# Method for Reflection and Team Improvement

A Method With Focus on Individual and Team Reflection



Group d602a

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June 4, 2010



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#### Synopsis:

<ul> <li>Title: Method For Reflection and Team Improvement: A Method With Focus on Individual and Team Reflection</li> <li>Project period: SW10, spring term 2010</li> </ul>	Failing software projects have been an is- sue since the early beginnings of computer science. This report tackles the problem by using reflection in software teams. It describes the development of a new reflective team improvement method. The method works with reflection for both individuals and teams. To support the individual reflection, a software tool has been developed, which tries to use questions and conversations. For the team reflection a board game has been created in which the team can discuss improvement topics based on user generated questions. The project has been classified as design science and the design science research methodology (DSRM) has been used as a research methodology.			
Project group: d602a				
Members: Dennis Peitersen Esben Pedersen Kenneth Pedersen Supervisor: Ivan Aaen				
Copies printed: 5	During the evaluation, a case study has been on conducted on a team of students from Aalborg University. They used the method for two iterations of their student project.			
Appendix count and type: 3 text	The evaluation shows that they are positive towards the method and find it useful, but also have some reservations regarding the impact of the method.			
Finished date: June 4, 2010	From a research perspective this method gives an alternative view on the topic of reflective evaluations in the software industry.			

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# Preface

This report is written by software engineering group d602a as the groups master thesis at the Department of Computer Science at Aalborg University. The project is based on the work conducted in the fall semester of 2009. The report is written within the Information Systems research group and the theme of the report is reflection both individually and in teams. The report is addressed to students, supervisors and anybody who may have interest in the topic. To read and understand the report one must have a general understanding of computer science and theories in information systems. A summary of the report can be found in Appendix C.

Citations refer to the bibliography entries found in the back of the report and are marked with "[]" containing the author's name and the year of publication, e.g. [Aaen, 2008]. It should also be mentioned that each time the word "we", "researchers", and "our" are used, it refers to the authors of this report and "he" refers to "he/she".

We want to express our gratitude to our test group for their cooperation in the case study and their devoted effort through out the experiment. Also, a thanks goes to our supervisor Ivan Aaen for guidance and helpful idea sessions in both the former project and the current one.

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"Motivation is the art of getting people to do what you want them to do because they want to do it." Dwight D. Eisenhower

# Introduction

# 1.1 Problem Identification and Motivation

Software development is a very complex and high-risk undertaking that requires integration of many concepts and activities. Throughout the history of this field, the industry has gone through at least four generations of programming languages, low level from machine code and assembly languages to high level languages like C, C# and java, and finally languages with a specific purpose in mind, such as the development of commercial business software. Three major development paradigms have also been identified, the waterfall, iterative and agile development paradigms. There has also been much focus on how to develop software correctly and standards have been introduced in organizations that require specific technologies. However, we still struggle with the ability to successfully and consistently move from an idea to a product. [Reel, 1999]

Despite the advances in tools and new technologies, failures and delays are still common. This implies that advances in development technologies are not sufficient to improve the rate of successful system implementation. [Lyytinen and Robey, 1999] This would suggest that human factors decide the success or failure of software projects. No man is perfect, and that is also true for the software developers. Therefore, errors are bound to be made during projects. Actually, according to Collier et al., quoting Don Norman, "the behavior we call human error is just as predictable as system noise, perhaps more so". [Collier et al., 1996] These errors can cause problems or conflicts that are destructive for the project.

Lyytinen and Robey argue that the reason why so many software projects fail is because many software developers fail to learn from their experiences. Ironically, much of the information that the developers need in order to learn and improve themselves is already available from previous experience. To mitigate learning failure in software projects, it is necessary for developers to learn from their own and others' experience and use this knowledge to change their development practices. [Lyytinen and Robey, 1999]

It would seem that software developers are so focused on new progress that they forget to reflect on the work they have done or are currently doing. This causes them to miss the golden opportunity to improve their work based on the experiences they gather through projects.

Failures and poor performance in software projects are often very expensive. According to Kasi et al. the information technology capital spending in the U.S. has reached 50% of nominal business capital spending based on numbers from 2003. When this is compared to the suggested evidence that 40% of the IT investments fail to deliver their expected returns the losses are considerable. It is estimated that failed IT projects cost U.S. businesses \$75 billion each year. [Kasi et al., 2008]

Based on this it is clear that companies will welcome any solutions that will strengthen the

developers' ability to effectively produce software and lower the failure rate of software projects. If possible, this has potential to save the companies billions of dollars and much frustration.

# **1.2 Definition of the Solution Objectives**

Before any solutions can be designed or implemented it is important to define and understand which objectives the solution must fulfill, and how the solution is going to have an impact on the problems described in the previous section.

Projects seldom run without problems or conflicts along the way. It is important that these conflicts are realized and dealt with. Sometimes the problems are clear to every project member while other times the problems or conflicts can be more hidden. One way to identify both hidden and obvious problems and conflicts is to reflect.

Reflection in practice have been a topic discusses and researched for decades ([A. Schön, 1983] and [Jepsen et al., 1989]). Schön introduces the term reflection-in-practice and underlines that practioners do reflect in action. He argues that they sometimes look back on older projects or situations, which suddenly make more sense to them and thereby help their understanding of the original problem. Schön finally coins a term called reflection-in-action, which is reflection happening during a project. Jepsen et. al. uses this theory as base for their work on diaries, which also underlines the argument for individual reflection.

Both Collier et. al. and Myllyaho et. al. emphasizes that reflection in teams lead to better understanding of the problems and struggles fought in the project. Collier et. al. state that team reflections give the team a forum to discuss the identified problems and conflicts, and address the collaboration between team members internally. It can also be a place to clear tensions between team members and allow them to cleanse the air, empty old baggage and renew the energy in the team. [Collier et al., 1996] Myllyaho et. al. look at the different ways of reflecting after a software project and find six major advantages with team reflection. [Myllyaho et al., 2004]

- It helps project team members share and understand each other's perspectives;
- It integrates individual and team learning;
- It identifies hidden problems;
- It documents good practices and problems (in order not to repeat bad practices);
- It increases job satisfaction by giving people feedback about their work;
- In some cases, it can even improve project cost estimation.

To sum up: in this project there will be focus on conducting a solution which must support the developers by focusing on the four following tasks:

- Increase individual and team reflection
- Identify and address problems and conflicts
- Learn from the mistakes that have been made
- Improve future work practices and team collaboration

"Research is what I'm doing when I don't know what I'm doing." Werner von Braun



Any credible research must be based on an appropriate level of knowledge and understanding of the field in which the research is conducted. Hence it is appropriate to conduct a study of existing literature and research that is relevant for the project. This study was conducted in an earlier project and Section 2.1 recaps the most important findings.

Some problems encountered in this report are complex in nature and are difficult or impossible to solve. These problems are called *wicked problems*. Section 2.2 takes a closer look at these types of problems to get a better understanding of them.

This project is centered around finding a method to increase reflection and learning from own experiences in software projects. This places the project in the research discipline of Information Systems. Therefore, a relevant question is how good research can be conducted in Information Systems? Section 2.3 introduces two paradigms of research within Information Systems, one of which is design science. Arguments are presented why this project can be categorized as Design Science research and in Section 2.4 a research methodology for Design Science is introduced. This Design Science research methodology (DSRM) are applied to some extend in this project and an explanation of this is found in Section 2.5.

# 2.1 Literature Study

In order to accomplish the proposed solution mentioned in Section 1.2 former research needs to assessed. The former research builds mainly upon large recommendations of using postmortem evaluations, but also states that they are not used in practice. Also, the development paradigm accounted for in the majority of the former research is the traditional paradigm, not the agile paradigm, which is interesting because it already incorporates some of the four tasks in the proposed solution, e.g. daily stand-up meetings. Section 2.1.2 describes the differences in performing postmortem evaluations in both the traditional development paradigm and the agile paradigm, which was found reviewing former research.

## 2.1.1 Initial Approach for a Solution

The concept for a reflective team improvement method presented in this report, is an ongoing development from an earlier project, conducted in the fall of 2009. [Peitersen et al., 2009] The initial intention of that project, was to make slight changes and provide tool support for postmortem evaluations, to increase their utility in software projects.

Postmortem evaluation is a method to gather lessons learned from projects [Collier et al., 1996, Myllyaho et al., 2004, Birk et al., 2002, Tiedeman, 1990]. As the name suggest, the evaluations are conducted when the project has finished, or possible after major milestones in larger projects.

The literature is filled with references to the positive effects that these evaluations have, when conducted properly. [Collier et al., 1996, Myllyaho et al., 2004, Birk et al., 2002, Tiedeman, 1990, Desouza et al., 2005] According to the literature, postmortem evaluations could very well solve many of the problems, mentioned in the introduction and just above, some of which, the software industry has struggled with for decades. However, the concept of postmortem evaluation is not a new idea or phenomenon, but was developed in the 1980's. Since then, the industry has still struggled with the problems, and postmortem evaluations have not been accepted and applied in the industry in general. There might be many reasons for this, some of which are outlined in the article by Kasi et al. Here they point out that there seems to be a number of barriers that prevent postmortem evaluations from being successfully carried out in software projects. [Kasi et al., 2008]

As Peitersen et al. state, it became clear that the postmortem barriers could not be sufficiently mitigated by slight changes or new tool support [Peitersen et al., 2009]. A new concept for a method will therefore be developed. It must achieve many of the same benefits as the postmortem evaluations, but in a way that hopefully raises less or milder barriers. The definition of a method in this project is defined in Definition 2.1 and will be used through out the rest of the report.

#### Method

**Definition** An orderly procedure or process; regular manner of doing anything; hence, manner; way; mode; as, a method of teaching languages; a method of improving the mind. [Merriam-Webster Online Dictionary, 2010]

Definition 2.1: Definition of Method

#### 2.1.2 Traditional Post Project Learning vs. Agile Post Sprint Learning

In 1996 Collier et. al. published a five step process describing the postmortem evaluation process used in Apple at the time. This five step process is widely used in the literature as the example of a successful postmortem evaluation in the traditional development paradigm. However, the process is very expensive and is meant to accumulate reports, which are months in the making. As Myllyaho et. al. states, most software companies occupies less than 20 people [Myllyaho et al., 2004]. Therefore, a large report might be unnecessary in the case of small software firms.

As postmortem evaluations had not made an impact in its traditional form and paradigm, Dingsøyr and Hansen conducted some experiments with a more lightweight postmortem evaluation form used in the agile paradigm. They respond positively to the lightweight approach, which in the experiments was used to support students in their the learning of XP and of course their customization of it.

The differences between these two approaches are that even though Dingsøyr and Hansen still call it postmortem evaluations, they actually changes the concept. The concept is changed from after project learning to after iteration learning, which essentially means that problems and conflicts have a chance of being fixed during the project rather before the next project. The differences between the two approaches are explained in Table 2.1.

Traditional Post-Project Learning	Agile Post-Sprint Learning
Learning after the project.	Learning between sprint.
Motivation is to learn by mistakes, so they do not present	Motivation is to learn during the project.
themselves in later projects	
Large report	No report
Large organizations needs reports to their quality assur-	The students learned by doing. This could be the same for
ance departments.	small companies.
Organizational learning	Team learning
Idea is that by publishing the reports to the entire orga-	Focus is mainly on helping the team improve, not the entire
nization, then everyone will learn.	organization.

Table $2.1$ :	Differences	in	the	two	approaches	$\operatorname{to}$	learning.
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# 2.2 Wicked Problems

When trying to solve a problem without knowing all the background information beforehand, it is not possible to give a complete solution. This makes it a *wicked* and not a *tame* problem as Rittel and Webber state it [Rittel and Webber, 1973]. They also give ten propositions that describe a wicked problem. Rittel and Webber originally researched in city planning. Therefore, the following is an explanation of how their ten proposition can be mapped to the wicked problem of developing a method.

## 1. There Is No Definitive Formulation of a Wicked Problem

The only way of actually formulating a solution to a wicked problem would be to know every possible sequence of events in the problem. This is not possible in any wicked problem and of course not when developing a method, which is to be used by people. There is no definitive answer to this problem, but it is still possible to get closer to a good answer, than a bad one. This of course makes it difficult to generalize the results. However, as with any method it has never been the subject to find a general solution for everybody, but to find guidelines.

# 2. Wicked Problems Have No Stopping Rule

The process of solving the wicked problem of developing a new method is the same as trying to understand the nature of the problem. As there is no criteria which states that there is sufficient insight into the problem to actually solve it, then there cannot be a stopping rule.

Interesting wicked problems, such as work methods will always interest researchers and the industry and as time changes the environment, the lessons learned will need to be reconsidered.

# 3. Solutions to Wicked Problems Are Not True-or-False, but Good-or-Bad

A new method cannot be true or false, it is up to the users to judge whether it is good or bad. Furthermore, it might not be a good method for everybody, but only in the right environment.

# 4. There is no immediate and no ultimate test of a solution to a wicked problem

As mentioned the method may be decided to be either good or bad by different test groups, solely because the environment and need are different. This also underlines that an ultimate test

cannot be made, because there are too many factors (time, environment, people etc.) in work for each test.

## 5. Every solution to a wicked problem is a "one-shot operation"; because there is no opportunity to learn by trial-and-error, every attempt counts significantly

Many operations during developing software run with a trial-and-error approach, but whenever the operations involve people, the problem becomes a wicked problem. Introducing a new method cannot be undone, it will always leave a trace.

As mentioned, there are also a lot different factors working at the same time, which make it impossible to redo an attempt. However, even though the outcome of a new attempt is not the exact same, it is still possible to judge the empirical evidence.

# 6. Wicked Problems Do Not Have an Enumerable (Or an Exhaustively Describable) set of potential solutions, nor Is There a Well-Described Set of Permissible Operations that may Be Incorporated Into The Plan

When developing a method various stakeholders will have different ways of looking at possible solutions. It is a judgment call to the individual stakeholder to figure out when enough solutions have been developed and which one is most plausible to have an effect. In the case of this project the objective is to find a solution capable of achieving the four main objectives listed in Section 1.2.

## 7. Every Wicked Problem Is Essentially Unique

Even though two wicked problems can seem essentially similar, they are always unique in some matter. In terms of the method being developed the problem differs on many different levels. The most crucial one here might be the people involved, but the time period, the environment etc. is unique as well. Therefore this argument is intervened with proposition five, because it underlines that a wicked problem is a "one-shot operation".

# 8. Every wicked problem can be considered to be a symptom of another problem

Every wicked problem has more than one point of attack and when one point of attack is chosen then it becomes a symptom of the others. In terms of this project the central point of attack is "Lack of reflection leads to poor team knowledge and bad software". This discrepancy is closely intervened with other points of attack such as "Lack of team relationships", "Poor management" etc.

## 9. The Existence of a Discrepancy Representing a Wicked Problem can be explained in numerous ways. The choice of explanation determines the nature of the problem's resolution

There are a number of ways to attack the problem of high failure rate in software projects, this project chooses to approach the problem: "Lack of evaluation leads to failure in projects". Kasi et. al. give further points of attack to that problem to the traditional point of attack [Kasi et al., 2008]. However as the fourth proposition states it is not possible to put the solution

to an ultimate test. Therefore, we can not be sure that the discrepancy chosen is the correct one.

#### 10. The Planner Has No Right to Be Wrong

The last proposition is closely bound to Rittel and Webber's example with city planners. However, it can essential mean the same for the wicked problem of developing a new method. The aim as with planning is not to find the truth, but to improve the every day life for those using the method. Therefore the method developer or those applying it have no right to be wrong, but need to take the affected people into their considerations.

# 2.3 Introducing Two Paradigms in IS Research

Much of the research conducted in the Information Systems discipline can be characterized in two paradigms: behavioral science and design science. Hevner et. al defines the two paradigms accordingly:

The *behavioral-science* paradigm seeks to develop and verify theories that explain or predict human or organizational behavior.

[Alan R. Hevner and Ram, 2004]

The *design-science paradigm* seeks to extend the boundaries of human and organizational capabilities by creating new and innovative artifacts.

[Alan R. Hevner and Ram, 2004]

Both paradigms are fundamental in the field of Information Systems and are complementary to each other. The behavior-science paradigm has its roots in the natural science research methods. It addresses research through the development and justification of theories that explain or predict phenomena surrounding the analysis, design, implementation, management, and use of information systems. This means that the goal of behavioral-science research is truth (or approximations of it). [Alan R. Hevner and Ram, 2004]

The design-science paradigm has its roots in engineering and is fundamentally a problemsolving paradigm. It addresses research through the building and evaluation of artifacts designed to meet the identified business need. Therefore, the goal of design-science research is utility.[Alan R. Hevner and Ram, 2004]

This research project concerns the creations of several new innovative artifacts and therefore falls into the design-science paradigm.

# 2.4 Introducing Design Science

Before diving deeper into how Design Science research is used in this project, let us make it clear what Design Science research is and what it is not. There is a difference between Design Science research and routine design or system building. Routine design is according to Hevner et. al, "the application of existing knowledge to organizational problems, such as constructing a financial or marketing information system using "best practice" artifacts (constructs, models, methods, and instantiations) existing in the knowledge base". Design Science research on the other hand, "addresses important unsolved problems in unique or innovative ways or solves problems in more effective or efficient ways". In their article from 2004, Hevner et. al define seven guidelines to follow in order to conduct and evaluate good Design Science research. These guidelines are listed in Table 2.2. [Alan R. Hevner and Ram, 2004]

Guidelines	Description
Guideline 1: Design as an Artifact	Design Science research must produce a viable artifact in the form of a construct, a model, a method, or an instantiation.
Guideline 2: Problem Relevance	The objective of Design Science research is to develop technology-based solutions to important and relevant business problems.
Guideline 3: Design Evaluation	The utility, quality, and efficacy of a design artifact must be rigorously demonstrated via well-executed evaluation meth- ods.
Guideline 4: Research Contributions	Effective Design Science research must provide clear and ver- ifiable contributions in the areas of the design artifact, design foundations, and/or design methodologies.
Guideline 5: Research Rigor	Design Science research relies upon the application of rigor- ous methods in both the construction and evaluation of the design artifact.
Guideline 6: Design as a Search Process	The search for an effective artifact requires utilizing avail- able means to reach desired ends while satisfying laws in the problem environment.
Guideline 7: Communication of Research	Design Science research must be presented effectively both to technology-orientated as well as management-oriented au- diences.

