consider the reasons for this lack of enthusiasm for researching creativity and innovation. While doing the research for [pmc06] it became apparent that there is a certain amount of ambiguity and diversity with regards to concept- and research definitions which might lead to researchers staying clear of this subject.

While there is no question as to the importance of innovativeness and innovative thinking in the software development industry, the definitions of the concept remain ambiguous. To be innovative is often perceived as the ability to adapt quickly to changes in the surroundings, applying solutions and ideas from other areas in a new context and when describing new inventions. A major part of being innovative is, of course, to be creative, but both innovativeness and creativity are hard to define, especially since it is difficult to perform experiments in an ordered environment and also, both concepts are hard to measure in any satisfying way.

Loose definitions pose a problem, especially with regards to the difference between inventions and innovations. It causes misunderstandings and misconceptions when the concepts used are not clearly defined it could mean that the predicate “innovation” is loosing its intended meaning leading to enhanced ambiguity and insecurity, especially in research situations. The diversity in opinions about definitions is especially apparent in the world of software development, and this has lead to a multitude of different attempts to model innovative processes, enhance the innovative abilities in individuals as well as groups, and books on how to be innovative. These attempts are often interesting and shows relevant points, but are also based on either loose or no definitions of the involved concepts. In both 1995 and 2005, OECD published a version of the so-called Oslo Manual, a report describing innovation as well as a proposal on, how to measure the degree of innovation in a country. Below, the two definitions are presented:

Existing Definitions

The definition of innovation has changed over time. OECD have published two report presenting a framework for measuring and comparing degrees of innovation on a national level. These reports contains a definition of innovation, the first published in 1995 is as follows:

> *Technological product and process (TPP) innovations comprise implemented technologically new products and processes and significant technological improvements in products and processes. A TPP innovation has been implemented if it has been introduced on the market (product innovation) or used within a production process (process innovation). TPP innovations involve a series of scientific, technological, organizational, financial and commercial activities. The TPP innovating firm is one that has implemented technologically new or significantly technologically improved products or processes during the period under review.*
>
> - The Oslo Manual ’95 definition of innovation

> *An **innovation** is the implementation of a new or significantly improved*

> *product (good or service), or process, a new marketing method, or a new organizational method in business practices, workplace organization or external relations.*
>
> - The Oslo Manual ’05 definition of innovation

These two definitions illustrate that, in the eyes of OECD, a product or process is only innovative if:

a. A product implementing new and significant technological improvements is launched.
b. A production process implementing new ideas and technological milestones leads to the launch of some product

Furthermore, this means that, when applied to software development, the only way to be innovative is to write and distribute applications that either utilize significant technological improvements or has been developed using some sort of innovative process. The problem is that these definitions are not developed specifically for software development. While the OECD-definition may not be a tailor-made solution for this project, is shows an interesting fact. The definitions has undergone a transformation during the years between their publishing dates, where the major difference is that the latest version describes the effects of the innovation by using the word “implementation”. This acknowledgement follows a trend in the software development industry where several of the existing definitions agree that inventions become innovations when they have the ability to foster social transformation in their area of implementation.

Peter Denning wrote, in 2004, an article on innovation in software development using Tim Berners Lee and the evolvement of the Internet as an example. His definition of innovation is:

> *“The adoption of a new practice in a community. Innovation is therefore a social a social transformation in a society”*
>
> - Denning(2004)

When describing the frame of mind of the persons involved in the project, Denning states that they:

> “*…understood they were working for social change and not just inventing a new technology.*”
>
> - Denning(2004)

Both of the above quotes clearly illustrates that the point on which we differentiate between inventions and innovations is their effect on society.

The major difference in the definitions is that while the first OECD describes new *inventions*, Denning talks about *innovations*, meaning that when regarding innovations, one has to take in to consideration not only the *invention*, but also the *effect* of the invention. This is an expansion of the OECD definition and seems more usable since it disallows ambiguity and differentiates between the two concepts. Inventions are new products, methods or processes, but inventions only become innovations when they have an impact on the community and environment in which they are implemented. This way of differentiating between the concepts is supported in several articles from the software development community such as [Allen2000], [Greene2002], [Berkhout et al2004]and [Quintas1994]

The ambiguity is quite clear in the existing definitions, which reflects on the attempts that have been made to model innovation. While they are certainly interesting and well argued, they have mostly been grounded in theory and difficult to prove in practice.

In this project, the following definition of innovation will be used:

> *Innovation in software systems development can be seen, either as a new product, implementing technological improvements or the process of developing these products. The product is either an application which uses these new technologies (Innovative Software Systems Development Processes), as applications which enhance innovative thinking (Innovation- and Creativity Enhancement Tools), or as new and improved processes (Innovative Systems Development) which again lead to applications or tools supporting innovative and creative thinking (innovative tools). Furthermore, an invention only becomes an innovation when it has an impact on the society or community in which it is implemented*
>
> - Definition of innovation used in this project.

How to be innovative and how to foster innovation is a concern in many industries, but it seems harder to solve the riddle when it comes to software development. While the opinions and points of view are plenty, there is however points on which most researchers agree, namely the usability of computerized programs and systems as a tool to ease or enhance the innovative process. Since these claims are difficult to prove wrong or right due to the nature of creativity and innovation it is interesting to research how these tools work in practice and how they influence on the software development process.

This project contributes to the software development literature, not by presenting a model, recipe or cookbook on how to foster innovativeness and creativity, but by describing the work processes and methods used when utilizing the tools available. The theory is researched in [pmc06] and the empirical data consists of video material showing a group of computer science students working in an innovation enhancing environment called the Software Innovation Research Lab or SIRL. It is important to stress that while creativity and innovation is important in most other industries, the only concern in this project is the software development industry. The main research objective is of a descriptive nature, namely to describe a software development process with the participants utilizing innovation- and creativity enhancement tools.

2. Previous research

The theoretical foundation for this project is a piece of work done in the fall of 2006 and consists of a literature review of several articles on software development. This section is dedicated to a short description of that project.

The main contribution of [pmc06] was a model of the literature which was to create an overview in an otherwise quite unfocused mass of literature. This model allowed up and coming innovators to gain an insight into the concept. Research was done by making a literature review of a set of articles, all found in esteemed scientific databases by using the same set of search phrases. The articles where then subjected to the same analysis consisting of three steps; Extraction,

Categorization and Modeling. Extraction covered the extraction of main arguments from each article, which resulted in a document describing the essence of the literature collection. These extractions made it possible to categorize the articles by utilizing a concept matrix - a spreadsheet where all articles were categorized by their main area of interest. These categories then served as components in the model and the links between them were grounded in the articles.

The model consisted of a set of concepts, all derived through the analysis process. These were; Innovative Software Development Processes, Innovative Software Systems, Innovation Enhancement Tools, Creativity Enhancement Tools, Implementation and Diffusion and Social Transformation. These concepts were defined as follows:

Innovative Software Systems Development Processes:
The process of developing software regarded as innovative or entirely new development methods used in the hope that they might yield innovative software

Innovative Software Systems
Innovative software systems are systems which are adopted by a society, either big or Small, which foster transformation by simplifying certain tasks, providing new possibilities, or enlarging productivity.

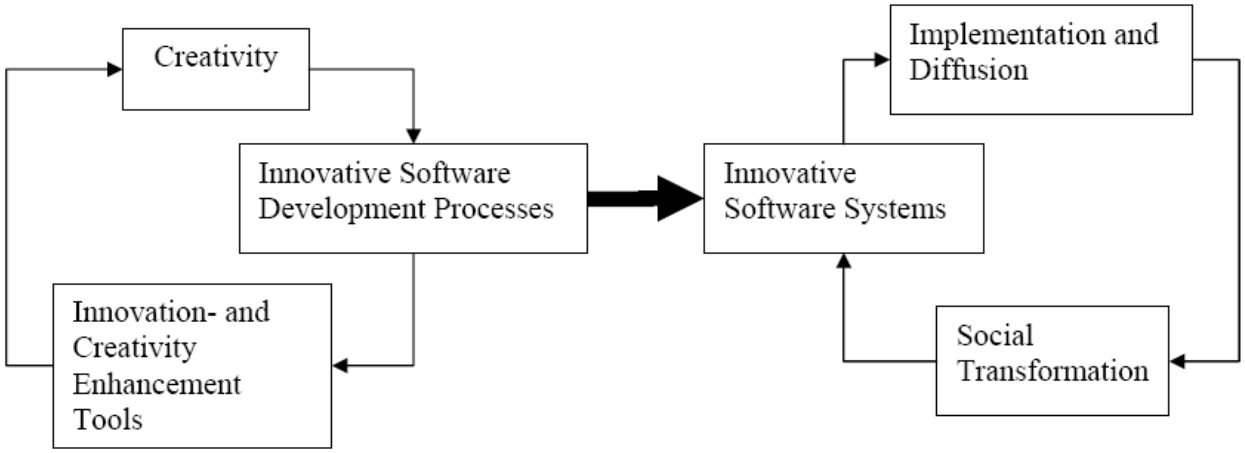
Innovation Enhancement Tools
The concept of Innovation Enhancement Tools is defined as a process, an application or a set of exercises which strives to create new and un-familiar ways of considering and solving problems.

Creativity Enhancement Tools
The concept of Creativity Enhancement Tools is defined as a process; an application or a set of exercises that, by creating new and un-familiar ways of considering and solving problems, enhances people's creative skills.

Implementation and Diffusion
The effects of implementing an invention presumed to be an innovation and the prediction of these effects.

Social Transformation
The changes occurring in a community, being either; geographic locations such as neighborhoods, cities, nations or larger parts of the world or localities spanning from a single department in an organization to an entire organization.

The research confirmed the notion of ambiguity in this area. Many researchers proposed models showing ways to be innovative, but very few provided their definition of innovation and while most researchers concluded that their research was successful, their results were seldom in agreement with other researchers. Most interesting was that although very few clearly defined the concept of innovation, a general consensus seems to exist that innovation are inventions that have an explicit effect in the environment of the implementation: innovations are inventions that foster social transformations.

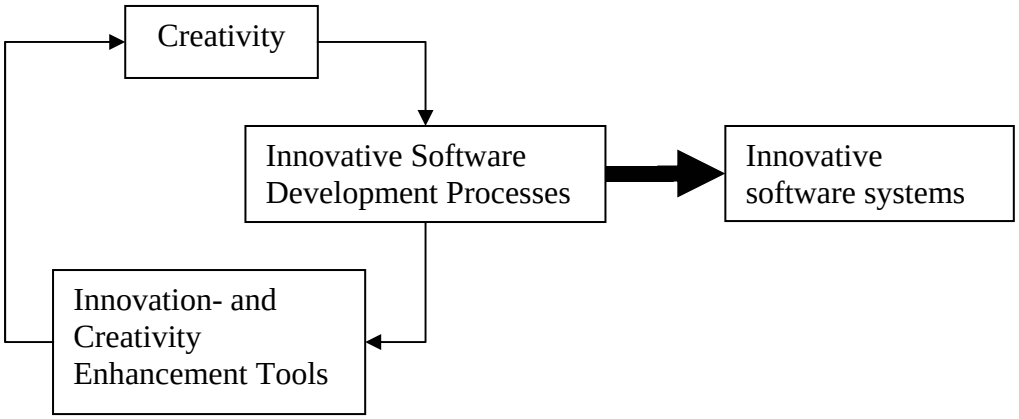


- Figure1 – Modeling the literature on innovative software development [pmc06]

The main contribution in [pmc06] is the model shown above. It shows the way the innovation in software development is reflected upon by the literature. The six different components are products of the categorization process and the links between them products of the analysis of articles. The model is not another attempt to dissect the innovative process or an attempt to describe which steps one should take in order to gain in innovative abilities. It is a reflection of the literature, a model showing how the different elements are connected.

3. Scope and purpose

The model from the previous research is extensive and covers a wide variety of subjects. It is far too big to be covered in a project this size, and especially the right side containing social transformation and implementation and diffusion are concepts which are difficult to research before the launch and distribution of an example application or system. Furthermore, with the information technology presenting the possibilities it does, the concepts of innovative software development processes and innovation- and creativity enhancement tools are the more interesting of the six. Due to the nature of the empirical data available (video-clips), the scope of the research is limited to the left-most side of the model, depicted in the figure below;



- Figure2 – Model from [pmc06] revisited

The purpose of the research in this part of the model is to describe the elements involved in Innovation- and Creativity Enhancement Tools. The foundation for these observations is the video material mentioned in the introduction. Since concepts such as innovation and creativity are difficult to measure and compare in numbers, this project will not take a stand as to whether the facilities in SIRL create an environment fostering innovation or creativity. Furthermore, no conclusions concerning enhancement of the participant's innovative and creative skills will be made due to the fact that such assessments would require intensive knowledge of the innovative and creative skills of the participants at project initiation. The purpose of this project is to test the model derived from the theory against the empirical data available, followed by a descriptive conclusion on the usage of the derived concepts and categories. Furthermore, the development process of the group is researched. The conclusion to this part of the research will purely be focused on the idea-development process since this is the process depicted in the empirical data. As a last point of interest, the concept of innovative software systems will be researched with the goal being to investigate whether the supposedly innovative software system developed by the SIRL-group (The PayWay PSA) includes the features found in the literature to characterize innovative software systems. To summarize, the research questions in this project is as follows:

1. Is the theoretical model in accordance with the empirical data from SIRL?
2. Is the idea development process at SIRL innovative?
3. Based on an analysis of the PayWay PSA, does the development process utilized by the group lead to innovative software?

It should be stressed that the research performed in this project will only be directed towards creativity- and innovation enhancement in software development, not towards other areas.

4. Method

The natural division between the development of theory and analysis of the empirical data available make it reasonable to focus on the research methods for the two parts separately. In this section, the research methods used are described.

