# Triggers for the critical engagement with decision support systems


**Abstract**

In previous work, we showed that the critical engagement with a decision support system during its implementation by a project team is an important antecedent for the successful later use of the technology. However, the mechanisms that trigger such critical engagement are so far not well understood. Drawing on Heidegger's modes of Being-in-the-world this paper provides a theoretical frame to understand trigger mechanisms of critical deliberation in more detail. In particular, I argue that critical engagement is triggered by breakdowns during which the system becomes unavailable for use. Such breakdowns, in turn, enable thematic deliberation which leads to critical engagement with the decision support system. I also argue that breakdowns can alternatively lead to periods of theoretical detachment during which the meaningful use of the decision support system and meaningful manipulations of the system to implement it for a specific decision making purpose are not possible. To provide first evidence for these mechanisms, I will analyze a number of episodes that I observed while participating in a large-scale decision support system implementation effort on a major construction project. By developing and illustrating how critical engagement is triggered by breakdowns, the paper contributes to our in depth understanding of grassroots decision support system implementations by project teams.



*Keywords:* technology implementation, decision support systems, Heidegger, critical engagement

## 1. Introduction

In the last years, the project organization research community has made great progress in understanding innovation processes at the industry level accounting for the industrys fragmented and diverse structure (Taylor, 2007; Taylor and Levitt, 2007; Dubois and Gadde, 2002; Gann and Salter, 2000). However, despite all these successes, empirical studies at the project level still document great struggles with the adoption and effective use of IT applications (Hartmann et al., 2008; Galloway, 2006). Understanding about these struggles and in general about the implementation dynamics at the project level is, however, of essential importance. Research in project-based industries shows that practitioners need to explore new technologies on single projects before company executive research and development R&D departments can disseminate them through the whole company (Brady and Davies, 2004). Additionally, due to the unique nature of many projects it is often not even possible to develop standard use procedures that can be implemented in a top-down manner. Thus, the existing, strategic, top-down innovation understanding of the construction research community needs to be complemented by a better understanding of bottom-up implementation processes at the operational project level.

To further this understanding about bottom up processes, we developed a theoretical model that describes project-based implementation dynamics at the micro-level of a project team(Hartmann and Levitt, 2010). Based on this model, we showed that the project-based implementation of decision support systems is a highly iterative process of making sense of how the system can help in the current context and of implementing the system to enable the previously identified possibilities (Hartmann, 2011; Hartmann et al., 2012). We also showed that the critical engagement with a decision support system during its implementation within a project organization is an important antecedent for the successful later use of the technology. We showed that critical engagement starts new implementation cycles to improve the use of a system within a project based setting Hartmann and Fischer (2009). The mechanisms that trigger such critical engagement, however, are so far not well understood. Drawing on Heidegger's three modes of Being-in-the-world this paper provides a theoretical frame to understand these triggering mechanisms in more detail. In particular, I argue that critical engagement is triggered by thematic deliberation after breakdowns during which the system become unavailable to support decisions in the way it was intended to. To provide first evidence for these mechanisms, I analyzed a number of episodes that I observed while participating in a large-scale decision support system implementation effort for a major construction project. By developing and illustrating how critical engagement is triggered, the paper contributes to our in depth understanding of implementations by project teams. In particular, this paper provides a link between earlier predictive theories about the importance of resistance for the success of implementations (Hartmann and Fischer, 2009) and explanatory theories about the ongoing sense-making about the decision support system during implementations (Hartmann, 2011; Hartmann and Levitt, 2010).

The paper is structured as follows: It starts with an introduction in the micro-dynamics of decision support systems at the project team level. Afterward, the paper introduces Heidegger's fundamental modes of existence. After a short description of the applied research method, the paper will use these modes to explain how critical engagement was or was not triggered using episodes from a longitudinal case study. The paper closes with a discussion about the theoretical and practical implications of the presented work.

## 2. Micro-dynamics of decision support systems at the project level: Grassroots theories

To improve the understanding about bottom-up implementation processes, researchers first need an in-depth understanding of how engineering project teams are organized. Projects organize workforce detached from the formal hierarchy of an engineering company. This hierarchical detachment, in turn, allows project team members to make the creative and timely decisions needed to produce unique products of the built environment without the need to escalate decisions or possible problems to upper level managers. However, the same detachment, oftentimes, impedes the top-down implementation of new technologies, since upper level managers lack an in-depth understanding of local work processes and environments (Brady and Davies, 2004). Therefore, it is important that project team members drive the implementation of new technologies from the bottom-up.