Table 2.2: The seven guidelines from Hevner et. al. [Alan R. Hevner and Ram, 2004]

These suggested guidelines are indeed important to remember and provide the Design Science researcher with some good advice on what to achieve through the research. However, they do not provide a methodical approach to conducting good Design Science. It has been pointed out that the lack of a methodology may have been contributed to a slow adoption of Design Science as an accepted and used research paradigm. [Ken Peffers and Chatterjee, 2007]

In 2008, Peffers et. al then proposed a Design Science research methodology (DSRM) for conducting Design Science in information systems. It was based on the work of Hevner et. al along with other important contributors to the discipline.





Figure 2.1 shows the suggested process model for the methodology. It consists of six activities:

1. Problem identification and motivation: Design the specific research problem and

justify the value of a solution. Justifying the value of a solution accomplishes two things: it motivates the researcher and the audience of the research to pursue the solution and to accept the result and it helps to understand the reasoning associated with the researcher's understanding of the problem.

- 2. Define the objectives for a solution: Infer the objectives of a solution from the problem definition and knowledge of what is possible and feasible. The objectives can be quantitative, such as terms in which a desirable solution would be better than current ones, or qualitative, such as a description of how a new artifact is expected to support solutions to problems not hitherto addressed. The objectives should be inferred rationally from the problem specification.
- 3. **Design and development:** Create the artifact. Such artifacts are potentially constructs, models, methods, instantiations, or "new properties of technical, social, and/or information resources". Conceptually, a design research artifact can be any designed object in which a research contribution is embedded in the design.
- 4. **Demonstration:** Demonstrate the use of the artifact to solve one or more instances of the problem. This could involve its use in experiments, simulation, case study, proof, or other appropriate activity.
- 5. Evaluation: Observe and measure how well the artifact supports a solution to the problem. This activity involves comparing the objectives of a solution to actual observed results from use of the artifact in the demonstration. Depending on the nature of the problem venue and the artifact, evaluation could take many forms. It could include items such as a comparison of the artifact's functionality with the solution objectives from activity 2, objective quantitative performance measures such as budgets or items produced, the result of satisfaction surveys, client feedback, or simulations. It could include quantifiable measures of system performance, such as response time or availability. Conceptually, such evaluation could include any appropriate empirical evidence or logical proof. At the end of this activity the researchers can decide whether to iterate back to activity 3 to try to improve the effectiveness of the artifact or to continue on to communication and leave further improvement to subsequent projects.
- 6. **Communication:** Communicate the problem and its importance, the artifact, its utility and novelty, the rigor of its design, and its effectiveness to researches and other relevant audiences such as practicing professionals, when appropriate.

This process is structured in nominally sequential order, but this does not mean that the activities must be accomplished sequentially from activity 1 to activity 6 like a waterfall approach. In reality, a project may start in any of the four first activities. It depends on what initially sparked the interest for initiating the research. If the idea for the research resulted from the observation of a problem then researchers might proceed in the suggested sequence. On the other hand, a design- and development-centered approach would start in activity 3. This would be the case in the existence of an artifact not yet formally thought through as a solution for a specific problem domain. It might be an artifact from previous research, or an artifact used to solve a different problem.

How the methodology and its six activities are used in this project is elaborated on in Section 2.5.

# 2.5 The Application of the Design-Science Research Methodology

From a research perspective we acknowledge the benefits of a common and well understood framework for conducting design science. However, the DSRM suggested by Peffers et. al poses some restrictions and concerns that need to be addressed. Despite the attempts to conceal it, the method in its core is based on a waterfall approach and as such inherits much of the known problems associated it. DSRM allows researchers to start in any of the four phases depending on the type of project and its origin.

An entirely waterfall based approach is not applicable with the development of a new method, which in its nature is a wicked problem. Section 2.2 tells us that every wicked problem is unique (Proposition 7) and that every wicked problem can be considered to be a symptom of another problem (Proposition 8).

The following quite from Peffers et. al [Ken Peffers and Chatterjee, 2007] states that when first tested, one should not iterate back longer than to the design phase.

"At the end of this activity the researchers can decide whether to iterate back to step three to try to improve the effectiveness of the artifact or to continue on to communication and leave further improvement to subsequent projects. The nature of the research venue may dictate whether such iteration is feasible or not."

However, every solution to a wicked problem is a "one-shot" operation (Proposition 5). Meaning that it is not possible to just change the design and try again, because the first attempt left a trace. Therefore, the critique of DSRM must be that in the case of wicked problems it must be possible to iterate back to the problem identification phase.

Despite these concerns, DSRM is still the best documented method for conducting design science in information systems. Moreover, the objective when researching a wicked problem and especially in this short term project is not to find some universal truth. The objective is to take a step in a better direction or at least get some insight into what needs to be done. Therefore, the method will be use as a framework in this project, but as with any method it must be altered to fit the problem basis and with a wicked problem the iteration mechanism needs a more experimental approach. In the next sections it will be explained how each phase of the method will be used in this project.

## 2.5.1 Problem Identification and Motivation

Design the specific research problem and justify the value of a solution. Justifying the value of a solution accomplishes two things: it motivates the researcher and the audience of the research to pursue the solution and to accept the result and it helps to understand the reasoning associated with the researcher's understanding of the problem.

This research project is problem based and therefore takes its starting point in this phase. The introduction gives motivation for the initial problem serving as this project motivation. As mentioned this phase may need to be revisited as every iteration must be seen as working on a unique wicked problem. Meaning that after evaluating with a test group the results will become symptoms for a new wicked problem, which can become the spark for the next iteration.

#### 2.5.2 Define the Objectives for a Solution

Infer the objectives of a solution from the problem definition and knowledge of what is possible and feasible. The objectives can be quantitative, such as terms in which a desirable solution would be better than current ones, or qualitative, such as a description of how a new artifact is expected to support solutions to problems not hitherto addressed. The objectives should be inferred rationally from the problem specification.

This phase defines the plan of attack to the problem. Initially the problem have four major objectives as described in Section 1.2.

#### 2.5.3 Design and Development

Create the artifact. Such artifacts are potentially constructs, models, methods, instantiations, or "new properties of technical, social, and/or information resources". Conceptually, a design research artifact can be any designed object in which a research contribution is embedded in the design.

When the solution objectives are clear they are put into context by applying them in the method and potential other artifacts. As the problem at hand is wicked the design is never final, but will be reassessed with an incremental approach. This way, it is possible to keep the artifact updated with the newest solution objectives. The design of the method is explained further in Chapter 3.

#### 2.5.4 Demonstration

Demonstrate the use of the artifact to solve one or more instances of the problem. This could involve its use in experiments, simulation, case study, proof, or other appropriate activity.

A study group at the university is used in order to get the responses needed for the method to evolve. Their task is to try out the method and give back feedback. During this demonstration the project group will follow them closely and look for flaws and successes in the method. This will hopefully give some insight into utility of the method and its use. The demonstration will run as a case study, where the study group will not only use the method, but also be involved in individual interviews and a final group interview.

#### 2.5.5 Evaluation

Observe and measure how well the artifact supports a solution to the problem. This activity involves comparing the objectives of a solution to actual observed results from use of the artifact in the demonstration. Depending on the nature of the problem venue and the artifact, evaluation could take many forms. It could include items such as a comparison of the artifact's functionality with the solution objectives from activity 2, objective quantitative performance measures such as budgets or items produced, the result of satisfaction surveys, client feedback, or simulations. It could include quantifiable measures of system performance, such as response time or availability. Conceptually, such evaluation could include any appropriate empirical evidence or logical proof. At the end of this activity the researchers can decide whether to iterate back to activity 3 to try to improve the effectiveness of the artifact or to continue on to communication and leave further improvement to subsequent projects.

In order to gain insight into wether or not the objectives for this project is met or not, an evaluation will be conducted using a test group. The results procedure for this evaluation is explained in Chapter 5 and Chapter 6 present the results.

As this project only runs for a short period of time the intention is to gain as much insight into the problem and how the test group reacts to the method.

#### 2.5.6 Communication

Communicate the problem and its importance, the artifact, its utility and novelty, the rigor of its design, and its effectiveness to researches and other relevant audiences such as practicing professionals, when appropriate.

The communication activity of this research project is most importantly the artifacts developed and the response they get from the users. This is of course communicated by this report, the discussion in Chapter 7 will explicate on where this project has its utility and how it will affect the field.

# 2.6 Summary

This chapter began with a recap of the important findings in the literature study from a previous project. Here it was concluded that postmortem evaluations were a good reflective method to collect experiences and lessons learned in a project. But postmortem evaluations also have its limitations and have not been adapted by the industry. Therefore, it was decided to develop a new concept for a method.

To get a better understanding of the nature of the encountered problem, which is *wicked* rather than *tame*, wicked problems were investigated.

This project is placed in the information systems field of research. There exists two dominant research paradigms in the information system field and because of the constructive nature of developing a method, Design Science should be applied. In the search of a methodology or framework to support the conduction of research, Peffers' Design Science research methodology is chosen. It is not a perfect match to the problem at hand, but it is the only existing methodology that tries to create a standardization for the conduction of design science research.

"A common mistake that people make when trying to design something completely foolproof is to underestimate the ingenuity of complete fools."

Douglas Adams



# Design of a Reflective Team Improvement Method

How does a team improve its ability to successfully develop software? It is a simple question with no simple answer. In this chapter a new concept for a method is developed to accommodate that. The overall concept for the method is presented in Section 3.1.

The cornerstone in the method is reflection; both at the individual level and as a team. By the use of reflection it is possible to critically evaluate the experience gathered throughout the project. The individual and team reflection phases are explained in detail in Section 3.2 and Section 3.3, respectively.

One of the theoretical models which the new method is based on is the SECI-model. The model shows the creation and transformation of knowledge. In Section 3.4 it is explained how the method is inspired from and relates to the SECI-model.

In the development of the method it became obvious that the visions for the method would be hard to realize without support from a software tool. Section 3.5 present the reasoning and argumentation behind the need for such a tool.

# 3.1 New Concept for a Reflective Team Improvement method

This section introduces the new concept for a reflective team improvement method. First, the aim is presented in Section 3.1.1, which is based on experiences from the initial approach to mitigate the problem is explained in Section 2.1.1. Second, Section 3.1.2 explains the theory behind the method, and finally an overview of the developed method is presented in Section 3.1.3

#### 3.1.1 The Aim

As stated in Section 1.1, failures in software development are very expensive and often related to human factors. It is therefore important for companies to improve their software development teams to work better and more effectively.

One angle to focus on is problems and conflicts experienced by the software team. If the problems and conflicts are not identified and dealt with, they damage the performance of the team. Therefore, it would be a huge benefit if a method or tool could be found or developed that can help to mitigate these problems.

The solution objectives for such a method or tool have been defined and explained in Section 1.2 and are

- Increase individual and team reflection
- Identify and address problems and conflicts

- Learn from the mistakes that have been made
- Improve future work practices and team collaboration

Due to the research made in postmortem evaluations (Section 2.1.1), the aim for this project is to develop a method or tool to support these objectives to help improve software development teams. [Peitersen et al., 2009]

#### 3.1.2 Reflection as a Ground Pillar for Improvement and Knowledge Creation

The strength of the postmortem evaluations presented in the literature study in Section 2.1 are the evaluation meetings. In these meetings it is possible to have discussions internally in the team to identify problems and conflicts. The evaluation meetings are reflective in nature since the team look back on the experiences they have had throughout the project. The identified problems and conflicts can be discussed internally in the team, to learn from the experiences and find improvements for future projects. These improvements can include changes to processes and tools used in the projects. The important point is that through reflection and hindsight it is possible to identify problems and opportunities for improvements.

This principle can also be illustrated by the German philosopher Martin Heidegger, who talks about breakthroughs through breakdowns. He uses the terms "ready-at-hand" and "present-athand" to explain the difference between tools and objects that are an unobtrusive extension of the body and those that we become aware of and attend to. The reasoning behind this philosophy is that we use tools and objects to complete some tasks and goals without thinking about how and why these tools and objects are used. They are just ready-at-hand, a natural extension of our own bodies. But when something breaks or goes wrong with the tool or object then this illusion disappears and we become aware of them. A breakdown occurs and the tools and objects become present-at-hand which means that we have to deal with them and take action. [Dahlbom and Mathiassen, 1993]

In some cases it makes sense to force a breakdown to make improvements and breakthroughs. When the tools and objects are ready-at-hand, the users will often continue using them without realizing the possibilities of improvements that can be made. By forcing a breakdown the users will have to deal with the situation and start reflecting on their use of the tool or object. Through this process new improvements and knowledge might be created.

In software projects, the tools and objects that Heidegger refers to can also be defined as tools, processes or social behaviors. Tools, processes or social behaviors can cause problems and conflicts in software teams. These problems and conflicts may be experienced as a breakdown. These breakdowns can be realized during the project, but can also be forced by reflection. Once identified, the breakdown can lead to the breakthrough by coming up with possible solutions.

Others have also come to the conclusion that reflection is an important tool to make improvements in software development. Mathiassen for example, refers to the importance of reflection during software development and comes to some of the same conclusions as Heidegger. [Mathiassen, 1998] He points out that there exists some knowledge that is implicit in our behavior. It consists of actions, recognitions and judgments that we know how to do, but do not think about before doing them, and we are often unaware of how we learned to do them. This knowledge usually gets us through the day, but sometimes we get stuck, caught by surprise or our expectations are not met. Then we start to think about what we are doing, and reflect on our actions. According to Mathiassen, when you look at reflection from an improvement and evolution perspective, the challenge is to identify the problematic situations, reflect on them and thereby engage in an iterative learning process. [Mathiassen, 1998]

Both Heidegger and Mathiassen refer to reflection as a tool to understand problems and breakdowns and find solutions and breakthroughs to them. This process involves understanding and expanding the knowledge we have and thereby creating new knowledge.

Nonaka have created a model that explains the transformation and creation of knowledge. In principle there exist two different kinds of knowledge: explicit knowledge and tacit knowledge. Explicit knowledge is possible to express and share and can be words, diagrams, manuals etc. This kind of knowledge can easily be transmitted between individuals.

Tacit knowledge is something that is hard to see and express. A classic example is the knowledge of how to ride a bike. It cannot be expressed or taught to others, but must be learned by actually riding a bike. There are two dimensions to tacit knowledge. The technical which includes personal skills or crafts sometimes referred to as "know-how". The other is the cognitive dimension which consists of beliefs, ideals, values, schemata, and mental models, often taken for granted but shapes the way we perceive the world around us.[Nonaka and Konno, 1998]

New knowledge is created through a cycle process of interactions between tacit and explicit knowledge. This concept creates four conversion patterns. Each of these four patterns can be understood as processes of self-transcendence. [Nonaka and Konno, 1998]

- Socialization means to transfer knowledge from tacit knowledge to tacit knowledge through observations, direct interaction, and being in physical proximity. [Nonaka and Konno, 1998]
- Externalization is when tacit knowledge is converted to explicit knowledge. The explicit knowledge can take the form of words, concepts, figurative language (metaphors, analogies or narratives), and visuals.[Nonaka and Konno, 1998]
- **Combination** means to go from explicit to explicit knowledge. That happens when knowledge from different sources such as documents, meetings, telephone conferences ect. are reconfigured. To reconfigure explicit knowledge could be to sort, add, combine, or categorize the knowledge. [Nonaka and Konno, 1998]
- Internalization is to take explicit externalized knowledge and make into individual tacit knowledge in the form of mental models or technical know-how. [Nonaka and Konno, 1998]

The model is named the SECI model, after the four knowledge conversion patterns. A graphical representation of the model can be seen on Figure 3.1.

Based on these theories and models about reflection and knowledge creation and transformation the aim is to design a new concept for a reflective team improvement method.

#### 3.1.3 A New Reflective Team Improvement Method

Postmortem evaluations are trying to discuss reflections during the evaluation meetings and thereby begin a learning process. As presented in the literature study in Section 2.1 postmortem evaluations have not been adapted by the industry in general. Therefore, a new concept for a reflective team improvement process must differentiate itself to offer a real alternative. By analyzing the postmortem evaluations, four areas have been identified, where improvements are possible, which may cause a greater impact on the software developers during the discussions in evaluation meetings.

1. It seems like a wasted opportunity to only conduct the evaluations after the project is finished. This way no improvements can be made to ongoing projects, which means that changes will only occur after the projects fail or are delayed.





Figure 3.1: The SECI-model. [Nonaka and Konno, 1998]

- 2. In the postmortem evaluations, the participants only reflect just prior to and during the meeting. This means that much of the experiences from the daily work, are forgotten. This is especially true if the project runs for a long time.
- 3. Being an evaluation method for traditional development methods, postmortem evaluations only deals with the experiences and lessons learned in the projects. There is a potential to widen the scope of the evaluations.
- 4. Many and long discussions can be tiresome and create a negative atmosphere. Postmortem evaluations do not contain any techniques to counter this.

The first problem must be viewed in light of the traditional development methods that dominated at the time of the conception of postmortem evaluations. However, in the last decade, the focus has slowly shifted to the more agile development methods, which responds well to rapid changes. It is therefore an obvious opportunity to make several evaluations throughout the project. It was decided to tailor the method to one of the most known and used agile development methods; Scrum. It is however, the intention that the method can be used with any iterative and agile methods. Its time boxed 30 days sprints are natural intervals to use for evaluation meetings. Each sprint will then end with an evaluation and the end results of the discussions will be five improvement goals. These five improvement goals would be selected by the participants as the five most important topics the team should focus on improving during the next sprint. Five is chosen as the number of improvement goals because three are too few to make an impact and more than five will make it harder to focus on those chosen. Therefore, five improvement goals seem like an optimal number.

The second problem concerns the timing of reflection. To counter the time lag between action and reflection, daily individual reflection is introduced in the method. By allowing time to reflect on a daily basis, much more of the experiences will be recorded and remembered, and can be discussed at the evaluation meetings.

The solution to the third problem is to widen the scope of the evaluations. Being an evaluation method for traditional development methods, postmortem evaluations only deal with the experiences and lessons learned in the projects. With the new and agile development methods the development teams become the center. In traditional methods, there are often frequent changes of employees throughout the life of a project. Specialized employees are working on the project and when the project changes to a new phase they are replaced by others, more specialized in that area. In agile projects it is more common that teams work together throughout the life of the project and participate in all the phases of the project. More control is also transferred from management to the team. So the team is the center of the agile methods and it is therefore natural to focus on team improvements during the reflections and evaluations.

To respond to the fourth problem, it is decided during the development of the method, to change the format of the discussion meeting. Instead of a formal meeting where issues are simply discussed and experiments and lessons documented, a board game is created as a framework for these discussions. Some of the primary reasons for this initiative, is to make the discussions less tiresome and boring, and to keep a free positive atmosphere and setting for serious and complicated discussions. When tackling for instance, teamwork problems internally in a team, it can quickly turn into a heated debate that creates a negative atmosphere where people blame each other for all the teams' problems. It is the belief that a game would mitigate these problems while still allowing the participants to discuss important topics.

