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The right fidelity: designerly representations that enhance multidisciplinary product development

Guido Stompff[a,b], Frido Smulders[b]

[a] Océ Technologies; [b] Technical University Delft, IDE

In product development, representations of the intended product are needed to enable specialists to learn about what they develop together. A variety of representations is deployed, ranging from textual documents like requirements, up to integrated prototypes. The difference between these representations is the fidelity: the degree to which a representation corresponds to the eventual real world product.

In a long term participatory study, we observed that some of these representations serve as boundary objects: objects that have a capability in teams and organizations to transfer, translate and transform knowledge across difficult epistemological barriers. However, the fidelity of these representations varied considerably. Expressing the intended product is not merely a translation of a preconceived idea in an appealing visual, but co-shapes the social process.

We categorized the representations into four groups, and found that the 'right' fidelity of a representation is situational dependent where the situation is formed by the involved boundaries and aim of the social interactions. We present the categories and a framework to explain our findings, including the relation with the team process.

Keywords: *Boundary objects, Collaboration, Co design, Boundary Spanning, visual representations*

* Corresponding author: Guido Stompff | e-mail: guido.stompff@oce.com

Introduction

Boundary objects are objects that have a capability in teams and organizations to transfer, translate and transform knowledge across difficult barriers such as between specialists, between departments or between disciplinary functions (Star & Griesemer 1989; Carlile 2002, 2004). Consider, for example, a plan board: even when people do not see each other, or communicate, they can still instil what they have to do and when and interact. The term boundary object proved to be particularly valuable in the context of New Product Development (NPD) (Leonard-Barton 1991; Cook & Brown 1999; Bechky 2003; Bucciarelli 1994; Carlile 2002, 2004; Levina & Vaast 2005). These boundary objects for NPD can be sketches; engineering drawings; models; abstract notions; timelines; charts; spreadsheets and so on.

Lately, there has been much interest in the notion of 'boundary objects'. But despite the scholarly interest, there are many questions unanswered for boundary objects. What objects may become boundary objects, why and when? How can these objects be improved for their boundary spanning capabilities? How can boundary objects explicitly be developed and managed? This leaves practitioners inside NPD teams and managers empty handed when it comes to developing effective boundary objects.

A specific kind of objects we are interested in are representations of the product and/or service a NPD team is developing. These enable specialists to learn about what they develop together. In a six year lasting participatory study of NPD teams in-the-wild these representations were omnipresent, ranging from textual documents like requirements and business cases, up to integrated prototypes. The difference between these representations is the fidelity: the degree to which a representation corresponds to the eventual real product. These representations proved to be of particular importance to facilitate collaboration in those teams (see Figure 1). In this paper we explore these representations, in order to understand and predict what kind of representations become boundary objects and in what context.

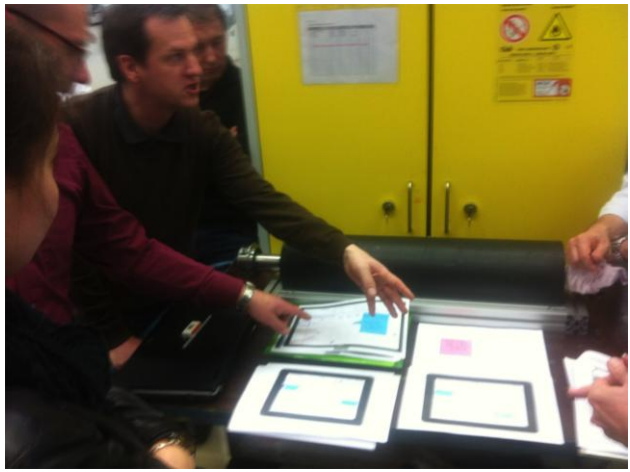

Figure 1 An emotional discussion alongside sketches of a user interface. The project leader on the left discovered by means of the sketches that there was disagreement on the functionality of the product. It shows how objects are critical for multidisciplinary collaborative knowledge work.

