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Identifying requirements for communication support: A maturity grid-inspired approach

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Abstract

Communication is a critical success factor in design. It can be seen as the social and cognitive process by which information is selected, messages are exchanged between interacting partners, and meaning is created. How communication processes can best be captured, analysed and assessed, as a preliminary step toward suggestions for improvement of communication practices, remains a challenge for researchers and practitioners. To this end, a maturity grid-inspired approach to audit communication practices has been developed. This paper employs a maturity grid approach and reflects critically on the construction and application of the approach in a structured group workshop in software design. Such an approach yields dual benefits: (a) as a research method to gather insight into communication and (b) as a guide to plan improvements in practice. Conclusions are drawn for the process of auditing communication in design.

Keywords: Communication assessment; Communication support; Maturity grid; Collaborative design

1. Introduction

Design—be it mechanical or software—is a complex technical and social process (Bucciarelli, 1994; Henderson, 1999; Hubka & Eder, 1987; Minneman, 1991; Rodden, King, Hughes, & Sommerville, 1994). Communication is an essential part of any design process and has been identified as a major determinant for project success or failure (Chao & Ishii, 2003; Hales, 2000). Many problems in design are due to poor communication (Allen, 1977; Clark & Fujimoto, 1991; Eckert, Clarkson, & Stacey, 2001; Eckert & Stacey, 2001; Moenaert, Caeldries, Lieve, & Wauters, 2000; Ostergaard & Summers, 2003; Sosa et al., 2002). Designers and software engineers may be located at different geographical sites and time zones. To ensure that ‘out of sight’ does not mean ‘out of sync’ (Hinds & Bailey, 2003), communication has to be adequately understood, organised and supported. It is, however, often difficult for design managers to ascertain whether communication as such is the problem, or whether it is a manifestation of, for example, inadequate process planning or personality issues (Eckert & Clarkson, 2003).

Observational studies conducted by the authors show that, in many companies, the immediate reaction to communication problems is to look for a technical solution. Information Technology (IT) or specific computer supported cooperative work (CSCW) tools are readily invested in. However, these tools often address only the symptoms and do not solve the underlying problems.

CSCW systems provide a broad range of tools that support ‘work’ in all its forms. The CSCW spectrum of systems can broadly be divided into two categories: systems that support work processes and systems that support people working in groups. Many authors provide a classification of CSCW systems. For an overview see, for example, Ellis, Gibbs, and Rein (1991), who, based on earlier work by DeSanctis and Gallupe (1987) and Johansen (1988), present a classification of groupware systems (for example electronic communication systems and shared workspace systems), using two taxonomies: the space/time taxonomy.
and the application-level taxonomy. As Van der Aalst (2005) argues, the literature on CSCW is typically restricted to a small class of software products named ‘groupware’, while other products supporting work are excluded. He refers to workflow management software, which some authors do not consider as part of the CSCW spectrum.

The point is that communication in design may be supported through the use of CSCW systems and other software tools, such as process planning tools, which can aid communication by providing visualisations of information about the design or the design process. Yet, successful integration of CSCW tools or knowledge management systems (KMS) depends on the situation to which they are introduced. And, as Cooper (2003) argues, tools can reduce known risks, but also introduce new ones through unforeseen side effects.

Before applying a solution, there should therefore be a phase of analysis of the problematic situation. Communication practices need to be taken into consideration before introducing any kind of tool to enhance collaborative design and communication into a situation that is not well known.

This paper claims that software tools are not always the right solution, and that additional spending on information technology or CSCW systems does not compensate for poor management. Technology and good management complement each other and it is important to find the right level to intervene and adjust.

Information system research and requirements engineering have long recognised the necessity of analysing processes to understand the need for software tools, and to design processes and tools together to assure effective support. They have developed a host of tools and techniques to analyse processes (see Blanchard, 2004; Cossick, Byrd, & Zmud, 1992; Gottesdiener, 2002; Nuseibeh & Easterbrook, 2000; Tansley & Hayball, 1993 for an introduction and overview).