4.1 Literature Study

The literature study is developed using the guidelines presented in [Webster&Watson]. It is divided into two parts, the extraction of the main arguments, and categorization of articles in order to develop concepts to be used when modeling. Material has been found at the established scientific article databases IEEE and ACM using combination of the search phrases; innovation, creativity and software development. Furthermore, the search has been expanded to include books and articles found in the lists of references in the existing collection of literature. From a researcher's perspective, the most interesting parts of an article, the findings and conclusions are highlighted and easy to find which simplifies the extraction process. While this is a seemingly trivial task, the extraction process is not as easy as it seems. Most researchers conclude that their work has been successful and presents their findings as major contributions to the combined literature. Their somewhat overly optimistic approach to their own findings are often good and logical in their argumentation, the quest is to read between the lines in order to find the parts that can be used in this project. The categorization process benefits from the concept matrix introduced in [Webster&Watson]. The concept matrix is a spreadsheet especially designed for this purpose. As each article is analyzed and a suitable category is found, the matrix grows in size. Each article is represented by its own row with ample possibility for recording main arguments and proposals in shorthand.

4.2 Empirical Analysis

The empirical follows along the same line of analysis as the literature with only minute modifications. The extraction process is the same, set aside that the material in this case is not written but rather video clips were the main arguments and points of interest have been collected in a single document [See app.A]. Other changes concern the categorization process. In the literature analysis, the categories came as a result of the extraction process but since the objective in this project is not to construct a model but rather test whether the model constructed in [pmc06] are true in accordance with the empirical data, these categories have been found in a different way. In this case, the categories have been found utilizing creativity techniques such as brainstorming and concept-mapping and have subsequently been organized to suite the appropriate level of abstraction.

The next step in the research process is to analyze the collection of empirical data. The analysis is based on a collection of extracts from the video clips, showing a group of fellow computer science students working in an innovation enhancing environment, utilizing innovation- and creativity enhancement tools. The clips have been analyzed over several iterations with focus on a specific category an, by this, follows the line of the literature analysis. In addition to looking for evidence supporting the categories already found, it is also interesting to search for categories not in the

original model. It should be mentioned that the language spoken on the video clips is Danish and that all quotes have been translated in order to enhance the reading experience.

4.3 Modeling

The modeling process is performed using iterative development. The base of the modeling process is the model from previous research [pmc06] which is revisited continuously through out the project. After performing the literature analysis, the model is equipped with a set of categories representing the different concepts. These are then used as a base in the analysis of the empirical data which are being reviewed multiple times, each time with a specific category in mind. After the analysis of the empirical data, the model will presumably undergo changes with regards to categories not mentioned in the theory and- or categories mentioned in the theory but not present in the empirical data. These two models serve as the foundation for the comparative and descriptive conclusion as an answer to the proposed research questions.

5. Literature Study

5.1 Innovative Software Development Processes

Innovative Software Systems Development is the art of developing software systems regarded as being innovative. The concept covers all states in the development process and includes analysis, design, concept-development, implementation and launch/diffusion. One of the key factors in the overall development process is the technological advances continuously presented by hardware vendors. These technological progresses create new possibilities for functions and features and as a result, the development speed of hardware influences on the demand for improved functionality in software. The effect of this is, that innovative software systems development depends on both the context of the product as well as innovativeness in both mind-set and technology.

When producing software products, the methods and processes used by the development team has a direct influence on the product. If the desired product should be able to utilize the newest and fastest-changing technology, it might be a good idea to develop in an iterative way that allows changes in specifications in order to better utilize these new technologies. Another example is the development of systems or applications used to enhance creative and innovative skills by forcing user to change their way of thinking, then it might be effective to use the tools considered for implementation in the actual development process. For this project, Innovative Software Development Processes are defined as follows:

> *The process of developing software regarded as innovative or entirely new development methods used in the hope that they might yield innovative software*

The importance of investing in these processes is clear in the statement in [Berkhout et al 2004];

> *"…merely investing in product development is not enough. Utilization of the atest insights in innovation processes might be a better strategy"*
>
> - Berkhout et al 2004

Since software development processes are usually heavy entities and are usually customized to suit specific organizational needs, the interesting factor in this context is the individual elements that make a large development process successful. This section describes some of the process elements characteristics in developing innovative software systems.

5.1.1 Iterative Development

One of most effective way to innovate is to organize the development process so that it is more adapt to changes in the surroundings [Quintas 1996]. A better understanding of the innovative process directly affects the outcome of the overall development process. Furthermore, innovation is not to be taken for granted, and processes and methologies should be evaluated and chosen with regards to the problem at hand [Quintas1996]. This approach is an early attempt to solve two major problems in the software development industry in the '90ies;

1. The productivity level of software development in general has increased faster than that of hardware development.
2. Poor quality and lack of innovativeness is a consequence of 1.

- Quintas 1996

In Quintas' opinion, the solution to these two problems is to create systems and methods that are better at coping with changes that arise as the development speeds along;

> "*There is need to build systems which evolve with and support the changing requirements of the organization"*
>
> - Quintas 1996

The way to evolve with and support changes is to re-iterate at a frequent rate and by this, follow the natural flow of the environment and the market.

5.1.2 Frequent delivery of small pieces of code

The transition from developing large and complex systems in one go and instead developing small pieces of codes what can be customized to serve multiple functionalities as a way of creating innovative software is described in [Quintas 1996];

> "*The substitution of generic products or packages for custom development"*
>
> - Quintas 1996

This notion fits the general idea that, in order to generate and develop innovative software system, the strategy should be to develop small pieces of working code. By doing this, the development team is constantly ready to converge to any changes in their developing environment or the technical specifications of the product being developed.

5.2 Innovative Software Systems

The product of the Innovative Software Systems Development process is Innovative Software Development. These are software systems which either take advantage of new technological landmarks such as improved platforms or improved performance of processors, or systems that guides users towards a more creative or innovative mind-set. The optimal effect of this process is to create a loop where the product helps improve the development process which, in turn, helps create even more innovative software systems. It is obvious that these systems are not systems one encounters on an every-day basis. According to the definition of innovation, Innovative Software Systems are those systems that become so widely used that they can be said to foster some sort of

social transformation. The term “social transformation” is however quite powerful. It covers every environment ranging from intercontinental communities to small departments in an organization. This could prove to be a way of categorizing and evaluation innovations, but since this is not covered in the scope of this report it will not be discussed further. Instead, the focus will be on characteristics of Innovative Software Systems, following the line of the following definition:

> *Innovative software systems are systems which are adopted by a society, either big or small and which fosters transformations either by simplifying certain tasks, providing new possibilities or enlarging productivity.*

5.2.1 Work Process Improvement

One way for software systems to change the environment of the implementation is for example to change work style processes of its users. Software systems provide possibilities for easier training and increased versatility of employees as well as increased possibilities for dissemination of results. By changing these, relatively small, elements in the everyday life of employees, it is possible to evaluate recent and develop future work style processes. This is especially apparent in the case of e.g. mobile applications where employees are able to take their work with them, and in some cases this is a major factor in their productivity.

5.2.2 Effectivisation

Another way of imposing social transformation is by giving people the option to do the same job more effectively. Just like in the case of abacus’ or pocket calculators that allows advanced mathematical expressions to be evaluated in almost no time. Furthermore, applications such as text-editors allow the construction of longer and more elaborately designed documents than a pencil and a notepad. This is of course in the interest of employers to whom an effective organization is quite important, but the increase in productivity can also have an effect on the employees. As they increase their own productivity they are more likely to feel that they make a difference which in turn has the effect of creating an air of satisfaction and happiness.[Stimulating Creativity]

5.2.3 Entertainment Value

Besides changing the work style processes and solving the same tasks more effectively, software systems have the ability to enlarge the entertainment value in a given task. This is often done by implementing interesting designs and user interfaces. Although design obviously plays a relatively big part in providing entertainment, the mere fact that solving a given task includes working with new technology has an effect on most people.

5.2.4 Value Addition

Innovative software systems often have the tendency to present its user with features they did not expect and in addition, the applications and systems are often used in areas that surprise even the developers.

5.3 Innovation- and Creativity Enhancement Tools

The definitions proposed so far implies that innovative and creative skills are something which needs to be honed continuously in order for it to prosper and evolve. This section defines the concept of Innovation- and Creativity enhancement tools, and places it in the broader scope of the project.

As soon as the importance of both creativity and innovation in the software development has been recognized by both developers and decision makers, the next step is to research and create a set of tools to help evolve the participant's creative and innovative skills. The word tools covers, in this case, both the development of processes and applications that helps reach this goal. Of course, one of the goals when developing these tools, is to create new processes and application, but the overall criteria for success, is the development of tools that, when used, challenges the worldviews and mind-sets of the users. These should be forced to abandon a stringent set of thought and by this, create and foster new way of considering and solving problems.

Innovation- and Creativity Enhancement Tools are, in this case, software systems which facilitates different functionalities helping the user to explore his/hers creative and innovative abilities. These tools should be available to developers, managers etc. and should include possibilities for brainstorming, lateral thinking, Creative Problem Solving etc. The definition of Innovation- and Creativity Enhancement Tools is proposed below:

> *The concept of Innovation- and Creativity Enhancement Tools is defined as a process, an application or a set of exercises which strives to create new and un-familiar ways of considering and solving problems.*

Innovation- and creativity enhancement tools can be divided roughly into two categories. One is of course concerned with the technical aspects of innovation and creativity enhancement such as features which should be supported by software systems. The other category is somewhat fuzzier as it concerns tools and techniques used when searching for creative and innovative skills within one self.

5.3.1 New thinking

One of the biggest reasons for innovation and creativity to emerge is that people are successful en breaking their conventional thought patterns. This means that in order for users of innovation- and creativity enhancement tools to actually become more creative, these tools need to force the users think in different ways. One of these techniques is called Interrogatories Technique or 5Ws/H. The idea is that exploring the problem from multiple angles might result in new ideas or new and interesting ways of solving existing problems. The foundation for this technique is to ask a series of questions regarding the project/problem at hand and subsequently answering the same questions. These questions are; What?, Why?, When?, Where?, Who? and How?. The theory is, that by using questions based on these six words it is possible to go through a set of cycles where the questions are constantly revised to fit the new cycle. By doing this, the problem or opportunity is explored exhaustively.

5.3.2 Support of features

In the theory of innovation- and creativity enhancement tools, several attempts has been made to find the right combination of functions and features to be implemented in a software systems usable when training innovation and creativity. These features are a natural expansion of the theories considering creativity and several studies on their effects have been made. One of these studies was performed by Sharon Greene in 2002 in which she describes two different innovation- and creativity enhancing systems implemented on two separate occasions [Greene 2002]. The two systems, the EXPO ’92 Guest Services System and Explore Modern Art, have both been implemented and their used evaluated based on statements provided by users. The EXPO ’92 system was implemented at the EXPO ’92 in Seville and allowed a total of over 15 million people to explore the fair using a multitude of touch-screens utilizing the possibilities to view information on the different stands, but more importantly to create multimedia messages containing pictures taken by the visitors themselves as well as finger paintings created by the visitors using the touch screens. The other system, Explore Modern Art, was implemented at the Museum of Modern Art, urging visitors to explore the museum in untraditional ways, looking at digital representations where it is possible to enhance different parts to look closely at details and solve several different exercises concerning different artistic periods. The combined efforts from both projects resulted in a list of functionalities considered to enhance innovativeness and creativity in the users;

- Support pain-free exploration and experimentation (sandbox-mode)
- Support engagement with content to promote active learning and discovery
- Support search, retrieval and classification
- Support collaboration
- Support iteration
- Support and perhaps encourage instructive mistakes
- Support the domain-specific actions that must be done

While these features, according to Greene, has been observed to enhance the creative process of the users, they are unable to conclude that these are an absolute set of needed features, and furthermore, it can not be concluded that any of these features are indeed needed in the innovative and creative processes observed.

In two other articles written by Ben Shneiderman, there is an enlarged focus on sharing of results and knowledge. The theory is that searching for inspiration in the results and research of other scientist’s results in enhanced creativity [Shneiderman 2000] and [Shneiderman 2002]. Furthermore, Shneiderman proposes eight tasks or features to support creativity;

- Searching and browsing digital libraries, the Web and other resources
    - Searching is becoming increasingly important when developing new software tools. More and more applications include new and more effective search options that allow the search for information to take place in increasingly specific areas.

- Visualizing data and processes to understand and discover relationships
    - Visualization of processes and products is often an extremely useful tool when considering different options and it helps keeping focus on tasks already started.

- Consulting with peers and mentors for intellectual and emotional support
    - Consultation is important in several ways. It allows the sharing of ideas at en early stage and opens up possibilities for feedback in all aspects of the development process.

- Thinking by free association to make new combination of ideas
    - Thinking in different ways and out side the box is what makes the creative wheels go round. When the problem at hand has been identified, different tools can be utilized to find solutions otherwise located beyond the normal thought patterns of the members of the group. One of the most common techniques is thinking by free association, otherwise known as brainstorming. Another well-used practice is lateral thinking which is covered in another section of this report.

- Exploring solutions using what-if tools and simulation models
    - Creative exploration of different solutions and scenarios is another important task. Simulations can be utilized to explore the effects of decisions and thus explore several scenarios before making choices or taking decisions. One of the most used examples of such an application is an ordinary spreadsheet. They can be utilized especially when planning budgets etc. and every decision made is instantaneously shown on-screen. Other examples of simulations are collision of starts, growths of forests and world economics. The important thing is, that it is absolutely safe to run simulations since there aren't any direct impacts on the project as a whole until decisions are being made.

- Composing artifacts and performances step by step
    - The most common composition tool is of course the basic text editor used for creating documents, letters and reports such as this. Other composition tools include graphics composition tools or photo editing applications that, together with a digital camera, allows users to take, edit and publish snapshots. Even slideshow editors such as Powerpoint are being used by schoolchildren in the lowest grades of public schools.

- Reviewing and replaying session histories to support reflection
    - Another powerful but so far not very widely used tool is a review and history options. Other than being able to "roll back" to previous stages in the development process, users could benefit from being able to send development histories and log-files to peers with the thought of feedback in mind. Furthermore, the history feature should be expanded to include options for saving frequent patterns of use as well as replaying specific parts of their history-library.