Figure 3.2 shows the overview of the suggested method for reflective team improvement. The next sections will examine the phases of the method and explain the individual reflection and the game with improvement goals in greater detail.



Figure 3.2: An overview of the new concept for a reflective team improvement method

# 3.2 The Individual Reflection Phase

This section will examine the individual reflection phase. Section 3.2.1 presents the purpose of the reflection and Section 3.2.2 goes into the prior development. In the end, Section 3.2.3 then explains the new design done in this project.

#### 3.2.1 The Purpose of the Individual Reflection Phase

The main purpose of the individual reflection is to stop and think about how and what you are doing. All too often, companies and their employees pressure themselves and forget to reflect on how things are going. It is easier just to continue working instead of dealing with possible problems or conflicts. By not taking the time to reflect, they miss a great chance improve themselves and their work habits.

The individual reflection can help to identify some of the problems and conflicts that arise in the team. Sometimes, the team members might not even be aware that a problem exists before they have time to reflect. Once identified, it is possible to deal with the problems and conflicts, which in the end improve the team. These improvements could be in the form of changes to the processes, tools or social behaviors of the team members. It is not the scope of the method to deal with changes in employees or selecting the right people for the team, but to make the team perform better as it is.

One of the postmortem barriers identified by Kasi et al. is "lack of time for reflection". There are simply too little time and opportunity for critical reflection as part of the postmortem evaluations. In order to remedy this situation the new proposed method puts more focus on the individual reflection. Specifically, each member of the team must reflect individually for five minutes daily. The time limit on five minutes is set to ensure that the reflection does not require too much time and resources. It must be a task that can be accomplished without disturbing the normal workflow in the team too much. It is important that the reflections become a daily habit, and must therefore not be a frustrating or boring task.

#### 3.2.2 Prior Development

During the project in the fall 2009 it was decided that the individual reflections should be conducted as a diary where each member of the team would write about the experiences of the day. This could be positive as well as negative experiences, explaining things that went particularly well or problems and conflicts. However, the diary was abandoned as a tool for individual reflection because the evaluation showed that it quickly became tiresome and boring to write in the diary. Trying to answer the same questions in a diary each day, did not inspire the team members to reflect and the diary slowly lost its purpose. [Peitersen et al., 2009]

It was therefore clear that a new concept for the individual reflections were necessary. The problem with the dairy was that it was static in the sense that it was always the same task. The task of writing positive and negative experiences never changed which slowly made the diary less inspiring to write. The new concept for reflections will have to be more dynamic and interactive with the user to keep him motivated.

#### 3.2.3 Redesigning the Daily Individual Reflection

A new concept for the individual daily reflection was then designed. The challenge was to make the reflections with the user more interactive and less of a routine. Also, the method should be able to help and trigger new reflections in order to identify problems, conflicts and possible solutions that will otherwise not be discovered.

The chosen strategy to archive these new requirements for the individual reflections is to go from the diary format (monologue) to a dialogue format. In a diary, you only communicate with yourself, but no one is questioning you or asking you to reflect deeper. No one is suggesting other areas to focus your reflections towards. In a dialog or conversation you communicate with the system. This allows the system to guide and challenge you with questions and comments that can make your reflections deeper and more specific than the general reflections in the diary format. It might make you see things from different perspectives which can lead to new viewpoints and improvements.

Because one of the problems with the diary is that it becomes boring to do the same task each day and answer the same questions over and over, the questions in the dialog must be more varied to mitigate the problem. At the same time it is important that the dialog has a good flow and that the user feels that it has a purpose and utility.

To facilitate this variation two types of questions are designed. The first type is simple multiple choice questions. These questions can be used to quickly identify areas where further reflections could be necessary. Some of these questions can have choices of yes/no while other has five-scale answers like the following, "always, to a great extent, yes and no, to a less extent, never". Examples of such questions could be: "Is there conflict surrounding the openness of the information flow?" or "Is the goals and subtasks clearly defined?"

If an answer to a multiple choice question identifies a problem then the user will be given a follow-up reflection question. This question has no answer suggestion. Instead the user is asked to reflect on the question and write down his reflections. As an example, here is the reflection question related to the multiple choice question about goals and subtasks: "What is missing in order to make the goals and subtasks more clearly defined?"

By combining these two types of questions it is possible to have a dialog or conversation with the system in which the users answers a number of multiple choice questions before being asked a reflection questions. One the reflection questions has been answered it is possible to begin a new conversation.

To mix it, it is possible to make some very open reflection questions that can be asked without having to answer a series of multiple choice questions. An example could be: "What is the best thing you have done for the project this week?" or "What is the most annoying part of the project?"

As in the previous work ([Peitersen et al., 2009]), this design also relies on the full view on the process introduced by [Aaen, 2008]. The elements of the process are

- **Product** Since this is targeted at software development, the product is the software being developed, the design, architecture, source code, etc.
- **Project** The project concerns the planning of a project.
- **Process** The process is about the practices in the software team, e.g. the practices described by a development method followed by the team.
- **People** The people aspect concerns the people of the project and namely the different stakeholders, e.g. the developers in the software team, the customer, the project manager, the end users, etc.

The questions for the individual reflection phase are divided into these categories. To aid the writing of the reflective questions for the individual reflection phase, frameworks for elements of the process has been examined. To assist the people view, the framework *Teamwork Quality* (TWQ), introduced by [Hoegl and Gemuenden, 2001] is used.

In the end of the individual reflection each team member looks over his notes from the reflections and uses them to prepare for the team reflection phase explained in the next section.

# 3.3 The Team Reflection Phase

Similar to the previous section, this section dives deeper into the team reflection phase. Section 3.3.1 and Section 3.3.2 explains the purpose and prior development before the new design is explained in Section 3.3.3.

#### 3.3.1 Purpose of the Team Reflection Phase

The main purpose of the game in the team reflection phase is to facilitate reflective discussions. Where the daily conversations are focusing on identifying problems and conflicts through individual reflection, the game on the other hand focuses on the team. Through the game, the participants will have a platform for group reflections and discussions where they can find solutions to the identified problems and conflicts. This will help them improve their team by making changes to their tools, processes or social behaviors if necessary.

To make the reflections and discussions successful, it is important that there exists a positive atmosphere. It is important to stress out that this is not a blame game, where the individuals responsible for failures are singled out and critisized. The objective is to help each other improve as a team. To support that, the game must help by creating a positive and less formal forum for the discussions, to avoid a negative atmosphere.

The results of the game must be concrete initiatives in form of improvement goals, which the team can apply to their projects.

#### 3.3.2 Prior Development

The game is designed and developed in [Peitersen et al., 2009]. In this report the focus will be on the game itself and how it is used in the method.

The game is a classic board game built from three main components; discussion questions, fact questions, and team building exercises.

- **Discussion questions** The most important component are the discussion questions which are user generated questions that refer to problems and conflicts, identified during the individual reflection. These questions are used to start the discussions in the team concerning a problem or conflict. The team will discuss the questions until some form of consensus or solutions are found.
- Fact questions These questions are also user generated and are used to break the flow in the game, to make sure that it is not just one discussion after another. The fact questions also bring a fun and competitive element into the game. It is encouraged that the questions are project relevant, but they may also be of a more funny and entertaining character.
- **Team building exercises** These exercises are meant to bring the team closer together and create a fun and relaxed atmosphere. The exercises can for instance be related to teamwork or communication, but the main purpose is that they are fun and bring the team together in a positive manner. Especially for new teams, these exercises could also be used to get to know one another better.

Before the game can start each member of team prepares three to five discussion and fact questions. This will supply an appropriate number of questions for the game, and do not burden each member with having to write to many questions. For the discussion questions the members can use the notes and answers from their individual daily reflections. Through these notes and answers they generate questions based on the problems and conflicts they have identified. For the fact questions the users might find inspiration in their reflections, otherwise they will have to use their imagination.

The game is designed for 4 to 8 players. The team size is generally recommended not to exceed 7 members in agile methods and it is therefore logical to develop a game that supports this team size. In theory it is possible to use the game in larger projects much like scrum recommends using scrum of scrums, where scrum masters participates in a coordinating scrum team. In this scenario each scrum team reflects and plays the game separately.

A concept was developed for the game to make it more interesting to play. Figure 3.3 shows the board. The game is centered in an office building and the objective of the game is to get to the corner office on the top floor and become C.E.O. of the company. Once C.E.O, the objective is to survive as such for the remainder of the game.

The players are divided into two teams each competing to become C.E.O. Each team starts at ground level and move up through the building during the game. When a team lands on a field with a "D" both teams take part in the discussion of a discussion question. When a team lands on a field with a "?" they get a fact question and only that team may answer. If they answer correctly they may continue their turn. If one of the teams land on a field with a "!" both teams will participate in a team building exercise.

During the discussions, minutes are taken to ensure important remarks and solutions are remembered. These minutes are used after the game when the players must decide upon the five improvement goals. They can use the minutes from each discussion to recall the conclusions they reached and use them in their selection.

The improvement goals are the five most important changes that the team will try to make during the next iteration. Also, it can be something that the team did exceptionally well and want to keep focus on in the next iteration. During the following iteration the team will be reminded about the improvement goals and have a chance to reflect on how well they are living up to them.

The evaluation in [Peitersen et al., 2009] shows that the game worked well as a platform for discussions. The combination of serious discussion questions and more fun fact questions and team building exercises seemed well balanced and helped to keep a positive atmosphere during the discussions. It was however, only tested with three team members and it therefore remains to be tested how well it works on larger teams.

#### 3.3.3 Redesign

During this report, not many changes have been made to the game itself. The game worked very well as it was and no changes were needed, so the focus was shifted towards improving other parts of the method. One area did however get some attention.

As in postmortem evaluations, it seemed like a good idea to bring in a facilitator role during the game. The facilitator is a neutral person whose primary objective is to control the game and its discussions. His secondary objective is to take minutes from the discussions which can be used in the end of the game when the five improvement goals must be decided.

There are two different approaches to the facilitator role. The facilitator can be an internal member of the team or an external person, and either approach has pros and cons. An internal facilitator cannot be completely neutral because he is a part of the team and the problems and



Figure 3.3: The game board developed for the game

conflicts that are discussed. This can also be considered a strength since he knows the internal relations in the team and can pick up things in the discussions that would not be possible for an external facilitator.

An external facilitator on the other hand can be more neutral and will not be participating in the discussions himself. As such, he can moderate the discussions more objectively if necessary. His disadvantage is the fact that he does not know the internal relationships in the team and can have a hard time following discussions relating to specific topics in the project of which he has no knowledge.

Desouza et. al have studied the facilitators role in postmortem evaluations and strongly advice an external facilitator. They argue that if a neutral facilitator is not present then the

project manager will quickly become the internal facilitator. This can be disastrous since he is biased and may not take criticisms gently and may show favoritism to individual team members. The success of postmortem evaluations is tied to the openness of the participants and a neutral and unbiased external facilitator can greatly contribute to this.[Desouza et al., 2005]

Another thing to consider is the economic aspect of hiring an external facilitator. It will probably be more expensive than having an internal facilitator. That is of cause unless an unbiased and neutral external facilitator can be found internally in the company. In that case the cost would be greatly reduced. It may even prove to have an additional benefit by spreading experience across the company. The facilitator can bring the experiences from the evaluation with him to his team. This way the learning is spread on a organizational plan instead of limiting it to a team level. This situation is especially beneficial in the example of running scrum of scrums, which would make it possible for other scrum masters to become internal facilitators.

Everything considered, an external facilitator is preferred in the method, because it removes bias and allow team members to be more open during the discussions. All team members can focus on the reflection and discussions. No members have to take minutes or moderate the debates, but all can participate on equal terms. This way the team will get the most out of the method and have the best experience.

## 3.4 Inspiration Based on the SECI-Model

As presented in Section 3.1.2, the development of the method has been inspired by the SECImodel of knowledge creation and transformation. In this section the model will be used to show how the method creates and transform knowledge. To ease the overview and presentation, the model has been applied on the individual reflection and the game separately. Section 3.4.1 will explain the individual reflection 3.4.2 the game.

#### 3.4.1 Individual Reflection

Figure 3.4 shows the SECI-model applied on the individual reflection. Socialization happens when the individual team member works daily in the team. He observers and collaborate with the team and gain tacit knowledge about the internal workings of the team.

When he then commences in a dialog with the system and starts to reflect and writes down his reflections, this tacit knowledge is transformed into explicit knowledge. At this point it is still only notes that are personal and not meant to be shared by others, but the knowledge is written and explicit.

The knowledge in the notes from the daily dialogs with the system are sorted, combined, and edited into questions for the game. This happens in the combination transformation pattern. The knowledge is transformed from one explicit form of knowledge to another form of explicit knowledge.

The final transformation of knowledge is in the internalization. Here the input from the system during the dialogs can make the users think in new ways and gain new perspectives on the project. By gaining new perspectives the user might view the project in a different way. And then we are back at the socialization observing the team with a fresh view, and gain new tacit knowledge.

#### 3.4.2 Team Reflection

Figure 3.5 shows the SECI-model applied to the team reflection phase containing the game. The socialization part of the game is the learning of tacit knowledge in the form of unwritten rules,



Figure 3.4: The individual reflection shown on the SECI-model

roles, and procedures that exist in a team. Often, the team members are not entirely aware of these rules, roles, and procedures. It is important, especially for new team members to learn this tacit knowledge. The team building exercises are important in this respect. Through the exercises the members can get to know each other better. Through the socialization the tacit knowledge of the rules, roles, and procedures will emerge. Examples of this knowledge could be, how to best communicate to each other, what boundaries the other members have, and which hidden or unhidden roles they play in the project.

During the meeting there is a lot of externalization. First, there are the discussions, where tacit individual knowledge becomes explicit and shared through verbal discussions. The notes from these discussions are written down and are therefore also explicit.

In the end of the game, the notes from the discussions are sorted, edited and used to create the improvement goals. This resembles the combination in the SECI model.

Finally, the internalization of the game is when each member uses the discussions to create his own perspectives and mental models of the problems and solutions. It creates new individual tacit knowledge which the members bring into the next reflection phase and can be used in socialization in the reflection.

## 3.5 The Need for Tool Support

As the development of the method progresses, it becomes clear that the method will benefit from having support from a software tool. There is a flow of much information and knowledge that can be easier to control and manage if a software tool is developed. In this section, further arguments are given for the need and benefits of tool support for the method.

First, there is a lot of information to handle throughout the process. Below is a list of some of the information used in the method:



Figure 3.5: The team reflection phase applied on the SECI-model

- Questions presented by the system during the reflection dialog
- Reflection notes and answers given by the user during the reflection
- Game questions (discussion and fact)
- Notes from the game discussions
- Improvement goals

All this information will have to be written in hand and much effort will be spend on storing and structuring the information. In a digitalized system this can all be handled by the system. The information is stored and archived automatically and can be displayed to the user in a sorted and organized way. This lets the users focus on the creation of information instead.

It will also be hard to imagine a private individual dialog as envisioned in the method, without a software system to fill out the role as a conversational partner. One will have to manually pick questions on cards and reflect over them without the possibility of following up with new related questions. In a computer system it is possible to create strategies for the selection of questions based on the answers of the user. This creates a much more dynamic and useful form of reflection.

A software tool will also be able to link the information from the individual reflection to the team reflection phase. The user-generated questions will be possible to import directly into the game by creating a digital game screen displayed to the players during the game. This further allows control over questions used in the game. For example, it is possible to ensure that fact questions written by players from team 1 are always asked to team 2. This way, no team gets a fact question written by their own players.

# 3.6 Summary

In this chapter we have introduced the design of a new reflective team improvement method. It has been based on known theories about reflection and knowledge creation and transformation.

The method consists of two main components, an individual reflection phase and a team reflection phase. The individual reflection phase is created in attempt to create a continuous reflection by using questions, rather than using a static diary. By doing so the method also differences itself from postmortem evaluations by consistently gathering reflection during the entire project period.

The purpose of the team reflection is to bind individual reflections together by discussing user generated questions in a game. The development of the game began in a former project and have been further developed in this project. The addition to the game have been the creation of a facilitator role.

Finally, the design of the method revealed the need for a software tool to support complex tasks in the method.
"A successful tool is one that was used to do something undreamt of by its author."

Stephen C. Johnson



What is needed from a software tool to support a dialog between a human user and a computer system? The dialog needs to be designed in such a way that the users can have meaningful conversations with the system, where they are given the opportunity to reflect on a daily basis. From the design of the method the conversations with the system is envisioned as being question driven. This means that the system needs to be developed to handle different types of questions and strategies to select questions that shall be presented to user. The tool also needs to be the supporting link between the individual reflections and the team reflections in the reflection game. These considerations are taken into account in the development of the tool and are presented through an analysis in Section 4.1 and design and implementation in Section 4.2.

# 4.1 Analysis

Section 3.5 established the need for tool support and underlined that a software tool would be beneficial. This section describes how the initial requirements for the tool merge into screens with interaction models. Section 4.1.1 explains the requirements and how they can be met. These are developed further into screens in Section 4.1.2.

# 4.1.1 Requirement for Tool Support

The need for a tool assisting the user's reflection is explained in Section 3.5. The requirements for such a tool is based on the five main support tasks and can be seen in Table 4.1.

The five tasks here are written in chronological order, however 2 and 3 actually takes place in the same phase of the method. This implies that they will be useful to have on the same screen.

	Information to handle in the tool	Requirements to the tool
1.	Questions asked by the system during the re-	Manage questions and conversations with the
	flection dialog	user during the individual reflection.
2.	Reflection notes and answers given by the user	Handle notes and answers given by the user dur-
	during the reflection	ing the individual reflection.
3.	Game questions (discussion and fact)	Create an easy way to write questions for the
		game.
4.	Notes from the game discussions	Minutes taking during the game.
5.	Improvement goals	Support the team when locating their improve-
		ment goals.

Table 4.1: A table showing the five main tasks the tool should support and the requirements for the tool.

#### Conversation

**Definition** A conversation is defined as a sequence of questions with the corresponding answer selected by the user, and the final remark by the user to the entire conversation.

Definition 4.1: Definition of Conversation

The other three tasks are independent and will not benefit from being put together on the same screen. That leads to four screens where the user interacts with the system.

Name of screen	Description	
Individual Reflection Screen	The screen used for daily conversations and reflection tasks.	
Pre-game Screen	A screen with recordings of old conversations from the individual reflection.	
	The screen also includes functionality to create questions for the game.	
Note Screen	A minute taking screen for the facilitator to manage minutes during each	
	discussion of the game.	
Post-game Screen	A post game screen which supports the team in writing their improvement	
	goals.	