This paper advocates a maturity grid-inspired approach to assess and reflect communication in design. Based on a specific understanding of design processes we have developed a method that facilitates the identification of discrepancies in perceptions about the nature and quality of communication processes. By capturing the views of individuals and teams regarding the current and desired state of communication and issues pertinent to it, it is possible to directly assess potential areas of improvement and target additional investigation and analysis.

The maturity grid-inspired approach described here can be used as a diagnostic instrument to quickly identify potential application areas for CSCW tools or other computer support tools. The approach gauges where improvements might be necessary and possible, so that the person in charge of the company’s decision-making process can choose adequate techniques, methods or technologies to improve human communication in design.

The remainder of the paper is organised as follows: section two presents empirical observations that support the thesis of this paper. Section 3 briefly points to methods to assess communication, gives a brief overview of maturity-based approaches to audit products and processes, and reflects on experience constructing a ‘communication grid’ to audit communication. Section 4 gives an example of the application of such a maturity grid for communication in industrial settings. Section 5 critically reflects on the method used and presents initial results from the empirical study. In Section 6, results are summarised. In Section 7 conclusions and suggestions for further work complete the paper.

2. Examples of communication issues

To support the argument of the paper—that computer support tools are not always the right solution to a communication problem—this section gives an overview of communication breakdowns observed in industry. The first case study points to a situation where it was obvious that a software tool could improve the situation. The second case study shows that, instead of software tools, different management approaches were needed. The third case study exemplifies that a systematic assessment of the nature of communication breakdowns is required.

2.1. Aerospace manufacturer

In 1999, the second author undertook a case study to monitor engineering change at a UK aircraft manufacturer (see Eckert, Clarkson, & Zanker (2004) for details). To briefly sketch the complexity of the design and manufacturing process: a new version of a helicopter contains over 10000 different parts and is developed by several hundred engineers over a period of about two years. While the supply chain is distributed internationally, the main development is shared between the UK and Northern Italy.

After conducting 22 interviews with engineers from different departments based at the UK headquarter it became clear that, while engineers had an understanding of their own task, they had little understanding of where key parameters were generated or of who used the results of their analyses. Designers often changed the values of parameters without understanding who used them in parallel or later on. This led to many problems during the design integration phase, and to costly delays.

In this case many problems originated from a lack of understanding about how the tasks in the design process fitted together, so that designers could not retrace where design information was generated. In this case, the designers could be effectively supported with CSCW tools and intelligent solutions. See, for example, the parameter-based task model of the design process proposed by Flanagan et al. (2003) which promotes visualisation of the flow of parameters through an organisation.

2.2. Engineering materials manufacturer

In 2002, the second author conducted a case study to investigate communication problems at the consultancy
wing of a UK engineering manufacturer. Methods used included semi-structured interviews with 15 designers, and two weeks of observation over a period of two months. The group consisted of about 40 engineers housed in a beautiful building at the outskirts of a large city. The engineers all knew each other well and respected each other’s technical competency.

They had a canteen where fresh meals were cooked everyday, a tearoom with unlimited free tea and coffee, a meeting room and picnic benches outside. Despite plenty of opportunities to converse informally, everybody agreed that communication did not work well in the organisation. Several CSCW and knowledge management systems (KMS) were purchased. Designers were encouraged to put their diaries on shared systems. In addition to that, a reward scheme was introduced for entries into a ‘lessons learned’ database. Yet, communication did not improve, and we were asked to investigate.

It quickly became clear that communication problems arose at a management and interpersonal level. The unit had a fierce technical director who did not like to manage. He introduced a three-tier hierarchy and communicated only with those on the top level. The only time he interacted with the engineers was to demand new work or to criticise. The people who reported to him were selected for technical rather than managerial skills.

In addition to that, workload differed enormously among the project teams, leading to envy between teams. Further acrimony was generated through the way hours were booked to projects. Time could only be booked to funded projects, so that work on new projects or speculative work had to be assigned to existing projects. This not only destroyed any ability to account for work but also increased animosity between project teams.

While everybody in the organisation was discontented with the communication amongst employees, they were well informed about what was going on. As the organisation was small, people understood the flow of information well and knew who needed which piece of information. However, there was no proactive information sharing.