Models that describe such bottom-up processes need to account for four characteristics that are intrinsic to the implementation process of decision support systems by project teams:

- Systems supporting decision making at the operational level pf projects consist of bundles of software, hardware, and processes that can be used in different ways (Bidgoli, 2003; DeSanctis and Poole, 1994; Rice and Rogers, 1980). Thus, it is often unclear how to configure software, hardware, and processes to support specific decision making tasks. The application of different configurations of software, hardware, and processes can often lead to the same outcome; alternatively, the use of the same configuration can result in different outcomes.

- Upper management cannot mandate the effective use of an IT system to support project-based decision making. Even though project team members have the opportunity to adopt and use the system, they can continue to make decisions without using it. There is no easy way for the upper management to control whether or not a system is used at all or used efficiently.

- Due to the high levels of reciprocal interdependence between many project tasks, project team members are dependent on information updates from other members (Thompson, 2003; Gann and Salter, 2000; Levitt et al., 1999). Therefore, the successful implementation of a decision support system by a project team depends on a high level of integration of the system within the team.

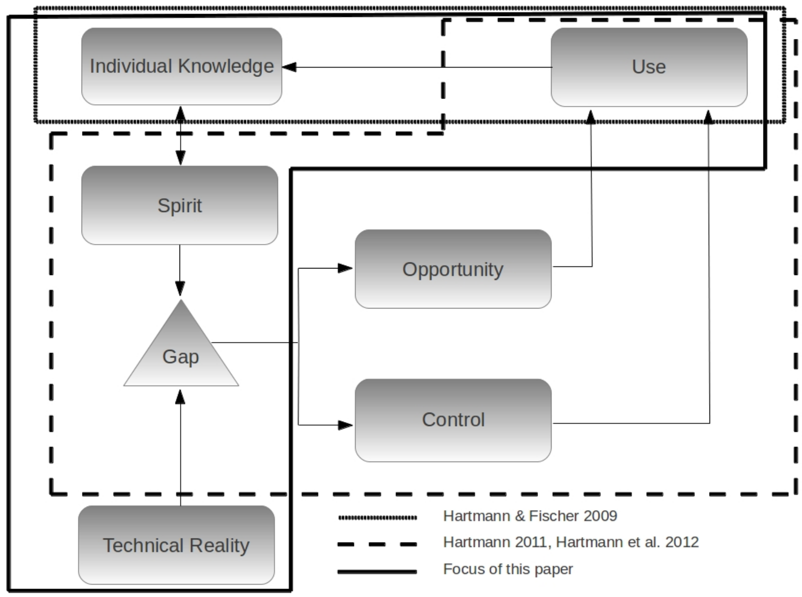


Figure 1: A summary and overview of the previously developed grassroots theories of decision support implementation by project teams. The figure shows the overall theory and how the overall model is covered by previous publications. It also indicates the focus of this paper.

- A project team is a temporary organization. Therefore, project teams have only limited time to develop procedures about how to use a new decision support system. Further, how the members of the team define various attributes of the decision support system will vary throughout the project. A stable institutionalization (Scott, 1995) of the use of a decision support system is thus unlikely.

To account for these characteristics, we have developed a grassroots theory to describe the dynamics of decision support systems by project teams summarized. At the core of the theory is the grassroots model of technology implementation that is summarized in Figure 1 (Hartmann, 2008). Building upon sense-making theory (Weick, 1995; Berger and Luckmann, 2007), the model explains how members of a project team mutually generate the spirit of a decision support system that captures the outcomes of the project team members sensemaking processes about the system in the local project environment. This spirit describes the subjective characteristics of such systems as they are jointly perceived by the members of the project team (Majchrzak et al., 2000; DeSanctis and Poole, 1994). The model asserts that this spirit is different from the technical reality i.e., the real potential of the system to improve the work processes and the real technical knowledge that is needed to implement the system in the respective project environment. The model assumes that the two constructs of technical reality and spirit are never entirely identical, so that there exists a gap between them. The size of this gap is influenced by how accurately the spirit - the outcome of the project teams sensemaking - describes the technical reality.

