DESIGNING AN APPROPRIATE INFORMATION SYSTEMS DEVELOPMENT METHODOLOGY FOR DIFFERENT SITUATIONS

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Abstract: The number of information systems development methodologies has proliferated and practitioners and researchers alike have struggled to select a 'one best' approach for all applications. But there is no single methodology that will work for all development situations. The question then arises: 'when to use which methodology?' To address this question we used the design research approach to develop a radar diagram consisting of eight dimensions. Using three action research cycles, we attempt to validate our design in three projects that took place in a large administrative organization and elsewhere with groups of IT project managers. Our artefact can be used to suggest a particular one-off approach for a particular situation.

1 INTRODUCTION

Information systems development methodologies (ISDM) concern information systems development processes and products. They lie at the core of the discipline and practice of information systems. Systems development typically unfolds as a lifecycle consisting of a series of stages such as requirements analysis, design, coding, testing and implementation. In practice, these stages do not have to be carried out sequentially but can be done as a series of iterations, sometimes more or less in parallel. Often each stage operates with a defined notation and will often result in a prescribed artefact, such as a requirements specification or a computer program.

An ISDM is a prescribed way of carrying out the development process. The description typically includes activities to be performed; artefacts resulting form the activities; plus some principles for organizing the activities and allocating people to perform the activities. An ISDM can be aimed at a specific type of development, e.g. database-intensive applications with less than 10 people involved, or it can be specific to a company. However, many ISD methodologies claim to be of generic use. Avison and Fitzgerald (2006) describe 34 generic approaches which they refer to as *themes,* and 25 specific methodologies which they argue are very distinct.

Early ISDMs were based on practical experiences, where experienced practitioners described how they developed their applications. Others are often anchored in theory, such as Highsmith (1999) that (partly) builds on the theory of *lean thinking* (Womack 1996).

On the other hand, the practicality of using ISD methodologies has been questioned altogether. A growing number of studies have suggested that the relationship of methodologies to the practice of information systems development is altogether tenuous (Fitzgerald, 2000, Wastell, 1996 and Wynekoop & Russo, 1997). It seems that the idea of an all-embracing methodology has been so dominant in our thinking about systems development that it may have become somewhat imaginary. In many situations where an ISD methodology was claimed to be used, this was not evident to researchers (Bødker and Bansler, 1993). Indeed Truex et al. (2000) suggests that systems development is *amethodical* in practice, arguing that in reality the

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management and orchestration of systems development is done without the predefined sequence, control, rationality, or claims to universality implied by much of methodological thinking.

The conclusion of this line of thought, however, is intolerable. If any ISDM only has academic but no practical value then any ISD project team is left on their own without guidance. On the other hand, we agree that most methodologies are designed for situations which follow a stated or unstated 'ideal type'. The methodology provides a step-by-step prescription for addressing this ideal type. However, situations are all different and there is no such thing as an 'ideal type' in reality. So the mode of thinking that suggests a methodology for all occasions is also illusory and unrealistic.

Our world-view, therefore, is that we can describe something of some use for an IS development project, and the above harsh critique of IS development methodology thinking is more a matter of not finding a useful way of *reducing* a methodology to an approach for a *particular situation.* We need to guide developers as they develop an application, but this is more likely to be a *methodology framework* than a prescriptive methodology.

Our experiences and thinking therefore concur with Avison and Wood-Harper (1990) when describing their Multiview framework and Checkland (1999) in describing soft systems methodology, that we need some form of guiding framework. But even a generic approach at the level of a framework needs to be reduced to apply to a specific situation. The important words in the above are *reduced* and *particular situation,* as the real challenge lies in how this reduction is done for a particular practical situation.

Avison and Wood-Harper, for example, argue that in their experience IS development is *contingent* on the particular situation and finding the right combination of methods, techniques and tools is really more like an *exploration* than the practice of applying a methodology because:

- The 'fuzziness' of some applications requires an attack on a number of fronts. This exploration may lead to an understanding of the problem area and hence lead to a reasonable solution.
- Tools and techniques appropriate for one set of circumstances may not be appropriate for others.
- As an information systems project develops, it takes on different perspectives or 'views' and any methodology adopted should incorporate these views, which may be human, political, organizational, technical, economic, and so on

However, few writers give help on choosing which *specific* combination is appropriate to which specific situations. It is true that Avison and Taylor (1996) identify five different classes of situation and appropriate approaches as follows:

1. Well-structured problem situations with a well-defined problem and clear requirements. A traditional prescriptive approach might be regarded as appropriate in this class of situation.
2. As above but with unclear requirements. A data, process modeling, or a prototyping approach is suggested as appropriate here.
3. Unstructured problem situation with unclear objectives. A soft systems approach would be appropriate in this situation.
4. High user-interaction systems. A people-focused approach would be appropriate here.
5. Very unclear situations, where a contingency approach, such as Multiview, is suggested.