The computer technology they bought to enhance the information flow did not solve the problems they had, because the software tools supported aspects of their work that did not need supporting. Yet, the explanation the group gave was that the tools did not work because the problems did not go away.

2.3. Aerospace supplier

In 2003, the first author conducted a case study at an aerospace supplier in the UK to investigate communication practices. Several methods were used. The daily work practice of a group of about 20 design analysts was observed to better understand communication patterns throughout the design process. This functional group, working on stress analysis, thermal analysis, reliability, detail design and performance analysis, supported the project engineers across different projects, and also conducted research into technological innovations. Interviews were conducted with higher management to get a ‘top–down’ view on important issues in and around engineering design practice. Additionally, a questionnaire was distributed to elicit the information needs of designers and design managers.

Within the group communication worked well, but it became apparent that several communication problems existed between different departments in the company. One was that different disciplines used different terminologies, for example at the interface between design and manufacturing. There was, furthermore, a problem of data transmission at the CAD/CAM interface. Another issue was that the company had gone through three phases of ownership change within six years. Relics, in the form of different corporate logos on shirts, cups, manuals, business cards and, more importantly, procedures were still visible. This exemplified a lack of an overall corporate identity, a problem that manifested itself in communication conflicts between the style of the ‘old’ and ‘new’ company. Having accumulated several communication issues, it became clear that there would not be one single solution to all. Instead, the need for a structured analysis of communication support was detected.

Taken together, the examples show that the specific ‘communication situation’ in the company has to be understood first. There is a need for a method that aids in reflection, in both sense of the word: to mirror back perceptions about communication in industrial practice as well as to think about communication practices in a systematic way. To this end, a method with which communication can be systematically assessed has been developed and is introduced in the next section.

3. Assessing communication

As shown by the examples of communication breakdowns at the aerospace manufacturer, engineering materials manufacturer and aerospace supplier, we needed to analyse the situation first in order to find the appropriate way to improve it. To decide at which level to intervene, a structured way to assess communication—an audit—would therefore be extremely useful. At its most basic an audit is an evaluation of a designated process. Here it is a means to gain insight, to analyse and assess the communication philosophy and practice in an organisation (Booth, 1986; Emmanuel, 1995; Goldhaber, 1983; Goldhaber, Dennis, Richetto, & Wiio, 1979; Jones, 2002; Tournish & Hargie, 2000).

Questions that need answers are as follows: what is the current (‘as-is’) communication situation in a company? What is the desired (‘to-be’) communication situation? How do factors influencing communication interrelate and form communication patterns? How do interrelations of factors lead to potential problems? How can managers recognise whether communication is the problem or the cause of the problem in a particular situation?
There is a multitude of methods that can be used and combined in different ways to audit communication in any kind of business process, e.g. participant observation, interviews, questionnaires, critical incident analysis, experiments, or focus group sessions. This paper is part of a wider project in which the usage and applicability of several methods to audit design communication are being explored (Maier, Eckert, & Clarkson, 2004). The focus of this paper is the use of a maturity grid-influenced approach applied in a structured participatory group workshop as a method for capture, analysis, assessment, and reflection of the state of communication in a practical setting.

A maturity grid-influenced approach can capture both the ‘current’ and the ‘desired’ state of communication in an intersubjective way whilst at the same time taking note of the subjective opinions of the participants. A bias toward the opinions of the researcher or of a single informant can thus be avoided.

An assessment via a maturity model is structured around a matrix or grid, which creates a series of cells by allocating levels of maturity against several key aspects or key activities (Austin et al., 2001). The cells contain text descriptions of typical performance at different levels of granularity. Maturity, literally meaning ‘ripeness’ conveys the notion of development from an initial to a more advanced state. The subject under consideration may go through a number of intermediate stages to reach the label ‘mature’. Process maturity refers to the degree to which a process or activity is institutionalised and effective (Chiesa, Coughlan, & Voss, 1996; Dooley, Subra, & Anderson, 2001; Paulk, Curtis, Chrissis, & Weber, 1993).