The model then asserts that the size of the gap between the objective technical reality of the system in use versus the subjective spirit that is established influences how project team members perceive the control they have over the implementation and how they perceive the opportunity that the system offers them to improve decision making tasks. The model posits that project team members who, due to a small gap between the spirit and the technical reality, gain a feeling of control over the implementation of the system and who perceive that the system offers opportunities to improve their decision making tasks maximize the possible benefits the technology offers during implementation. In contrast, if the gap is large the model predicts that project team members conclude that they do not have control over the implementation and that they do not think that the system is an opportunity are likely to try to minimize the expected negative consequences of the technology implementation. In these cases, project team members are not likely to utilize the new system and try to avoid using it as much as possible.

The developed model also posits that the above described process is highly iterative. Through the use of the decision support system, project team members will gain new knowledge. With this new knowledge, the subjective characteristics of the used system and, hence the system's spirit will also change. This change, in turn, influences the gap between the spirit and the technical reality. Empirical studies of the implementation of decision support systems by project teams, showed that use mainly influences technical knowledge, but also project task related knowledge (Hartmann, 2011; Hartmann et al., 2012).

Further theoretical elaborations on the model then suggest that resistance is necessary for individuals to understand, engage with, and use new technologies (Hartmann and Fischer, 2009). Therefore, these elaborations suggest to treat user resistance not as a reaction to a change that involves mistrust, but as a rejection of parts of the change based on careful and thoughtful investigation of aspects of the change (Knowles and Linn, 2004; Ford et al., 2008). The grassroots model assumes that, during each of the above described iterations, change recipients pursue parts of a proposed change and reject other parts (Wegener et al., 2004). Thoughtfulness is the important attribute that helps change recipients to determine what to pursue and what to reject. Thoughtfulness, in turn, is triggered by resistance because only resistance enables project team members to critically engage with the change. Additionally, user resistance, not only triggers the above described iterations, but also increases process awareness, serves as an early warning system about issues and expectations, and helps to evaluate new processes around a technology. From a grassroots perspective, resistance should, hence, be treated as an intrinsic characteristic of the change process that serves as an important and necessary function to ensure a meaningful and thoughtful implementation.

All together, these previous theories can provide a good lens to understand decision support system implementation by project teams. However, so far it is not yet well understood how critical engagement with a implemented decision support system is triggered. This paper sets out to increase understanding about this question. To this end, it will draw in Heidegger's theory of being in the world (Heidegger, 1963). The next section will provide a brief overview about this theory.

## 3. Being-in-the-world: Heidegger's fundamental modes of existence

Heidegger suggests that there is a continuum of how we engage with the world that ranges from complete immersion to detachment (Figure 2). On this continuum immersion is the most basic and natural form. Acting immersed means that we are, in first instance, not separated with the objects and other human beings that surround us. We unconsciously act by immediately anticipating what action to conduct next. Being immersed in such a way, we lack the ability to reflect about situations using object-subject relations to abstract aspects of systems or tools, or in Dreyfuss's translation of Heidegger, equipment, we use to support our ongoing activities (Dreyfus, 1991, p.78).

According to Heidegger, we will only leave this basic mode of being if we encounter interruptions or breakdowns that forcefully stop our immersed activities. In most cases, we are able to deal with a temporary breakdown using the second mode of being: involved thematic deliberation (Dreyfus, 1991). During thematic deliberation, we attend to the breakdown by starting to pay deliberate attention to what we do and how equipment, helps us to do so. In this mode, we are still involved in practical activity, but we now start to heedfully attend to what we do. The relational whole of our current practice temporary moves into view. This, in turn, enables us to derive plans for the use of equipment in the future. Dependent on the severity of the disruption these plans will have a short term or long term focus.

If the breakdown becomes to sever, we enter the third mode of being: theoretical detachment. In this mode we become "too paralyzed to act" (Sandberg and Tsoukas, 2011, p.2011). We have to stop whatever we are doing and start to try to understand the abstract properties of the situation at hand by detaching us from the actions we were unconsciously involved with. Through this detachment, however, we loose the context of the actions we were involved in previously. Hence, we will no longer be able to meaningfully manipulate equipment to appropriate it to the context at hand. To phenomenologically illustrate the above describe modes of being-in-the-world, we will use the modes to analyze a number of episodes from a decision support system implementation effort that we observed in the next section.

