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Using the Cognitive Walkthrough Method in Software Process Improvement

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Abstract

In the past years, efforts in the field of Software Process Improvement were increasingly focusing on human aspects making one aware that people participating in the processes have a high impact on the success of any improvement. Applying the usability methodology to these problems is a promising new approach to dealing with the people issues in Software Process Improvement. This approach builds on the strengths of the usability perspective, most importantly its rich method library. One of these methods is the cognitive walkthrough method, used extensively by practitioners in software development projects.

Keywords: Usability, Software Process Improvement, Cognitive walkthrough

1. Introduction

Recently, more and more Software Process Improvement (SPI) research studies the impact of people aspects on SPI projects, for example Korsaa et al. [1], Biró et al. [2, 3], Mahrin et al. [4], Kellner et al. [5], Prikladnicki [6], Siakas & Siakas [7] and Mumford [8] This impact stems from several factors. People taking ownership of the processes care more for the results and the proper execution, they are also more empowered for improvement and innovation, resulting in better processes and better products based on Messnarz et al. [9], O'Keeffee & Harington [10] and Christiansen & Johansen [11].

While SPI has an ever greater emphasis on people issues, another discipline, usability, is becoming more important as computers become ubiquitous. The usability methodology is about designing software and systems based on human needs, and as we are increasingly surrounded by computers, the ease of use of these devices becomes a major factor. Usability as a discipline has a history of helping to produce software, and more recently systems which are suitable for users, thus resolving many people related problems other engineering fields are not suitable to handle. The usability methodology builds on a wide range of methods based on psychology and ergonomics principles helping practitioners to design systems which support users in their tasks. The User-centered design [12], forming the core value of the usability methodology, enables to view all development projects, including SPI projects with a fresh eye focusing on the humans involved in the systems.

We presented the usability approach to SPI in our previous paper [13], and while we discussed the application of some usability methods, more elaboration is needed to make this approach viable in practical work. Following this, I will describe the usage of the cognitive walkthrough method in SPI in this paper.

The remainder of this paper is structured as follows. The second section describes the people issues in SPI, the usability methodology and the usability approach to SPI. The third section introduces the cognitive walkthrough method

and discusses its use in usability projects. The forth section presents the use of the cognitive walkthrough method in SPI. Finally section five I draw some conclusions.

2. The Usability Approach in Software Process Improvement

2.1. People issues in Software Process Improvement

Processes are considered the cornerstone for many organizations as the most effective way of producing quality products. Organizations also realize the need to improve these processes to become more successful in their business, to be more competitive, to make products of higher quality and cheaper than their competitors. In the end processes are still carried out by people, so the effective process completion relies on the abilities, skills and motivation of individuals. While employing excellent team members certainly helps, personalities of people can still make or break a process influencing the end product. This inspires process improvement professionals to handle people issues.

The importance of people issues was realized gradually by practitioners. Korsaa et al. [1] describes how the focus got on people instead of the processes from the early days of process improvement. A study about organizational learning by O' Keeffe & Harington [10] showed evidence to support this shift of focus to people, stating that 58% of the success factors for the implementation of innovation and improvement are influenced by human and organizational aspects.

Recent models also address people issues as an important factor in improvement:

- In the ImprovAbility Model [11] by Christiansen and Johansen people aspects appear in most of the 20 parameters.
- In the Process and Enterprise Maturity Model [14] by Hammer people issues appear on most organizational and process maturity levels.
- In the team centered processes by Jacobson et al. [15] by looking at a processes from a performer's perspective concludes that process needs to enable responses to situations.

Most recently, the SPI Manifesto [16] stated the principle: "We truly believe that SPI must involve people actively and affect their daily activities". This reinforces the focus on human aspects shifting from expert designers to the process applicators in defining and improving the processes. This principle is also supported by a number of values in the SPI Manifesto:

- "Know the culture and focus on needs": for the SPI to work, the organizational culture should be studied, as the people making up the organization carry values and practices. The SPI must consider these values to succeed.
- "Motivate all people involved": motivated people are more eager to participate in innovation and improvement, striving to look for solutions in their work.
- "Base improvement on experience and measurements": the SPI efforts must be based on the actual practices done by the organization, and all improvement activities should be based on quantifiable data.
- "Create a learning organization": the main benefit of this value is the culture supporting the continuous improvement.