Table 4.2: The four screens interacting with the user.

#### **Project Specific Requirements**

This project has a limited time period and the tool is developed as a prototype specifically for this experiment. Therefore, a couple of project specific requirements help to point out the important factors in this development.

Requirement	Description
Usability over reusability	The method needs to be presented in a simple and easy manner, otherwise it risks not being evaluated due to bad usability design. Therefore, it is more important that time is used on the tools appearance rather than creating reusable components, since this is a one shot trial experiments.
Manual administration over complex auto generation	A simple tool for question generation is needed for base of questions in the individual reflection. This is more important than creating algorithms for questions generation.

Table 4.3: The project specific requirements

In Table 4.3 two non-functional requirements are listed. The First is *Usability over reusability* and is valid because this software will be used for testing purposes and then require focus on *Usability* to avoid test failure on that account. *Reusability* is less important compared to *Usability*. The terms are used according to [Zeiss et al., 2007].

The second requirement is *Manual administration over complex auto generation*. Since the test is limited to few weeks as further described in Section 5.9, it will be more beneficial to manual generate the questions to the system. An interface for this is then required.

#### 4.1.2 Interaction Between User and System

This section will explain the interaction between the user and the four screens defined in Table 4.2. Beside the four screens another screen is also used to show questions during the game, but is not explained further since there is no direct interaction with the user. The interaction space design is according to [Dolog and Stage, 2007].

#### Individual Reflection Screen

The individual reflection is as mentioned in Section 3.2 a daily task, which helps the user to reflect on different aspects of the project. This makes it the most viewed screen by the user, which also causes the potential biggest threat of failure in the method, because it is a recurring task. Therefore it cannot demand more effort than the value it brings.

The interaction design of the screen is simple and simulates a conversation with the user. As shown in Figure 4.1, the system simply keeps interacting with the user until a time limit is reached. Section 3.2.3 explains the different reflective tasks and questions given to the user by the system. The difference in the conversation does not change the basic interaction model and is therefore easy adjustable and expandable.



Figure 4.1: Interaction between user and system in the individual reflection screen.

#### Pre-Game Screen

As Section 3.1.2 states, the ground pillar in this method is reflection. The idea behind the pregame phase of the method is to reflect over previous conversations in order to prepare discussion questions for the game. The interaction in this screen is therefore not much other than the user writing the discussion questions and fact questions. However, the way the overview of old conversations is display is important for the process of restoring old reflections.

#### Note Screen

During a game there are two active screens, one displaying the current question or task for the players to see and one used by the facilitator to control the game and write notes in. The interaction described here is the interaction between the facilitator and the system.

The system interacts with the user on several occasions in this screen. Firstly, the facilitator must setup the game and adjust variables such as which team is next and what type of question/task is needed. Secondly, if the team gets a discussion question, the facilitator takes minutes and persists it together with the question as shown in Figure 4.3.



Figure 4.2: Interaction between user and system in the pre-game screen.



Figure 4.3: Interaction between user and system in the note screen.

#### Post-Game Screen

The interaction in this screen demands a good overview over the notes from discussions, because this will be essential to the teams final discussion on their improvement goals. Figure 4.4 shows the simple interaction model in the screen, which also underlines the importance of simplicity in the design of this screen.

# 4.2 Design and Implementation

In this section, the design and implementation of the tool supporting the method will be described. The tool consists of several screens in which different tasks can be solved.

The purpose and reason for the different screens were explained in Section 4.1. In this section, some of their designs are described, and the functionality that is contained in these screens described as well.



Figure 4.4: Interaction between user and system in the post-game screen.

## 4.2.1 Overview of the Platform

Before developing the system, a platform needs to be chosen. The criteria for this platform are to address the target group of the experiment and ensure that they are able to use the tool. To avoid cross platform compatibility problems a web platform is chosen.

The back-end system is developed in Java and the physical setup of the system is a Linux server running an Apache Tomcat servlet engine where the system then is deployed. [Brittain and Darwin, 2007, Arnold et al., 2005]

The system is classified as a rich Internet application and therefore requires Internet browsers supporting Ajax. [Paulson, 2005, Bozzon et al., 2006]

#### 4.2.2 The Individual Reflection Screen

In this screen, the users can perform their daily reflection as described previously in Section 4.1. A screenshot of the individual reflection screen is found in Figure 4.5. In the screen, a conversation has been started and the system has provided the user with a question as seen in the middle box of the screen. In the text field, the user is encouraged to further comment on the question. To the right the improvement goals are listed.

To explain the mechanisms, Figure 4.6 shows each step in the cycle that is involved when using the reflection tool.

Each of the steps involved in the reflection tool will be further explained in the following sections.

#### **Beginning a Conversation**

When a user has been identified by the system. The user is allowed to begin the daily reflection. The daily reflection can be considered as a cycle with a conversation as subject for each cycle.

As Definition 4.1 on page 36 describes, the system must create an empty conversation for the user when reaching this step. The conversation will then have questions and user answers assigned to the conversation each time the user answers a question.

The server is responsible for creating this object and keep it in the session context for the current user.

When a conversation object is created for the user, and the a conversation session is commenced, the user needs to be presented to the first question. Different strategies for selecting



Figure 4.5: A screenshot showing the screen for the individual reflection



Figure 4.6: Figure showing the steps in the making of a conversation in the reflection tool.

questions exists, and these are explained in details when explaining strategies for question drawing.

#### Answering a Reflection Question

The next steps in the cycle shown in Figure 4.6 is to present a question and answering the question presented. First, to present questions the questions need to be defined, and second how to answer the question needs to be defined as well. There exists different types of questions, and each of these questions has different answer types.

- Simple Question These questions are the simplest imaginable. The question contains a question string and the answer type is free text. The *Simple Question* also terminates a conversation.
- Multiple Choice Question Multiple choice questions contain a simple descriptive text and suggests multiple different answers.

Third, a communication protocol needs to be established in order to enable a dialog between the server and client. For communication between the server and client during conversations, the AJAX protocol is used and the DWR library is used as abstraction. The AJAX protocol reduces overhead compared to full-page postbacks[White, 2005, Smullen III and Smullen, 2008].

#### **Termination Conditions**

There are several termination conditions for a conversation. These conditions comes from question design, testing the system and time constraints when doing the reflection. When referring to termination conditions, one distinguishes between the termination of a conversation and the termination of an entire reflection session.

A conversation ends when

1. The question is of type Simple Question.

A reflection session ends when

- 2. The reflecting user exceeds the time frame for reflection.
- 3. The user has exceeded the maximum number of conversations for a single reflection session.
- 4. The user has answered all questions in the database.

The first element in the list is simply a matter of question design. When a question does not have any references to other questions or references to a category, the conversation obviously terminates.

It was a requirement in the method to time box the daily reflection. Therefore, Item 2 describes this constraint.

In order to prevent the users from answering the questions too quick - and thereby not getting absorbed in the questions - there is a limit on the number of conversations that can be started for each reflection session.

When there is no more questions in the database, the reflection session obviously ends as Item 4 states.

With reference to Figure 4.6, when terminating a reflection session, the user are unable to commence any other conversations. However, if the criteria for termination are not met, the cycle will continue towards presenting the user for another question.



Figure 4.7: A map between strategies and which conditions trigger the different strategies.

#### Strategies For Next Question

When the system is to choose the next question in a conversation, there exists several strategies. Each strategy is applied under different circumstances. Each of the strategies will be examined along with the conditions in which they occur. In Figure 4.7 a map between the different strategies and the conditions that trigger them is sketched. The different conditions that are checked before choosing a strategy are

- Is first question in conversation The first relevant condition in the system is *Is first question in conversation*. This condition is true when a conversation is finished and a new one is about to be opened, or when the user first enters the reflection tool. This condition is also represented in Figure 4.6 and is found in the arrows leading to the *Begin Conversation* state.
- Max conversations per day not exceeded As mentioned earlier, a limit on the number of conversations a user can start is introduced. This condition is true, if the user has not reached this limit. The program will exit the user from the reflection tool if the condition

is false.

- Max time for daily reflection exceeded As part of the design criteria for the method, the daily reflection was time boxed. This condition ensures this criterion.
- Answer from previous question contains subquestion In the question design, the question is designed as a tree structure. Meaning, questions can occur as subquestions to a root question. If an answer is chosen that contains a subquestion, this condition is true.
- Answer from previous question links to other category The question design opens an opportunity for creating categories and assigning questions to categories. Also, it is possible to have an answer linking to a random question in a given category. If this is the case for the current answer, this condition will be true.
- Answer from previous question links to other question Apart from linking to a category, an answer can also be linked directly to another root question. This option is in general very similar to having a subquestion. If the answer is linked to another root question (a question which is the root of a question tree), this condition will be true.
- 20% chance for simple question This condition is artificial created in order to ensure diversity of the questions in 20% of the times. This will force the system to draw a question of type simple question. Because of the nature of these question, it is desireable to have them only in 20% of the cases, and therefore, this criterion has been constructed.
- 20% chance for simple improvement goal question As the previous criterion, this condition has been created to ensure drawing of questions regarding to the improvement goals. The percentage rate can be adjusted to serve the needs of the group.
- No more multiple choice questions in database If there is no more unanswered multiple choice questions for the current user in the database this condition will be true.

When having an overview of the different conditions that arise and is checked, the strategies for dealing with these conditions can be examined. In Figure 4.7 the different strategies are also outlined and represented as squares. All of the strategies maintain the property no question is presented more than once to the user. The different strategies are

- Get initial question This strategy chooses a random multiple choice question from the set of unanswered questions in the database.
- Get default The *Get default* strategy chooses the subquestion to the answer selected from the previous question. This is called default, since this is the default compared to the question design.
- Get from category This strategy chooses a multiple choice question from the set of unanswered questions with the category instructed by the answer from the previous question. If the category is exhausted a random question from any category will be chosen.
- Get from link The *Get from link* strategy is simple and just returns the question appointed by the answer from the previous question. The property of not presenting a question more than once may be violated in this strategy.
- Get simple question The *Get simple question* strategy is important, since a simple question is terminating for a conversation. The strategy therefore, has several conditions that may trigger it. However, the strategy itself is very simple, and chooses a simple question by random in the set of unanswered questions from the database.



Figure 4.8: A screenshot showing the pregame screen

• Get simple improvement goal question This strategy is similar to the previous strategy. However, the strategy chooses only simple questions regarding the improvement goals. This is achieved by assigning an improvement goal category to the questions.

# 4.2.3 The Pregame Screen

In the pregame screen, the object is to provide the user an interface for preparing for a game. The preparation of the game is to write discussion questions and fact questions. In Figure 4.8 the interface is shown. To the left the overview of old conversations is placed and the user can use this overview to find inspiration to the discussion questions. The interface for writing discussion questions is placed to the right. An interface for writing fact questions are found below the interface for the discussion questions. When discussion question is submitted to the system, it is stored in the database and associated with the current game. The discussion question will then be available to the game. The same story apply for fact questions.

## 4.2.4 The Note Screen

The note screen provides an interface for writing minutes to the current discussion question. The note screen also functions as a game control screen. In Figure 4.9 a screenshot of the interface is shown. To the right a text box is provided for the notes to the current game. To the left interfaces for controlling the game is placed. In the upper left corner the teams are displayed, and a button for shifting turns is provided along with a scoreboard. Below, interfaces is provided for drawing of questions.

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Tillidsøvelser/Teambuilding •		

Figure 4.9: A screenshot showing the note screen

#### **Drawing of Questions**

The drawing of questions needs to be designed in order for the game not to be spoiled. The drawing of discussion questions is no problem, since all participants of the game should participate in group discussions. However, it is not desirable that the fact questions are presented to the author of the question. Since the game is designed in a way to divide the participants into teams, the drawing of questions must ensure that the fact questions are always drawn from the set of fact questions provided by participants from the other team.

#### Interacting With Game Presentation View

In the system a *Game Presentation View* screen is also necessary. This screen's only objective is to display the current question drawn from the note screen. The *Game Presentation View* screen then needs to be notified when a question is drawn. An observer pattern applied on the question drawing event seems obvious. However, since the client observing is a web client, the solution must use technologies allowing a the server to invoke a method on the web client. The DWR library used as abstraction for the AJAX communication also provides this functionality.

## 4.2.5 The Postgame Screen

The postgame screen is to be used immediately after the game has finished. The minutes from the note screen is displayed in this screen. In Figure 4.10 the notes are displayed to the left of the screen. To the right interfaces for typing in the five improvement goals are provided. Each discussion question is associated with their notes and can be browsed for inspiration.



Figure 4.10: A screenshot showing the postgame screen

# 4.3 Summary

In the end of last chapter a need for tool support was identified, this chapter investigates the tasks that needs support by an IT-system. The tasks is analyzed to find the interactions between user and system, this is shown in Section 4.1. The analysis also includes some project specific requirements, which essentially points to building a prototype solution for the experiment, rather than focusing on finishing a reusable system.

The design and implementation of the system is explicated on in Section 4.2. It shows how the interaction design is made in the system, in order to simplify the tasks for the user. The section also shows screenshots from the prototype used in the case study. "Failing to plan is planning to fail" Alan Lakein

# 5 Evaluation Procedure

When conducting an evaluation with an experiment it is always important to have made some considerations about the procedure beforehand. Through this chapter it will be explained how the evaluation experiment is going to be conducted. The purpose of the experiment will be presented in Section 5.1 followed by Section 5.2 that explains the focus of the evaluation in form of a key question. The participants for this evaluation is a group of students at AAU and they are presented in Section 5.3.

One of the important decisions when conducting an evaluation is to choose the right method. In Section 5.4 several possible methods are analyzed and it is described how the chosen method is applied.

Through the experiment the participants will have to complete a number of tasks. These tasks are explained in Section 5.5. It is also important to set the context and list the equipment that is necessary to complete the experiment. This information can be found in Section 5.6.

Once the experiment is over the participants will be debriefed through a group interview. The contemplations about the form of the interview can be found in Section 5.7. In interviews it can sometime be difficult to capture the essence of the meaning which the participants are explaining. Therefore Section 5.8 look into techniques to improve the validity of the interviews.

Finally an overview of the planned schedule for the evaluation is presented in Section 5.9.

# 5.1 The Purpose of the Experiment

The purpose of the experiment is to evaluate the effect and utility of the proposed method. The aim is to document whether the method has a positive effect on the team's behaviors and if the method has any utility for them. If that is the case, then the point is to show that these effects can be linked to the individual and group reflections incorporated into the method.

A secondary purpose of the evaluation is to receive new and valuable feedback from the participants, which can be used to improve the method and its utility even further.

In an earlier project, a previous version of the method was evaluated by the research team, see [Peitersen et al., 2009]. Based on the experiences the method has been modified to the current version described in this report. Therefore, it is important that the new evaluation is carried out with participants that are independent of the development of the method. This makes them able to evaluate the method in an objective manner. Independent participants will naturally be less biased and therefore able to give a more credible indication of the utility of the method.

An important aspect of the evaluation of utility is to apply the method in a realistic context and setting. The main component of the method is reflection, both individually and as a group. To fully evaluate the utility of the method, the reflections will have to show changes and effects in the behaviors of the team in the context and setting, where their project is developed. This is important because there can be unidentified influences from the context and setting that affects the results of the method.

Another aspect of the utility of the method is the learning curve associated with it. If the learning curve is too steep and it takes too long time to learn how to use the method effectively then the utility will be less in a short evaluation period. The experiment will give an indication of the learning curve that the method will have and that must be taken into account in the evaluation of the potential utility of the method.

# 5.2 Key Question

To keep focus during the evaluation it is beneficial to know the key question that the evaluation addresses. In this project it is necessary to evaluate whether the method has a positive effect and if it has any utility. Therefore, the key question for the experiment is

Does the method have any utility for the participating team, and does it have any positive effects or influences on the behaviors of the team.

To answer this broad question, it is necessary to look into several different aspects of the behavior in the team. This could be changes to their development process, the way they collaborate on the project, a therapeutic effect like their general feeling of "satisfaction" towards the project, or other types of changes to the teams' behavior. This could be the result of discussions in the game about problems or conflicts in the group and actions that can be taken to solve these. If it is possible to show a link between the use of the method and the positive changes and affects it causes, then the method has a utility.

It is also important to gather information about how well the participating team follows the method and their motivation for participation. If the team does not complete enough daily reflection for example, or are not motivated to take the reflections seriously, then the results of the utility of the method are weakened considerably. Therefore it is important to understand how the team applied the method in practice and if there were any deviations from the intended use.

# 5.3 Experiment Participants

The chosen team for this evaluation is a software engineering group on the 8th semester. There are seven group members in the team and they work from a common group room at the university. Their project is about the development of an application for mobiles phones. The team has chosen to use SCRUM as their development method.

# 5.4 Test Method

This section will concern the test method used in the evaluation. Different evaluation methods will be presented and analyzed, before diving deeper into the chosen method and the application of it.

# 5.4.1 Overview of Evaluation Methods

Evaluation in software engineering is seldom a small and simple task. It takes time and careful planning to design an evaluation that produces meaningful and useful results. The researcher

has a variety of evaluation methods at his disposal, all of which have strength and weaknesses. It is imperative to select an appropriate evaluation method based on the context and setting of the objects or subjects that are being evaluated.

The aim of evaluation in this project is of cause the proposed method. When a new method is introduced in a team, complex and unpredictable changes are often the result. The evaluation method must be able to capture these changes. It is also important that the evaluation method is flexible and adjustable during the evaluation. There is only one chance in this project to complete an evaluation and if for some reason it fails or goes wrong and no usable data result from the evaluation, then it will cause much harm to the project. Therefore, the evaluation method must allow the researchers to react and intervene, if necessary, in form of changes to the method or tool.

Wynecoop and Conger have identified several research methods that could be applied to an evaluation of the proposed method: [Wynekoop and Conger, 1990]

- Case Study
- Field Study
- Action Research
- Formal Experiment
- Sample Surveys

Field studies are expost facto, meaning that they are conducted after the actions are completed. They are based on recall and self-report of participants and no independent variables are manipulated during the evaluation. In this evaluation it becomes a problem that no data is collected before the test period of the proposed method has been completed. It does not allow intervention from the researchers during the evaluation.

One of the purposes of this evaluation is to get an independent assessment of the method. Therefore, action research is not applicable either because the heavy involvement of the researchers creates undesired bias.

Finally, sample surveys are not practically possible to apply in this project. It would require that many teams are willing to participate in the evaluation. Also, it poses the same problems to researcher intervention as field studies does.

This leaves two types of evaluation methods left to be further analyzed - the case study and formal experiments.