- Disseminating results to gain recognition and add to searchable resources
    - When the finished product is of a satisfying standard, the next logical step is of course to share it with the rest of the world/research community. However, were the most used method of dissemination is

simply by turning in the results to customers or review boards, it might be more effective if users where able to filter e.g. email addresses from everyone who might have helped out during the development process. This has the advantage that instead of sending results to everyone, it would be possible to send only to those that actually find the work interesting. Another and somewhat more ambitious idea would be to send electronic acknowledges to people who has proven to follow similar paths of research, for example other users who visits the same web sites in their hunt for knowledge.

5.4 Creativity

When regarding the definition of innovation presented in [introduction], it is clear that an element in the innovative process is the creation and development of new ideas. This means that creativity is an undeniable part of the innovative process, and during the last decades, researchers have been devoting increasing efforts to understanding the elements of the creative process [Piirto2004]. Creativity and innovativeness have strong natural links, and this section is dedicated to describing the key elements in creativity, different types of creativity theories as well as different creativity blocks.

5.4.1 Research Types

The existing theories on creativity are divided into two categories, implicit or explicit [Runco et al.]. Implicit theories are generally based upon a conceptual understanding of the problem and are generally based on empirical data. In contrast, explicit theories are based on “hard” theoretical evidence that is, based on the knowledge and research on the functionalities of the human mind and are often constructed with the creation of a certain hypothesis in mind. Both branches of the theory are important. Explicit theories produce, as mentioned, hypotheses and implicit theories serves as a construct on which the results of explicit theories can be evaluated; one could say that implicit theories are the framework used when evaluating explicit theories.

5.4.2 Styles

As it is often the case in many other aspects of personal traits, creative abilities differ from person to person, not only in the way that some people are more creative than others, but also in the *way* people are creative. These various styles of creativity are comprised of visioning, experimental, exploring and modifying [Couger96]. It is important to note that most people have the ability to asses a given problem from all four perspectives, and that the tendency to utilize a single style more than the other is a product of preferences and not a lack of abilities.

Visioning Style Creativity

People with a tendency towards the visioning style of creativity tend to concern themselves with the bigger picture. When faced with a problem they rely on their imagination to help them envision the ideal solution and the use their ability to vision the future to maximize the output of their efforts.

Furthermore, they are hardworking, determined and persisting visionaries who set goals for themselves and strive to fulfill them at all costs.

Experimental Style Creativity
Persons who prefer an experimental approach to problem solving are fact finders. They start their process by gathering as much information and as many facts as possible. They prefer to have looked at a problem from every possible angle before making a decision. They seek to find their solutions by utilizing well-established research methods as well as trial-and-error by combining different elements and analyzing the results in retrospective.

Exploring Style Creativity
As it were the case with experimentalists, explorers also start by gathering as much information as possible in the hope that this will help them see possible solutions which they had not otherwise thought of. Initial goals are non-existing and their work processes are adventurous. Furthermore, they like to be challenged and have a hard time accepting routines.

5.4.3 Blocks

As important as it is to distinguish between different types of creativity and realize that these can be used for enhancing creativity, it is equally important to acknowledge that the removal of elements blocking the creative process, in itself can be considered an enhancement of one's creative skills. These blocks are not necessarily due to lack of intellectual skills, but could also exist based on emotional, cultural or environmental differences. Furthermore, they most likely vary in both intensity and number from person to person. The reason that these blocks are important is that only after realizing the existence of blocks is it possible to begin working around them or breaking them down. The most common blocks are [Couger96];

- Emotional blocks
- Cultural blocks
- Environmental blocks
- Intellectual blocks
- Perceptual blocks

Emotional Blocks
Emotional blocks arise when circumstances create poor opportunities for communicating ideas to others. Some of the reasons for this situation arising are fear of failure or risk-taking, or the inability to accept ambiguity. One of the more important blocks is the tendency to discard ideas at an early stage. New ideas need the time to evolve in order to show potential and even more importantly, they might lead to other ideas. These are not the only things that might create an emotional block. The tendency to force the development in order to present the results quicker might lead to some ideas being discarded prematurely and furthermore, the lack of ability to change mind-sets and the presumption that one is not a creative person is also a serious candidate for creating emotional blocks. In general, the best way to deal with these blocks is to accept that new ideas may come at all possible times and that creativity thrives best in a flexible environment.

Cultural Blocks
Cultural blocks are highly influenced by both the cultural background and the environment surrounding the place of work. What might be considered a taboo in one culture might not be

considered to be so in another, and the tendency to prototype other cultures as behaving in a certain way is strong in most people. Other cultural blocks could be to live and work in a society that considers playfulness and imagination as a waste of time, or that any scientific problem can be solved with enough time and money. If one has to demolish these cultural blocks, diversity has to be present and one has to accept other cultures for the positive elements. Another type of cultural blocks is those that state that well-proven and recognized methods are the only ones that work. A big part of being creative is to be able to wrap ones mind around problems from different angles, and it is especially important to recognize that the known and secure methods are not always the best. In addition, being afraid to ask critical questions under the assumption that all others already know the answer and hence ridicule one self is a major creative block. This means that the work space environment is of utmost importance when facilitating creativity which links cultural and environmental blocks, the latter is described in the next paragraph.

Environmental Blocks

When the social or corporate surroundings impose changes that create boundaries on the creative limits of human beings, they act like environmental blocks. These environmental blocks are especially obvious in the case of deadlines or cut-backs demanded from decision makers in an organization. Other scenarios include lack of trust from colleagues and support when presenting new ideas. In addition, bosses who notoriously deny usability in ideas not presented by them, fail to reward people who make an extra effort or punish risk-taking that does not work out are all good examples of environmental blocks.

Intellectual Blocks

Intellectual blocks do not, as the name might suggest, evolve as a product of stupidity or lack of intelligence. Instead, they are the product of a too rigid mind-set, and a lack of ability to break habits as well as a strong tendency to use methods and tools that worked in previous projects. This single track mentality limits the process of identifying other choices, mental tactics and alternative solutions and hence limits the creative process considerably. Another course for intellectual blocks is too much reliance on logical thinking, much likely due to the predicate of unseriousness concerning extended use of imagination (see Cultural Blocks). This leads to a fear of exploring the unknown, an area where the imagination is the driving force, which again sets boundaries regarding creativity.

5.5 Conclusion

It is important to acknowledge that four types of creativity exist, and utilizing them to look at a problem from a different point of view is an exercise which by it self could prove to be creativity-enhancing. On the same note, while utilizing creativity types can be an enhancing experience, negligence of these types or even failure to admit that they exist can act as a barrier to the possible development of new ideas. This means that one has to consider and evaluate the different types, and more importantly, figure out which type one prefers. Furthermore, if working in a group, you should realize that your colleagues may be of different types and which type they are which has the effect of priming the group to meet its full potential.

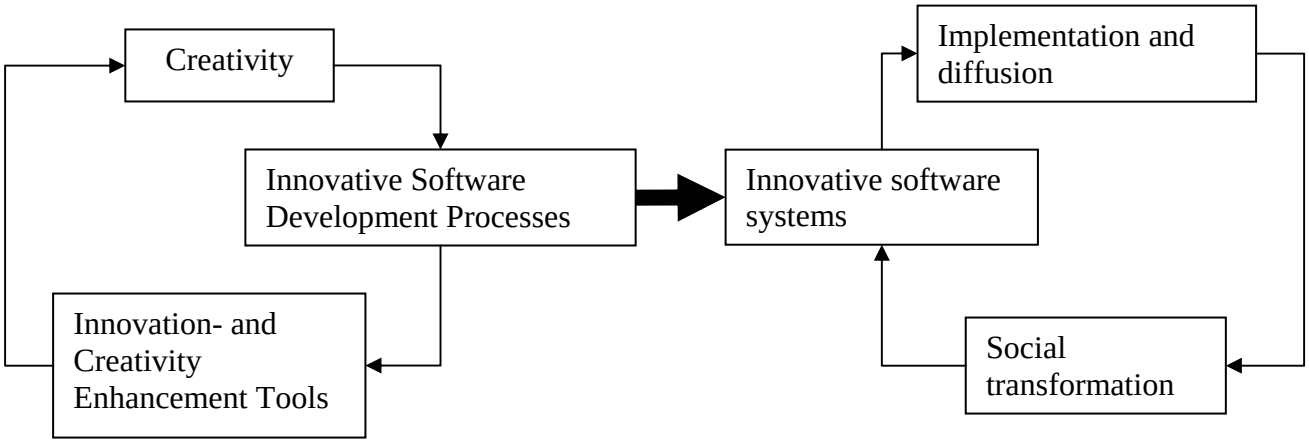
Factors, circumstances and other things blocking creativity are as important to acknowledge as the different creativity types. Creativity blocks hinders processes which otherwise could create new ideas and different solution which might work even better. In order to effectively work around these blocks and perhaps even start breaking them down, it is important to acknowledge their existence. The blocks show that in all aspects of battling things blocking creativity, it is important to embrace other mind sets and try to be flexible when making selections regarding both research and work methods.

6. Model Development

Since the purpose of this project is to investigate whether the model produced in [pmc06] is in convergence with a development project in real life, it is fitting to dedicate a section to the description and development of said model. Furthermore, this section presents the development of the model to be used further in this project when exploring whether the theory and empirical data gathered on innovation in software development is in co-ordinance.

6.1 Modeling the literature

The model from [pmc06] is a product of a literature analysis. It is not an attempt to create a causal model of innovation, it is not a recipe or cookbook which one can use to be more innovative, it is a model showing how different concepts are connected in the literature and hence, its overall purpose is to create an overview of the literature on innovation software development. The figure is shown below;

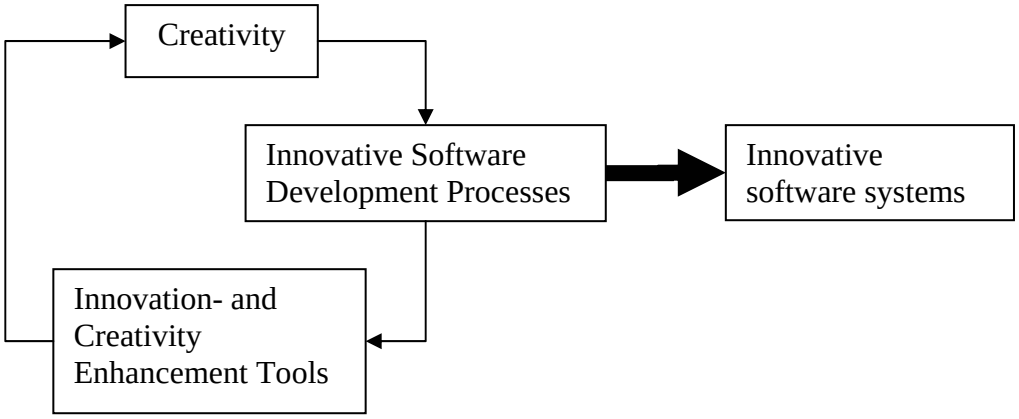


- Figure 3 – Modeling innovation in software development [pmc06]

As it can be seen on the figure, the literature is largely comprised by to different groups. One, the left side, is concerned with the conceptual difficulties in defining creativity, constructing new and improved development processes (or describing well known processes), and describing and creating theories and tools supposed to enhance creative and innovative skills. The right side of the model concerns characteristics of software concerned to be innovative as well as implementational and diffusional difficulties and theories concerning this type of software. Furthermore, the model shows the link between implementation and diffusion and the effect of innovative software systems, social transformation. Furthermore, is has been made clear that the left- and right-hand side of the model is strongly connected by the enlarged arrow. It should be stressed that the links in figure 3 do not constitute causal relationship between concepts, but rather that one concept is, by way of the literature, connected to other parts of the literature.

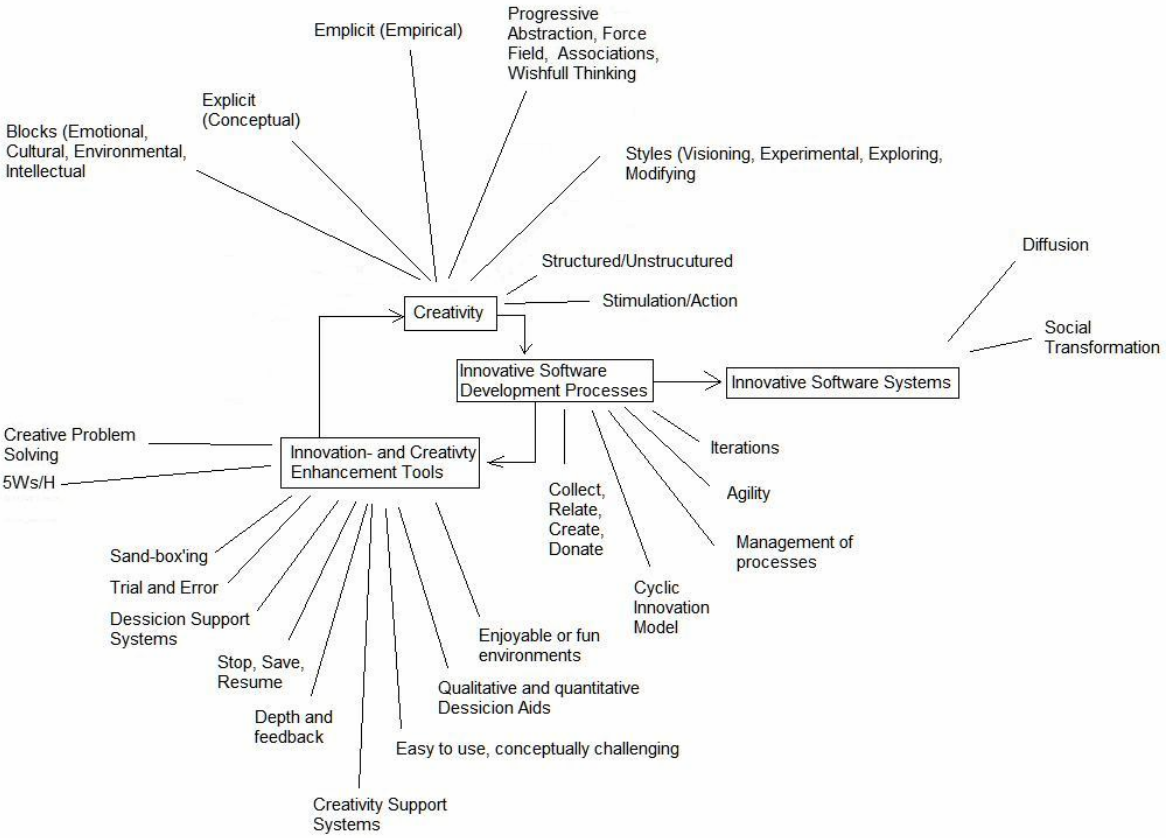
6.2 Theoretical model – Revisited

It is prudent to acknowledge that some of the concepts mentioned in the literature can only be studied in hindsight. The concepts of "Implementation and Diffusion" can only be studied when the development process has been concluded and the software has already been launched, and the concept of "Social Transformation" is difficult to study before the software has been on the market for some time. Since the empirical data [See chapter 8] does not support the investigation of these two concepts, the model which is to be used in the investigation of empirical data is changed as shown below [For further reading on the scope of the project see chapter 3];