However we feel that this advice is rather too general and we wished to design a finer approach. So to address this research question we set out to develop a framework, which we tested at one specific organization – Danske Bank – and we did it over several years (2001-2005) as an action research undertaking. We now believe that we are beginning to have an answer to the question, in the form of a framework focusing on the final product, with a few well-chosen patterns through the 'maze' of possibilities, and some rules for choosing methodology parts.

We discuss our research method in section 2. In Section 3 we describe a technique for documenting the different types of development situations that we refer to as 'radar diagrams'. We also illustrate four typical patterns and suggest strategies to develop applications in these four situations. In section 4 we show how we began to validate our approach at Danske Bank using three action research cycles and later with groups of project managers at a number of companies. Finally, in section 5 we conclude and suggest future research.

2 RESEARCH QUESTION AND METHOD

Several books and consultants have claimed to have found the methodology for all (or most) applications in all (or most) situations, but it seems that there is no single method that will ever work for (nearly) all development situations. The question then arises: When to use what?

We used two research approaches to address this question. In the first part we used design science to formulate a way of characterizing particular situations. In the second part we used action research to apply our design to see if it could be demonstrated in practice and to improve the basic design using this practical experience. Cole et al. (2005) provides a discussion about cross-fertilization between the two approaches of design research and action research.

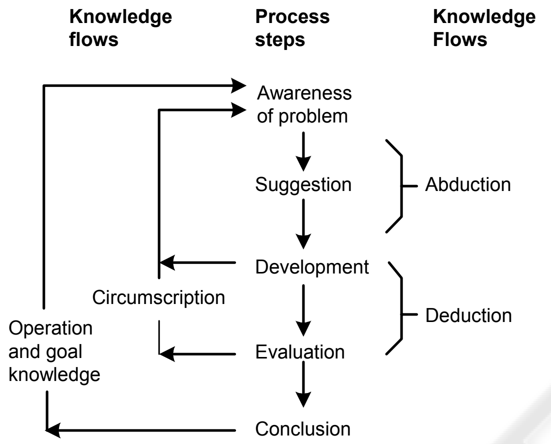

Figure 1: Design research (from Takeda, et al., 1990).

Design science 'seeks to extend the boundaries of human and organizational capabilities by creating new and innovative artifacts' (Hevner et al., 2004). In the model shown as Figure 1 (see also ISWorld, 2006), awareness of the problem suggests either a formal or informal proposal for a new research effort. In our research we proposed the idea of a 'radar' that could be used as a basis for understanding the type of situation. A tentative design is produced in the suggestion phase. As we shall see, our tentative design consisted of a 'radar' of eight dimensions and we developed this artifact. We then tested this as an action research project consisting of three cases that took place in a Danish bank. Each specific act of construction, that is, each action research case, leads us to understand the design-in-action further and hence to evaluate it and modify it as necessary and make conclusions from this evidence and procedure.

Action research fits well into the design research cycle. It can be used to cover the *deduction* part of the design cycle, that is in our research, development or modification of the 'radar' design, its testing in a real-life situation. This in turn may be followed by further evaluation and circumspection, which may lead to a modification and retest or simply a retest. Again, this itself may be followed by a further cycle evaluation and circumspection, which may lead to another modification and retest or simply yet another retest. In this way the artifact is *tuned* further.

Action research also implies a synergy between researchers and practitioners. Researchers (like us) test and refine principles, tools, techniques and methodologies to address real-world problems whilst practitioners as well as researchers may participate in the analysis, design and implementation processes and contribute to any decision making.

A fuller description of the action research cycle is given in Susman and Evered (1978) as shown in Figure 2. (A new text edited by Ned Kock (2006) provides a very comprehensive information systems view of action research).