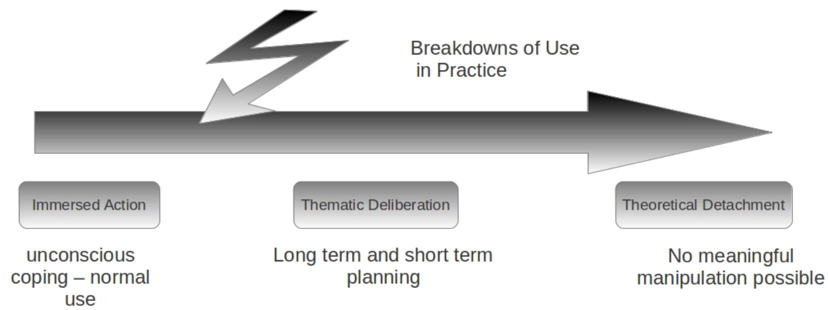


Figure 2: Application of Heidegger's modes of being to the implementation of decision support systems by project teams. Temporary breakdowns enable users to involve in thematic deliberation which allows the development of long term and short term plans for the implementation. Complete breakdowns will lead to theoretically detachment from the actual decision making context. In this mode, no meaningful implementation steps are possible.

## 4. Evidential episodes from a longitudinal case study of technology implementation

### *4.1. Research Method and Case Introduction*

The field study used to illustrate the above described theoretical modes of being was concerned with the design phase of a major subway-reconstruction project in a metropolitan city in the United States. The same field study has already served well to illustrate previously developed parts of the grassroots model (Hartmann, 2008, 2011) and, hence, has been analyzed from a number of different theoretical angles. Therefore, the case serves not only to illustrate the here developed theory, but also helps to understand the different parts of the grassroots theory in context.

The project serves as a great example of the previously described characteristics of project teams and decision support systems. The client of this project – the subway department of the metropolitan city – had subcontracted the design of the project to several design companies. To obtain support with managing this design effort, the subway department hired a consulting construction management (CCM) team to review the incoming designs. This CCM team represents the study's organizational unit of observation.

The CCM team was lead by a project director under whom a number of project managers worked. Despite this two-level hierarchical structure, the project managers were responsible for making their own decisions with respect to most of the CCM teams work tasks. The role of the project director was mainly limited to communicating the project managers decisions to the other project stakeholders. Additionally, the work of the project managers was supported by a number of office engineers, who, though they formally reported to the project managers, were expected to work independently on tasks. Next to its flat hierarchical structure, another important characteristic of the CCM team was that few common routines existed at the start of the project. The CCM team was a joint venture founded specifically for this project, and few of its members had worked together previously.

To support its design review and constructability analysis tasks, the CCM team decided to utilize a decision support system to better understand project complexities. This system, a so-called 4D system (Hartmann et al., 2008; Hartmann and Fischer, 2007), was designed to simulate and visualize the planned reconstruction sequence, starting with the existing conditions at the construction site and ending with the proposed final conditions of the project. To be able to successfully use the 4D system, the project managers needed to extensively configure the tool. In particular, it was important- to generate three-dimensional (3D) models and schedules that would allow for meaningful visual simulations of construction sequences. Hence, this case, with its absence of stable working routines within the CCM team and the necessity to configure the 4D system, is ideal to further an understanding of how actors influence the implementation of a decision support system in complex project-team settings.

The longitudinal case data presented in this paper were collected during a one-year participatory field study with the above described CCM team. Following the main idea of participatory research methodology (Jorgensen, 1989), the writer tried to get as involved in the daily project-management work as possible. This allowed the writer to normalize his role as a researcher by becoming a member of the project team, which is an important requirement for longitudinal case studies. The participatory involvement allowed for deep insights into who influenced the implementation of the decision support system at different times during the implementation and how the influence of different actors changed over time.