Processes are represented by artifacts, namely the process descriptions. The ease of use or more specifically the usability of process descriptions was investigated by Mahrin et al. [4]. They found that there are usability related factors (for example understandable, tailorable, reusable, etc.), but their impact was not determined. Some of these factors were also proposed by Kellner et al. [5]. Other studies by Moe & Dybå [17], Scott [18] and Wang [19] showed that process descriptions have many usability problems impacting the application of the processes in a negative way.

2.2. Usability for Software Process Improvement

Usability is part of the software engineering quality model described in the ISO 9126 standard [20], and is often the most important attribute of a product from the user's point of

view. It also belongs to the broader field of Human-Computer Interaction studies on how humans use systems with software.

The most broadly accepted definition for usability is from the ISO 9241-11 standard [21]: "3.1 Usability: Extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use." This definition implies that we cannot produce a system that provides the same results under different contexts, with different users and different goals. Also the definitions state that with usability we are not just striving to get things done (effectiveness), but we need to do it with as little effort and resources consumed as possible (efficiency), while providing the users with a positive feeling and motivation (satisfaction).

Accurately describing the three product usage aspects (context, user and task) is an important part of usability engineering activities. Practitioners developed many methods, some of them coming from other disciplines (for example psychology, marketing and anthropology). Methods can be grouped based on the delivered data type (quantitative or qualitative), on the goal of the study (summative or formative) or on the persons involved (experts or experts and users). While not all methods produce quantitative data, most can produce easily measured values as described by Tullis [22].

For long, usability was mainly a software-engineering related discipline. With recent technological advancement and ubiquitous computing, usability is now considered in a much broader sense, also applicable to complex systems. This is reflected in the definition too, using product instead of software. The broader interpretation makes it possible to think in usability terms about complex themes like the interaction between citizens and the state (Citizen centered design, as presented by Hewitt [23]).

In discussing usability, there should be a clear distinction between the different meanings of the term. Practitioners use it to denote the quality of a software, the process of the design, and it is often hard to discern the exact meaning. Keinonen has described all these meanings in [24]:

1. The development process of a product.
2. The attribute of a product
3. The use of a product
4. The user's experiences while using a product
5. The user's expectations about the usage of a product.

For the remainder of this paper, I will use the first and second meaning and use "usability" when referring to the product quality and "usability engineering" when referring to the development process.

Applying usability concepts in SPI has two advantages, the first one is focusing on the user and designing systems based on their needs. The resulting systems will have greater acceptance because of user involvement and will be more efficient because they more accurately capture the needs and expectations of the process performers. If this is an SPI related system, besides acceptance, the performers will have an easier time to follow it, as it was designed with the specific context in mind. Another advantage is the already established set of methods of usability engineering applicable to many kinds of tasks. While some of the methods need adaptation to be usable in an SPI environment, basic ideas stay the same.

For the usability approach to work, its concepts for the definitions have to be aligned to the SPI environment:

- Product: The system where the SPI is going to be applied, a set of processes, a process model.
- User: The performer of the process, the person doing the task.
- Context: Work conditions and situations, including the organizational and other levels of culture. Some elements of the cultural context may be strongly connected to the user (for example when having a strong national cultural background)
- Task: The process that the user performs. While the preconditions of a given process are defined by outlying elements (business goals, organizational needs, standards) the exact realization, the design of the task and

the task conditions are well within the scope of usability engineering.
- Effectiveness: The process has to come to an end with process goals successfully achieved.
- Efficiency: The process execution shall require as little resources and effort from the user as possible
- Satisfaction: The user's experience of the executed process should be positive, empowering.