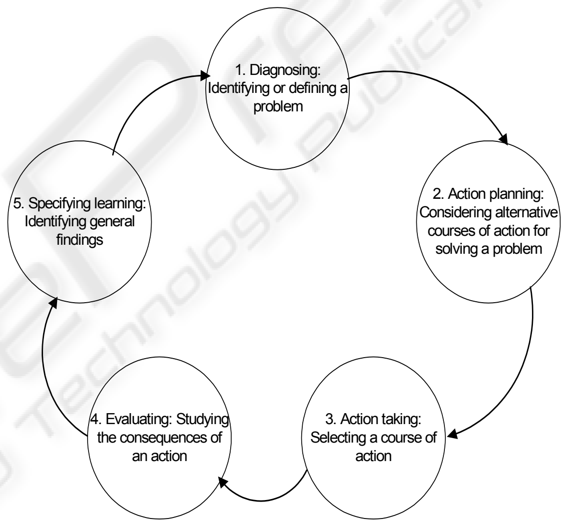

Figure 2: The Action Research Cycle (from Susman and Evered, 1978).

3 TAILORING PROJECTS: RADAR DIAGRAMS

The infrastructure for our project was first established in the fall of 2001. A project group was established with five people from Danske Bank and a researcher (one of the authors) from outside. Three of the six had worked together prior to this project in another successful design undertaking (Pries-Heje et al. 2001). This influenced the choice of a combined design science and action research approach for this project.

Early in 2001 it was questioned inside Danske Bank whether the existing company ISDM was good and useful enough. The diagnosing of this situation was done by means of an interview study undertaken among IS project managers within Danske Bank. This study revealed that the existing company methodology was very hard to tailor to the specific needs of particular projects. The assumption that 'one size fits all projects' had proved invalid! After this diagnosis a formal action research undertaking was established. We were asked to intervene, but we could see the advantages of doing so with the practitioners, hence the action research approach. We saw ourselves as researchers not consultants. Furthermore the projects demanded more help and better tools for the tailoring process. Thus what we called the *tailoring project* started.

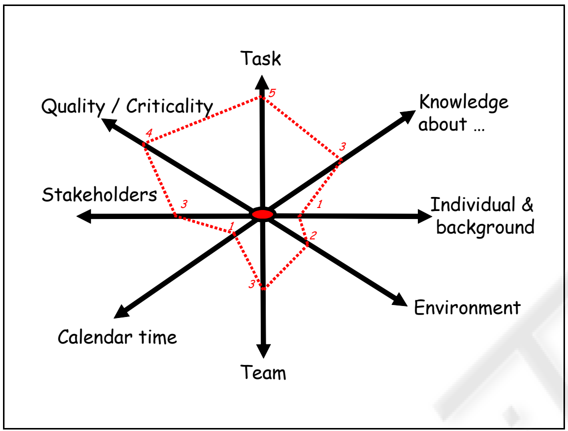

Figure 3: The 'radar' developed to characterize a project along 8 dimensions.

The first idea – or theory – in the tailoring project was to find a number of characteristics of different projects, and then use these characteristics to identify a subset of methods from the company methodology. We analyzed the notes from the interview study and we studied existing literature and identified eight dimensions that could be used to characterize a project. We decided to use a 1 to 5 scale to score each dimension. When a concrete project was scored, and the *project profile* thereby identified, we then wanted to have a set of guidelines to help us to tailor the company methodology for the specific project. In figure 3 we show the eight dimensions with an example scoring. We called this project profile the *radar*.

In the middle of the radar is the 'sweet spot' meaning the characteristics that make the project as 'developmental friendly' as possible. For example, for the dimension called Team, the scoring '1' would be given in relation to a project which, for example, would be carried out in a small group, with group members sharing the same background, having worked together before, and with a perfect mix of personality types and temperaments in the group. On the other hand, the scoring '5' on the Team dimension might be given for a large group; having different backgrounds (education and/or experience), an unbalanced mix of personality types and temperaments, and where the team members do not know each other.

Figure 3 gives the case where aspects in the lower half, including the Team dimension were developmental friendly, whereas those in the top half, for example, difficulties with regard to the task to be performed, and quality requirements would prove to be much more challenging.

The radar gives a good insight into what kind of IS project one was facing. We were also able to establish specific advice for each of the eight dimensions in the radar. For example, to score 5 on the dimension 'Individual and background' the IS development project might be characterised by:

1. Individuals having minimal or no project experience,
2. Individuals being forced into the project – and therefore may be feeling 'punished' by being assigned to project, and
3. Individuals allocated part time – and the other projects they are allocated to are of higher priority.