During the field work, data was collected from different sources and interesting observations related to the configuration or use of the decision support system were constantly recorded in a field journal. The writer also conducted formal interviews with project participants that were recorded as thoroughly as possible in the same journal. Additionally, a large number of documents were collected, including approximately 100 different streams of electronic communications related to the decision support system, 26 meeting minutes summarizing decision support system related meetings, and eleven presentations slide-shows that either directly focused on issues related to the decision support system or that involved outputs of the decision support system to support the communication of other project-related issues.

To derive a theory from the vast amount of qualitative data that was collected during the participatory research, a grounded research approach was applied (Glaser and Strauss, 1967). Already, during the field work, the writer started to summarize all applications of the decision support system that were observed in a separate notebook in an effort of theoretical memoing (Glaser and Strauss, 1967). For each identified application, the actors that were involved, the configuration steps the actors took, and how the actors eventually used the decision support system to inform their decisions were traced. After leaving the field, a formal data-organization framework was developed and used to further structure the data. This effort resulted in narratives of 4D system configurations organized in several configuration episodes.

The rest of this section will describe a number of the identified episodes during the implementation process of this 4D system to illustrate how Heidegger's modes of being help to understand the implementation dynamics observed.

*4.2. Start of the Implementation: Theoretical Reflection*

At the beginning of the implementation, the CCM team hired a computer-visualization company to create the 3D models that are necessary as a technical input to the 4D system. Concurrently, to the modeling effort of the visualization company, the CCM team conducted regular meetings to discuss the progress of the modeling effort. Because of the detachment of the modeling work with the ongoing project management activities, these 4D related meetings were mainly focused on discussing abstract characteristics of a 4D system. A clear understanding of how the models could be used on the project could not be developed. Instead, the project managers developed their own abstract properties of the 4D system. For example, in an effort to control the ongoing 3D modeling efforts better, the project managers developed abstract metrics to measure progress. These metrics described the progress of modeling by dividing the project into logical physical sections describing the different stations using the letter of the respective subway lines (AC line, RW line). For each of these stations they then tracked an abstract percentage of how much of the model for each line was completed. This abstract property "percentage complete", however, was not related in a meaningful way to how the 3D models should be used in the 4D system to support project management.

The purely theoretical reflections described above, prevented the CCM team to develop meaningful models together with the visualization team. Both sides, the project manager and the visualization specialists remained in a mode of theoretical deliberation. Only as outsiders from a software company that sold a 4D model application got involved, this state of theoretical deliberation could be resolved. With the help of the experts from the software company, the CCM team realized that it was not possible to establish visualizations of construction sequences with the generated 3D models. The models were simply in a too coarse level of detail that did not allow to meaningfully distinguish between different construction activities.

To solve this situation, the CCM team and the technology manager decided to stop working with the visualization company. Members of the CCM team started to explore the technical problems from a project-task background. They decided to identify in-house personnel with both project management and technical knowledge about 3D modeling. Then, the team started a configuration phase of the 4D system that allowed for a number of successful applications of the system that is described in the following sub-section.

*4.3. Absorbed Coping*

Soon after the first meaningful 3D models became available, the CCM team started to use the 4D system to support ongoing project management decision making tasks. For example, one of the CCM teams project managers had worked on evaluating whether it was possible to renovate one of the projects subway stations while maintaining the traffic on the street above. However, with the existing project documentation material, it was not easy to conduct this evaluation. The existing two-dimensional (2D) drawings represented the street level and the subway station level on two different drawing sheets. Therefore, the project manager was not able to quickly determine the opening size required to install the subway station underneath by using the station-level drawing, nor was he able to determine how much of the street would be covered by the opening. By using the measurement feature provided by the 4D system with the 3D model that represented the street and subway station levels, project manager A was able to extract the required information in less than ten minutes from the 4D system. He was now quickly able to determine that the required 11-ft traffic lane could be maintained and was able to make the decision that the respective subway station design was constructable.

A second example shows an unintended successful use of the 4D system. In one of the ongoing 4D meetings, the CCM team looked at the existing 3D models to ensure that the model adequately represented the planned construction work. Interestingly, this meeting turned into an actual project-management meeting, during which project managers started to evaluate possible ways to construct a tunnel connecting two different subway lines underground.