In order to use the concept of process maturity for communication one has to bear three concerns in mind. First, it is hard to find criteria for ‘good communication’ or, for that matter, ‘ripe communication’ that are universally applicable. Second, items under consideration, such as ‘information flow’ and ‘corporate culture’ are not independent. Third, communication is not a straightforward process; hence institutionalised practices can be ineffective even though labelled mature, and chaotic and undefined processes can be effective even though labelled immature.

### 3.1. Origins and evolution of maturity audits

The following section provides a brief overview of the origin and evolution of maturity-based approaches. For a detailed discussion refer to maturity models to assess processes originated from quality management. The basic assumption is that, in order to improve product quality, the quality of the process has to be improved. Crosby’s quality management maturity grid (QMMG) defines six aspects of quality management at five levels of ‘maturity’. The levels of maturity of the ‘quality grid’ range from ‘uncertainty’, ‘awakening’, ‘enlightenment’, and ‘wisdom’ to ‘certainty’ (Fraser, Moultrie, & Gregory, 2002).

In the 1990s the idea of process assessment via a maturity model was adopted in the software domain under the name software capability maturity model (S-CMM). The S-CMM combined both process assessment and capability evaluation to guide the control and improvement of software design (Paulk et al., 1993). The scale used ranges from ‘initial’, ‘repeatable’, ‘defined’, and ‘managed’ to ‘optimising’. The S-CMM has now been superseded by the capability maturity model integration (CMMI). The CMMI combines the S-CMM with a systems engineering capability maturity model (SE-CMM) and an integrated product development maturity model (IPD-CMM).

In contrast to Crosby’s simpler ‘quality grid’, capability maturity models are complex assessment tools which demand performance in baseline ‘key process areas’ (KPAs) in order to progress along the maturity scale (Fraser et al., 2002).

Maturity-based approaches have been applied to many different areas, including new product development (NPD) (Paulk et al., 1993), product cycle-time excellence (PACE) (McGrath, 1996), innovation (Chiesa et al., 1996), project management (Chrissis, Konrad, & Shrum, 2003), and to assess people with the people capability maturity model (P-CMM) (Hefley & Curtis, 1998). The latest application of maturity grids to audit the product development process and the product has been pursued by Moultrie (2004). There is as yet no attempt to apply it solely to communication in design.

### 3.2. Construction of the maturity grid for communication in design

This section gives a thorough description of the construction process for a ‘communication grid’ for design. In particular, the rationale behind the selection of ‘key factors,’ which drive communication as well as the selection of the ‘maturity levels,’ is pointed out.

#### 3.2.1. Selection of ‘key factors’

In developing a maturity grid the following items have to be decided on: the ‘key factors’; the ‘subheadings’ of these key factors or key process areas; the maturity levels or scale points; and the respective text descriptions in the cells (see Fig. 2).

To decide upon the ‘key factors’ or ‘key process areas’ that will be analysed and assessed, criteria are selected which—if fulfilled—are likely to lead to a ‘good design’ process and hopefully a ‘good design’ outcome. For the purpose of this research, the question is which factors influence communication. For the purpose of this research the question is which factors influence communication. The assumption being that they are enablers as well as barriers for ‘good communication’. Taken together, perceptions about the current and desired performance on selected factors form the specific ‘communication situation’ at the respective industrial collaborator. Factors influencing communication are derived from the empirical studies mentioned earlier, as well as from the literature. A communication framework has been put together which informs the
systematic selection of the factors (Eckert, Maier, & McMahon, 2005; Maier, Eckert, & Clarkson, 2005).

Factors are grouped under five categories: organisation, team, product, information and the individual communicator. Each category holds two key factors, which, in turn, are subdivided into four or five sub-factors (see Fig. 1).

As an example, the key factor ‘awareness’, which is part of the category ‘communicator’ (see Fig. 1), will be shown. Empirical studies have shown that lack of awareness can lead to a communication breakdown (Eckert et al., 2001; Goldhaber, 1983).

Furthermore, awareness of the activity of the group is one of the most important components of collaborative work. The concept of awareness has come to play a central role in CSCW. Early on, CSCW researchers have been exploring how computer-based technologies could facilitate ‘awareness’ among and between cooperating actors (Chiesa et al., 1996). Dourish and Bellotti (1992) define awareness as follows: “The understanding of the activity of the others, which provides a context of your own activity.”