Thus a score of 5 on this dimension constitutes a very challenging situation for the project manager. Nevertheless we were able to find mitigation remedies to recommend to the team. For example, based on McConnell (1996) we might advise that development project managers:

1 Aim at uninterrupted days or periods for the people working in the project. So, for example, they could agree that a 20% allocation occurs every Tuesday full time instead of an hour or so here and there.
2 Write things down – make a kind of contract with the individual.
3 Try to identify and focus on the motivation of the individual

In Figure 4 we have shown what is required to score '5' in the seven other dimensions.

However, in practice it was very difficult for us to establish the causal relationship between the 'radar picture' and recommendations for both the IS management process and the IS development process. In the literature we could find simple causal relationships, like 'IF you have sparse calendar time AND on-time delivery is important THEN use time boxing' (inspired by McConnell 1996). However, we could not find complex relationships like 'IF Team + Task is High AND Knowledge about is low THEN do this and that'.

Dimension	5 is characterised by
Task	Large task. Unclear goal. Complex = hard to understand or use.
Knowledge about …	Limited domain knowledge on the application of research project. Limited knowledge for developing the project results. Limited technical and tool knowledge.
Environment	You are sitting far from each other – different buildings/countries. Impossible to avoid interruptions. Imperfect spatial conditions.
Team	Large group,, different background (education and/or experience) Unbalanced mix of personality types and temperaments Don't know each other.
Calendar Time	Short time. Time critical – have to be delivered by a specific date
Stakeholders	Conflict and disagreement. Many stakeholders. Limited attention from management. Long and unclear decision making
Quality and criticality	Critical – defects will threaten life. Very specific process requirements, i.e. things have to be done in a specific way. Target group need unknown and hard to elicit. Many and difficult product requirements.

Figure 4: What characterises scoring '5' in the radar.

Thus we looked for a simpler way to characterize projects. The framework developed by Mathiassen and Stage (1990) has two dimensions, complexity and uncertainty. The degree of complexity represents the amount of relevant information that is available in a given situation. In contrast, the degree of uncertainty represents the availability and reliability of information that is relevant in a given situation. Complexity can be measured on a 2-point scale from simple to complex. Likewise uncertainty can be measured on a 2-point scale from stable to dynamic.

Using the resulting 2-by-2 matrix we succeeded in establishing the relationship between project characteristics and recommendations (Mathiassen and Stage, 1990). We have shown this in figure 5.

Now we had eight dimensions that literature *and* practice in Danske Bank told us were of importance. We also had the simple 2-by-2 matrix with recommendations (figure 5) that looks closely at the task dimension. We then examined our data carefully and succeeded in identifying four patterns in the scoring of the eight dimensions. The four patterns we called: 'Sun', 'Ant', 'Amoeba', and 'Bomb'.

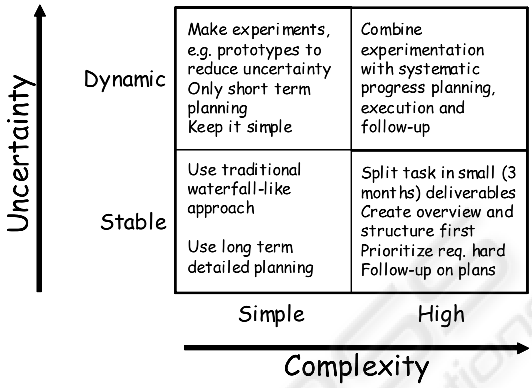

Figure 5: The simple 2-by-2 matrix we used for tailoring.

The 'Sun' is characterised by low scoring on the eight dimensions. In this case the project at hand is developmental friendly and we may simply use a traditional waterfall approach. We have shown an example of the sun in figure 6.

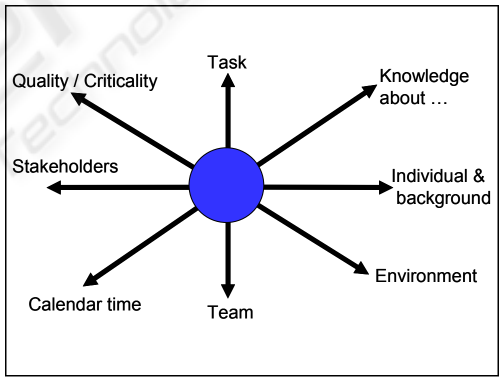

Figure 6: An example of the 'Sun' pattern.