Theory: boundary objects

In development of complex products, specialists create something none of them can conceive beforehand, as these products require too much knowledge to be developed by one person (Schrage 1995). However, collaboration is not simple, as each specialist has his own practice, constituted by their occupational and educational background, including jargon, tools, models, and the like. In short, specialists have different object worlds (Bucciarelli 1994). These specialists have problems to understand each other's practices and boundaries can be observed (Doughtery 1992; Carlile 2002): imaginary/felt demarcations between specialists, departments or disciplinary functional units. Boundaries are known to stifle innovation (e.g., Dougherty 1992) and also to incite innovation (e.g., Fiol 1995). Spanning boundaries is crucial for organizations that develop complex products and/or services. Not only to enhance its innovative capabilities, but also to reduce costly errors and iterations as a result of poor cross-disciplinary collaboration. Several mechanisms are known and studied to span these boundaries, such as (assigned) roles like boundary spanners; or

specific tools such as 'wikis'. It is found that some objects used in teams also have boundary spanning capabilities.

Boundary objects (Star & Griesemer 1989) refer to a wide range of artefacts, observable by many actors that are robust enough to maintain a common identity across the divers practices, yet are plastic enough to adapt to distinctive practices. Although the name suggests that boundary objects are at the edges of practices, Star & Griesemer (1989) described them differently. Boundary objects 'sit amidst' all practices, that is are part of the practices of many specialists. For example, a project planning is shared among all specialists and is part of all their individual practices. Thus, boundary objects should be conceived as nodes in a network, where practices become joint.

Carlile (2002, 2004) developed extensive theories to explain why some objects enable boundary spanning. He found that knowledge inside NPD teams is structurally different for specialists and that it is embedded in practices and cannot be articulated. Carlile identified four categories of boundary objects: repositories, standardized forms and/or methods; objects/models and maps. The importance of Carlile's writings is that he showed that there is a relation between the kind of boundary and the kind of boundary object. Repositories (as specification databases) and standardized forms are good for transferring and translating knowledge across boundaries, but have limited value when e.g. contradictory aims exist and knowledge has to be transformed. Put differently: when something new has to be invented.

Ewenstein & Whyte (2009) studied visual representations in architecture, like drawings and sketches. They highlight that these representations are characterized by a 'lack' or incompleteness that precipitates unfolding. In time, the objects change, the meanings shift and layers of information are added. The drawings serve as boundary objects, but are in flux, continuously adapted and never complete. These drawings have an 'unfolding ontology' (Knorr Cetina 2001) and are essentially mutable. This insight opposes the view that boundary objects are relatively stable, a view that is implicit in many publications on the subject.

What is lacking in literature are insights in the expressive form of these boundary objects themselves. For example: it is observed that sketches are boundary spanning (Ewenstein & Whyte 2009; Henderson 1999), yet what sketches? Are it 'back-of-the-napkin' kind of sketches, or well crafted and precise sketches? Do they need to convey beauty and elegance, or has a

clumsy sketch also boundary spanning capabilities? In this paper the focus is on representations of the final product and/or service in NPD. The research question we explore is: what representations have boundary spanning capabilities, how, why and when.

METHOD

This paper deploys the data and analysis of a large PhD study conducted in 2006 - 2012 in the Netherlands. Aim of the large study was to understand what designers contribute to multidisciplinary teams and organizations. This paper deploys the same data and shifts the empirical lens from designers to representations used in the design process, in order to reflect on the boundary spanning capabilities inherent in some of these representations.

Method and context

The large study (Stompff 2012) was instigated to contribute to the theory development on design, namely designing in multidisciplinary teams. There is a large body of literature on design, but design *teams* in the wild are rarely discussed. The other way round, there is an even larger body of literature on innovation, but designers are remarkably absent (Hobday, Boddington & Grantham 2011). A large, multinational, high tech company served as the context, developing printers, software and services. These are developed by a R&D organization of 2000+ employees that is based in nine different countries around the world. A topic was chosen that well represents multi-disciplinary NPD teamwork: Operator Recoverable Errors (ORE). ORE concerns enabling users of printers to solve errors, such as paper jams. In the company at hand, ORE is known to be a notoriously complex topic that impacts the work of many developers including mechanical-, software-, and electrical engineers; product- and interaction designers and quality assurance specialists.