Group awareness information includes knowledge about what tasks people are working on, who is on the project, how the information flows, what changes are being made to the code or in the organisation as a whole. This knowledge is vital if distributed developers are to coordinate their efforts smoothly, add code, make changes that affect other modules, and avoid rework (Gutwin, Penner, & Schneider, 2004; Tollmar, Sandor, & Schoemer, 1996).

3.2.2. Selection of ‘scale points’

What runs through the whole exercise of constructing a grid is the balance between universal applicability and specific suitability. How would a situation have to look in order to be considered ‘good communication’? It is difficult to find universal criteria that would definitively hold true for every company in all situations. For example, intuitively, one would say that regular team meetings are necessary and vital in a large company. If they occur, are conducted well etc., one would probably give meetings a high score. However, the case study at the IT firm presented in the next section will show that communication can work well without regular meetings. Hence, it would not make sense to have a scale with “no meetings” as the beginning of the scale and “meetings every week” at the end of the scale.

The difficulties encountered while constructing the grid raise an interesting question, which is also a potential weakness of maturity-based approaches: should a poorly-defined, poorly-documented, but effective process be deemed immature, just because it does not fit the description of a mature stage? Conversely, should a highly-defined, well-documented, but ineffective process be considered mature (Chiesa et al., 1996; Dooley et al., 2001; Paulk et al., 1993)?

The rationale behind using a maturity grid-inspired approach to identify requirements for communication support aims at arriving at an intersubjectively valid assessment, based on which process improvements can be planned. The last two columns on the individual sheets of the ‘communication grid’ (see Fig. 2) refer to the current and the desired position. Each participant was asked to populate the cells with the letter that he thought best described the current and desired position of the company. By giving them the opportunity to score the desired position, one avoids arriving at a completely wrong conclusion as an outsider, even though the question still persists as to whether a group knows on its own what is best. A gap-analysis between the actual performance and targeted outcome can provide the basis for action planning.

To measure intersubjectivity, it would be possible to use a Likert scale (1932) where respondents are given one extreme of performance as an anchor point and are asked to position themselves on a numeric scale. There is, however, no further assistance as to what value the numbers would have, or what they would mean. By contrast, maturity grid approaches assist the respondent by giving descriptions in the cells of the grids as to what a choice of performance would mean.

What lies behind the process of diagnosing the state of communication in the company and identifying areas for communication support is the task of raising awareness about communication and its relation to the design process, and of engaging the individual employees and the company in an ongoing reflective learning process (Maier et al., 2004). Therefore, the maturity levels in column A–D and the descriptions in the cells (see Fig. 2) are chosen based on an adaptation of the learning theory by Argyris and Schön (1978, 1996).

4. Using the ‘communication grid’

This section briefly describes how the ‘communication grid’ was used to capture the ‘as-is’ and the ‘to-be’
communication situation as part of a four-week empirical study at a Fortune 500 IT company in the UK.

4.1. Objectives of the communication audit

The objectives of the study were to gain insight into current communication practices at the industrial collaborator and to recommend possible improvements. Of major importance to the company was to raise awareness of communication issues within all teams involved in software development and support. In addition, the research objectives were twofold: (a) to test the suitability of a maturity grid-influenced method to capture, analyse and assess the communication process in a design project, and (b) to test whether a maturity grid-influenced method suffices as a standalone instrument. The role of the researcher was to directly observe the operations and activities of the selected team in the UK in its interaction with its partner teams in India and the US.

4.2. The team(s)

The core team, observed in its interaction with other teams on site and in other countries, consisted of ten people with different degrees of expertise and experience in software development and support. They were responsible for fixing problems that customers found in the company’s software.

It was a well-established team, the members having worked together for several years. During the period of the study, some experienced team members left and new graduate students joined. The team leader and manager were both very alert to the importance of communication, and experienced in leading teams.