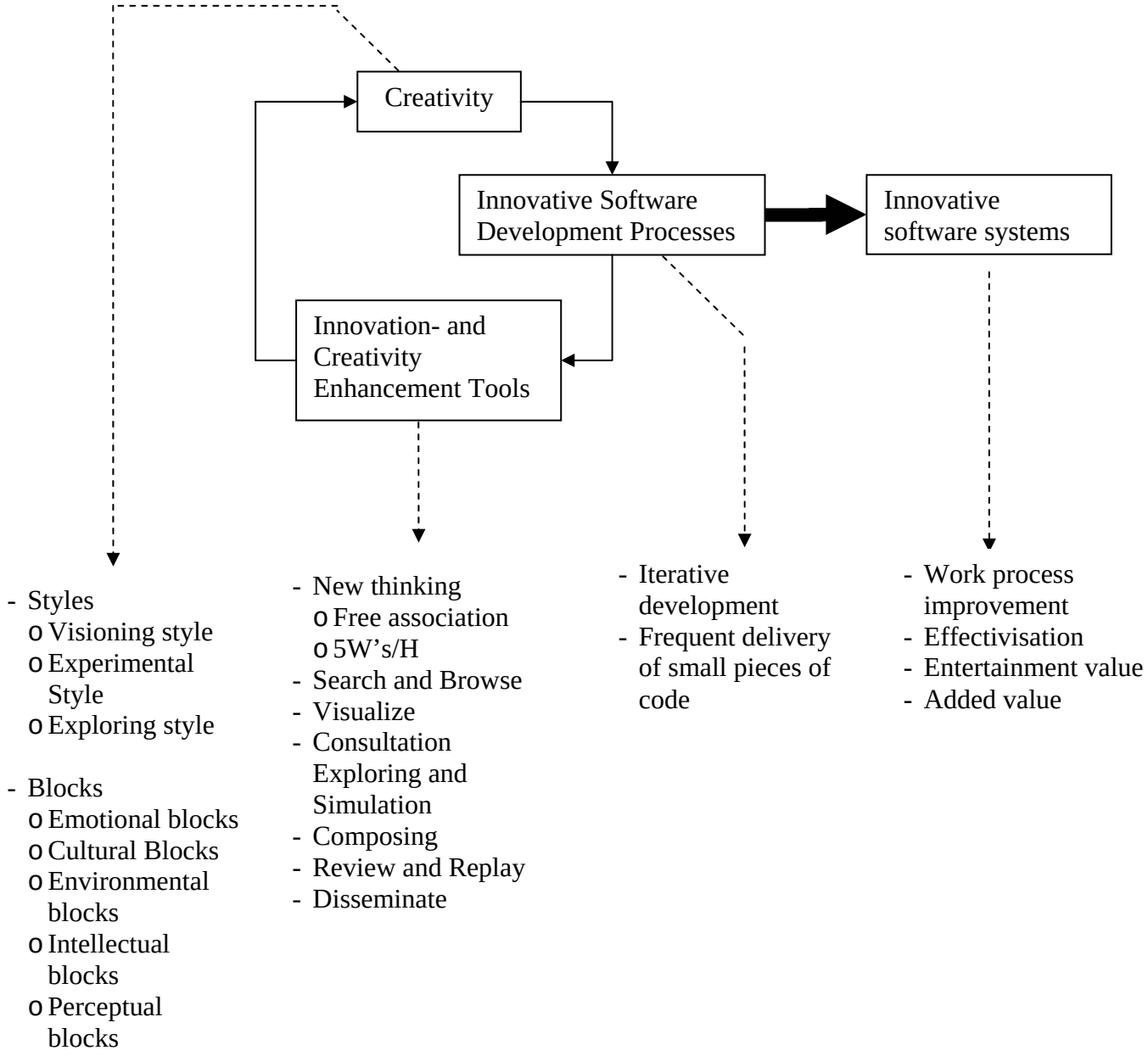
- Figure 4 – Edited model

In order to develop a model which can be held against the empirical data for further investigation, the next step is to design a preliminary model on which the categories on which the theoretical and empirical comparison process is to be performed is added. These categories are the product of both the expanded literature analysis [see chapter 6] which has been performed after creating the concept-map shown below. The concept-map is furthermore the product of an analysis performed after reading the collection of literature;



- Figure 5 – Analysis of categories for investigation.

Since these products of the brainstorming session presents a challenge as to the level of abstraction with regards to the further investigation, they have been combined into more descriptive categories. These categories are furthermore a product of the literature analysis [See chapter 6]. The model with attached categories is shown in figure 6;



- Figure 6 – Theoretical model with categories

The categories shown in figure 6 are, as mentioned, a product of analyzing the literature, and their purpose is to be used in the empirical analysis of software development in action.

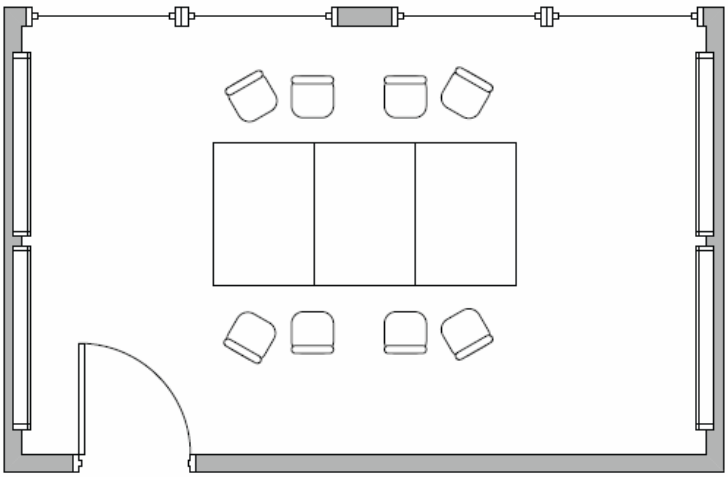
7. Describing the empirical data

Since the empirical data used in this project is of a somewhat complex nature, this chapter is dedicated to the description of the different elements comprised in the Software Innovation Research Lab (SIRL) and the different elements in the Essence framework for software development. Since the SIRL-project is quite new it has naturally received little attention and thus the existing descriptions of both SIRL and the framework are quite limited. For this particular reason, the following description is based on information in the project report published by project group d513a in the fall of 2006 [SIRL-report].

7.1 SIRL

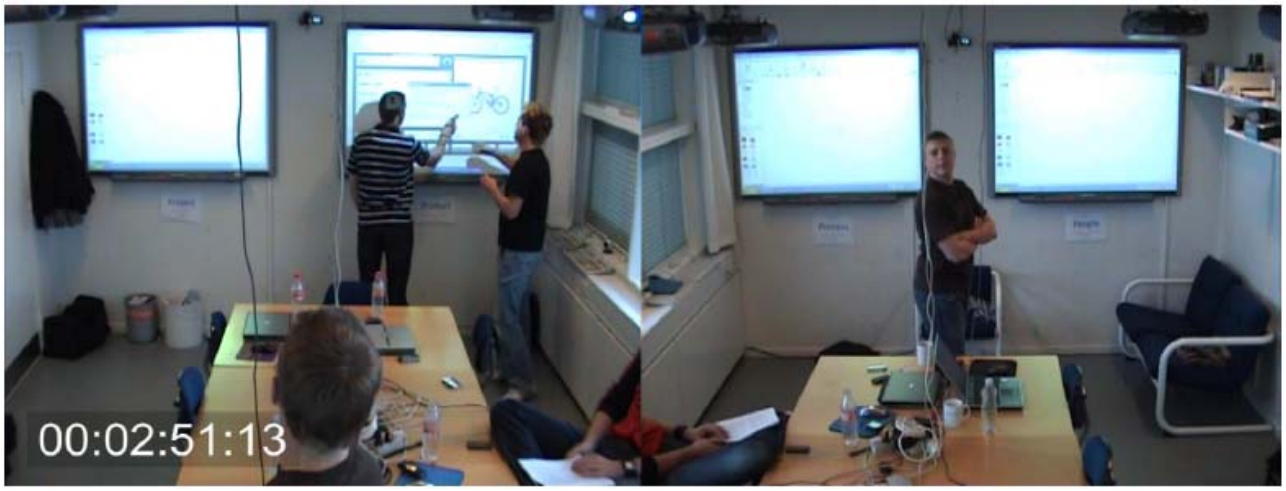
The Software Innovation Research Lab (SIRL) is a product of research conducted by the Information Systems group at the Department of Computer Science at Aalborg University. It has been developed in an effort to create an environment in which research innovation in software development and to train or educate users in innovation in software development. The background for the project is a suspicion of the founders that the future of the IT industry in countries like Denmark relies on the ability to innovate. In the attempt to foster creativity in a general fashion, many organizations today attempt to launch innovation labs by them selves, but SIRL is presumably the first of its kind, developed solely for the purpose of researching in innovation in software development.

SIRL is a standard 22m2 university group room, designed as shown on fig 7. There are three accessible walls and one wall consisting of windows, allowing for a light and inspiring work environment. All furniture is movable in order to provide different setups for different situations and all excess furniture has been removed. Furthermore, mobility is secured by providing power- and network cables from the ceiling and by hiding stationary computer equipment in window panes. The heart of SIRL is the four flat-screens placed in two's on both end walls, called SMART boards. These provides the same possibilities as conventional black- or white boards as they are touch-sensitive, but at the same time they implement software supporting drawing- and text recognition (OCR) –features.



- Figure 7 – Layout of SIRL [SIRL-report 2006]

Furthermore, in order to conduct experiments and review the work progress in SIRL, two video cameras has been places on both end walls, allowing video recordings of all four SMART boards as well as conversations conducted in the lab. A screenshot of the layout of the video recordings is shown in fig. 8



- Figure 8 – A video clip screen shot [SIRL-report 2006]

7.2 The Essence framework

Essence is a framework drafted by Ivan Aaen at Aalborg University and utilizing the layout of SIRL. It consists of three different modes; Idea, Planning and Growing, each mode in turn consisting of four different views; Product, Process, Project and People. Furthermore, when working in Essence, three roles need to be filled, each posing different obligations to its performers. Since the goal of this project is not to asses or evaluate the usability and/or innovative features of Essence the following description of the framework is kept short on purpose.

7.2.1 Modes

Essence is, as mentioned, comprised of three different modes, each considered as being the part of any software development process. The first mode is the Idea mode in which new ideas are being developed. In addition, Idea mode can be used to improve on existing ideas or proposing new courses of action. In Planning mode, the processes performed ideally lead to a plan about what to do an in which order. Furthermore, in this mode tasks and time schedules are developed. The last mode is the Growing mode. This is where the work on the tasks from the Planning mode are performed, tasks that generally implies coding and implementation. The tasks are ideas from the Idea mode which has been organized and fine tuned in Planning mode. It is recommended that focus at this point is on tests and frequent builds.

7.2.2 Views

The four different views in Essence each represent the current project from a different angle which, combined with the three modes, provides a powerful tool in the development process. Each view is independent of the three others which allow the development team to switch between them at will. The Product view represents the current project situation from the developing team’s perspective, thus in this view, the focus is on what is technologically possible, and not on what the customer wants. The second view, the Process view, focuses on the different ongoing activities in the overall development process, identifying possible development pitfalls and the procedures necessary to avoid them. The Project view creates an overview of the development process, providing a status on

the ongoing tasks and the resources available. The last view, the People view, represents the project as seen through the eyes of the end-user, visualizing the end product with the features that made to the requirement specification.

7.2.3 Roles

When working with the Essence framework, three roles need to be filled. These are Challenger, Responder and Anchor respectively. The role of the Challenger is be the driving force behind specifying requirements to the end products and is preferably filled by one or more representatives from the customer. The Responder is typically one or more members of the developing team, responsible for meeting the requirements of the Challenger, proposing time estimates and furthermore, since the Responder typically has a more advanced insight in the technological possibilities, to relate the possible solutions to the Challenger. The last role, the Anchor is responsible for keeping the discussion on track and to maintain focus for the participants. Furthermore, it is the Anchor's responsibility to issue breaks in case of deadlocks as well as to ensure that every participant is heard.

7.2.4 The Essence matrix

The Essence matrix is a representation of the information in the paragraphs above. Is shows the different modes and views, allowing users to look up keywords to each of the views and modes. It is depicted in table 1.