The 'Ant' is characterised by Task scoring high and 1-2 characteristics scoring high as well (but the others scoring low). In this case the recommendation to the project team is to use a phased model. Focus first on getting an overview and structure to the work, and then split the complex task into smaller deliverables, for example. one every third month. This splitting can also be made by prioritizing requirements. Figure 7 represents an example of the 'Ant' pattern.

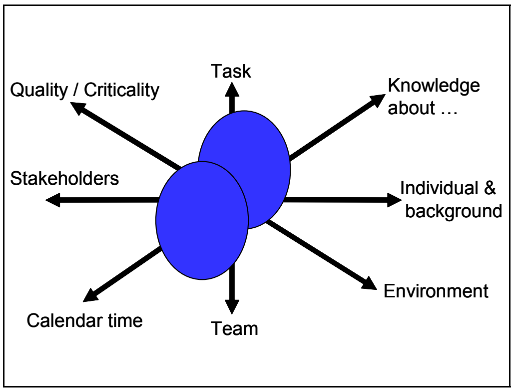

Figure 7: An example of the ‘Ant’ pattern.

The ‘Amoeba’ is the adverse of the ‘Ant’ in that the Task is scoring low but at least 3 other dimensions are scoring high. This creates considerable uncertainty for the development project. The advice on methodology in this case is to use 2-3 development iterations to reduce uncertainty and to do this as soon as possible. This can be achieved by making usability prototypes, hole-through testing, and scenarios to illuminate problems. We also advise against promising an end date to the whole project. It is best to make only short-term detailed plans; 1-2 months ahead. In figure 8 we show an example of an ‘Amoeba’.

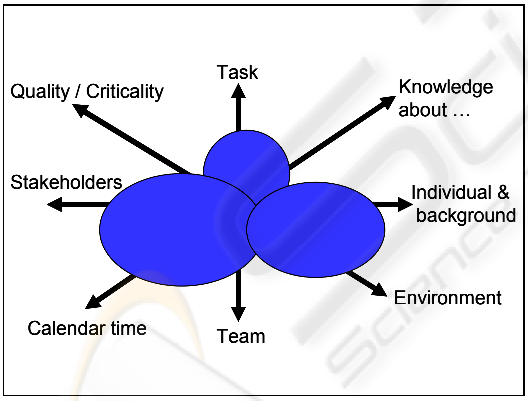

Figure 8: An example of the ‘Amoeba’ pattern.

Finally, the ‘Bomb’ (as the name suggests) is characterised by high scoring on all dimensions. The advice on methodology that we derived here was to use a development model that includes many experiments – preferably risk-driven (for example, the spiral model of Boehm, 1986). We also recommend to experiment early and to have many iteration cycles. Further, we suggest starting the project by creating an overview, trying to establish some structure, planning carefully. Yet at the same time have many milestones and small deliverables. In figure 9 we have shown an example of the ‘Bomb’ pattern.

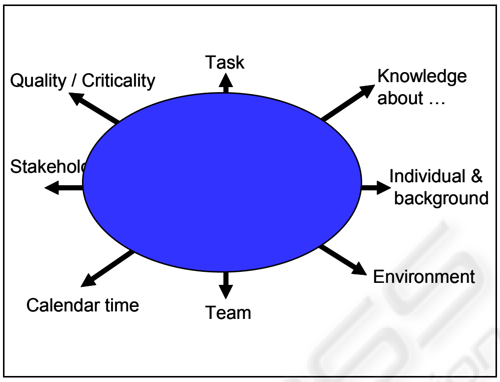

Figure 9: An example of the ‘Bomb’ pattern.

4 TESTING THE DESIGN AT DANSKE BANK

The Danske Bank group is a financial institution that provides all types of financial services such as banking, mortgaging and insurance in northern Europe. Danske Bank employs 17000 employees and has more than 3 million private customers in Scandinavia. As part of the Danske Bank Group there is an IT department with 1700 employees located at four development centres.

IS development projects at Danske Bank vary widely in size; most are small and short-term, but there are also some major projects that have strategic implications for the entire Danske Bank group. Project teams of three to five people typically handle the smaller projects, which usually take from six to 12 months. Large projects, such as the Year 2000 compliance project, typically involve up to 150 people and last from 6 months to 3 years.