4.3. The grid session

Three weeks into the study the ‘communication grid’ was applied to the group during a two-hour group workshop. Eight people attended the session, which was audio-tape-recorded. Ten individual sheets with more than fifty subfactors grouped in five categories (see for example Fig. 1) were distributed at the beginning of the session and projected against the wall. In terms of logistics, an allocation of two hours was insufficient to accommodate everyone’s comments on every topic.

The researcher asked the group to choose the cell that most adequately describes the current position and to place another tick-mark indicating the desired position. Thus, the current and desired scores were captured for each team member. After each completed sheet, the researcher asked the group whether they would be able to find a consensus as to where the desired state should be. Even though the participants all belonged to one team, their view of the desired state differed for some topics. Different opinions and perceptions became clear especially with regards to ‘documentation’ and ‘perception of their colleagues in the other countries’. When it came to documentation of problem records, some would definitively write them regularly and post them on a collectively accessible shared intranet site whereas others would not do it because they thought it would waste their time. It was thought that an adequate technical system and a perfect search engine would, once implemented, lead to increased usability and hence to increased input and usage by everyone. Similarly, in order to improve communication between the geographically dispersed groups, video-conferencing and regular use of webcams were suggested. What the grid test showed, however, is that it was not a technical issue but rather an
issue of how the capability of the respective other team was perceived. In both cases, technical solutions are necessary but not sufficient in order to improve the communication situation.

There is a question as to whether this method can be used as a standalone ‘tool’. How can one tell whether the answers given are right? Having observed the group for four weeks in total, the researcher knew that the answers given were accurate and honest. However, this concern should not matter too much in that it should be in the interest of the company to get the most accurate picture as possible in order to arrive at a possible plan to improve the situation.

Feedback from the participants on the grid session noted that it was valuable to initiate a discussion on ‘enablers of work’ or on ‘the environment of work’. It was also interesting for the team members to hear the opinion of their colleagues.

Most interesting for the researchers was to observe the interplay between the discussion around the grid, the dynamics of the group, the choices given on the sheets and the comments and questions given by the facilitator. The richness of this interplay holds many clues to arriving at an accurate picture of the perceived state of communication in the company, the description of which would, however, be beyond the scope of this paper.

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5. Utility of the ‘communication grid’

This section reflects on the construction, application, suitability and usefulness of a maturity grid-influenced approach for communication in design. First, it will be asked whether the case study and research objectives mentioned in Section 4.1 and at the beginning of this paper were achieved. The results are summarised in Tables 1 and 2.

5.1. Case study objectives met?

The study objectives mentioned in Section 4.1—to gain insight into the current practices of communication and to recommend possible improvements—are achieved with this approach (see Table 1). Nevertheless, it would be ideal to conduct a session twice during a certain interval to see whether improvement has taken place.

Of major importance to the company was to raise awareness of communication issues with teams involved in software development and support. The grid session fulfilled this demand by initiating a discussion on the topics raised.

5.2. Research questions met?

Table 2 summarises responses from a maturity grid-inspired approach to the research objectives set out at the beginning of this paper and in Section 4.1. To recapitulate, the research objectives read as follows:

- Can both the ‘current’ and the ‘desired’ communication situations be captured, analysed and assessed?
- Is it possible to identify potential areas and needs for CSCW systems?
- Can the connectivity of factors that influence communication practices be analysed?
- Is it possible to differentiate between a communication problem as cause or effect of a problem?
- What is the suitability of a maturity grid-influenced method to capture, analyse, assess, and reflect communication processes in design?
- Is a maturity grid-influenced method sufficient as a standalone method to accurately capture communication in design?

Using a maturity-grid influenced approach to audit communication, it is possible to capture, analyse and assess both the ‘current’ communication practices and the ‘desired’ communication situation in a company. Thus, it facilitates the identification of potential areas of need for CSCW applications.

How could one accommodate the fact that key factors influence each other and are hence not orthogonal? With a grid-based approach ‘key factors’ are weighted individually, whereas more complex capability maturity models require ‘maturity’ in some areas before the company can move up a stage as a whole. For a simple snapshot of the ‘as-is’ communication situation this question does not seem to cause great concerns. Hence, if the maturity grid-influenced approach is used to identify potential areas for CSCW applications this is not a problem.