In both above examples, project managers did no longer think about the characteristics of the 4D system, even if this was the initial intention as in the second example above. This is, for example, illustrated well by project managers referring to the system as 4D, while both of the above applications of the model were not using any visualization function showing planned construction: the 4D aspect of the system . During these application, the project managers still appropriated the 4D system to the task at hand, e.g., they used the measurement function to measure the width of the street or they used the navigation function to understand the changed design. However, while they appropriated the system project managers were not aware of the 4D system itself and focused on the project management decision making tasks.

### *4.4. Deliberate Coping: Reflective Planning*

At the start of this episode, the subway department decided to significantly change the design of the project to reduce the estimated costs of the project. These changes, in turn, rendered portions of the existing 3D models obsolete. This triggered a number of questions among the CCM team members about the value of the 4D system that none of the team members had thought of before. This caused a serious disturbance in the use of the 4D system, because CCM team members started to question its functionality within the given context.

The consecutive discussions were mainly shaped by one of the project managers. His opinion can be best assessed by the following statement:

*To be honest, I am not sure any longer whether it makes sense to apply a 4D system on a construction project. So far we spent more than $100,000 to create all these 3D models and we have hardly used them to support our work. I mean, yes we looked at the model, but it is mainly pretty pictures that do not really help to make decisions. And now with the value engineering we would need to remodel 70% of the 3D and I do not see how this can be defended in front of the client who pays for it. The 3D modeling process necessary is simply too expensive for us as construction managers to do (Project manager C, personal communication, 2005).*

The other team members also began to support this opinion. On multiple occasions, team members stated their concerns of how to explain the large amount of money the team had already spent on the 4D system to the subway department.

These discussions triggered a deliberate effort to understand the 4D system in relation to the costs of the modeling effort required. This deliberation revealed that though the design company had redesigned large parts of the project, half of the previously created 3D models represented the existing conditions of the project site before the start of construction activities. Hence, the part of the 3D model that represented these parts did not needed to be remodeled. The CCM team prepared a number of graphs and figures summarizing the 3D modeling effort and detailing its costs. All the deliberation, however, was within the context of using the 4D system to support project management tasks. All financial considerations were discussed in light of the previously successful applications of the 4D system.

The deliberation, in turn, allowed the CCM team to develop a short term plan of how to make the 4D system financially working on the project. The 3D modelers were asked to remodel the changed design, while the CCM team implemented a number of processes to reduce and control the costs of the 3D modeling effort. One part of these new processes was that the team decided that the modeling of new parts of the project should be discussed with project managers in detail to make sure that all models would also be used to support project-management decisions. Further, the CCM team started to track the costs of the modeling effort on a continuous basis. Additionally, the CCM team developed a number of guidelines that described processes of using the 4D system and how to create schedules and 3D models as input for the system. Finally, the CCM team trained an office engineer in how to use the system.

Successively, the members of the CCM team started to intensively use the 4D system to visualize the projects complicated areas. The team used the model to simulate and plan construction sequences and to evaluate whether the new design could be constructed within the tight project conditions within a mode that can be best described again as absorbed coping.

*4.5. Deliberate Coping: Long Range Planning*

This episode describes another breakdown, this time more severe as the CCM team failed to use the 4D system. Whereas, in the previous episodes, the CCM team mainly used the 4D system to support internal decisions of the team, in this episode, the CCM team decided to additionally support its communications with the client. The CCM team committed to a client request to support one of its public relations presentations with the 4D system. This presentation was a great failure because the CCM team was not able to generate a visually appealing 4D visualization to support the communication for this meeting. Although the CCM team had previously configured the 4D system to be able to flexibly support project management decision-making tasks, it was not suited to support 4D visualizations for presentations to project-team outsiders.

The client of the project reacted to the CCM teams failed attempt by threatening to stop financing the effort if the CCM team could not show its ability to effectively use the 4D system. The following excerpt from an e-mail illustrates this episode.