There is previous research mentioning the application of the usability methodology in the field of SPI, but these studies concentrate on the process descriptions, on the physical artifacts of the processes (for example by Mahrin et al. [4]). There is also some work concerning the usability of the tools used in SPI (for example by Al-Ani et al. [25]). While both of these fields are important, they represent just part of the scope of usability as they only deal with parts of the presentation and infrastructure layers.

Further details were presented on the usability approach in SPI by the author with Biró [13].

3. The Cognitive Walkthrough Method

The cognitive walkthrough method was described in detail by Nielsen and Mack [26]. It is one of the more widely used inspection methods. While it has its roots in the code-reviewing technique, the code walkthrough has been modified to identify usability issues in a product. An overview of the theory underlying the cognitive walkthrough method is provided by Rieman et al. [27].

The cognitive walkthrough is a quick and resource light method, and is usable even in the concept phase of development as it does not need a working code. The cognitive walkthrough is essentially based on the tasks of the user it tries to follow the user's thinking while trying to learn a system through exploring the systems options.

A walkthrough is composed of six steps:

1. List the tasks the users of the system are expected to perform. If only a part of the system is analyzed, a subset of these tasks should be chosen for evaluation.
2. Separate the tasks into intentions and goals (of the user). The intention is the overall end result the user is trying to achieve, while the goals are the result of the steps the user performs to arrive at the end result.
3. Decompose the tasks into steps. This helps to understand exactly where the system has problems.
4. The tasks and steps should be organized into evaluation sheets.
5. Perform the evaluation with chosen tasks. In each step the following questions should be asked (from [26]):
   a) Will the user try to achieve the effect that the subtask has? Does the user understand that this subtask is needed to reach the user's goal?
   b) Will the user notice that the correct action is available? E.g. is the button visible?
   c) Will the user understand that the wanted subtask can be achieved by the action? E.g. the right button is visible but the user does not understand the text and therefore will not click on it.
   d) Does the user get feedback?

   Will the user know that they have done the right thing after performing the action? If one or more of these questions uncover issues, a weight should be added, and if necessary also notes describing the problem.
6. After the evaluation is complete a review should be held to decide how to act on the issues.

An example evaluation worksheet is shown in Table 1.
- Step No.: The number of the current task step.
- Task step: The name and short description of the current task step.
- Operation: The operation the user has to perform in the current step.
- Result: The expected result of the operation.
- Aspect: The question that has uncovered some issues.

Table 1. Example of a cognitive walkthrough evaluation worksheet

<Task identifier>-<Task name>						
Step no.	Task step	Operation	Result	Aspect	Weight	Note
1.						

– Weight: Weight given to the uncovered issues.
– Note: A short description of the found issue or anything else the evaluators found out or would liked to note down.

While the cognitive walkthrough is a universal method (meaning its usage is not limited to a type of software systems), it has been adapted to specific types of software, for example Pinelle & Gutwin modified it to groupware [28], and Rowley & Rhoades presented a light weight modification the cognitive jogthrough [29]. These examples show the flexibility of the method.

Little research was made however on its applicability to processes. Novick describes a method to apply the cognitive walkthrough for operating procedures [30]. Operating procedures are similar to processes; they provide step by step instructions to follow to ensure a predefined, good outcome. As Novick states cognitive walkthrough for operating procedures provides insight into usefulness and safety beyond that associated with the cognitive walkthrough for physical interfaces. He changed the method for adaptation to procedures in five points:

1. As the steps are part of a procedure, some steps are not necessarily performed on an interface, for example when human-human interaction is concerned.
2. Procedures exist most of the time as artifacts informing the user what to do. This means that the form of these artifacts modifies the user's understanding of the instructions.
3. At each step it has to be decided if training or experience needed for the step's execution.
4. The correct execution of the steps should be identified not just from the user's viewpoint but from the overall systems viewpoint too.
5. In safety critical systems (where operating procedures are often used) errors can affect overall safety, so the error's probability should be identified.

This application of the cognitive walkthrough method to operating procedures can be expanded to the SPI environment.