	Product	Process	Project	People
Idea	The overall architecture – packages, classes, etc.	Heuristics. Strategies for use-scenario development.	Scoping iterations. Ideas for acceptance testing and for later versions.	Product visualization through personal lenses.
Planning	Task planning.	Suggesting organizational patterns.	Incremental planning. Estimation and tracking.	Project stakeholders. Communication.
Growing	Source code, automatic testing, builds.	Suggesting design patterns, test patterns, and similar.	Project status, progress, estimation accuracy, and speed.	Visualizing the product. User stories. Acceptance testing.

- Table 1 – The Essence matrix [SIRL-report 2006]

7.3 The PayWay Personal Shopping Assistant

The PayWay Personal Shopping Assistant (PSA) is a project developed by the same group that wrote the report on SIRL [SIRL-report 2006]. It is a product which is developed for use in supermarkets in order to present customers with a set of features that should heighten the shopping experience, as well as providing enhanced possibilities for the supermarkets to present personalized commercials. It consists of touch screen display mounted on shopping carts. This touch screen combined with location detection and automatic detection of the contents of the shopping cart provides the supermarket with the opportunity to advice the customers of special offers in their vicinity as well as providing commercials based on their shopping habits. The advantage for users is that they become able to create shopping lists at home, and uploading them to the PayWay PSA makes the shopping experience digital. Furthermore, these shopping lists, combined with the automatic detection of shopping cart contents allows for cross references in order to present the user (shopper) with suggestions for recipes.

7.4 SIRL Experiments and video clips

The empirical data gathered from the utilities described above is a combination of video clips showing four different experiments as well as a document describing the results of said experiments.

7.4.1 Experiment 1 – Brainstorm

In experiment one the focus is on brainstorming possible features for the PayWay PSA. The experiment takes place in Idea mode in Essence and the purpose is to investigate which functionalities are necessary when conducting a brainstorm in SIRL. During the experiment the group works in People and Product view respectively.

7.4.2 Experiment 2 – Developing a business plan

Experiment two takes place in Project mode where the focus is on investigating whether the SMART boards are usable in developing the business potential in the PayWay PSA. The session takes place in Project view, but with no specific mode in mind.

7.4.3 Experiment 3 – Categorizing brainstorm results

The third experiment is a second iteration of experiment number one. The purpose is to categorize and filter the results from the first brainstorm session and to identify the functionalities needed for this process in SIRL. The experiment utilizes all four views and takes place in Idea mode.

7.4.4 Experiment 4 – Utilizing W5H2

The purpose of the fourth and last experiment is to test the usability of the W5H2 framework in SIRL. The process takes place in Process view and Idea mode and seeks to answer the seven questions in W5H2.

8. Analyzing the SIRL experiments

In this section, an analysis of the gathered empirical data is presented. Since the empirical data provides the possibility to perform the research from two different angles, the analysis is organized as follows. The analysis follows the lines of the model and is divided into four concepts and their responding categories. Three of these concepts are analyzed with respect to the SIRL-environment and tools, these are; Innovative Software Development Processes, Creativity and Innovation- and Creativity Enhancement Tools. The last category, Innovative Software Systems, is analyzed with respect to the software system developed by the group of computer science students depicted in the clips, called the PayWay PSA. This is done in an attempt to resolve whether the PayWay system contains some of the characteristics associated with an innovation and thus, if it has the potential to become an innovation after its implementation and diffusion period.

8.1 Innovative Software Development Processes

The first concept to be investigated is Innovative Software Development Processes. The analysis has been conducted with regards to the different key elements in the process utilized by the project group. While these elements might be part of a larger development methodology, there is no evidence of this and thus, the analysis is limited to elements that can be proven by analyzing the empirical data.

8.1.1 Iterative Development

There is no doubt that multiple iterations of different elements in the project play an important part in the development process. This is evident even in the organization of the video clips. Clip number one covers a brainstorming session of concepts developed in previous semesters, clip number two is yet an iteration cycle where the business aspects of the project are investigated, clip number three is a categorization session where the ideas from both the brainstorm- and business case sessions are organized and clip number four is the three previous sessions exposed to a creativity theory called W5H2.

The organization of video clips is not the only evidence of the existence of iterative cycles within the development process. In clip number three at 00:00:19, a member of the group states that:

> "We're changing focus a bit since we've found out that we do a lot of categorizing on the fly"
>
> - 3 – 00:00:19

This statement illustrates that the project is taking a turn due to observations done in previous iterations. This line of thinking is also evident in the following quote;

> "That wasn't the initial idea, the initial idea was to by our own (RFID-tags red.)"
>
> - 3 – 00:02:40

While the two quotes above both indicate the presence of iterations in the process, the evidence becomes much harder in clip number three at 00:11:38 where a member of the group says:

> "Last time, in the first iteration, one of the big tasks was to…"
>
> - 3 – 00:11:38

In this quote, the existence of iterations is quite clear, as it is the case in clip number four at 00:10:22 where a group member suggests;

> "Couldn't this point also include something about our amount of iterations? How we want the roll-out (of the product red.)"
>
> - 4 – 00:10:22

It is clear that iterations are a factor in the development process. Along side the organization of the video clips there is both indirect and direct evidence of their existence.

8.1.2 Frequent delivery of small pieces of code

As mentioned in the literature analysis, the frequent delivery of small working pieces of code combined with an iterative development process might be a good way of embracing changes in environments and requirements. While the use of this element is hard to prove due to the lack of programming in the video clips, it is possible to find indications of this concept in the empirical data. The idea is mentioned in clip number four at 00:18:43 where a member of the group suggests that:

> "What we might want to do is to split it (the product red.) up into small mini programs"
>
> - 4- 00:18:43

While the quote above is not evidence of this being the practice *per se*, it still goes to show that it is among the considerations of the project development group.

8.2 Innovation- and Creativity Enhancement Tools

The next concept to be analyzed is Innovation- and Creativity Enhancement Tools. This is a set of tools, either mental or software based that, when utilized enhance the innovative and creative skills of the users. The focus in this part of the analysis is on the software tools utilized by the group in the development process.

8.2.1 New Thinking

Thinking by free association or brainstorming is used in multiple examples. The first of these examples is actually the whole of video clip #1. The clip is showing an entire brainstorming session lasting an hour. During the session multiple ideas were suggested and the touch screens and the underlying software heavily supports this process by allowing fast note-taking and better overview during the process. The use of brainstorming in the process is also evident in clip no. four where a completely new idea is suggested after the visualization of a business plan. While discussing which features to be implemented in PayWay, a member of the group suggests:

> "..it could be selling insurance"
>
> - 4 – 00:04:30

This is brand new idea and is suggested in the context of a business plan, but even though it's not a direct product of a brainstorm session, it is still a product of free association thinking and thus shows that support of free association thinking is an important element in a set of innovation- and creativity enhancement tools.

Another way of the group fostering new ideas is found in their use of the W5H2-framework. This creativity enhancing technique is used extensively in the development process. In video clip number four, the focus is on using this technique to create new ideas for the project. The technique used in this clip is a variant of the 5W's/H described in the literature analysis, called W5H2, named so due to its seven elements instead of six, the extra element being an extra question of "how?". Below is the list of questions used by the group as well as timestamps for their appearance in the video clips;

- "What is the application providing?"
  - 4 – 00:00:40
- "Why is there a need for this application?"
  - 4 – 00:06:29
- "When is the application intended for use?"
  - 4 – 00:09:56
- "Where is the application going to be used?"
  - 4 – 00:11:18
- "Who are the intended users?"
  - 4 – 00:19:18
- "How much is economically required for creating a successful business case?"
  - 4 – 00:23:38
- "How is the application technologically being realized?"
  - 4 – 00:25:50

These questions are all answered by the group and organized into a diagram. During the process of answering the questions, there seemed to be a bit of disagreement as to the effect of using this tool to create new ideas. At 00:17:35 in clip number four, a member of the group claims that;

> "This is really just another way of categorizing"
>
> - 4 – 00:17:35

Asked to elaborate on this point, the member of the group replies;

> "So far we haven't found any new ideas!"
>
> - 4 – 00:17:37

However, another group member argues that;

> "A minute ago we where talking about the cookbook (a feature in the PayWay PSA red.) and that it should be accessible from home"
>
> - 4 – 00:17:50

This statement is clearly made with the intention of mentioning a new idea generated by using the creativity technique and it receives backup from the rest of the group, including the member who previously criticized the concept. Another example of this tool helping to generate new ideas

becomes evident in clip number four at 00:21:18 at which a member of the group suggests a completely new idea;

> "Actually, you could use this for making surveys as customers move around in the supermarket!"
>
> - 4 – 00:21:18

This point is made in an attempt to illustrate that this technique can be a useful tool for creating new ideas, providing that the participants realize how the process works and are receptive to the ideas generated. Furthermore, as mentioned in the literature analysis, it is recommendable to use this technique using more than a single cycle in order to adjust the questions and avoid ambiguity. In the case of the group, only a single cycle is used, and it is clear that not all questions are to the point and that there is different opinions as to the meaning of some questions. A good example of this problem can be seen in clip four. At 00:10:06 and 00:10:22, the question "When is the application intended for use?" is discussed, but with quite different points of view. The first reply to the question is, as mentioned, at 00:10:06 where a member of the group says:

> "When you're shopping in a supermarket"
>
> - 4 – 00:10:06

This is the natural reply to the posed question, especially in the context of the product. The problem of ambiguity in the question is obvious when considering the second reply to the same question, found at 00:10:22 in clip number four;

> "Couldn't this point also include something about our amount of iterations? How we want the roll-out (of the product red.)"
>
> - 4 – 00:10:22

When viewing the two different responses to the same question, the need for multiple cycles is apparent. While there are no rules stating the right- or wrongness of the responses to these questions, and while both replies address two significant parts in the development process, the diversity of the answers implies that more work needs to be done for this process to live up to its full potential.

8.2.2 Visualization

When analyzing the video clips, visualization proves to be an essential part of the set of innovation- and creativity enhancement tools available to the group. The first example of the software system supporting visualization is at 00:02:47 of video clip number one where a member of the group very efficiently finds a diagram representation of their work which helps visualizing the parts that need more attention. Another example where the software supports the visualization of the project is evident in clip number one where, at 00:42:12, a group member makes the request:

> "Write "payment" over there will you?"
>
> - 1 – 00:42:12

This request is followed by the group member responsible for updating results on the touch screens who swiftly adds an element to the diagram. This scenario shows, once again, that supporting

visualization is important in this set of tools. The enhanced visualization options are also evident in the second video clip. At 00:00:41, this feature is illustrated by the group member responsible for the touch screen. He starts by showing a diagram of the overall project and states:

> "We'll start by looking at the "vision"-element"
> - 2 – 00:00:41

This is followed by a double click on the vision-element on the screen which changes focus and shows the sub-elements of "vision". While this is a relatively short and uncomplicated task, it shows the visualization in a powerful way. Utilizing traditional black- or white-boards or conventional drawing application, this process is usually slow and has the potential to leave group members without overview of the process. Utilizing this feature in the software system creates continuity throughout the process and shows the dependencies between elements in a very pedagogic way. This feature of shifting focuses is not the only feature supporting visualization. The diagram functions are implemented with unlimited drawing space which, how simple it might sound, is a powerful tool. When drawing diagrams either on black-boards or in computerized drawing applications, one is usually limited either by the size of the blackboard or by the size of a standard page in the application. In the second clip at 00:19:38, a group member is drawing a diagram on the touch-screen and runs out of space. The solution to this problem is found in the unlimited drawing space available which allows the designer to simply move the parts of the diagram so that more space becomes available. The last example on increased possibilities for visualization is found in video clip number four. At 00:28:47 the group has completed a diagram showing the features in their product. As the diagram has increased in size during a period of time, it has also grown in complexity and it is hard to gain focus. This problem is solved by a feature in the touch-screen software which, at the push of a button, allows the designers to get the software system to arrange the diagram in an ordered way, creating an enlarged overview. This feature is especially powerful when creating large diagrams consisting of a large number of elements.

8.2.3 Exploration and Simulation

The options for exploration and simulation are fewer than those for visualization. However, in the entire clip number two, the diagram tools in SIRL are used in the exploration of business ideas for the PayWay project. The lack of support for these kinds of experiments could however be a product of the nature of the PayWay-concept. The product is still at its early stages, and an elaborate simulation of the effects of PayWay would require modeling of supermarkets and shopping habits of customers. This subject is found to be outside the scope of the PayWay project.

8.2.4 Reviewing and Replaying Session Histories

While reviewing and replaying of session histories are not directly supported by the SIRL software, these aspects are used in the development process anyway. In clip number two, the scenario is a replay of a brainstorming session with the purpose of constructing a business plan for the PayWay project. In this session, the brainstorm from clip number one is re-evaluated. Furthermore, the reviewing process is evident in clip number three where a member of the group states that;

> "Today we are going to look at categorization and sorting of the results from the first brainstorming session"
> - 3 – Whole clip

The best way to describe the support of reviewing and replaying in SIRL is as being indirect. The software presents options for saving work for later reviewing and replaying, but no direct tools are insofar available.

8.2.5 Dissemination

No evidence was found to support dissemination as an important innovation- and creativity enhancement tool in SIRL.

8.2.6 Searching and Browsing

No evidence was found to support searching and browsing as an important innovation- and creativity enhancement tool in SIRL.

8.2.7 Consulting

No evidence was found to support consulting as an important innovation- and creativity enhancement tool in SIRL.

8.2.8 Composing

No evidence was found to support composing as an important innovation- and creativity enhancement tool in SIRL

8.3 Creativity

While analyzing the literature, several interesting topics on the concept of creativity emerged. However, not all of these concepts are suitable for an analysis based on the empirical data collected. It should be possible to ascertain notions about the different styles of creativity employed by the students in the project group, but, an analysis of potential creativity blocks would require a closer investigation of the group members. Furthermore, the psychological aspects of these blocks do not fall within the scope of this project. This scope being defined, the analysis on the concept of creativity is limited to observations considering the creativity styles of the members of the project group.