*We had a major presentation today with the client. Once again, conversion of the [3D] model files to [the 4D system] proved to be an insurmountable challenge. The client made it very clear today, [that] if we are unable to show the value of a 4D model by next Thursday, they will no longer provide monetary support for this effort (Project manager D, personal communication, 2006).*

After the failed presentation, the CCM team started to deliberate why the 4D system was not working. Some members concluded that the software was the problem and that the CCM team should acquire different software that according to the Technology Manager

*... has now become the preferred software solution for 4D Modeling across the industry (Technology manager, personal communication, 2006).*

Simultaneously, other members of the CCM team argued that the problem was not with the 4D software itself but with the process of converting 3D models as input for the 4D application:

*[I] think the main issue we had yesterday was that [3D modeler A] was not properly shown how to organize and convert the model [... to omit unnecessary details for a presentation- ...], and since [3D modeler B] was out for the week [3D modeler A] didnt have someone to confer with (Office engineer, personal communication, 2006).*

In the end, the CCM team decided to acquire an alternative 4D software system following the recommendations of the more experienced team members. This decision was mainly made on a long-term background. Overall, the CCM team expected that the switch to the new software would allow them to more consistently and flexibly support project management decision tasks.

After the acquisition of the new software, the CCM team used the 4D system successfully to support a number of presentations to team outsiders, as the following excerpt from an interview with one of the project managers illustrates:

*Oh yes we still use the 4D system. Last week we just had an outstanding success. We invited a number of people from [the subway department] over to review the latest schedule that we created for the [one of the subway lines]. By seeing the schedule simulated within the model, they were able to sign off on our plan within 3 hours. This process would have usually lasted 3 weeks if not longer (Project manager A, personal communication, 2007).*

Another interview with the CCM teams project director further underlines this fact:

*...4D is useful for construction planning and we have used it within the last months a number of times. At the beginning we were overenthusiastic and did not know how to use 4D right. We spent a lot of money on modeling things we really did not need to see in the model. But in the end, 4D is very helpful (Project director, personal communication, 2007).*

## 5. Discussion

If nothing more the above episodes show well that Heidegger's modes of being are helpful to understand the dynamics during the implementation of decision support systems by project teams. The first episode describes, how pure theoretical deliberation fails to achieve a successful implementation. In this phase, the CCM team could only theoretically discuss about the characteristics of the 4D system without meaningfully relate it to the decision making context at hand. This is in line with the grassroots model that describes use as one of the important factors to consider. During such phases, it seems to be likely that the gap between the perceived spirit of the system and the project reality growth which will hinder a successful implementation. On the case project, this deadlock could only be broken, by outsiders that actually attempted to use the created 3D models for the initially intended purpose.

At the same time, the above episodes also show that during normal use of the system, project managers did not deliberate about the aspects of the system to improve the implementation. Only after temporary breakdowns of the 4D system through malfunction of the tool or other disturbances, such as the re-design of the subway station that made some of the existing 3D models obsolete, members of the CCM team started to deliberate about the aspects of the 4D system for the current decision making context. Only in situations in which the 4D system broke down its various references to the situation at hand showed up. In these situations, the characteristics and properties of the 4D system became clearly visible to the CCM team and its various references to the decision making context of the project showed up. This allowed project team members to then detach themselves from the ongoing use situation and develop new insights. These insights, in turn led to adjustments of the overall implementation of the system, such as the introduction of more cost efficient modeling procedures or the switch to different software systems.

In conclusion, the application of Heidegger's modes of being to understand the implementation characteristics allowed to further provide more detail for the grassroots model of decision support implementations by project teams. Previous research shows that implementations in these contexts can be highly iterative and need to be iterative to be successful because the knowledge of the involved persons about the meaning of the system for the current context changes (Hartmann, 2011; Hartmann et al., 2012). This paper complements these insights by showing how new iterations can be triggered and by providing more details in the mechanisms of how new knowledge is developed by the implementing members of a project team.

Understanding decision support implementations from the lens of Heidegger's modes of being offers a number of benefits to organizational practice. Being aware of how the modes of being influence the implementation helps project managers that intend to use a decision support system and technology specialists that manage implementations to better organize their efforts. To support relative standard problems by implementing decision support systems it seems obvious to try to avoid any form of disruption so that project managers can use the decision support system while being immersed in project management practice. However, once the decisions to be supported become more and more complex it might be a good strategy to intentionally cause temporary and complete breakdowns that allow everybody involved in the implementation to deliberate about the meaning of the system in the current context. However, moments of deliberation and use should be balanced carefully. In case deliberation gets too detached from ongoing project management practice, it will no longer be possible to meaningfully relate the system to the existing decision making context. This situation might then, in turn, lead to a theoretical deadlock similar to the one observed at the beginning of the implementation on the test case project.

## 6. Acknowledgments

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