#### 5.4.2 Analysis of Evaluation Methods

According to Kitchenham and Pickard [Kitchenham et al., 1995], formal experiments are more likely to be useful for the evaluation of independent tasks. Independent tasks can be isolated from the overall product-development process and investigated formally without being unrepresentative of the way they are actually performed. The results can be assessed in isolation from other project processes, so that small benefits can be identified and distinguished from other variables. Formal experiments also require appropriate levels of replication, and experimental subjects and objects that are chosen at random within the constraints of an experimental design. [Kitchenham et al., 1995]

A formal experiment allows the researchers to follow the participants closely during the experiment. This enables the researchers to intervene if necessary before the evaluation is completed. Since experiments are often conducted in a lab, many options for data collection are also available including audio, video, screen recording etc.

When a new method like the proposed is introduced in a project team, the effects can be very widespread. Formal experiments require controlled environments and because the results of the method cannot be isolated and analyzed outside the context of the project in which it is applied, the evaluation will have to be set in the project's normal context and setting. This makes it difficult to control and is therefore not optimal for this project.

Wohlin et. al defines a case study as a method to conduct an investigation of a single entity or phenomenon within a specific time space. The researcher collects detailed information on, for example, one single project during a sustained period of time. During the case study, a variety of different data collection procedures may be applied. [Wohlin et al., 2000] These data collection procedures could include interviews, observation, questionnaires, computerized data, and written materials.[Wynekoop and Conger, 1990]

The major advantage of case studies is that changes and processes over time can be analyzed. [Wynekoop and Conger, 1990] The effect of these changes can only be assessed at a high level of abstraction because the process change includes smaller and more detailed changes throughout the development process. [Wohlin et al., 2000]

Compared to formal experiments, case studies are conducted in the natural setting for the object under evaluation and this makes data collection harder than in a lab. The fact that the method under evaluation is divided into multiple phases makes the data collection even harder since different data collection procedures must be applied for each phase. A case study does, however, allow the freedom to select any appropriate data collection procedure that can be applied in the natural setting.

The problem with a case study is that it is harder to interpret the data and difficult to generalize. It shows the effect of the applied method, but it cannot be generalized to every possible situation. [Kitchenham et al., 1995] This means that if the method is applied in a project running SCRUM as a development method then the effects cannot be generalized to projects running other more traditional development methods. Further case studies would be necessary to determine the effects in such contexts.

#### 5.4.3 Case Study Chosen as Evaluation Method

The arguments presented above make case studies more suitable as an evaluation method than formal experiments. It is the best evaluation method to document the effects that the method has on the participating team working in their natural setting. Because the multiple phases in the method under evaluation are different in their nature, they require different data collection procedures. For example, the reflection phase is hard to manually observe, when done in the team's natural setting, because it is individual and private. On the other hand, the game phase is easy to observe while the team plays the game. Therefore, the data collection procedures have to be carefully selected and planed according to the phases in the method. Section 5.6.1 explains which data is going to be collected during each phase and which data collection procedures are used to do it.

Another concern is the limited generalization that the evaluation support and this must be kept in mind. This means that the evaluation cannot be used as a conclusive documentation that the method has the shown effects when applied in any software project. What it can do however, is to identify and document the effects the method has on this team and their project. Further research would then be needed to show whether the identified effects can be generalized.

The biggest concern, however, is if parts of the method fail which might cause the entire evaluation to fail or cause unusable data. Therefore, a slight modification to the normal definition of a case study is introduced. The researchers will be able to intervene and make changes to the method during the evaluation if they find it necessary. This is not a typically approach in a case study but a necessary one to heighten the chances of useful evaluation data. There is only one opportunity to conduct an evaluation so it is very important to get the best of it.

# 5.4.4 Application of the Case Study

As stated in Section 5.3 the case study is of a project developed by a software engineering group at the 8th semester. To better be able to overview the different aspects of the case study it has been divided into phases. There will be the four phases and below each of them is explained:

- 1. Introduction to the method Before the team can begin to use the method it is important that they get an introduction to the method and the way they are going to use the reflection tool. It is critical that the team understands the intentions with the method and tool in order to maximize the utility of them. If the participating team is not fully motivated then the effects of the method might have less impact. As part of the introduction to the method the participating team will also be asked to present a short introduction to the project they are working on.
- 2. **Reflection phase** In this phase the team will reflect on a daily basis using the reflection tool. There will be no interference from the research team. The phase runs during an iteration in the development process which is approximately two weeks.
- 3. Game phase During the game phase in the end of an iteration, the team will play the game. One researcher will act as a facilitator during the game, to control the flow of the game and possibly moderate the discussions if they get out of control. The rest of the research team will observe the discussions and interactions of the team.
- 4. **Debriefing** A group interview will be conducted with the team. Here the team will be able to express their experience with the method and the reflection tool. This is very important feedback from a research point of view. Here it will be established whether from the teams point of view that the effects and changes of behavior can be contributed to the use of the method. The participants will also be able to suggest modifications and additions to the method and reflection tool for further improvement.

In this case study, step 2 and 3 is repeated twice in order to capture data from two iterations. This is done to evaluate the effect of the method over a longer time span, but also to record any changes between the first and second time the game is played. The iterations are set to two weeks, which means that the case study will run for about four weeks in total.

# 5.5 Task List

The tasks list defines the tasks that the users will have to complete during the evaluation. In the case study the tasks are related to the two phases in step 2 and 3 from Section 5.4.4, namely the reflection phase and the game phase.

# 5.5.1 Reflection Phase

In the reflection phase (step 2) the participants will have two main tasks

- 5-10 minutes daily individual reflection using the reflection tool. They will be using the dialog feature to answer questions and write reflective statements. The questions will be divided into categories for the test. Since the participants are relatively new to working as a team with SCRUM, the first category will address the team's ability to conform to SCRUM while adapting it to fit their specific project. Other categories concern the teamwork and the ability to work effectively and efficiently as a team, and the 4P (product, project, process, people).
- Near the end of the reflection phase the participants will be asked to individually create discussion questions and fact questions for the game. The data from the reflection will be available as inspiration for the generation of reflection questions.

Each of these two tasks is critical for the success of the method. If the team is not motivated to do the daily individual reflections, then many of their problems and conflicts may not be identified. If that is the case, then there is no useful input for the game and then the method will lose its effect. A similar problem arises if the problems and conflicts from the reflection are too hard to convert into reflection questions for the game.

The researchers will not be present while the participants conduct their individual reflections using the reflection tool. The researchers will however be able to monitor the system and the resulting answers from the reflections. These answers, along with individual interviews throughout the reflection phase will be the sources of intelligence for the researchers to identify if intervening actions is necessary to increase the motivation of the participants or make adjustments to the method to increase its utility.

There can be many reasons for the loss of motivation but there are a few simple actions that the researchers may take to make the teams motivation return. If the loss of motivation is caused by lack of incentives for using the method, then simplest action is to remind them of the benefits that they gain from participating in the evaluation. Explain how they can use the method and the experiences they gain from it in their project report. It is important that the team realize the value that the extra effort adds to the project.

If the motivational problem lies in parts of the design of the method which damages the utility, then changes might be necessary to motivate the team to complete the evaluation. As mentioned earlier it is imperative for the project that the evaluation is completed with useful data results, since it is only possible to conduct one evaluation. If it fails no other evaluation containing impartial users will be conducted.

#### 5.5.2 Team Reflection Phase

During the game phase (step 3) the participants will have the following tasks:

- Play the reflection game to initiate the group reflections through the discussions. The rules of the game is further explained in Section 3.3.3.
- Decide upon five improvement goals that the team will try to achieve during the next iteration.

Contrary to the reflection phase the researchers will be present during the game phase. The biggest threat in this phase is whether the discussions are constructive and fruitful instead of destructive and harmful. The method already has a build in mechanism in the form of the facilitator, to deal with this threat. One of the researchers will be given the role of facilitator for this evaluation.

# 5.6 Context and Equipment

In accordance with the arguments laid out previously in this chapter, the reflection phase of the evaluation will be carried out in the team's own group room at Aalborg University, while they are working on their student project. This ensures that the method will be applied in the context and setting in which the development takes place.

The game phase will be held in a lab at the university called SIRL. The benefits of conducting the game phase in SIRL is the interactive screens that is present in the lab. The screens are large touch screens, and can be used to show the game screen while the game is played. Once the game is over the minutes from the game can be posted and the players can use the interactive screen to look through the minutes and write their five improvement goals. The interactive screen allows them to be more active and totally in control of the process of writing the improvement goal. [Aaen, 2008]

The necessary equipment needed to conduct the evaluation includes

- A reflection tool server: A server to run the reflection tool.
- A video camera: To record the game phase for later analysis.
- A laptop with the game client: A laptop used during the game to access the game client.
- SIRL and the interactive screens.

In addition to this equipment, it is assumed that each participant have a laptop to their disposal, which they can use to access the reflection client for the daily individual reflection.

## 5.6.1 Data to be Collected

Data will be collected throughout the entire duration of the case study. The type of data depends heavily on the phase of the study. Below is an overview of the data that will be collected in the respective phases.

#### 5.6.2 Introduction to the method

• Notes: During the introduction it is noted whether the team has any questions or concerns regarding the evaluation. As part of the introduction the participating team will also be asked to give a short presentation of the project that they are working on during the evaluation. The researchers take notes of this and will be able to tune the reflection tool with questions relevant for team's project.

#### 5.6.3 Individual Reflection phase

- Participant's dialogs with the reflection tool: The history of the questions presented to each participant and the corresponding answers are recorded in the system.
- Individual interviews: During the reflection phase the researchers conduct individual interviews with the participants. Not all at once, but one or two participants a few times per week. This is a chance to get some insight and feedback on the method during the reflection phase from a personal perspective. They will be able to give feedback without being under peer preasure from the rest of the team. It will also be possible for the researchers to ask questions directly linked to the reflections the participant has given without compromising

the privacy of the content to the rest of the team. It will be short interviews of a few minutes and will not require any preparation from the participants. This ensures minimal disturbance and impact to the team's workflow. During the interview, a researcher will take notes for documentation.

#### 5.6.4 Team Reflection Phase

- Video recording: The game phase will be recorded using a video camera to capture the content of the game and discussions and how they were conducted. This will be used for further analysis to improve the method.
- Minutes from discussions: The minutes from the discussions are primarily used to select improvement goals but can also be used at a later point to analyze the discussions.
- Improvement goals: Is a result of the game phase. Is also used as input for further reflections in the reflection tool during the next iteration. As these improvement goals are concrete results of the reflections in the game, it is interesting to analyze if they have an impact on the team.

# 5.7 Debriefing

When the two iterations are completed and the last game has ended, a debriefing in the form of an interview with the team will be conducted. The purpose of the interview is to let the participating team express their experience with the method and the reflection tool. It is important to document what changes and effects the method has had on the team and whether they believe that these changes and effects are worth the extra effort. For further improvement, the participants will also be able to comment and suggest modifications and additions to the method and reflection tool.

It will be a group interview since it allows the participants to discuss their experiences and contribute with extra comments inspired by others opinions. This will increase the value of the interview compared to conducting individual interviews because they can be inspired by each other's comments. This is not possible in individual interviews.

According to Robinson, [Robinson, 1993] group interviews are more likely to focus on the discussions of the group's experiences (normative responses) compared to individual experiences. This is desirable because the method's purpose is to improve the team as a hole and therefore it is most interesting to examine the normative responses.

# 5.8 Validity of Interview Documentation

The individual and group interviews are mainly documented by taking minutes. But it can be difficult to capture the exact meaning of the people being interviewed. It is possible that something is misinterpreted or misunderstood. To deal with this, triangulation is used to verify the documented statements. There are different types of triangulation but in this study methodological triangulation is used. This means that multiple methods is used to examine the phenomenon. In this case the phenomenon is the participating team's use of the method.[Denzin, 2009]

Once the minutes from the interviews have been transcribed in questions and answers, they are sent to the team so they can verify the content. The group interview is sent to every member of the team while the individual interviews is send separately to each member to whom the interview concern. This way, two methods (interview and verification e-mail) are used in sequence to verify the same result are also referred to as sequential triangulation. [Creswell, 1994]

# 5.9 Evaluation Schedule

Now that all the individual elements of the evaluation plan has been presented and explained a final overview of the schedule for the evaluation is presented. On Figure 5.1, the schedule for the evaluation can be seen. As mentioned the evaluation runs during two sprints. The evaluation starts on Tuesday the 6th of April, and not Monday the 5th because of Easter. It ends on Friday the 6th of May.

The individual activities during the evaluation can be seen in Figure 5.1. In addition to these, the participants conduct the individual reflections on a daily basis. Because of lectures and other preplanned events it is not possible to play the game in the end of the sprints, and therefore both games are played in the beginning of the next sprint.



Figure 5.1: The schedule for the evaluation.

# 5.10 Summary

During this chapter, the procedure of the evaluation has been presented. The main purpose of the evaluation is to decide whether the method has any utility for a team of software developers. The team chosen to participate in the evaluation is a software engineering group from the university that studies at the 8th semester.

Through a case study the team will be studied while they use the method. The team will use the method during two iterations, where they will reflect daily using the individual reflection tool. In the end of each iteration they will play the reflection game.

Data will be gathered about the use of the reflection tool. There will also be conducted individual interviews throughout the evaluation period. In the end of the evaluation an group interview will be conducted to capture the experience that the team have had using the method. "Experience is a hard teacher because she gives the test first, the lesson afterwards."

Vernon Law



Sometimes the results from an experiment are precisely what you had anticipated. Other times they might not be exactly what you expected them to be. You might even be surprised by the outcome. This is often true when the experiment involves human beings in complex situations. Nevertheless it is always important to try and relate and understand the outcome of an experiment.

Section 6.1 presents the results from the evaluation that was conducted based on the procedure described in the previous chapter. These results include the some of the observations that the researchers collected by monitoring the individual reflection tool and the reflection game. It also includes the interviews that were conducted during the evaluation period. These results are then analyzed and interpreted in Section 6.2.

## 6.1 Presentation of Evaluation Results

This section presents the results form the evaluation of the method. The results are grouped in four sections. The first is the results from the individual reflections where the team has been using the individual reflection tool. These results can be found in Section 6.1.1. Next is the results from the two games that were played during the evaluation. They can be found in Section 6.1.2. Section 6.1.3 presents the results from the individual interviews conducted throughout the evaluation phase. Finally Section 6.1.4 presents the results from the group interview conducted after the last game.

#### 6.1.1 Individual Reflection Phase

During the individual reflection phase the participants were asked to reflect by using the developed reflection tool on a daily basis. Through conversations with the systems they would answer a series of questions. This section will show how much they used the tool throughout the evaluation period.

Figure 6.1 shows a diagram showing each day in the evaluation period. It shows for each day how many participants answered questions and how many questions that were answered in total. Finally it shows a curve showing the average number of questions answered per participant daily.

In Figure 6.1 there exist some dates where the tool is not being used. The tool is only used on days where the team has done any actual work on their project, and the gaps either represent weekends or days where the group members have been occupied with other work, e.g. lectures.



Figure 6.1: The diagram shows how many participants have answered on given days and the number of questions answered.

Game	Time	Discussion Questions	Fact Questions	Team Building Exercises
1	97 min.	16	11	4
2	73 min.	20	19	2

Table 6.1: Statistics from the two game sessions.

## 6.1.2 Team Reflection Phase

During the evaluation, the team played two games and it should be noted that all members of the team participated in both games. This section presents the data that came out of these sessions. In the table below it is possible to see the time of each game, and how many discussion questions, fact questions, and team building exercises that were completed.

After each game five improvement goals were chosen, which the team should focus on during the next iteration. Here are the lists of improvement goals the the team came up with during the two games.

#### Improvement goal from the first game

- 1. We should be better to tell the group when there is too much noise. Keep an eye on your own level of noise. One should respond to a request about being quiet.
- 2. At the start of a sprint we need to spend more time on defining tasks. The sprint backlog must be approved by the whole group.
- 3. Update the WIKI when an assignment is done, and when it has been proof read with a list of corrections.

- 4. We need to be more aware of assignments that can be handled by one person.
- 5. The scrum master should to some extend control the discussions. Everyone should be aware if the discussions leads to anything contructive.

#### Improvement goals from the second game

- 1. Write introduction to the implementation sections so they become easier to read for the reader of the report.
- 2. We must focus on which tasks are the most important in the final phase of the project.
- 3. The application must be visualized in the implementation sections of the report.
- 4. If one has to go early, one has to do some work at home for the next day. The tasks must be agreed upon before leaving.
- 5. Important points in the discussions must be written down in the WIKI by the scrum master.

#### 6.1.3 Individual Interviews

This section will present the results from the individual interviews. First, the proceedings will be explained and then, the results from the interviews.

#### Proceedings

The individual interviews were conducted throughout the evaluation period. Each participant was interviewed once during one of the three interview days. The schedule for the interviews has been presented previously and can be found in Section 5.9. The full list of questions and answers for each interview can be found in Appendix A.

During the interview one of the researcher acted as the interviewer, another as an observer with the possibility of asking clarifying or follow up questions. The last researcher took the minutes.

The interview was conducted as a semi-structured interview where a check list of questions were prepared before the interview, but with the option to ask further questions if necessary.

Depending on the responses, the interview could take different directions and improvised questions could be asked. When a topic had been exhausted a new question from the checklist could be asked. This form for interview is flexible because it allows the interview to improvise if something interesting comes up during the interview that needs to be further explored. This flexibility is a benefit because it can be difficult to predict the direction of the interview and all the relevant questions beforehand. It would be a shame to lose valuable experiences on that account.

#### Results

In this section, a sample of the results from the individual interviews will be presented. The full list of answers to the seven interviews are a comprehensive list and can be found in Appendix A. The questions and answers have been placed in two categories representing the individual reflection phase and the game phase.

#### Questions about the Individual Reflection

- **Q** Are you satisfied with the outcome of the individual reflection? Or how can you benefit more from this?
- A Subject #6 : As one did not have high expectations to this, the outcome has been surprisingly positive.

**Subject** #7: Subject #7 indicates that it would be appreciative to have the reflection questions as part of a project context, meaning that questions should address the current phase of the project.

#### Questions about the Collective Reflection

- **Q** How did you feel about participating in the game session?
- A Subject #5 : It was a positive experience, and subject #5 was surprised about the positive aspects of the game.

Subject #6 : Generally a good experience.

**Subject** #7: Subject #7 expressed that the game is a fun experience. Subject #7 is pleased with the idea of the 5 improvement goals that wrap up the game session.

#### 6.1.4 Group Interview

This section presents the results of the group interview. First, the proceedings for the interview will be explained before the important results from the interview are presented.