The study was set up according to a Deweyan inquiry, a method based on Dewey's pragmatist logic (1938). The method is aimed to deal with a doubtful situation, being a design situation that is not readily understood and thus, stalling progress. The study consisted of roughly two stages. First an analytic stage to instil insights from observations in the everyday practice, to understand the constituents and the relations. This theory building stage leads to new or revised theory and associated hypothesis. Data gathering for the first stage lasted two years, and included 29

interviews; 30 hours of filmed team meetings; and many photos and scans of objects, sketches, models and so on. In addition, observations by the participating designer were recorded in a journal. Analysis was done by means of five distinctive studies (triangulation of methods) and together with seven co-researchers that varied across studies (triangulation of evaluators).

The second stage consists of a range of guided experiments in the same practice, to validate or falsify the propositions. The second stage consisted of three guided experiments, that were done in-the-wild in the company at hand. The data from these stages consists of participatory observations recorded in a journal, plus photos and sketches of objects, sketches, the environment and the like.

One set of findings from the large study are subject of this paper and concern the role of representations in discussions and reflections on activities of specialists within and across their practices (Stompff 2012; Stompff & Smulders 2013). These representations seemed to provide a platform that served as common 'language' for the specialists to relate their activities to those of others and by that facilitate cross boundary discussions.

Representations as boundary objects

A range of distinctive representations was observed, including simple sketches up to beautifully crafted and expressive representations as models. Several of the experiments in the second stage of the study were geared for developing and using these representations, to span boundaries inside the organization at hand. Some of these boundaries that were included in the experiments are known to be problematic in the company at hand, such as between R&D and marketing. The experiments done during the studies showed some mixed results: there were successful and less successful ones. Consequently, the question arose what kind of representations span boundaries and in what situations.

Informed by the methodical principle underlying grounded theory (Glaser & Straus 1967) we moved back and forth between analyzing and collecting data. While keeping focus on the research question at hand, we worked inductively in order to instil ideas for a framework until 'theoretical saturation' was obtained (Glaser & Straus 1967). The framework we looked for needed to form a combination of sets of representations and design situations. We categorized the representations and subsequently reflected

on their contribution to the social processes in the design situation. A striking observation was that the fidelity of the representations seemed to be highly relevant for the situation and process a NPD team was in.

Findings

The continuous refinement of our findings enabled to obtain a fine-grained perspective on representations and design situations. Below we present and describe four categories of representations, with a varying fidelity.

Category 1: When every detail counts

The first category concerns representations whereby every detail seems to be of importance for the specialists involved. Consider for example, an integrated prototype or integrated CAD models that represented the work of a group of specialists (see Figure 2). Things that could not be seen were explained in depth in meetings by the specialists, e.g., such as software code. The photo of the integrated prototype shows that the team did experiments with the prototype collectively, interacting heavily with the prototype. They took much care that all steps for the experiments were done correctly. They closely scrutinized whatever happened. Discussions, proposals, experiments and reflections were cross disciplinary.

Interestingly, the interactions with the object itself seemed of particular value. Or more precise: not only the experiments they performed on the prototype provided additional information, also the experiences they had while interacting was important. The team members took parts in their hands to feel the robustness, sat on their knees to access a specific situation, listened to the sound of a motor gearing up and so on. The sensory experiences showed to be relevant. They felt that something inside was stuck; understood that a motor ran too hot due to the smell of ozone; or heard how something broke down. Consequently, the fidelity of the representations needed to be as high as possible. Any abstraction was considered a nuisance or was mistrusted. Only a detailed prototype allows to experience real time what the situation is at hand. If no prototype is available, a CAD model that depicts as best as possible the current situation is used instead. Put differently, these representations were not solely *abstract* boundary objects that represent something; also the *interactions* with the object proved to be meaningful and enabled boundary spanning.