8.3.1 Style

When analyzing the video clips, there is no conclusive evidence as to which style of creativity is utilized in the development process. However, there is, through the analysis process regarding the concepts of Innovative Software Development Processes, Innovative Software Systems and Innovation- and Creativity Enhancement Tools, a sense of the group using visioning style creativity. From the literature analysis it is evident that this means that the group envisions the bigger picture and that they rely on the imagination to overcome obstacles in the development process. However, this result could prove to be closely related to the experiments conducted throughout the video clips since tools like brainstorming, W5H2 and categorization are all visioning by nature.

8.4 Innovative Software Systems

The next concept to be analyzed with respect to the empirical data is Innovative Software Systems. This concept is interesting in that the analysis is not performed with the software system used by the group in mind, but rather with respect to the product of their development process, namely the

PayWay PSA. The objective is to investigate whether the requirements for innovation derived from the literature analysis are present in PayWay.

8.4.1 Work Process Improvement

Since the analysis of innovative software systems are being conducted in the context of the PayWay PSA, the work style processes changed in this paragraph are those connected to the everyday process of shopping groceries. The change of work style is evident even in the concept of a personal shopping assistant. A good example of this is in clip number one at 00:27:56 where a feature supporting handicapped customers in supermarkets is discussed.

> "If, for example, I were blind or deaf, I would like to be able to get help"
> - 1 – 00:27:56

The implementation of features allowing handicapped customers to shop on their own or get instant help from customer support would mean a big difference for such unfortunate people. Another example of features changing the work style is given in clip number one at 00:18:54. The group is considering different features which could be implemented in the shopping assistant and one member suggests;

> "I, for one, would really like to get this guidance-feature working"
> - 1 – 00:18.54

The idea behind the guidance feature is that customers should, using the PayWay PSA, be able to receive guidance to the groceries of their choice. While this feature might not be preferred by the supermarkets who invest large sums every year to organizing their products so that the sales go up, it would certainly improve the shopping experience for the customers who would be able to conduct their shopping in the shortest possible route.

8.4.2 Effectivisation

The term effectivisation covers the concept of performing the same task more efficiently than it could be without the use of the software system. There are, in the empirical data, several examples on feature in the PayWay PSA that accomplishes this goal. One of these is in clip number one at 00:26:07 where, while discussion new features, the following suggestion is being made:

> "Search for products"
> - 1 – 00:26:07

Giving the customers or users of PayWay PSA, the opportunity to search for one product while on their way to collect another product allows for effectivisation of the shopping experience. Another example on the PayWay PSA providing an effectivisation when shopping is given in clip number one at 00:27:06 where a group member suggests;

> "I would like to be able to get help from or contact the customer services department while shopping"
> - 1 – 00:27:06

An implementation of this feature would, as stated, allow customers to ask questions and get help from the customer services department on the fly, and would mean that customers would be able to receive prices, ask for equivalent products and so forth while walking around the supermarket instead of being held up at a particular point in the store. Another, and perhaps more classical example is given in clip number on at 00:29:28 where a feature presenting the customers for the opportunity to simply walk through a set of censors at the supermarket exit and have the amount of money corresponding to the contents of their shopping cart automatically withdrawn from their bank accounts/credit cards.

> "How about something a bit more technical such as being able to simply walk through at the registers"
>
> - 1 – 00:29:28

There is no doubt that implementing this feature would indeed present the users with a more effective shopping process as a lot of time otherwise spent waiting in line to pay would be eliminated.

8.4.3 Entertainment Value

As to increasing the entertainment value for the users of the PayWay PSA, the group has some interesting ideas. At 00:37:06 in video clip number one, the idea of implementing a dating service is proposed;

> ""We need to meet new people in this forum, we need a dating service!"
>
> - 1 – 00:37:06

This would clearly provide a greater entertainment value for some users (preferably those who are single!) and the idea is backed by another member of the group;

> "Actually, it's a fun idea, especially if you want to make it entertaining for possible users to go to their supermarket and give it a try."
>
> - 1 – 00:37:14

While the implementation of this feature might have a negative effect on some of the effectivisation features, there is no doubt that the entertainment value would increase for some customers and furthermore, the statements show that the group has some focus on the added entertainment value. Another suggested idea is to implement a chat function and thus allowing customers to communicate with e.g. their families at home in case they have further suggestions as to which items to purchase;

> "What about enabling customers to chat?...you know, with people at home?"
>
> - 1 – 00:37:45

8.4.4 Added Value

The features providing added value to the systems are quite versatile as they should be in order to provide interesting and unexpected features to the users. One of these features is that the system should be able to provide commercials to the users with the contents being adjusted to the personal shopping habits of the users;

"We've already done that, made it possible to show commercials"

- 1 – 00:19:40

This feature would have the effect that users would automatically be notified is any of the products they usually buy are on sale. Another idea is to provide the users with a cookbook. This cookbook would allow users to enter an amount of money they would like to spend on a meal and subsequently guide the users to the products needed to complete the meal;

"I think we need to look at how this cookbook should work"

- 1 – 00:19:45

In addition to proposing recipes based on cost, it would be preferable if the system could propose recipes based on the users entering the current contents of their refrigerators, automatic generation of shopping lists and the possibility to create personal profiles e.g. to avoid suggestions to buy products that the customers dislike or are allergic to. In another part of video clip number one, another suggestion is made;

"There ought to be some sort of membership discount for those willing to use the system"

- 1 – 00:32:30

This is another way of presenting potential users to an added value from the system. This could prove to be a useful tool in order to persuade people to use the system. Furthermore, implementing this feature would prove helpful to the supermarket itself. For the feature to work, it would be necessary to keep track of the product purchased by the customers which means that the supermarkets would have huge quantities of data and statistics on the shopping habits of the users. In clip number four the concept of added value is mentioned directly;

"..also to sell alternative services through our system"

- 4 – 00:04:27

It is clear that added value is a component of the PayWay PSA and that there is quite a lot of focus on providing these opportunities to both customers and supermarkets themselves.

8.5 Concepts outside the model

The concepts analyzed so far have all been parts of the revised model and these concepts have naturally been receiving special attention. However, during the process of analyzing the video clips, there have been other interesting finds. Some of these falls outside the scope of the revised model since the have been considered long term effects of the implementation of innovations but since they were part of the original model they deserve a place in this analysis.

8.5.1 Fulfilling existing needs vs. creating new

The first interesting find is that the group indirectly works towards a goal where the diffusion of their product is considered to enhance the chance of their product being successful. This is done

during a discussion in video clip number two where different aspects of a business plan are being discussed. The existence of a focus on diffusion is evident in the statement;

> ”To create a need in the customers so that they demand it (PayWay red.) of the supermarkets”
>
> - 2 – 00:13:01

This statement clearly illustrates that diffusion of the PayWay PSA is, not surprisingly, an important part of the business plan. There are however different points of view inside the group as to how to reach the goal of diffusion. When considering marketing strategies, the above statement clearly illustrates a desire to focus on creating a need for the product in the customers who are going to use it, and in the quote below, another approach is taken;

> “Marketing isn’t especially important since we don’t need to reach individuals, the marketing efforts should be focused on chains (of supermarkets red.)”
>
> - 2 – 00:13:45

The quote above illustrates another view on the demand for marketing in order to achieve maximum diffusion. Since the customers in the eyes of the development team are the supermarkets, they become the natural area of interest. As the discussion progresses, another idea is suggested. In clip number two from 00:14:20 to 00:14:50, another possibility is discussed. This idea presents the idea of getting into a program called the Microsoft Business Excellence Program. The idea behind the program is that companies using Microsoft products enroll in the program and by this, receives information about new applications also utilizing one of the Microsoft development environments or –applications. This solution has both positive and negative sides. On one hand, the marketing process is handled by external partners and the development team does not have to spend efforts on other things than the development. On the other hand, by outsourcing this to the external partners, the diffusion process that is so important in order to achieve true innovativeness is left outside the influence of the group.

Another interesting point is being made. It leans heavily on the concept defined in the literature analysis as Social Transformation. While there is no direct focus on social transformation in the development process, the concept is still evident in some of the considerations made by the group. This becomes clear in clip number two at 00:19:48 where the group is discussing their business plan for the PayWay-project. The discussion turns to consider the need for their product which leads to the following statement;

> “There is no demand, the demand has to be created”
>
> - 2 – 00:19:48

This statement, along with the statements considering diffusion, shows that the group is considering the best way to get as many PayWay-users as possible. This shows that even though their objective is not specifically formulated to foster social transformation, it is still a big part of their goal given the fact that the more users they have, the more they help change the communities in which the product is implemented.

8.5.2 Usability problems

During the analysis of the video clips, the touch screens in the SIRL lab have proven to be a quite efficient tool in the development process. Despite its supporting features and many possibilities, there have been several observations of usability problems. One of the more serious of these usability problems is that the text recognition software implemented in the screens is not particular good at recognizing handwriting and thus looses most of its functionality, illustrated in the situation in clip number 1 at 00:21:50 where a member of the group says that;

> "We need a keyboard under these things! (the SMART-boards red.)"
> - 1 – 00:21:50

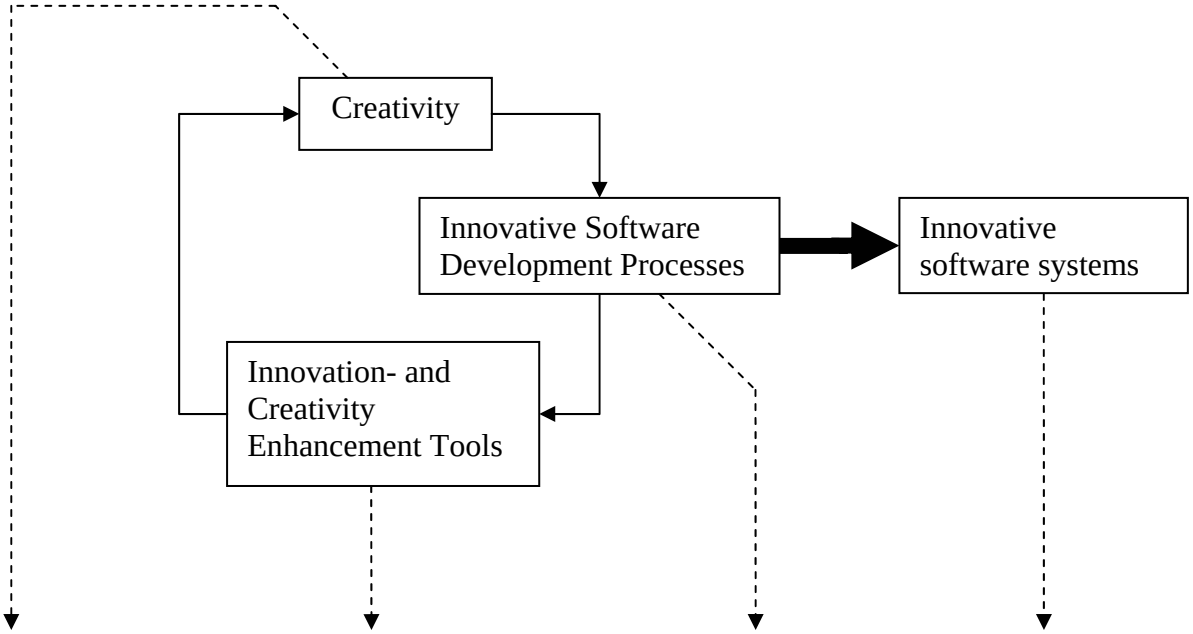
In addition to the problems regarding the lack of usability of the text recognition software, there are several examples of functions which the group has difficulties operating. In the third clip at 00:00:32, the group are discussing the removal of some nodes in one of their diagrams. Some advocate their deletion but one group member claims that the nodes in question should instead be hidden in case a situation arises where they are needed;

> "..maybe they (the nodes ed.) should be hidden so that they are not forgotten, but I don't know how to do that.."
> - 3 – 00:00:32

The above quote serves as an illustration of features that are either lacking or hard to find. There are two other examples in this context. One is located in clip number three where, from 00:04:45 to 00:05:04, there are difficulties in performing the relatively simple task of selecting another type of arrow in the diagram and how to assign a different color to it. The last example of insufficient usability is evident in clip number four where, from 00:05:30 to 00:06:13, there is considerable difficulties in getting a feature that allows automatic re-grouping of complex diagrams to work.