#### Proceedings

The group interview was conducted in continuation of the last game. All members of the test team were present as well as the researchers. The researcher that was appointed facilitator during the game acted as the main interviewer. Another researcher could ask clarifying follow up questions if necessary. That last researcher took minutes, but the session was also recorded on video to capture the entire interview.

Before the interview started, the interviewer began by thanking the team for their participation in this evaluation period. He then explained how this last interview was going to be conducted.

The interview was conducted as a semi-structured group interview where prepared questions were used as a checklist. The checklist was used by the interviewer to start discussions about a topic. The team discussed the topics internally but the interviewer could also participate and supply comments and clarifications from the researcher's point of view.

By choosing a semi-structure interview for the group interview as done in the individual interviews the same benefits apply.

#### Results

The results presented here are those answers from the interview that is important and interesting to analyze with respect evaluating the method. The full list of questions and answers can be found in Appendix B. The results have been divided into five categories depending on general topics.

• General Discussion about the experiment:

As the first question the team was asked about the effects they had experienced while using the method. To that they replied that it may have been too much to use the reflection tool every day. There were too little variations in the questions and they did not always address the phase that the project was currently in.

They also stated that the individual reflection combined with the game gave them an opportunity and a forum to discuss important topics. It had a positive effect that the discussions were held outside of the group room since it made it easier to keep focus on the discussions because there were less distractions. Everyone could keep focus on the discussions instead of their laptops or other things.

When asked about the impact that the method had on their team work or the way the team worked in general they replied that there were minimal impact. Only minor adjustments had been made based the use of the method (e.g. the noise reduction in the group room). They explain this by stating that they have been working together as a group for a long time already and know each other well. This has caused them to have very integrated routines and work habits which are difficult to change. They do however believe that the method may have greater impact on new teams or teams that are less tightly-knit.

The team was also asked to consider the effects of using the method over a longer time period. To that they responded that the questions would have to be adjusted to the phases of the project. On the other hand they also recognized the positive effects that more random questions can have. Such out of context questions can inspire the team members to think in new and alternative lines.

#### • Further adaptation of the method

The group was asked what changes they would make if they were to continue using the method. To that they answered that the method requires much time in its present form. Especially the game which takes half a day that is a big time consumer. That would require changes but they point out that they have been using the method with iterations of only 14 days. They acknowledge that it might be a different experience if the iterations runs for 30 days as recommended by SCRUM.

In the reflection tool they would like an "undo" button so they can roll back answers if the chose the wrong answer by mistake. This is relevant if they misunderstand the question and discover this in a follow up question. They would also like support for comments to all the answers in the conversation. They think that some answers were hard to choose between and would like to be able to give a reason for their choice.

The team was also asked if they would use the method or elements from it in the future. They could imagine using the method as a recurring event at the end of iterations with some of the changes they have suggested. Among the most important is to implement more variation in the questions. They do however point out that it is difficult to infer changes to well established groups or teams with well defined routines and processes.

One team member said that if he was team leader for a new team, then he might introduce them for the method in the beginning of a project. He felt that it was a good method for team members to get to know each other and to agree on work routines and processes.

#### • Effort versus effect

The team had some concerns about the effort and time consumption that the method requires. They were therefore asked if it was better to have less frequent individual reflection, maybe even just prior to the game. Their comments were that there should not be too large gaps between the reflections since it would be hard to remember what happened. This would result in loss of important views and reflections in their opinion.

In the same context they were asked if the five minutes of daily individual reflection was too long, short or appropriate? The team all agreed that five minutes were an appropriate amount of time to use on the reflection.

Based on these views the team was asked if they felt that the effects was worth the effort. To that they responded that the first game was worth the time and work. They felt they found some good improvement goals and that they were followed. As a comment to that, they liked the fact that they could see the improvement goals in the daily reflection tool. That helped them to be reminded of the goals and it gave a good effect to see the visual results of the reflections done in the method.

#### • Discussions about the Game

One of the questions about the game was how the atmosphere had been during the game. The team felt that the atmosphere had been great and that the team building exercises had been fun. They brought a fun and positive atmosphere, but had no negative influence on serious discussions. The team also made a comment that the team building exercises might even be more effective in new teams where the members did not know each other so well.

When asked about the fact questions they responded that they worked well, but did not bring much knowledge sharing into the game. They were however, a fun element and contributed to the competitive spirit of the game.

The team was also asked to consider the implications of running the game without an external facilitator. Instead an internal member could be given this responsibility. The team was not so positive to this suggestion. This would probably ruin the flow in the game in their opinion. Currently, it is an advantage that the players only focus on the discussion and are not interrupted. They could however imagine that the minutes could be taken after each discussion had ended. That would prolong the game and that might not be desirable. In their view, an internal facilitator may also rise problems, since he is not neutral. He could even be the person discussed in the game.

#### • Alternative Ways of Using the Method

The team was asked about how they liked the way of reflecting during the project compared to reflecting after a project has ended. They answered that this way of reflecting on the process is preferable compared to doing it after a project has ended. It is good to have a chance to correct an error in the process when it arises. After an iteration or project has ended, the motivation for reflecting on your process is gone. It is therefore better to reflect during each iteration and project. Often, people would like to have experiences made in the current project transfered to the next project, but it never happens for some reason. When you take lessens learned from previous projects you often only remember a few and they might not be so relevant in the new project. In this method you have concrete and relevant improvement goals that you can relate to during the project.

The team was also asked about the time of day for the reflection. They had chosen to reflect as the first thing in the morning before the daily stand up meeting in SCRUM. They felt that this had a positive effect and that it was a nice way to start the days work. They were then asked how they think reflecting in the afternoon would work instead. In their experience it would not work as well. Often, people would be mentally tired in the end of the day, which might cause them the to rush or skip the questions in the reflection. They were also asked about the possible effects the method could have had if introduced in the beginning of the project. They stated that the reflection phase probably would result in important discussions that would be taken earlier in the project process. It would also help to define work processes quickly and early in the project and keep focus for the duration of the project.

#### 6.1.5 Improvement Example

Figure 6.2 shows the intermediate results that the team has reached between the identification of a problem and the suggestion of an improvement. The topic of the example is noise in the group room.

This problem is identified using the individual reflection tool. On the figure it is possible to see the reflection note that one of the team members wrote about the annoying noise. This reflection makes the team member write a discussion question for the reflection game where the topic is the noise in the group room. The questions is discussed during the game, and the minutes from this discussion is presented in the bottom of the figure. During the discussion, one of the points are that people are failing to communicate when the noise are annoying them. This leads the an improvement goal that urge the members to point out when they are annoyed by noise and to be receptive when somebody tells them to keep it down.

This improvement goal may very well spark new individual reflections in future iterations.



Figure 6.2: This figure shows an example of the intermediate steps one topic went through.

# 6.2 Analysis and Interpretation of the Evaluation Results

In this section the evaluation results from the previous section will be analyzed and interpreted. First, the analysis of the results from the individual reflection is presented in Section 6.2.1. Then in Section 6.2.2 the same is done for the team reflection phase. In Section 6.2.3 the results for the method in general is analyzed and finally in Section 6.2.4 the results are compared to the solution objectives defined in the introduction.

#### 6.2.1 The individual Reflection Phase

First, of all it makes sense to look at the use of the tool for individual reflection. The team was asked to use the tool daily in their reflections. The diagram in Figure 6.1 on page 58 shows the days on which the team reflected during the evaluation. In that period they almost reflected on all weekdays except for days where they had lectures the entire day or were asked by the researchers to focus on other tasks like creating questions or playing the game. They reflected 15 days during the evaluation which on all accounts must be consider a satisfying result. It shows that they have taken their participation seriously.

When looking at the number of questions being answered daily, the diagram shows a high number of questions being answered in the beginning and then declining throughout the evaluation. There can be several reasons for this. One of the main reasons were that after two days of individual reflection, there was introduced a maximum number of questions that the participants could answer daily. They simply answered too many questions. It seemed like it became a sport for some to answer as many questions as possible in the five minutes of reflection. During the individual interviews it was also pointed out that they were supposed to be absorbed in the questions. This may also explain the change in behavior where more time is spend on each question. Indeed, they all answered that they were able to be absorbed in the questions. When asked directly if they could be absorbed one of the participants stated:

"To a great extent, and it is clear that the entire group is absorbed in the questions."

When we dive into their experiences with the reflection tool they are generally positive. All seven participants expressed that it had been a positive experience to work with the tool and the individual reflection and that they found it useful. Some state that it were a little odd in the beginning and that they did not have hight expectations to the method.

"Using the system was a little odd in the beginning, but later it has been very useful."

"As one did not have high expectations to this, the outcome has been surprisingly positive."

The daily reflection was introduced as a response to problems that are associated with only reflecting after a project has ended. The participants were also positive about this change, and preferred it compared to reflecting in the end or after a project has ended. They expressed this during the group interview

"It is good to have a chance to correct an error in the process when it arises. After an iteration or project has ended, the motivation for reflecting on your process is gone. It is therefore better to reflect during each iteration and project."

During the group interview they were also asked to discuss the time of day for the individual reflection. They had chosen to reflection as the first thing in the morning, before their stand up meeting. This worked very well for them and they expressed the the reflections in the morning as "It had a positive effect and it was a nice way to start the daily work."

They did not like the alternative suggestion about moving the reflections to the afternoon. In their opinion it would not work so well since people would be mentally tired at the end of the day, which would only cause them to rush the questions or skip the reflection entirely.

There were many opinions about the questions in the reflection tool. Generally the participants liked the tool and the way of reflecting using questions as part of a conversation. However several participants also commented that the questions should be more varied if the system should be used for a longer period of time.

"The system is fine, and contains relevant questions."

"Sometimes it feels like one is answering the same question over and over again because of the lack of variation."

The participants also noticed that the questions were not always relevant in their curring context.

"Sometimes the questions are not relevant in the current context. If the questions were asked in the relevant context, the tool may have an even greater impact."

One of the suggestions that the participants expressed were that the questions should follow the phases of the project. This is a very good idea. It would introduce more variation in the questions and make them more relevant because the questions would be asked in the correct context according to the phase of the project. It would increase the impact that the system would have when used in a project. It would however require some further development to make it work in practice. An option could be to integrate the reflection tool with some form of project management tool.

Some participants noticed that the tool had a utility in the sense that it made them reflect in other directions than they normally did. As one of the participants put it

"The tool has made the group aware of topics that they otherwise would not notice."

This shows that the reflection tool enables participants to be inspired and look at their project from new perspectives. This is very important in a reflection and evaluation process. It gives them new knowledge that they can use to improve their work.

When looking at the utility of the reflections and the reflection tool in the context of creating questions for the game there were also positive expressions. When asked if the conversations in the reflection tool could be used directly to create the discussion questions for the game one participant answered

"Yes, it seems that these conversations may be a very good introduction to the game."

An other participant also found the transition between the reflection tool and game easy. This was to a large extend because the design of the pregame screen made it possible for the users to see their conversations from their reflection and then directly write questions to the game inside the tool. As a participant state:

"The transition was very easy and the pregame screen was intuitive. To have the overview of every conversation presented made the process easier."

"The conversations are good to have when formulating discussion questions. It was very nice to be able to see the overview of the conversations, and the number of discussion questions one had to compose were suitable."

The participants also encountered a few problems. Most of the problems were mainly of a technical nature with respect to accessing to the server. However, several participants also expressed a need for a feature to be able to change an answer if the question had been misunderstood. As one participant explained, he found out that he had misunderstood the questions when he read the follow up questions. But he was not able to go back and change his answer.

#### 6.2.2 The Team Reflection Phase

The big question in the team reflection phase was whether the game would work as a forum for discussions of important team issues. First of all, it was important to confirm if the game and game flow would work as indented. Would the mix of discussion questions and fact questions be reasonable?

In Table 6.1 on page 58 shows some statistical information about the two games played during the evaluation. From that it was clear that the mix of discussion questions and fact questions were close to 50/50. In the first game there was a slight majority of discussion questions whereas in the second game there was only one more fact question that discussion question. It also possible to see that there were four team building exercises in the first game and two in the second. These changes are of cause due the the statistical uncertainty that is related to games affected by the toss of a dice. Both games have a mix of the three categories of actions which ensures a reasonable game flow. This indicates that the game board has correct proportions and that the rules for the game work.

It is also clear if we look at the time spend there is a difference between the two games. The first game took 97 minutes while the second game only took 73 minutes. The game were in both cases stopped when there were no more discussion questions left. Had there been more discussion questions the game would have been stopped when reaching the two hour mark, due to time constraints.

When you look deeper into the numbers it is also obvious that the second game is shorter but completes more questions. There are several explanations why. First of all, there were only two team building exercises and they do take from 5 to 10 minutes each. But that is not the whole explanation. Of cause the game also ran more smooth because the players were more familiar with the concept and rules of the game. The last thing that was observed, was that the types of questions had changed. In the first game there were more discussions about problems and work processes that could be changed. The second game was more focused on tasks that needed to be done for the rest of the project. They were also quicker to come to an agreement in the discussions which dealt with their work processes. It is difficult to say whether this is a tendency when using the method and playing the game over a longer period. It could also be caused by a change in the phase of their project. The iteration leading up to the game was the last iteration of development. The rest of their project was committed to writing their report. That might cause the changes in questions.

When we asked the participants about their experiences with the game they were in general positive. They felt that it gave them a good forum to discuss team related problems and conflicts. It was easier to keep everyones focus than when discussions took place in their group room. As they explained during the group interview

"It had a positive effect that the discussions were held outside of the group room since it made it easier to keep focus on the discussions because there where less distractions.

#### Every one could keep focus on the discussions instead of their laptops or other things."

They expressed that it was a fun experience and that the atmosphere had been really great during the game. Especially the team building exercises had brought a fun element into the game. At the same time it did not harm the serious discussions afterwards. On the contrary it helped to keep a good atmosphere which contributed to a constructive debate. It is very important that this part of the game works. If serious debates can be discussed in a good tone and atmosphere then the discussions tend to be more constructive and oriented toward problem solving. The opposite can happen if discussions get heated and they become more centered about individual persons in the team. It is so very important for the improvement of the team that the discussions does not turn into a blame game.

When asked about the fact questions they responded that they worked well, but did not bring much knowledge sharing into the game. They were however, a fun element and contributed to the competitive spirit of the game. There were different views on how hard it was to come up with good fact questions for the game. Some found it easy while other had more difficulties. This might be an area that need more investigation. If it is too difficult or takes too many resources to create these fact questions then it is a problem for the method. An alternative solution could be to have some predefined fact questions in the software genre that could be used as in classic quiz games like Trivial Pursuit. The down side to this is that the fact questions will be more general and not so personalized and fun. But how much it would otherwise affect the game is difficult to say.

One of the big questions that was brought up was whether the game could be conducted without an external facilitator. One of the solutions that were considered was to have an internal facilitator. That could be the scrum master, or an other appointed member of the team. The group felt that it would ruin the flow of the game and potentially cause problems in the discussions. In their opinion, a facilitator must be objective. A possible solution could be to use a scrum master from another team internally in the company as discussed in Section 3.3.3. It would of cause require a larger company where this is possible.

The way of ending the game with the creation of five improvement goals was also well received by the team. They liked the fact that the could see the improvement goals from the last game directly in the reflection tool. It was a nice way of ending an iteration and begin a new one. The improvement goals gave them a daily reminder of the goals on which they had agreed to improve during the next iteration. As they stated during the group interview

"It is a good way of ending the game. It can be used as a reminder of what was agreed."

#### 6.2.3 Results From Using The Method in General

When it comes to impact the general feeling in the team was that it had been a good experience, but it had not changed much in way the team worked. There were some slight changes and things they became more aware of, like dealing with noise in the group room. Their explanation was that they had been working together for a long time as a group. Therefore, they had a lot of well defined processes and integrated routines that are difficult to change. They actually liked the approach that the method had, to making changes and improvements to teams. However, they felt that it might be more relevant for newly formed teams and teams that had not yet developed tight and well defined routines and work processes.

The team acknowledged that the method might have been more useful if the was introduced earlier in the project instead of late as was the case in their project. As they state "The reflection phase probably would result in important discussions that would be taken earlier in the project process. process. It would also help to define work processes quickly and early in the project and keep focus for the duration of the project."

They also had some concerns with the time requirements. Especially the game took much time in their opinion. They would suggest to play the game less frequently. But they were also aware that their iterations of 14 days were short as opposed to the recommended 30 days in scrum. Longer iterations would cause the time requirement to the game to be less of a factor. When it comes to the individual reflection they agreed that five minutes were appropriate when reflecting. In the end they had a feeling that reflecting daily had become too much. This might also be caused by the lack of variation in some of the questions. It would be possible to change the frequency of individual reflection if it becomes a problem in the long run. It is however part of the method that it becomes habit and part of the daily work of the users of the method. And the participants also recognized that it were important that there was not too large gaps between individual reflection. As they stated in the group interview

"To have the daily reflection less frequent could be interesting, but there should not be too large gaps between, since it will be hard to remember what happened in these gaps. Important views and reflections will be lost if these gaps are too large."

When asked if they would consider to use the method or parts of it they were actually quite positive. If some of the suggestions and changes that were discussed could be implemented they could imagine to use the method to some extend. One of their main points were that there needs to be more variation in the questions being asked in the reflection tool if the method is going to be used over a long period of time. But they were convinced that the method has utility and expressed that

"This could be a method that should run as a recurring event at the end of every iteration."

Interestingly enough one participant also stated:

"If I was team leader for a new team, then I might introduce them for the method in the beginning of a project."

This at least indicates that they believe the method can have an important impact and utility when use in the right context and with a team that has room for improvements.

## 6.2.4 The Results According to the Solution Objectives

To wrap up this analysis of the results from the evaluation it makes sense to look at the solution objectives that were introduced in Section 1.2. Below are each of the four solution objectives listed and it will be explained how and why the developed method meets these.

- Increase individual and team reflection The method clearly has increased both the individual and team reflection. The participants have daily reflected individually through out the evaluation period. During that period they have also played the reflection game twice and thereby engaged in team reflection.
- Identify and address problems and conflicts The team that participated in the evaluation was a team that has been working together for at long time and did therefore not identify many big problems and conflicts. That being said the did participate with many interesting discussions and identified smaller things that they could adjust in their project and team work.

- Learn from the mistakes that have been made As stated just before they did not identify many problems and conflicts. But those minor problems that were identified did end in discussions which resulted in five improvement goals for each game. These improvement goals were taken into consideration during the following iteration of work.
- **Improve future work practices and team collaboration** They did make minor adjustments based on the reflection and discussion they had in the method. They also came to the conclusion that the method would work better on new teams or teams which had not yet established common work processes and well defined routines. Such teams would be greatly impacted by the method and be able to improve their work practices and team collaboration even further than the team who participated in this evaluation.