The four development centres are headed by a senior vice president. Each individual division is led by a vice president and organized into departments, with typically 20 to 50 people divided among five or so projects. Project managers oversee regular projects, while the vice president manages high-profile projects. IS developers in Danske Bank typically have a bachelor’s degree in either an IT-related field or banking, insurance or real estate.

After designing our concept model we validated it in an action research cycle with projects in Danske Bank. In total we did three action research cycles. The first action taking in a project lasted a full day and was carried out as a kind of facilitated workshop (with one of the authors of this paper as facilitator).

The action taking was in a project called 'online signup'. There were seven people from the project participating. The project scored high on three dimensions and we used most of the time to discuss how they could cope with these three specific dimensions. The evaluation of the first action taking suggested that our 8 dimensions used to characterise a project worked well. However, the learning that we elicited after evaluating was that a number of the detailed questions used to determine the scoring on the dimensions needed developing. In particular, we realized that the "Task" and the "Knowledge about …" dimensions were very weakly developed.

Following further study of the literature we developed an improved concept (a better radar). For example we improved the questions for deciding the scoring on the eight dimensions and we brought in the model shown as figure 4 to help us identify the 'Task' dimension. Further, we considerably improved the 'Knowledge about …' dimension by developing a concept called *knowledge maps* (Pries-Heje, 2004). As part of this action taking we considered many other alternatives than the ones chosen.

Our second round action taking took place in a project called 'new pay-out system' where four people from the project participated in the action. The second round action taking took place three months after the first round. With 5 people working approximately half time on average, that means that more than 7.5 people months were invested in one action research cycle.

Our evaluation from the second round action taking suggested that our improved questioning to each of the eight dimensions worked well, but that a workshop aimed at helping the project should take place at an earlier time than was the case here. The analysis phase for the project had more or less finished. For each of the eight dimensions we had come up with recommendations for the project. However, they were somewhat confused by the long list of recommendations. Evaluating this observation we realized that we needed some structure to the recommendations. As part of our third round action planning we decided to put all the recommendations of activities that we identified on a timeline as part of the workshop.

The third action taking was done in a project called 'credit secured by mortgage on real property'. This occurred in phase 2 of the project and phase 1 had already delivered some results. When evaluating the outcome we found that the eight dimensions and the recommendations related to scoring high on each dimension were working well. The uncertainty-complexity dimension also worked well but it was difficult to explain to the participants why one of the eight dimensions received so much more attention than the seven others. Based on this we specified our learning in the form of the 'Sun', 'Ant', 'Amoeba' and 'Bomb' as reported earlier in this paper.

After each action taking in the three action research cycles we asked the participants to evaluate their subjective satisfaction. On a scale from 1 to 5 we had an average of 4.11 with 5 being the best score. So the three project teams felt that the tailoring concept as we have presented it above was valuable and useful.

Further, all three projects followed the outcome from the action taking - in the form of recommended 'methodology pieces'. Participants were satisfied with the selection that resulted from the workshop.

All three projects were finished and delivered within their scope. Did they go better as a result of our action taking? It is impossible to know. We can never compare reality with a 'what-if' reality other than ask the participants whether they thought they were better off? But in that sense there was quite a positive evaluation.

However, we can also ask whether the action research reported here made a lasting influence on the organization? Here the answer is no: even though the projects were successful and practitioners satisfied, we could not convince top management in the organization that the tailoring concept was useful. At the same time Danske Bank implemented an organizational restructuring and the tailoring project was stopped (see Pries-Heje, 2006).

However, as one of the authors was teaching courses for professional IT practitioners (project managers) it was natural to validate the concept further. The first round of validation took place in the spring semester of 2004. These practitioners were divided into groups and each group had to identify a project in a real setting. They were asked to use the radar and show the resulting patterns. A second and a third validation took place in the spring semester 2005 and in 2006 with the project managers. In all projects, the project manager found the eight dimensions and the four patterns proved valuable to gain an overview and to make informed decisions on how to tailor a methodology for a particular project.

5 CONCLUSIONS

We argue that we have designed an artefact that can be used for *reducing* a methodology to suggest a particular one-off approach for a *particular situation*. We have validated the concept in one company and at the overview level in approximately 20 other companies and projects. However, the artefact needs to be tested in many more situations using action research in order to really convince and for refining purposes. We believe the concept is ready for further diffusion outside a Danish context and the classroom.

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