4. Applying the Cognitive Walkthrough Method to Software Processes

Cognitive walkthroughs can be applied to SPI based on two observations:

– Novick's work with operating procedures can be extended to the more general software processes improvement environment.
– Process can be viewed as a special type of software. Following this thought, the user interface through which the user works with the software is also the main concern of usability and the usability methods, or in this case the cognitive walkthrough. If we think of processes as software, there is an interface too, the process artifacts: descriptions, templates, tools, guidelines, standards, but also the activities and work product descriptions.

Based on these two observations we can use the cognitive walkthrough in a SPI environment.

To apply the cognitive walkthrough we first have to decide in which steps it can be used. The following generic steps of process improvement were described by Wang & King [31]:

1. Examine the needs for process improvement
2. Conduct a baseline assessment
3. Identify process improvement opportunities
4. Implement recommended improvement
5. Review process improvement achievement
6. Sustain improvement gains.

As cognitive walkthroughs are useful for evaluating design concepts, prototypes and finished products, they can be used for reviews in the second and fifth steps, their results present

issues for the third step and can evaluate improvement measures in the fourth step before executing them.

To adapt the method to SPI the changes made by Novick should be modified with process specific changes. The significant changes to the original method will be as follows:

- Using process steps instead of interface steps. Most of the time this involves the process performer interacting with a system or another human. While human-human interactions depend heavily on the individual and the organizational culture, the steps should be analyzed realistically (for example response times and schedules).
- How the process performer gets the information on the process should be evaluated too. This not only means the process descriptions should be inspected but more broadly the accessibility of these descriptions, the provided trainings etc.
- Each role involved in the process has to be evaluated separately, and also parallel to identify role interferences.
- The process achieves the results required by the overall system, the processes should be evaluated in the process environment.
- Determine if the errors found affect the process risk measures. Most projects include some kind of risk control, sometimes defined in processes. Risk should be evaluated at the process and also at the organizational level, which means that issues that may affect risk measures should be evaluated.
- Check if the step executions are aligned with the policies guiding the process.
- Key activities should be evaluated if they implement the overall goals of the process while they are executed as steps.
- Deliverables should be evaluated if they are accessible and understandable.
- Check if tools are used during the execution of the process, they should be inspected for potential issues.
- Other artifacts (guidelines, standards, templates and generally the contents of the process assets library) should be reviewed the same way as the deliverables.

With these changes to the original the cognitive walkthrough method is a viable method to apply in the SPI environment.

5. Conclusion

People issues in SPI are gradually recognized as an important success factor in improvement projects and the new approach of applying the usability methodology has a potential to handle these issues. This paper has introduced a practical aspect of this approach, the applications of the cognitive walkthrough usability inspection method to the SPI. I have shown how to execute the cognitive walkthrough method, and what are the significant changes needed for its application.

Cognitive walkthrough is a relatively quick and cheap method (in terms of resources, required staff and training), so its application should be viable in most organizations. While its benefits seem to be creating processes and process improvement more adaptable to the people using the processes, further research is needed on its performance under real project conditions.

References

[1] M. Korsaa, J. Johansen, T. Schweigert, D. Vohwinkel, R. Messnarz, R. Nevalainen, and M. Biró, "The people aspects in modern (S)PI management approaches," 2010, presented at the EuroSPI 2010.

[2] M. Biró, R. Messnarz, and A. Davison, "The impact of national cultural factors on the effectiveness of process improvement methods: The third dimension," 2002, software Quality Professional. Volume 4.

[3] M. Biró, R. Messnarz, and A. Davison, "Experiences with the impact of cultural factors on SPI," 2001, presented at the EuroSPI 2001.

[4] M. Mahrin, D. Carrington, and P. Strooper, "Investigating factors affecting the usability of software process descriptions," in *Proceedings of the Software process, 2008 international conference on Making globally distributed software development a success story*, Springer-Verlag, Berlin, Heidelberg, 2008, p. 222–233.

[5] M. Kellner, U.Becker, W. Riddle, J. Tomal, and M. Verlage, "Process guides: Effective guidance for process participants," in *Proceedings of the Fifth International Conference on the Software Process*, ISPA Press, Chicago, IL, USA, 1998, pp. 11–25.