# 6.3 Summary

This chapter presented the results from the evaluation. The main source of information comes from the individual interviews and group interview conducted in the evaluation but statistical data about the use of the individual reflection tool and the distribution of questions in the game were also gathered.

The results were analyzed and showed that the team in used the reflection tool to a wide extend. They were positive toward the use of the tool and the way of reflecting individually. They were also very positive about the game used for team reflection. They felt that the game was fun and gave a good atmosphere to discuss important and serious topics. The fact that it was placed outside their normal group room also enabled them to keep focus during the discussions. In all, they expressed that the individual reflection tool and game were a good platform and forum for the discussion of topics to improve the team in the future. Chapter 6: Evaluation Results
"The aim of argument, or of discussion, should not be victory, but progress."

Joseph Joubert



This project leaves some open questions, which need to discussed. We have developed a new team improvement method to increase reflection and learning in software projects. It consists of two main components, the individual reflection and the team reflection.

The two individual components will be discussed in Section 7.1 and Section 7.2. Among the discussed topics are the contributions of the components. In Section 7.3 it is also discussed how the method is differentiated from postmortem evaluations.

Furthermore, the implications for the research perspective is discussed in Section 7.4. This includes the projects contributions to the research field and the limitations of a single case study.

## 7.1 Discussion of the Individual Reflection

The individual reflection can be viewed as an independent sub-component of the general method developed in this project. The component consists of a tool for individual reflection that allows users to participate in questions-driven conversations with a system.

#### 7.1.1 The Component's Contribution

The individual reflection contributes to the identification of areas where the team can improve. This could be areas where there are problems or conflicts that need to be resolved. But it can also help the team members to think in new and alternative directions. The questions might also give the users new perspectives on their project. We verified that the individual reflection indeed had this effect on some of the participants in the evaluation. They express that the tool has made them aware of topics that they would not have noticed otherwise.

It is not difficult to imagine that the individual reflection will have an even greater impact and contribution, if the questions focus on the concrete phases in which a project undergoes. It could play an important role during the initial phases in a project where many important decisions are made and work processes defined.

#### 7.1.2 Important Consideration About Questions in the Reflection Tool

The questions in the reflection tool are the greatest strength but also the greatest weakness in the individual reflection component. In order to reflect using questions as inspiration as done in the reflection tool, there is a need for a large pool of questions. Just in the relatively short evaluation period, some of the participants answered over 130 unique questions. It takes many resources to generate so many questions, and if the reflections should run over a longer period of time, the number of required questions would be much higher. During the evaluation the questions for the tool have been written by the researchers. If the reflection tool should be applicable in real projects it would not be possible to have someone responsible for writing questions. Therefore, it would be necessary to create a large repository of general questions that could be used in the tool for many types of projects.

One could imagine that there could exist many different categories of questions that could be chosen depending on the phase and type of project. A comparison could be made to famous quiz games like Trivial Pursuit that also have a large repository of questions in several categories. It would be possible and easy to add new categories or extend existing ones with new questions. This way the tool could be calibrated with the relevant types of questions by selecting the relevant categories of questions, based on the context of the project. This was a feature that several participants desired, because it would make the questions more relevant and create more variation in the reflection.

## 7.2 Discussions about the Team Reflection

The team reflection can also be viewed as the second sub-component of the method. It consists of a board game which is played by the team members. Prior to the game is started, the team have prepared a number of discussion questions and fact questions to be used in the game. When the game ends five improvement goals are found which the team can focus on until the next game.

#### 7.2.1 The Component's Contribution

The main contribution of the game is to bring the reflection from an individual perspective to the team level. Of course it is good when the individual members reflect over their work and require new knowledge. However, it does not make big changes unless the rest of the team is brought into the discussion. This is what the game can facilitate. It is a forum where the players have the opportunity to discuss relevant topics. As the game is constructed as a board game, fact questions, and team building exercises, the game creates a fun a positive atmosphere. That is important when serious discussions about hard topics are to be discussed. Such discussion can quickly turn into heated debates that are often personalized which then again turn into discussion where the main objective is to decide the blame. That is not the objective of the discussion, but instead to have constructive and problem-solving discussions.

During the evaluation the participating team expressed that the game worked well as a forum for such discussions. They felt that it was easier to focus during the discussions because there were less distractions than when they discuss in their normal environment in the group room.

#### 7.2.2 Limitations of a Game

A game is a very alternative method for discussion in a team compared to other methods. It can be a problem that many might be prejudiced about playing a game as part of a serious project. It simply may be difficult to get everyone to participate in such an activity. However, in the evaluation, all participants participated fully and were very positive about their experiences with the game. They expressed it as a fun experience but at the same time they were able to discuss important topics concerning their project. In that respect it has been shown that a game like this can be used in such a situation. Whether it is a result that can be generalized is difficult to say based on the limited evaluation completed in this project. It could be a direction that further research could take.

## 7.3 The Method in General

In the previous two sections the two sub-components of the method have been discussed. It was clear that both sub-components could be used more or less independently of each other if desired. Together they complement each other well as they focus on the individual reflection and the team reflection.

#### 7.3.1 The Method is Differentiated

When compared to other methods that have similar purposes both sub-components are differentiated considerably. [Kasi et al., 2008] The method is therefore unique in its way to attack the issue of reflection in software teams.

Postmortem evaluations also try to collect reflections and lessons learned from a project. There are several suggestions ([Collier et al., 1996], [Tiedeman, 1990]) as to how these evaluations can be conducted to get the most out of these reflections. However, they have one thing in common. They only try to collect the reflections after the project has finished. This is an area where our method is considerably different. We recognize that it is important to reflect continuously throughout a project to better capture the important experience that is gained. If you wait several months to gather this, information the context will be forgotten or distorted in the memory.

It is also impossible to make changes during a project if the reflection is confined to the end or after the project has been completed. In our method the reflections are discussed during the project and steps are in place that will inspire the developers to improve themselves and their team.

These steps involve the team reflections that happen in the game. And the game is another place where the method is differentiated compared to e.g. postmortem evaluations. Postmortem evaluations have evaluation meetings with a variety of techniques to discuss the topics about the completed projects. But none of them involves playing a game, or the addition of the team building exercises. In general the postmortem evaluations purely focus on the lessons learned and not on improving the team.

The method can be criticized for being sequential and the fact that the team needs to put in a large work effort is an issue. Therefore it may as well be an option to start with the game and work on the problems/conflicts the team can remember at the time. Another interesting approach would be to use generic questions, which does not need any effort by the team. This may lead the team to realize that the entire method may be helpful and give them motivation to put in the effort of doing the individual reflections in the system.

## 7.4 Research Perspective

As in any case study with a short time period it is important to underline the results found and especially what not found in the experiment. This section focuses on both and their impact on this projects contribution to the research field.

#### 7.4.1 The Contribution - A New Concept With a Different Focus

The major contribution this project gives to the field of reflective evaluations in software teams, is that it offers another view on how to achieve individual and team reflection. It has never been the intention to create a final or complete concept. The main objective for this research was to investigate if it was possible to get a test group to reflect individually as a routine, without it

becoming a source of irritation. This had to be tied together with the objective to use the team reflection in an alternative forum of evaluation.

The objectives have been achieved, but not without the need for improvements. The test group argues that the individual reflections become a source of irritation due to lack of variation in the questions. However, they still see it as an easy way of getting themselves started in the beginning of the day. The game sessions have been performed with great success even though the group was in the final period of their project and therefore did not have many discussions besides their work process.

The test group argue that they do not feel that the concept gives them enough payoff compared to the work they put into it. Nevertheless, they still achieve to create discussions on important topics of their work, from their individual reflections and in the end create improvement goals from the discussions. This is a bit contradicting and may have to do with the limited time period and the fact that the questions they get in the individual reflection do not vary much.

#### 7.4.2 Limitations of The Research

The lack of results from more than one evaluation is the biggest limitation in terms of outlining the contribution made to the research. A single case study does only prove the utility in the evaluated case, but it is not possible to generalize to software project in general. It would take more evaluations to figure out if the concept is closer to a good solution than a bad one. However, the artifacts delivered here shows potential and one could potentially use the sub-components alone while applying another method to them.

## 7.5 Summary

Through out this chapter the contributions and open questions have been discussed. Firstly, the individual reflection was debated as an independent component. Its contribution is mainly that the evaluation of the tool actually showed that a daily reflection was manageable. However, there is still an open question when it comes to creating varying questions and also how to make a base of questions, which fits to the phases of a project.

Secondly, the game was investigated as an independent component. It was discussed how it was possible to transform individual knowledge from individual reflections into team knowledge in the forum of the game.

Next, the method as a whole was debated and results showed that the project met the objectives to show that individual reflection can be done and lead to team reflections. However, there is still a lot more to be done when it comes to motivating teams to start using the solution or developing it further. The proposal discussed to avoid this is to let the teams play the game before starting to use the entire method.

Finally, the research perspectives have been discovered, focusing mainly on the lack of evaluations made with this method. There is still a lot more to be done in this field and the objective here was to achieve a link between an individual reflection and team reflection, without it becoming a source of irritation. "No one can be a great thinker who does not recognize that as a thinker it is his first duty to follow his intellect to whatever conclusions it may lead."

John Stuart Mill



The initial problem that sparked our interest in the beginning of this project was the fact that many projects still fail or are delayed despite the advances in technologies and processes. Based on this, the assumption in the literature is that the human factors play a major role in the success or failure of projects. Our approach has been to look at the team as a focus for improvement. As an important factor we have used reflection as a tool for identifying areas where the team can improve themselves.

The work in this project is based on a previous project developed in the fall 2009. [Peitersen et al., 2009] Here it was established that postmortem evaluations were good methods

to reflect on experiences and lessons learned during a project. Through the discussion of this knowledge, teams are able to improve. However, postmortem evaluations have some limitations and have not been adapted by the industry. Therefore, it was decided to develop a new reflective team improvement method.

With reflection as a ground pillar, a method has been developed that focuses on individual reflection and team reflection. The individual reflection has been designed as a question-driven dialog where users can have reflective conversations with an IT-system. This has required the development of a software tool to support the individual reflection phase. Once areas for improvements have been identified in the individual reflection they can be discussed on a team level. As a platform for the team reflection, a board game has been developed in which the team can discuss improvement topics based on user generated questions. Through the discussions the team will identify five improvement goals that they will focus on until the next reflection game is played.

Development of a new method falls under the research field of Information Systems. Here, there were two dominant research paradigms and it was realized that this project could be classified as Design Science. There was a need for a methodology in order to conduct and document the research and Peffers' Design Science research methodology was chosen. It was not a perfect match to the problem at hand, but it is the only existing methodology that tries to create a standardization for the conduction of Design Science research. [Ken Peffers and Chatterjee, 2007]

During the evaluation of the method a case study was conducted on a team of students from Aalborg University. They used the method for two iterations of their student project. This included two phases of individual reflections and two game sessions playing the reflection game. The results of the evaluation were generally positive. The team used the reflection tool for the individual reflections and found it useful to identify areas of improvement. They did however, complain about lack of variation in the questions that were used in the reflection tool. The game was also very positively received by the team. They felt that the game was fun and gave a good atmosphere and forum to discuss important topics. The fact that it was placed outside their normal group room also enabled them to keep focus during the discussions. In all, they expressed that the individual reflection tool and game were good platforms and forums for the discussion of topics to improve the team in the future. However, they also felt that the method has had minimal impact on the team. Their explanation was that they as a team had been working together for a long time which meant that they had well defined routines and work processes. On the other hand they acknowledged that the method could be very useful for a new team or a team with less well defined routines and work processes.

From a research perspective this method gives an alternative view on the topic of reflective evaluations in the software industry. It is difficult to say anything about the generalization of the results provided in this project since the evaluation only consisted of a case study of a single project. However, the case study has show that the method has some positive effects on the reflection in the team, and the team were able to show concrete improvement suggestions based on the use of the method. "Effective managers live in the present but concentrate on the future."

James L Hayes

# **9** Future Development

## 9.1 Possibilities for Future Research

The empirical evidence found in this project shows that it is possible to achieve both individual and team reflection. However, a lot more evidence needs to be discovered in order to further develop the method.

The evaluation of the solution proposed in this project has only run in a test trial for two sprints in the end of a student project. First, the solution needs evaluations of it running throughout an entire project. In this case it was not possible due to time constraints and manual question generation for the individual reflection. Second, the solution must be tested in the long run and incorporate the industry. Otherwise, it cannot be said if the solution has any impact on the problem of software failures in the industry.

This project shows evidence that points in the direction that question-driven dialog may be more tolerable than diaries. This underlines a potential to look further into how these conversations can get more intelligent in terms of not irritating the user. Here lies an interesting possibility to investigate further into how users react to intense individual reflection in long term studies. It is also the key to success for this methods approval in the long run, since it needs the users to adopt the individual reflection as a part of their daily development routines.

## 9.2 Usefulness in Practice

The method offers a lot of practical use of itself and of course also its sub-components, the individual reflection tool and the game. This section strives to inspire the use of the method and its sub-components in a broader view than the rest of the report.

#### 9.2.1 Use of the Method in Practice

In practice the method can be used in both the intense manor or in a less intense version. As some of the users from the test group also state, it could be possible to use this just in the start of a project, since it has a great potential in team-building. Therefore, a less intense version could be possible to deploy on projects with new team members, without it being a long term solution.

The method is also seen by us to be more than just applicable to software teams, it could be any team working on projects delivering products. Of course the frameworks used in the individual reflection is targeted at software developers, but this is changeable. Therefore, this project shows potential to not only software teams, but teamwork in general. Which also gives the research a broader point of attack.

#### 9.2.2 Individual Reflection as an Independent Component

There are no reasons why the individual reflection component could not be used independently of the rest of the method. It is not dependent on the game in order to work and the benefits described in the contribution section in Section 7.1.1 are still relevant whether or not the game is played. It is however a shame if the knowledge is not shared in the team and it will not have the improving effects on the team unless the findings are discussed. This could however, happen in any form and does not necessarily need to be the proposed game to make the component work.

#### Other Relevant Applications

By being able to easily change the content of the questions based on categories, it allows the individual reflection component to be used for other purposes than software development. The 4P (product, project, process, people) was used as a framework for creating categories and questions for software projects. But this framework would also be relevant in many other project-based industries.

It does not need to stop there. It would be possible to go as far as saying that it could be used in almost any environment where reflection could be triggered by questions. If has of cause some limitations by the fact that it is bound to the reflection tool. In some industries or work environment it would not be practical or well received to use such a tool. But the possibilities for application are still endless.

#### 9.2.3 The Game as an Independent Component

The game itself can be used as an individual component. But on the contrary to the individual reflection, the game is dependent on input in order to work. In the method the input for the discussion questions and fact questions comes from the individual reflection. If the game is going to be played without having this reflection then the input questions must come from another source.

One could imagine that the questions were written just prior to the game without any previous reflection. The players would just have to rely on their memory to find topics for the discussion questions. However, the important thing to remember is that the impact of the game comes mainly from the discussion. If the topics from these discussions are of a poor quality then the outcome of the game will generally also be poor.

#### Other Relevant Applications

The game does not need to be used only for reflective team improvement. The framework of the game allows the game to be used to discuss any topic desirable. The fact questions and team building exercises can also be customized in different ways to give the game the qualities and focus which is desirable. For example, new teams could benefit a lot by have team building exercises that focus on getting to know each other. Other types of exercises could focus on communication or other team work related topics. The fact questions could be used to set focus and learning on specific topics is desirable. So in general the game concept is very open and can be used for many purposes.

If the questions were changed to support creative techniques, the game could easily be used as a platform for generating new innovative ideas. The idea of using creative techniques was actually already tested during the first trial run, but had little impact due to the late phase of the project.

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In this appendix the results from the individual interviews are presented. In the first section the results have been structured according to the questions being asked and the following sections presents the questions and answers for each of the seven interviews.

## A.1 Individual Interview Structured After Questions

This section presents the individual interviews and is structured after the question being asked. The questions are divided into two categories representing the individual reflection phase and the game phase.

#### A.1.1 Questions about The Individual Reflection

- **Q** What was the general impression of the system for use in the individual reflection? Do you find it useful?
- A Subject #1 : The system is fine, and contains relevant questions. However, some of the questions seems to assume that one is already finished with the project.

Subject #2: Generally it has been a good experience. Some of the questions are, however, unclear. Subject #2is missing the opportunity to comment on the answers and clarify the them.

Subject #3 : Using the system was a little odd in the beginning, but later it has been very useful. Some of the topics has later been discussed in the group.

**Subject** #4: Generally it is fine. Sometimes the answers does not fit the questions entirely in the multiple choice questions. It could be nice to have a status indication of the progress in a conversation. Variation in the categories in which the questions are placed from day to day would be pleasant. It would also be a good idea to have an indication on how the entire group replies to a certain question.

**Subject** #5: It functions very well. The duration of 5 minutes per day suits subject #5 very well. It has become part of the daily routine.

**Subject** #6: Generally, it has been a very good experience. But if the tool is to be used over a longer period of time, the questions need to vary more. It can be alright to run for shorter periods of time, if problems arise in the current project. Sometimes it feels like one is answering the same question over and over again because of the lack of variation.

**Subject** #7: Generally, the experience is positive. New views on a subject which subject #7 would not self have thought of is able to be uncovered. The external input makes subject #7 elaborate on the process.

- **Q** Have you experienced any problems with the system?
- A Subject #1 : No problems were uncovered.

Subject #2 : No problems were uncovered.

Subject #3: There has been technical difficulties concerning logging in. Subject #3 misses the opportunity for regretting an answer.

Subject #4: There has been problems accessing the server. Some error messages has occurred, which has made the tool unfit for use in these situations.

Subject #6: One should be able to regret an answer when answering questions.

- **Q** The general idea about the individual reflection is to be absorbed in the questions. Do you feel you are absorbed in the questions?
- A Subject #1 : The questions have had this effect on subject #1, but no discussion in the group has been triggered.

**Subject** #2: Yes. One is allowed to concentrate alone with the questions. However, sometimes, there is a tendency to hurry through the questions that can seem almost like a survey. It may be a good idea to time box the conversations.

Subject #3: To a great extent, and it is clear that the entire group is absorbed in the questions.

 $Subject \ \#6$ : That can be achieved. However, because the questions sometimes occur in multiple times in different words, this falls flat.

Subject #7: Subject #7 declares that it is very obtainable to be absorbed in the questions, particularly when the questions are of type: "Elaborate on..." or "Explain why...". Another good thing about the questions and the answers is they are personal and thereby allows one to vent.

- **Q** Are you satisfied with the outcome of the individual reflection? Or how can you benefit more from this?
- A Subject #3 : Yes. This functions well and subject #3 likes that the multiple choice questions finally leads to a possibility of commenting the entire conversation or the current question.