9. Discussion

In the discussion of the research results, it is interesting to look at the original categorized model, depicted once again below;



- Styles
  - Visioning style
  - Experimental Style
  - Exploring style
- Blocks
  - Emotional blocks
  - Cultural Blocks
  - Environmental blocks
  - Intellectual blocks
  - Perceptual blocks

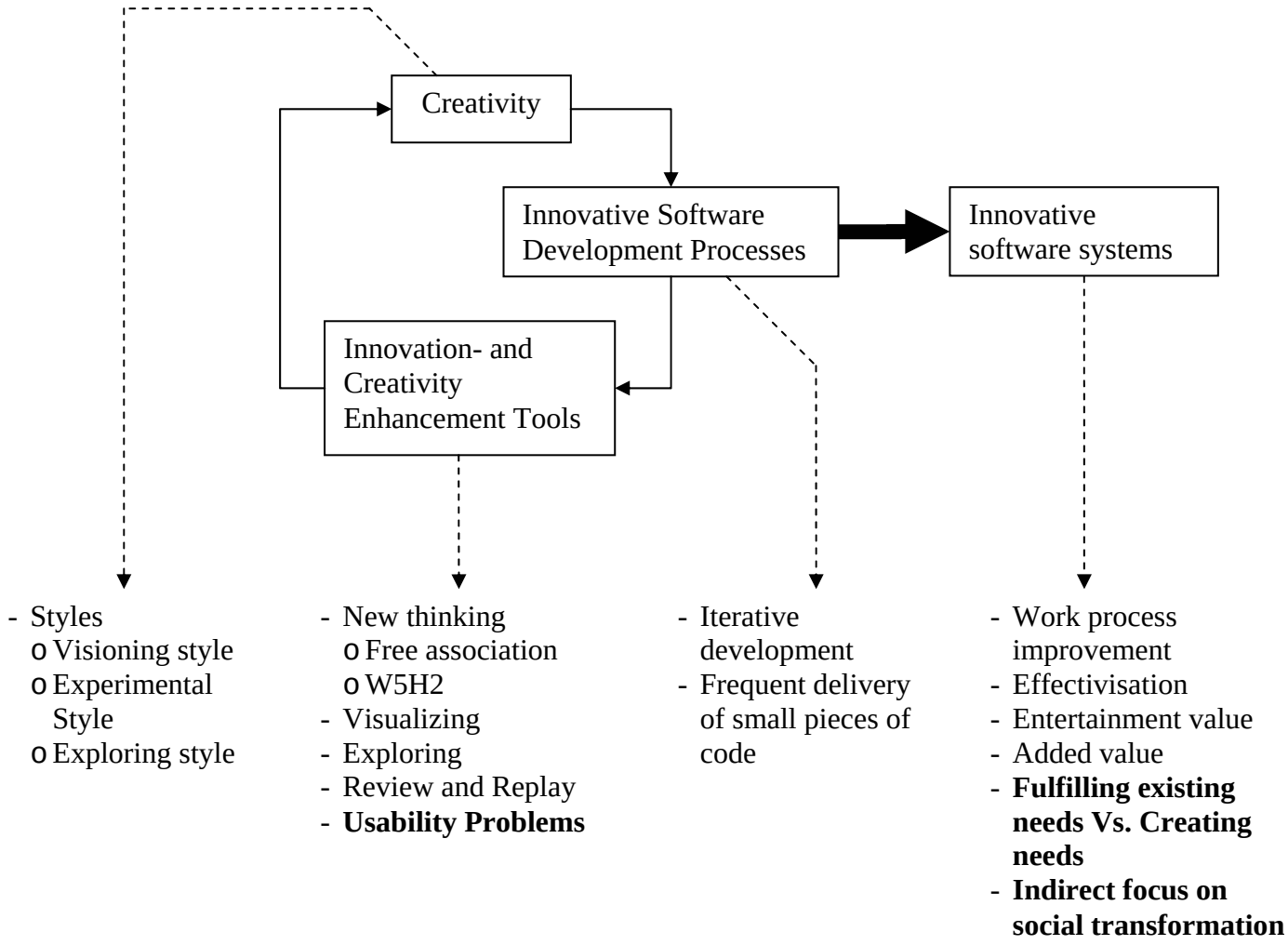
- New thinking
  - Free association
  - 5W's/H
- Search and Browse
- Visualizing
- Consultation
- Exploring
- Composing
- Review and Replay
- Disseminate

- Iterative development
- Frequent delivery of small pieces of code

- Work process improvement
- Effectivisation
- Entertainment value
- Added value

- Figure 10 – Initial theoretical model with categories

The model above is a result of analyzing the collected literature and shows, as mentioned previously, the categories associated with innovation in software development as considered in the theory. While analyzing this model with regards to the empirical data, some categories where found not to be represented in the data and others outside this model where found to receive attention by the group members. These findings have led to a second iteration of the categorized model with the categories not represented in the empirical date removed and the categories existing in the empirical data but not in the literature added. This comparative model is depicted in fig. 11 with the added categories marked in **bold** type;



- Figure 11 – Comparative model based on both theoretical and empirical data

The categories which are non-existing in the literature are primarily related to the concepts of creativity and innovation- and creativity enhancement tools. On the subject of creativity the lack of evidence regarding creativity blocks is perhaps not particular surprising. First, this is not a focus in the PayWay project and secondly, the factors involved in deciding these blocks are subject that concerns the more complex parts of both the human mind and the society surrounding us. To investigate these factors would demand a long and extensive study involving studies in areas of psychology and social sciences which would be considered outside the scope of this project.

Regarding innovation- and creativity enhancement tools, four categories where not mentioned or utilized in the empirical data; Searching and Browsing, Consultation, Composing and Dissemination. Support of these features are either non-existing in the SMART-board software or is not utilized by the group. The reason for the absence or lack of use of such features in SIRL are not evident and while consultation and dissemination might prove hard to implement in a satisfactory fashion, both searching and browsing as well as consultation implemented as web access and- or the option of making video conference calls could prove usable in the idea development and –sharing process. Furthermore, with regards to SMART-boards as supporting innovation- and creativity enhancement tools, the group shows that some features are hard to comprehend or has limited use due to usability problems. These lacks are especially apparent in the OCR (text recognition) feature

which, as the development progress, is more or less replaced by a regular keyboard as the primary typing device. In addition, some of the features such as hiding diagram nodes so that they can not be seen but can still be produced as part of a diagram seems less intuitive in their use than one could whish for. The same problem is evident in the use of an automatic diagram organization feature. The theoretical concerns about innovative software development processes both proved to be existent in the empirical data. It is quite possible that there are more categories related to innovative software development processes. The reasons for the absence of findings in relation to software development are most likely to be found in the nature of the empirical data. The experiments depicted in the four video clips are all showing different aspects of the idea-development process (which also is the intended use for SIRL), and investigation of the coding and implementation phases of the development process might shed light on more categories relating to innovative software development processes.

Some of the more interesting finds relate to innovative software systems themselves and the opinions of group members on this concept. Two categories have been added to the model; fulfilling existent needs vs. creating needs and social transformation. The question of whether to aim at fulfilling existent needs or creating new needs to suite the product is closely related to that of diffusion in the theoretical model. In addition, while the group does not focus directly on social transformation, evidence of their considerations on the subject is present in the empirical data. The interesting point about these two categories is, that they were originally excluded from the model since they were considered to be hard to prove without long-time empirical data. That these two categories are included in the PayWay project is not conclusive evidence of their part in the model due to the fact that more research of diffusion and the social transformations of innovative software systems is still needed.

10. Conclusion

The goal of this research project was to answer three research questions based on analysis of both theoretical and empirical data. These research questions where;

1. Is the theoretical data in accordance with the empirical data?
2. Is the idea development process innovative?
3. Based on an analysis of the PayWay PSA, does the development process utilized by the group lead to innovative software?

The method used to answer these questions involved a literature analysis of a collection of books and articles found at the established scientific databases IEEE and ACM, using a combination of fixed keywords and, in addition, supplemented by reviewing lists of references from the articles. The literature analysis is partly the product of research performed during an earlier semester but has been revised in order to derive categories usable for an analysis of empirical data. These consist of video clips showing the idea development process of a project group at the computer science study at Aalborg University. The objective of the project group is to develop an innovative software system called the PayWay PSA. The analysis of the empirical data has been performed using multiple reviews of the video clips with specific focus on a particular category each time while recording the results in a separate document containing key elements from the video clips. At the same time, the research process has been organized using a concept matrix showing timestamps and indications of the categories as they are mentioned in the empirical data.

It can not be concluded that the theoretical model matches the empirical data exactly. Categories concerning creativity blocks, composing, consulting, disseminating as well as searching and browsing have all proved to be hard to find in the empirical data. Furthermore, elements concerning social transformation and the problem of fulfilling existent needs versus creating needs in order to diffuse ones product have been found. In addition, several usability problems with the innovation- and creativity enhancing software system used by the group have been found. While this conclusion might seem to reflect poorly on the results of the literature analysis, the changes made in order to adapt the theoretical model to the empirical are relatively small and include a limited number of categories. On this note, the conclusion to the first research question is, that while it cannot be concluded that the two models are in convergence, the opposite is not the case either. The research process also shows that some of the categories that where not included for further research due to their time-dependent nature, namely social transformation and diffusion, are indeed present in the depicted development process. While extensive research into these two concepts, as mentioned, would include a long-term study of multiple software systems broadly regarded as innovations and thus cannot serve as conclusive evidence of their importance, it can be concluded that there is a certain probability of these being important. The two models are alike in most categories which combined with the fact that the research yielded evidence supporting the existence of characteristics innovative software systems intentionally left out of the model, in my opinion, show that work has not been in vain and that this research has the possibility of yielding a more precise model of innovation of innovative software development.

The answer to the second research question follows in somewhat the same line as that of question number one. While the process includes the categories of the model, the results are only valid on part of an overall innovative software development process. The empirical data only covers the idea development part of the project which leaves the code-, test- and implementation phases of innovative software development uncovered. However, with the focus being on the idea development process in order to accommodate the nature of the empirical data available, it is concluded that the idea development process has shown to be, in some way, innovative. The list of categories proposed in this project is cannot be considered complete as new development methods continuously replace the more traditional.

On the third and last research question the PayWay project has been found to implement all of the categories considered to define an innovative software system which shows that the potential of creating a product able to transform its environment of implementation is indeed present. However, the PayWay project cannot be concluded to belong in this category due to a number of factors. One of these is that the product has not yet been fully developed which means that difficulties in the implementation phase could lead to a product lacking some of the features planned in the idea development process. Should too many of these be excluded from the finished product, the probability of the PayWay PSA ending up as an innovative software systems declines. Furthermore, even though the existence of both social transformation and diffusion has been located while analyzing the empirical data, these are two factors that require an intensive study on the effect of the PayWay PSA at different times after it has been released, and a definitive conclusion on this point is left for further research.

Overall, the process and models proposed in this project are, based on the results of the research, concluded to be successful. While the answer to the research questions has proven inconclusive when considering them in a stringent and pragmatic fashion, this evaluation of the research questions could be a product empirical data not extensive enough to conduct a sufficiently detailed research. That the model, after analyzing the empirical data still hold for the larger part of the categories proves that this research project has presented a large step towards defining the concepts of creativity and innovation as well as proposing a model that has the potential to break the barrier blocking a better understanding of more innovative and creative software development.

11. Bibliography

[Shneiderman2002]
Creating Creativity; User interfaces or Supporting Innovation, Ben Shneiderman, ACM Transactions on Computer-Human Interaction, Vol.7, No. 1, March 2002, Pages 114-138-

[Shneiderman2000]
Creativity Support Tools – Establishing a framework of activities for creative work, Ben Shneiderman, Communications of the ACM, Vol. 45, No. 10, October 2000, Pages 116-120

[Denning2004]
The Social Life of Innovation, Peter J. Denning, Communications of the ACM, Vol. 47, No. 4, April 2004, Pages 15-19

[Greene2002]
Characteristics of Applications that Support Creativity, Sharon L. Greene, Communications of the ACM, Vol. 45, No. 10, October 2002, Pages 100-104

[Adamides et al2006]
Information technology support for the knowledge and social processes of innovation management, Emmanuel D. Adamides and Nikos Karacapilidis, Technovation vol. 26, 2006, Pages 50-59

[Candy et al2000]
Creativity Enhancement with emerging technologies, Linda Candy and Ernest Edmonds, Communications of the ACM, Vol. 43, No 8, August 2000, Pages 62-65

[Thomas et al2002]
Enhancing Creative Design via Software Tools: Why Creative Design is Important, John C. Thomas, Alison Lee and Catalina Danis, Communications of the ACM, Vol. 45, No. 10, October 2002, Pages 112-115

[Tiwana et al2005]
Expertise Integration and Creativity in Information Systems Development, Amrit Tiwana and Ephraim R. Mclean, Journal of Management Information Systems, Vol.22, No. 1, 2005, Pages 13-43

[Nichol2005]
Creative Geeks..? Facilitating the Creative Growth of Computer Science Students Using Engaging Environments, Sophie Nichol, Doctoral Consortium Submission; Proceedings of OZCHI, November 2005

[SIRL-report]
Bootstrapping Essence in SIRL, Morten Andersen, Søren Rode Andreasen, Lasse Bæk and Phillip Bredahl Thomsen, Dept. of Computer Science – Aalborg Universitet, Fall 2006

[Couger96]
Creativity and Innovation in Information Systems Organizations, D. Couger. Boyd and Fraser Publishing Co. Danvers, MA 1006, ISBN 0-7895-0109-0

External Reading

[Massetti1996]
An Empirical Examination of the Value of Creativity Support Systems on Idea Generation, Brenda Massetti, MIS Quarterly, March 1996