[6] R. Prikladnicki, "QUASE – a quantitative approach to analyze the human aspects of software development projects," in *Proceedings of the 2009 ICSE Workshop on Cooperative and Human Aspects on Software Engineering*, IEEE Computer Society, Washington, DC, USA, 2009, p. 78.

[7] K. Saikas and E. Saikas, "The human factor deployment for improved agile quality," 2006, presented at the EuoSPI 2006.

[8] E. Mumford, "The ETHICS approach," *Commun. ACM*, No. 36, 1993, pp. 82–.

[9] R. Messnarz, G. Spork, A. Riel, and S. Tichkiewitch, *Dynamic Learning Organisations Supporting Knowledge Creation for Competitive and Integrated Product Design*, 2009.

[10] T. T. O'Keeffe and D. Harington, "Learning to learn an examination of organisational learning in selected Irish multinationals," *Journal of European Industrial Training*, No. 25, 2001, pp. 137–147.

[11] M. Chirstiansen and J. Johansen, "Improvability^{TM} guidelines for low maturity organisations," 2007, presented at the EuroSPI 2007.

[12] "ISO 13407:1999 human-centred design processes for interactive systems," 1999.

[13] P. Polgár and M. Biró, "The usability approach in software process improvement," 2011, presented at the EuroSPI 2011.

[14] M. Hammer, "The process and enterprise maturity model," retrieved on 10.05.2011. [Online]. http://www.hammerandco.com/HammerAndCompany.aspx?id=58

[15] I. Jacobson and I. Spence, "Enough of processes – lets do practices," *Journal of Object Technology*, No. 6, 2007, pp. 41–66.

[16] "SPI manifesto," retrieved on 10.05.2011. [Online]. http://www.iscn.com/Images/SPI_Manifesto_A.1.2.2010.pdf

[17] N. Moe and T. Dybå, "The use of an electronic process guide in a medium-sized software development company," *Softw. Process: Improve. Pract*, No. 11, 2006, pp. 21–34.

[18] L. Scott, *Understanding the use of an electronic process guide*, 2002.

[19] Y. Wang, *Software engineering processes: principles and applications*. Boca Raton, Fla: CRC Press, 2000.

[20] "ISO/IEC 9126:2001 software engineering – product quality. iso/iec," 2001.

[21] "ISO 9241-11:1998 ergonomic requirements for office work with visual display terminals (vdts) – part 11: Guidance on usability," 1998.

[22] T. Tullis, *Measuring the user experience: collecting, analyzing, and presenting usability metrics*. Amsterdam, Boston: Elsevier/Morgan Kaufmann, 2008.

[23] J. Hewitt, "Citizen-centered design (slowly) revolutionizes the media and experience of U.S elections."

[24] T. Keinonen, "One-dimensional usability – influence of usability on consumers' product preference," Master's thesis, University of Art and Design Helsinki UIAH, 1998.

[25] B. Al-Ani, E. Trainer, R. Ripley, A. Sarma, A. van der Hoek, and D. Redmiles, "Continuous coordination within the context of cooperative and human aspects of software engineering," 2008, p. 1–4.

[26] J. Nielsen and R. Mack, *Usability Inspection Methods*. Wiley, 1994.

[27] J. Rieman, M. Franzke, and D. Redmiles, "Usability evaluation with the cognitive walkthrough," in *Conference companion on Human factors in computing systems*, 1995, p. 387–388.

[28] D. Pinelle and C. Gutwin, "Groupware walkthrough: adding context to groupware usability evaluation," 2002, p. 455–462.

[29] D. Rowley and D. Rhoades, "The cognitive jogthrough: a fast-paced user interface evaluation procedure," 1992, p. 389–395.

[30] D. Novick, "Using the cognitive walkthrough for operating procedures," *Interactions*, No. 6, 1999, pp. 31–37.

[31] Y. Wang and G. King, "Philosophies and approaches to software process improvement," in *Conference on Software Process Improvement (EuroSPI'99)*, Pori, Finland, 1999, pp. 7.24–7.38.