Subject #5: Sometimes the questions are not relevant in the current context. If the questions were asked in the relevant context, the tool may have an even greater impact.

Subject #6: As one did not have high expectations to this, the outcome has been surprisingly positive.

**Subject** #7: Subject #7 indicates that it would be appreciative to have the reflection questions as part of a project context, meaning that questions should address the current phase of the project.

**Q** Would you be able to use your conversations directly when creating questions?

A Subject #3: Yes, it seems that these conversations may be a very good introduction to the game. The tool has made the group aware of topics that they otherwise would not notice.

Subject #4: Yes probably, but it will require me to have an overview of the conversations in order for me to remember them.

- **Q** Sometimes you deliver short answers or none at all. What is the reason for this?
- A Subject #1 : It may be a good idea to have examples on answers. It may even be a good idea to be able to comment on multiple choice answers. Consider having shorter chains of questions without one being able to comment.
- **Q** Do you need an opportunity to comment on your answers?
- A Subject #3 : No. Subject #4 : No.
- $\mathbf{Q}$  How do you feel about the different types of questions (Yes/No and a scale in 5)?
- A Subject #4 : Subject #4 does not prefer one type of question over the other.

#### A.1.2 Questions about The Collective Reflection

- **Q** How did you feel about participating in the game session?
- A Subject #5 : It was a positive experience, and subject #5 was surprised about the positive aspects of the game.

Subject #6 : Generally a good experience.

**Subject** #7: Subject #7 expressed that the game is a fun experience. Subject #7 is pleased with the idea of the 5 improvement goals that wrap up the game session.

- $\mathbf{Q}$  How do you feel about the transition between individual reflection and the game?<sup>1</sup>
- A Subject #5 : It was very good that one could see the overview of the conversations. This was a great help when creating questions.

Subject #6: The transition was without any problems.

**Subject** #7: The transition was very easy and the pregame screen was intuitive. To have the overview of every conversation presented made the process easier.

- **Q** Were you able to benefit from the overview of the conversations and the content of these when creating discussion questions?
- A Subject #6 : Yes. The conversations are good to have when formulating discussion questions. It was very nice to be able to see the overview of the conversations, and the number of discussion questions one had to compose were suitable.

**Q** What was your impression on the fact questions? <sup>1</sup>Here meaning the game preparation, presented as the pregame screen of the reflection tool A Subject #5 : They were too easy to answer. But to have a break from the discussion questions was fine.

Subject #6: Real good. It have a nice break and added fun to the game.

- **Q** Was the making of fact questions difficult?
- A Subject #5 : No. Subject #5 found it rather easy.

Subject #6: Yes. One found that the making of fact questions was very much harder than anticipated, and time consuming.

- **Q** How is it to end the game by finding the 5 improvement goals?
- A Subject #5 : It is a good way of ending the game. It can be used as a reminder of what was agreed. It would be a good idea to display the improvement goals somehow afterwards.

## A.2 Questions for subject #1

Subject #1 was interviewed on April 9th 2010.

- **Q** What was the general impression of the system for use in the individual reflection? Do you find it useful?
- **A** The system is fine, and contains relevant questions. However, some of the questions seems to assume that one is already finished with the project.
- **Q** Have you experienced any problems with the system?
- A No problems were uncovered.
- **Q** Sometimes you deliver short answers or none at all. What is the reason for this?
- A It may be a good idea to have examples on answers. It may even be a good idea to be able to comment on multiple choice answers. Consider having shorter chains of questions without one being able to comment.
- **Q** The general idea about the individual reflection is to be absorbed in the questions. Do you feel you are absorbed in the questions?
- A The questions have had this effect on subject #1, but no discussion in the group has been triggered.

## A.3 Questions for subject #2

Subject #2 was interviewed on April 9th 2010.

- **Q** What was the general impression of the system for use in the individual reflection? Do you find it useful?
- A Generally it has been a good experience. Some of the questions are, however, unclear. Subject #2 is missing the opportunity to comment on the answers and clarify the them.

- **Q** Have you experienced any problems with the system?
- A No technical problems were uncovered.
- **Q** The general idea about the individual reflection is to be absorbed in the questions. Do you feel you are absorbed in the questions?
- A Yes. One is allowed to concentrate alone with the questions. However, sometimes, there is a tendency to hurry through the questions that can seem almost like a survey. It may be a good idea to time box the conversations.

## A.4 Questions for subject #3

Subject #3 was interviewed on April 15th 2010.

- **Q** What was the general impression of the system for use in the individual reflection? Do you find it useful?
- **A** Using the system was a little odd in the beginning, but later it has been very useful. Some of the topics has later been discussed in the group.
- **Q** Have you experienced any problems with the system?
- A There has been a technical difficulties concerning logging in. Subject #3 misses the opportunity for regretting an answer.
- **Q** Are you satisfied with the outcome of the individual reflection? Or how can you benefit more from this?
- A Yes. This functions well and subject #3 likes that the multiple choice questions finally leads to a possibility of commenting the entire conversation or the current question.
- **Q** The general idea about the individual reflection is to be absorbed in the questions. Do you feel you are absorbed in the questions?
- A To a great extent, and it is clear that the entire group is absorbed in the questions.
- **Q** Do you ever miss the option of commenting the multiple choice questions?
- A No.
- **Q** Would you be able to use your conversations directly when creating questions?
- **A** Yes, it seems that these conversations may be a very good introduction to the game. The tool has made the group aware of topics that they otherwise would not notice.

## A.5 Questions for subject #4

Subject #4 was interviewed on April 15th 2010.

- **Q** What was the general impression of the system for use in the individual reflection? Do you find it useful?
- A Generally it is fine. Sometimes the answers does not fit the questions entirely in the multiple choice questions. It could be nice to have a status indication of the progress in a conversation. Variation in the categories in which the questions are placed from day to day would be pleasant. It would also be a good idea to have an indication on how the entire group replies to a certain question.
- **Q** Have you experienced any problems with the system?
- **A** There has been problems accessing the server. Some error messages has occurred, which has made the tool unfit for use in these situations.
- $\mathbf{Q}$  How do you feel about the different types of questions (Yes/No and a scale in 5)?
- A Subject #4does not prefer one type of question over the other.
- **Q** Do you need an opportunity to comment on your answers?
- A No.
- **Q** Would you be able to use your conversations directly when creating questions?
- **A** Yes probably, but it will require me to have an overview of the conversations in order for me to remember them.

### A.6 Questions for subject #5

Subject #5 was interviewed on April 27th.

#### A.6.1 Questions about The Individual Reflection

- **Q** What was the general impression of the system for use in the individual reflection? Do you find it useful?
- A It functions very well. The duration of 5 minutes per day suits subject #5 very well. It has become part of the daily routine.
- **Q** Are you satisfied with the outcome of the individual reflection? Or how can you benefit more from this?
- A Sometimes the questions are not relevant in the current context. If the questions were asked in the relevant context, the tool may have an even greater impact.

#### A.6.2 Questions about The Collective Reflection

- **Q** How did you feel about participating in the game session?
- A It was a positive experience, and subject #5 was surprised about the positive aspects of the game.
- $\mathbf{Q}$  How do you feel about the transition between individual reflection and the game?<sup>2</sup>
- **A** It was very good that one could see the overview of the conversations. This was a great help when creating questions.
- **Q** What was your impression on the fact questions?
- A They were too easy to answer. But to have a break from the discussion questions was fine.
- **Q** Was the making of fact questions difficult?
- **A** No. Subject #5 found it rather easy.
- **Q** How is it to end the game by finding the 5 improvement goals?
- **A** It is a good way of ending the game. It can be used as a reminder of what was agreed. It would be a good idea to display the improvement goals somehow afterwards.

## A.7 Questions for subject #6

Subject #6 was interviewed on April 27th.

#### A.7.1 Questions about The Individual Reflection

- **Q** What was the general impression of the system for use in the individual reflection? Do you find it useful?
- A Generally, it has been a very good experience. But if the tool is to be used over a longer period of time, the questions need to vary more. It can be alright to run for shorter periods of time, if problems arise in the current project. Sometimes it feels like one is answering the same question over and over again because of the lack of variation.
- **Q** Have you experienced any problems with the tool?
- A One should be able to regret an answer when answering questions.
- **Q** Are you satisfied with the outcome of the individual reflection? Or how can you benefit more from this?
- **A** As one did not have high expectations to this, the outcome has been surprisingly positive.
- **Q** The general idea about the individual reflection is to be absorbed in the questions. Do you feel you are absorbed in the questions?
- **A** That can be achieved. However, because the questions sometimes occur in multiple times in different words, this falls flat.

 $<sup>^2\</sup>mathrm{Here}$  meaning the game preparation, presented as the pregame screen of the reflection tool

#### A.7.2 Questions about The Collective Reflection

- **Q** How did you feel about participating in the game session?
- ${f A}$  Generally a good experience.
- **Q** How do you feel about the transition between individual reflection and the game?
- A The transition was without any problems.
- **Q** Were you able to benefit from the overview of the conversations and the content of these when creating discussion questions?
- **A** Yes. The conversations are good to have when formulating discussion questions. It was very nice to be able to see the overview of the conversations, and the number of discussion questions one had to compose were suitable.
- **Q** What was your impression on the fact questions?
- A Real good. It have a nice break and added fun to the game.
- **Q** Was the making of fact questions difficult?
- **A** Yes. One found that the making of fact questions was very much harder than anticipated, and time consuming.

## A.8 Questions for subject #7

Subject #7 was interviewed on April 27th, 2010.

#### A.8.1 Questions about The Individual Reflection

- **Q** What was the general impression of the system for use in the individual reflection? Do you find it useful?
- A Generally, the experience is positive. New views on a subject which subject #7 would not self have thought of is able to be uncovered. The external input makes subject #7 elaborate on the process.
- **Q** Are you satisfied with the outcome of the individual reflection? Or how can you benefit more from this?
- A Subject #7 indicates that it would be appreciative to have the reflection questions as part of a project context, meaning that questions should address the current phase of the project.
- **Q** The general idea about the individual reflection is to be absorbed in the questions. Do you feel you are absorbed in the questions?
- A Subject #7 declares that it is very obtainable to be absorbed in the questions, particularly when the questions are of type: "Elaborate on..." or "Explain why...". Another good thing about the questions and the answers is they are personal and thereby allows one to vent.

#### A.8.2 Questions about The Collective Reflection Session

- ${\bf Q}\,$  How did you feel about participating in the game session?
- A Subject #7 expressed that the game is a fun experience. Subject #7 is pleased with the idea of the 5 improvement goals that wrap up the game session.
- ${f Q}$  How do you feel about the transition between individual reflection and the game?
- **A** The transition was very easy and the pregame screen was intuitive. To have the overview of every conversation presented made the process easier.

Chapter A: Individual Interviews

## **B** Group Interview

This appendix recaps the group interview with the test group immediately after the game was finished.

## B.1 General Discussion about the Experiment Throughout its Duration

- ${\bf Q}$  What effect have you as a group experienced when using this method?
- **A** The group replied that using the tool every day may have been too much. The Group also missed variation in the questions after a two weeks of use.

The questions from the individual reflection tool is not always addressing the same project phase that the project is currently in.

- **Q** How was the time consumption of five minutes for the individual reflection?
- A The group agreed that five minutes was appropriate for the daily reflection.
- **Q** What do you think the effect would be, if the experiment was carried out in a longer period of time?
- **A** If the experiment was the be carried out in a longer period of time, the questions should address the current state or phase of the project.

A SCAMPER tool<sup>1</sup> could be useful in the initial phase of the project. This could be be integrated in the questions with benefit.

On the other hand, sometimes it is good to have questions that are out of context with the project to be inspired by and to think along other lines.

- **Q** What impact does the method have on the team work?
- A The method has not have a great impact on the way the team work, but it has resulted in minor adjustments. This might be caused by the fact that the group already have been working together for a long time. The have very integrated routines and work habits that can be difficult to change.

 $<sup>^1{\</sup>rm SCAMPER}$  is a general purpose creativity technique that consist of a checklist of questions to boost you creative idea generation. [Passuelloon, 2008]

In less new or less tightly-knit groups, the method may have a greater impact.

- **Q** Has there been changes in the way the team work during the experiment?
- **A** The experiment has not resulted in greater changes in the way the team work. However, the distracting noise in the group room has been taken care of. And the experiment has had a positive effect on this issue.

The experiment with the individual reflection and the group reflection through the game creates a forum in which team work topics can be discussed. It had a positive effect that the discussion happed outside the normal setting in the group room. This made it easier to keep focus since there were less distractions from laptops and other work. Every one was focused on the discussions.

#### **B.2** Further Adaptation of the Method

- **Q** What changes would you make if you were to continue to work with the method?
- A The method requires much time, especially the game. One could consider having the game to be less intensive. However, the project groups has iterations of a duration of 2 weeks. Scrum recommends iterations of 30 days duration. This would result in the game being played less frequent.

In the second half of the experiment, the motivation was descending compared to the first half.

- **Q** What changes would you make if you were to continue to work with the reflection tool?
- **A** The tool for the individual reflection should support going backwards in a conversation in order to undo an answer. This could be relevant if a question was misunderstood, and this was discovered by the follow up question.

The tool should also support adding of comments when answering questions in the conversation. Sometimes the answer was hard to choose between and the group would like an option to comment on their answer.

- **Q** Would you like to use the method, or elements from it in the future?
- A It could be interesting to be more aware on the teams processes in the beginning of a project. This could be a method that should run as recurring event at the end of every iteration. One could, however, find it difficult to infer changes in an already established group which has well defined routines and processes. To run this method in the entire duration of a project requires more variations in the method.

One team member said that if he was team leader for a new team, then he might introduce them for the method in the beginning of a project. The team member felt that it was a good method for team members to get to know each other and to find and agree on work routines and processes.

## B.3 Discussion about effort versus effect

- $\mathbf{Q}$  Is it better to have the daily reflection less frequently, or even just prior to a game?
- **A** To have the daily reflection less frequent could be interesting, but there should not be too large gaps between, since it will be hard to remember what happened in these gaps. Important views and reflections will be lost if these gaps are too large.
- **Q** Do you feel the extra work is worth the effort compared to the effect of the method?
- A The group feels that the first game was worth the effort. They think they found some good improvement goals and that they have been followed. They especially liked when the improvement goals became visible on the reflection screen so they were reminded of them daily. It works well, that you can see the effects of what you have been reflecting over daily.

## **B.4** Alternative Ways of Using the Method

- **Q** How do you like this way of reflecting on your process compared to reflecting after a project has ended?
- **A** This way of reflecting on your process is preferable compared to doing it after a project has ended. It is good to have a chance to correct an error in the process when it arises.

After an iteration or project has ended, the motivation for reflecting on your process is gone. It is therefore better to reflect during each iteration and project.

Often, one would like to have experiences made in the current project transfered to the next project, but it never happens for some reason. When you take lessens learned from previous projects you often only remember a few and they might not be so relevant in the new project. In this method you have concrete and relevant improvement goals that you can relate to during the project.

- **Q** You have chosen to make the daily reflection in the morning. How do you think it would work if done at another time, for example in the afternoon before going home?
- **A** That would not work as well. Many are mentally tired in the end of the day, which might have the effect that questions will be skipped or answered quickly.

Doing the reflections in the morning had a positive effect. It was a nice way to get started with the days work.

- **Q** If the tool was introduced to you in the beginning of this project, would it have had a greater effect?
- **A** Because of the reflections, it would result in discussion earlier in the project, about topics that otherwise would be discussed much later.

It would also help to define some work processes quickly and early in the project.

It can help to keep focus for the duration of the project.

### **B.5** Discussions about the Game

- **Q** Would it be possible for the team to run the game without external facilitator or minute taker?
- **A** This would probably ruin the flow in the game. Currently, it is an advantage that the players only focus on the discussion and are not interrupted.

The group could imagine that taking minutes could be done immediately after a discussion has ended, and then wait for the minutes to be written. But it would prolong the game considerably which might not be desirable.

An internal facilitator may rise problems, since he is not neutral, or even could be the person discussed in the game. The facilitator role needs to be independent from the person undertaking the role.

- **Q** How has the atmosphere of the game been, and how is the team building exercises, the fact questions and the discussion questions influencing this?
- A The atmosphere has been great, and the team building exercises has been very well received. They bring a positive and fun atmosphere but they not not influence the discussions negatively. It is still possible to take the discussions serious after a fun team building exercise.

In a larger setting with people not as well familiar with each other as this group, the team building exercises may even be more emphasized.

The fact questions did not contribute to knowledge sharing, but was a nice break in the discussions and created a competitive aspect to the game. The feeling was that they worked well in the game.



For decades the industry has been trying to solve the recurring problem of failing software projects. Even though technologies and methods have been improved drastically since the 1980's it still seems that the human factor plays the largest role in terms of failure. Lyytinen and Robey argues that the reason many software project fail is due to the fact that many software developers fail learn from their failures. To avoid this behavior it is important for any software organization to deploy a strategy for learning. The literature is filled with recommendations about high levels of reflection using traditional postmortem evaluations, but this technique has never been fully adapted by the industry. This has to do with a number of barriers and the development paradigm, which were used at the time of postmortem evaluations origin.

In this project the attacking point is not to learn from already failed projects, but to learn during projects. We apply theories which help us to understand why both individual reflection and team reflection is important.

This report begins by giving a recap of the literature, which the project is build upon. This involves fitting a methodology to the problem while arguing that the problem of developing a method in its nature is a wicked problem. The design of the method is explicated using the prior development and experiences from a former project conducted in the fall of 2009 by the same research group. This leads to a new angle on individual reflection using questions and conversations with the user, rather than the traditional approach such as a static diary. The team reflects by playing a board game, which acts as a free and entertaining platform. Having such a platform enriches the discussion with a relaxed attitude and by adding the element of team-building exercises it becomes socializing as well.

After developing the method it was clear that a couple of complex tasks could be eased by creating a software tool to support them. This tool works primarily on the individual reflection and is an attempt to create a conversation based reflection between user and an IT-system.

Both method and tool have been evaluated in a case study conducted with a test group of students at Aalborg University. They have used the method for two sprints with a length approximately 14 days each. The results of this evaluation have been positive in terms of the objectives to achieve a consistent individual reflection, while being able those reflections into the team reflection. However, impact on of the method to the test group was not comprehensive, which therefore leads to open questions. Amongst these open questions are how to keep the questions in the conversations both varying and relevant to the project. This can be done by adding phases to the strategy that picks the questions. Another open question is the problem of getting a team to make the work effort of reflecting individually before actually playing the game, therefore it could be a possibility to play the game first with generic questions.