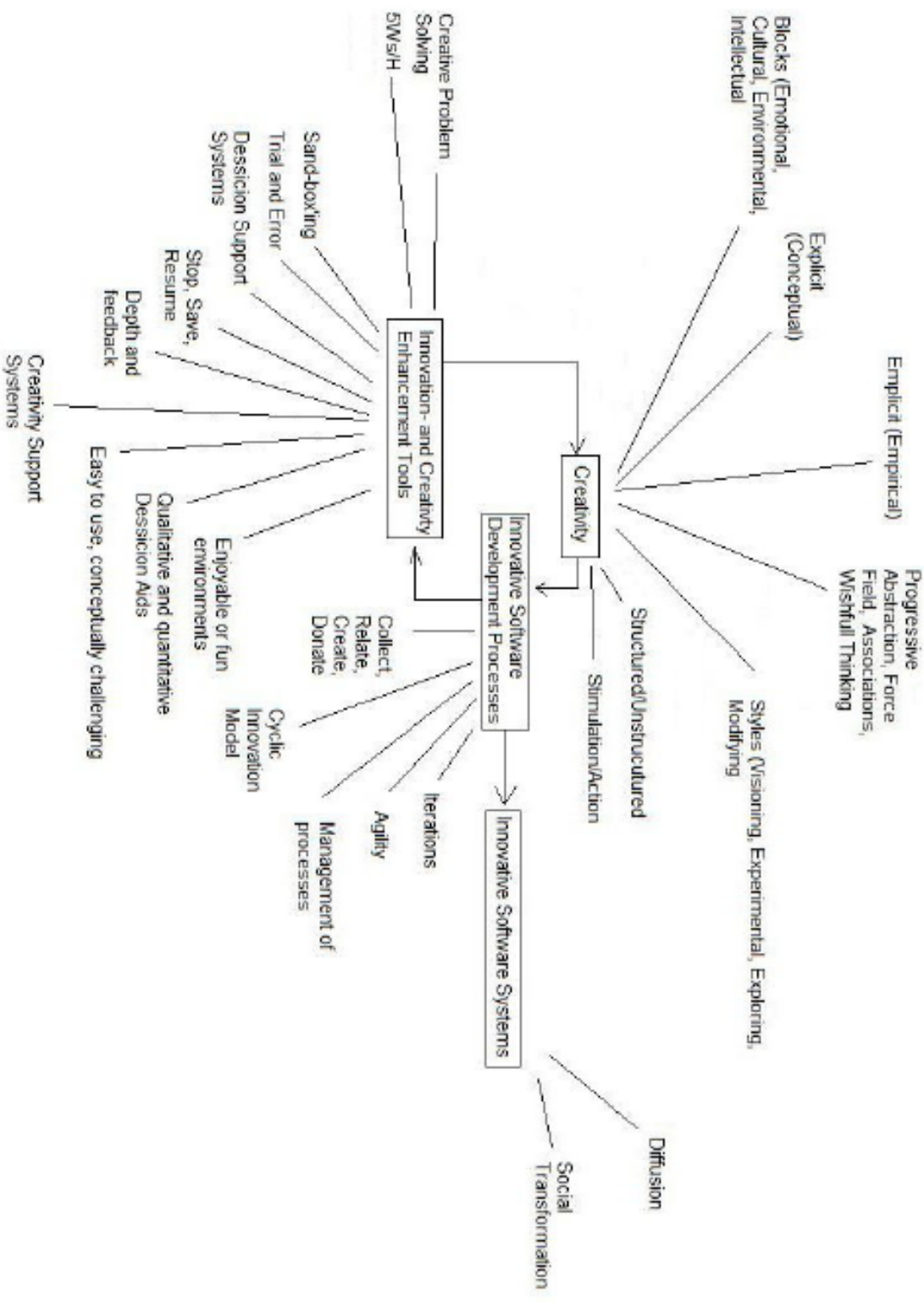
[Elam et al1990]
Can Software Influence Creativity?, Joyce J. Elam and Melissa Mead, The Institute of Management Sciences, INFORMS 1990

[De Bono71]
Lateral Thinking for Management – A Handbook of Creativity, Edward D. Bono. Harper Colophon Books, New York, 1973, ISBN 0-8144-5257-4

[Stein1974]
Stimulating Creativity vol. 1, Isaac Morris Stein, Academic Press Inc, 1974, ISBN 0-12-664201-X

[Stein1975]
Stimulating Creativity vol. 2, Isaac Morris Stein, Academic Press Inc, 1975, ISBN 0-12-664202-8

Appendix A – Concept Map



Appendix B – Video Clip Extractions

Innovative Software Development Processes

Iterations

- 3 – 00:00:19
  - "Vi ændrer focus en lille smule fordi vi har fundet ud af, at vi laver meget kategorisering "on the fly"
    - Ny iteration af "gammelt" materiale.

- 3 – 00:02:40
  - "Det var ikke det der var tanken først, det var at vi skulle selv købe nogen (RFID-tags red.)
    - Igen, diskussionen er baseret på hændelser fra en ældre iteration.

- 3 – 00:11:38
  - "Sidste gang var en stor opgave, I første iteration, at…"
    - Snakker direkte om iterationer som et led I udviklingsprocessen. Fortæller at der er mere end en.

- 4 – 00:10:22
  - "Kunne man ikke også, inde under det her, ha' noget om hvor mange iterationer vi vil ha'?....hvordan vi gerne vil ha' det til at rulle ud (systemet red.)
    - Snakker direkte om iterationer som et led af udviklingsprocessen. Snakker om, hvor mange iterationer der mon skal bruges.

Frequent delivery of small pieces of code

4 – 00:18:43
  - "Man kan sige at egentlig så burde vi måske dele det op I miniprogrammer"
    - Snakker tydeligvis om at dele softwaren I små selvstændige applicationer der til sammen udgør en helhed.

Innovative Software Systems

Change of Work Style Process

- 1 – 00:27:56
  - "Hvis jeg nu f.eks var blind, eller døv, så ville jeg gerne kunne få hjælp"
    - Kan ændre hverdagen for handicappede drastisk

- 1 – 00:18:54

- ”Som kunde kunne jeg godt tænke mig at få det der vejvisning til at virke”

Effectivisation

- 1 – 00:26:07
  - ”Søgning efter produkt”

- 1 – 00:27:06
  - ”Jeg vil gerne ha’ det sådan at jeg kan få hjælp/kontakt til kundeservice”

- 1 – 00:29:28
  - ”Hvad med sådan noget lidt mere teknisk som bare lige at kunne rulle igennem kassen?”
    - Automatisk betaling”

Entertainment Value

- 1 – 00:37:06
  - ”Vi skal møde nogle personer i det er rum, vi skal ha’ noget dating!”
  - 1 – 00:37:14
    - ”Det er faktisk en lidt sjov idé, især hvis man skulle ha’ nogen til at synes det kunne være sjovt at komme ned og prøve det her!”
- 1 – 00:37:45
  - ”Hva’ med at kunne chatte med…dem derhjemme”

Added Value

- 1 – 00:19:40
  - ”Det har vi jo allerede lavet det der med at den skal vise reklamer (personlige red.)
    - Systemet skal automatisk reklamere for de produkter kunden ofte køber

- 1 – 00:19:45
  - Snakker om at tilføje brugeren en mer-værdi i form af kogebog; ”Jeg synes vi skal se lidt på, hvordan den der kogebog skal fungere” (Også effektivisation)
    - Endnu en added value. Opskrifter på baggrund af budget, køleskabsindhold, automatisk generering af indkøbsliste, personlig profil så ting man ikke kan li’/tåle undgås osv

- 1 – 00:32:30
  - ”Der skal være en eller anden form for medlemsrabat til de der gider at bruge det her system”

- 4 – 00:04:27
  - ”..også at kunne sælge alternative services via vores system”

        - Brugeren (af PayWay) skal præsenteres for ”added value”

Innovation- and Creativity Enhancement Tools

Searching and Browsing

Consulting

Thinking by Free Association

- 1 – Whole Session
    - Hele første session er ment som en brainstorming-session.

- 2 – 00:04:30
    - ”Som f.eks forsikringer”
        - En idé som ikke har været nævnt før, kommer på bordet som følge af en visualisering af en forretningsplan.

Visualization

- 1 – 00:02:47
    - Finder hurtigt en tegning/repræsentation af deres projekt på en af tavlerne. Den meget lette tilgang til at tegne diagrammer er med til at lette visualiseringsprocessen.

- 1 – 00:42:12
    - ”Prøv lige at skrive Payment derovre”
        - Det er meget hurtigt og let at tilføje punkter, og dermed gør de øgede muligheder for visualisering det lettere at overskue hva der mangler/er for meget.
- 2 – 00:00:41
    - Klippet viser en session hvor forretningsmuligheder drøftes. Et medlem styrer sessionen og siger: “..og vi starter med at gå ind under vision” hvorefter skærmen ændres til et nyt diagram
        - Viser med al tydelighed at “gamle” og “under”-tegninger let kan findes frem igen, en opgave der er blevet udført lettere end normalt.

- 2 – 00:19:38
    - Diagrammet på skærmen kan flyttes og ændres “on the fly” meget hurtigere end hvis man bruger en traditionel tavle eller tegneprogram. Trykfølsomheden indbygget i tavlen gør denne process mere effektiv end ellers.

- 4 – 00:28:47
    - Applicationen (Touch-screen-softwaren) viser sig at have en funktion der automatisk kan re-organisere et ellers uoverskueligt diagram til et ordnet og overskueligt diagram (screenshot!)

Exploration and Simulations

- 2 – 00:01:15
    - Forretningsmulighederne i PayWay udforskes og simuleres ved hjælp af diagram-værktøjerne i skærm-systemet.

Reviewing and Replaying Session Histories

- 2 – 00:00:41
    - ”Jeg synes måske at vi, under ”keys” skal ha’ noget dataindsamling..”
        - Udtalelsen kommer som et led i en ny session hvor brainstorming-resultaterne fra første session gennemgåes i med et forretningsperspektiv for øje.

- 3 – Whole Session
    - Hele 3.session handler om at ”genspille” første sessions brainstorm med kategorisering/sortering af emner. ”I dag skal vi kigge på noget kategorisering/sorting..”

Dissemination of Results

5W/2H’s

- 4 – 00:00:25
    - ”W5/H2” Bruger en variant med et ekstra ”H”
- 4 – 00:00:40
    - What is the application providing?
- 4 – 00:06:29
    - ”Why is there a need for this application?”
- 4 – 00:09:56
    - When is the application intended for use?
        - 4 – 00:10:06
            - ”Det er det når man står i et supermarked”
        - 4 – 00:10:22
            - Kunne man ikke også, inde under det her, ha’ noget om hvor mange iterationer vi vil ha’?....hvordan vi gerne vil ha’ det til at rulle ud (systemet red.)
- 4 – 00:11:18
    - Where is the application going to be used?
- 4 – 00:17:35
    - ”Det her er jo faktisk på en eller anden måde en kategorisering”
- 4 – 00:17:37
    - ”Vi finder ingen nye ideer indtil videre i hvert fald”
- 4 – 00:17:50
    - ”Lige før sad vi da og snakkede om kogebogen og at man også skal ha’ mulighed for at se den hjemmefra.”
- 4 – 00:18:21
    - ”Varehuse, Storcentre” → er sprunget videre til ”where”
- 4 – 00:19:18

    - ”Who are the intented users?”
- 4 – 00:21:18
    - ”Man kunne egentlig lave sådan nogle surveys når de kører rundt i butikken!” Ny ide!
- 4 – 00:23:38
    - How much is economically required for creating a succesful business case?
- 4 – 00:25:50
    - How is the application technologically being realized?
- 4 – 00:25:20
    - Til samtlige punkter:
        - Benytter målrettet 5W/2H’s til at finde nye ideer
        - I 3. tidsangivelse rettes der kritik imod metoden der af et medlem af gruppen ikke anses som en kreativitets-metode men snarere som en metode til kategorisering af allerede erhvervede ideer.

Concepts outside the model

Fulfilling Existent Needs Vs. Creating New Needs

- 2 – 00:13:01
    - ”For at skabe et behov hos kunderne så de kræver det af butikkerne”
        - Diffusion hos kunderne gør det lettere for gruppen at sælge deres produkt til butikkerne

- 2 – 00:13:45
    - ”Marketing er ikke så vigtigt da vi ikke skal ud til privatpersoner….marketing skal rettes imod kæder”
        - Tydeliggør at udbredelsen af deres produkt er vigtigt, og at de er klar over at en øget udbredelse har en større chance for at produktet bliver en succes.

- 2 – 00:14:40
    - Fra 00:14:25 til 00:14:40 diskuteres en metode til udbredelse af produktet, et samarbejde med Microsoft Business Excellence.

- 2 – 00:19:48
    - ”Der er ikke noget behov, behovet skal skabes”
        - Det gøres klart at der skal skabes et behov for systemet. Behovet skal ikke skabes på falske grundlag men på elementer i dagligdagen som gør, at brugernes daglige liv bliver lettere → social transformation.

Usability Problems

- 1 – 00:09:25
    - Text-genkendelse virker ikke

- 1 – 00:21:50
    - ”Vi skal ha’ et tastatur under de skærme der!”

- 3 – 00:00:32
    - ”måske skal de gemmes væk så man ikke glemmer dem, men det ved jeg ikke hvordan man gør.”
        - Der er funktioner i systemet som gruppemedlemmerne ved eksisterer men ikke hvordan virker.

- 3 – 00:05:04
    - fra 00:04:45 til 00:05:04 er der tvivl om, hvordan en bestemt funktion udføres.

- 4 – 00:05:37
    - 00:05:30 til 00:06:13 hersker der tvivl om, hvordan funktionen til automatisk organisering af diagrammer virker.

Appendix C – Concept Matrix

Timestamp	Observation	Innovative Software Development Processes	Iteration	Frequent Delivery of Small Pieces of Code	Innovative Software Systems	Work Process Improvement	Effectivisation	Entertainment Value	Value Addition	Innovation- and Creativity Enhancement Tools	5W's/H	Searching and Browsing	Consulting	Thinking by free association	Visualization	Exploration and simulations	Reviewing and replaying session histories	Dissemination of results	Creativity	Visioning Style	Experimental Style	Exploring Style	Concepts outside the model	Fulfilling a need Vs. Creating them	Usability Problems
1 - 00:01:15														W											
1 - 00:02:47															X										
1 - 00:09:25																									X
1 - 00:18:54						X																			
1 - 00:19:40									X																
1 - 00:19:45									X																
1 - 00:21:50																									X
1 - 00:26:07							X																		
1 - 00:27:06							X																		
1 - 00:27:56						X																			
1 - 00:29:28							X																		
1 - 00:32:30									X																
1 - 00:37:06								X																	
1 - 00:37:45								X																	
1 - 00:42:12															X										
2 - 00:00:41															X		X								
2 - 00:01:15																X									
2 - 00:04:30														X											
2 - 00:13:01																								X	
2 - 00:13:45																								X	
2 - 00:14:40																								X	
2 - 00:19:38															X										
2 - 00:19:48																								X	
3 - 00:00:19			X														W								X
3 - 00:00:32																									X
3 - 00:02:40			X																						
3 - 00:05:04																									X
3 - 00:11:38			X																						
4 - 00:00:25											X														
4 - 00:00:40											X														
4 - 00:04:27									X																
4 - 00:05:37																									X
4 - 00:06:29											X														
4 - 00:09:56											X														
4 - 00:10:06											X														
4 - 00:10:22			X								X														
4 - 00:11:18											X														
4 - 00:17:35											X														
4 - 00:17:37											X														
4 - 00:17:50											X														
4 - 00:18:21											X														
4 - 00:18:43				X																					
4 - 00:19:18											X														
4 - 00:21:18											X														
4 - 00:23:38											X														
4 - 00:25:40											X														
4 - 00:25:50											X														