Maturity models—in whatever form and shape—are not intended to fulfil the role of a root cause analysis. A maturity grid-influenced approach can spot potential issues and areas for improvement. Once these issues are spotted, further methods, such as a root cause analysis, can be used to establish whether communication is the cause of a problem, the problem itself, or merely symptomatic of a problem in design.

The sufficiency of a maturity grid-based method as a standalone method for assessing communication in design is difficult to ascertain due to the subjective judgments of participants and to concerns previously raised. If used as it was in this study then the method is sufficient. For visualisation purposes, the results with regards to the utility of

<table>
<thead>
<tr>
<th>Case study objectives met?</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capturing and monitoring of the current ('as-is') communication situation</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Capturing of desired ('to-be') communication situation</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Raising awareness of communication in design</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Starting a discussion of potential areas for improvement</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Guide to plan improvements</td>
<td>✓</td>
<td></td>
</tr>
</tbody>
</table>
a maturity-inspired approach for communication in design are presented in Tables 1 and 2.

6. Summary

As the results suggest (Sections 5.1 and 5.2), the expected deliverables to the industrial collaborator were fulfilled, whereas some of the research questions could not be answered, or could only be answered ‘partially’ (see Tables 1 and 2). Overall, the approach yields potential, and refinements to the ‘communication grid’ will be applied in further work (see Section 7).

Practical benefits of using a maturity grid-influenced approach to audit communication in design are listed below. The method:

- enables a quick overview of both the ‘current’ as well as the ‘desired’ communication practices of a company,
- provides the opportunity to codify what might be regarded as good practice (or bad practice), along with intermediate and transitional stages,
- captures both the positioning of the individuals as well as consensus of the group,
- generates discussion,
- raises awareness,
- aids in reflecting upon communication practices,
- provides the possibility to mirror back communication practices based upon the scores of the individual participants,
- guides improvement planning,
- identifies potential areas and needs for CSCW applications.

To summarise, methodological concerns are raised with regards to the following aspects:
- connectivity and mutual influence of ‘key process areas’/‘key factors’;
- choice of scale points for the levels of maturity;
- description of cells;
- implied notion of how a process ought to change to reach maturity—the most mature stage on grid might not be best;
- universal versus specific applicability;
- no consideration or analysis of why processes are done the way they are;
- accuracy of picture of communication practices when used as a standalone method.

In total, the method developed provides a means to mirror back the perceptions of the participants on factors which influence communication. The mechanism to capture scoring of the sheets helps in comparing subjective views.

7. Conclusions

Despite the recognition of communication as a critical success factor in design, and the high number of CSCW tools and expert systems to support communication, there is at present no satisfactory method with which to pre-analyse the ‘current’ and the ‘desired’ communication practices in a very short amount of time, in order to ensure that the method and tool chosen is the right one for the specific situation. The problem described above can be addressed by developing a maturity-influenced approach to assess communication in design; an approach which was presented in this paper.

The currently developed variations of maturity-models do not specifically address communication in design. The approach presented here can fill this void. It can help industry to choose the right solution for a recognised discrepancy between the ‘current’ and the ‘desired’ state of communication.

By capturing individual participants’ impressions and facilitating the calculation of an average maturity assessment, this method generates an intersubjectively valid portrait of a difficult-to-measure topic. Furthermore, the method does not rely on a (potentially problematic) outsider’s judgement of what is best for a company.

Communication processes, as essentially cognitive and social processes involving technology as well as human beings, cannot be controlled—yet they can be influenced. Through raising awareness, a maturity grid-inspired approach aids in increasing team members’ self-observation and self-reflection capacities, and thus facilitates learning.

To address some of the concerns raised in Section 6, the workshop could be run in different ways. Firstly, to find out whether the ‘communication grid’ suffices as a standalone method, it could be tested with other companies, in combination with interviews. Secondly, to avoid ‘pushing’ a company into a certain direction on their path to ‘mature
communication practices', provision of cell descriptions could be abandoned in favour of letting the participants populate the cells themselves. Thirdly, to avoid running out of time during the session, the individual sheets could be electronically distributed in advance. The discussion to find a consensus on the desired position would thus start right away.

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