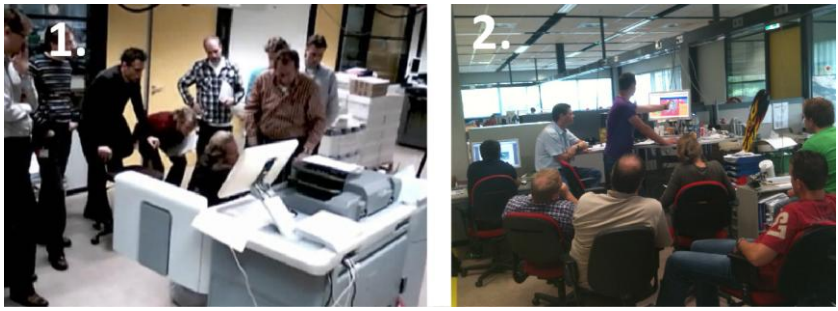

Figure 2 On the left (1) a team meeting is depicted while experimenting with an integrated prototype. On the right (2) a team meeting is shown when a review was held behind a CAD station. In both situations, interactions and (sensory) experiences were important for boundary spanning.

Looking at the situation in which the detailed object fulfilled its boundary spanning contributions we see the following. In these meetings specialists were discussing problems that were not understood well; work was reviewed that was new to others; or situations were discussed whereby the team members disagreed whether or not it was a problem, or whether or not a proposal would solve a problem. Often ambiguity prevailed and team members had different explanations and interpretations of what they observed before them. They tried to make sense of the doubtful situation they found themselves in. The many questions, discussions and interactions with the object were focused on how to interpret the situation at hand and this lasted until the actors agreed upon what brought them there. Put differently, the situations concern a social process of problem setting and making sense of the situation at hand. Sensemaking is devising plausible explanations of the situation a team faces, retrospectively (Weick 1995). Once the problem was set, the detailed representations seemed to lose their value as a boundary object in the discourse and objects of other fidelity entered the situation as the next category illustrates.

Category 2: A 'little sketch will do'

The second category opposes the first group in almost any conceivable way. This concerns crude sketches or maps, drawn on paper or on the whiteboard. A similar kind of representation was for instance a 'carton prototype' that a mechanical engineer made every now and then. He made those within few hours, showing, e.g., a cover or sub-frame. He

subsequently invited others to have a look, which sparked animated discussion and new ideas. The models were like 3D sketches and clearly served as a boundary object. The sketches include some words or arrows or circles to highlight something specific and typically have a very low fidelity.

In Figure 3 one such an example is presented, including what it evolved into in time. They are so rudimentary that these have hardly any meaning for those not involved in the meeting were these sketches were created, but make much sense for those that were part of the social activity. As an interviewee explained: "a little sketch will do". For example, the sketched map depicted in Figure 3 has some vertical boxes on the left side that have no words in it, whereas the boxes on the right have. These boxes with no text were already discussed and sketched before, so in this sketch just a hint suffices for the team members to grasp what is depicted. Also information is added, later in the meeting, adding another layer of meaning to the already existing sketch. The vertical curly lines were added to group some of the boxes together, which was done later in time.

These kinds of representations are swiftly created in multidisciplinary team meeting when collaboration is ongoing. Two or more specialists need to develop something together, e.g. to solve some problem that has impact on both their work. They have to find means to express to other disciplines what ideas they have and what enables the development and reflection on these ideas. While doing so, they develop a way to express their collective work in a sketchy way and meanwhile develop a common vocabulary and discourse. It is the essence of designing: to put forward an idea by means of a sketch and to reflect on it (Schön 1983). Thereby the sketches are changed, thrown away, drawn again and in time elaborated, just like a designer who is sketching, but then in a multi disciplinary setting. To show that, in Figure 3 also the final 'map' is depicted that evolved from these crude sketches, few months later. It is not hard to recognize the initial sketches in this map, although it is much more detailed and layered. The map enabled the team at hand to show and reflect on the relations between their activities.

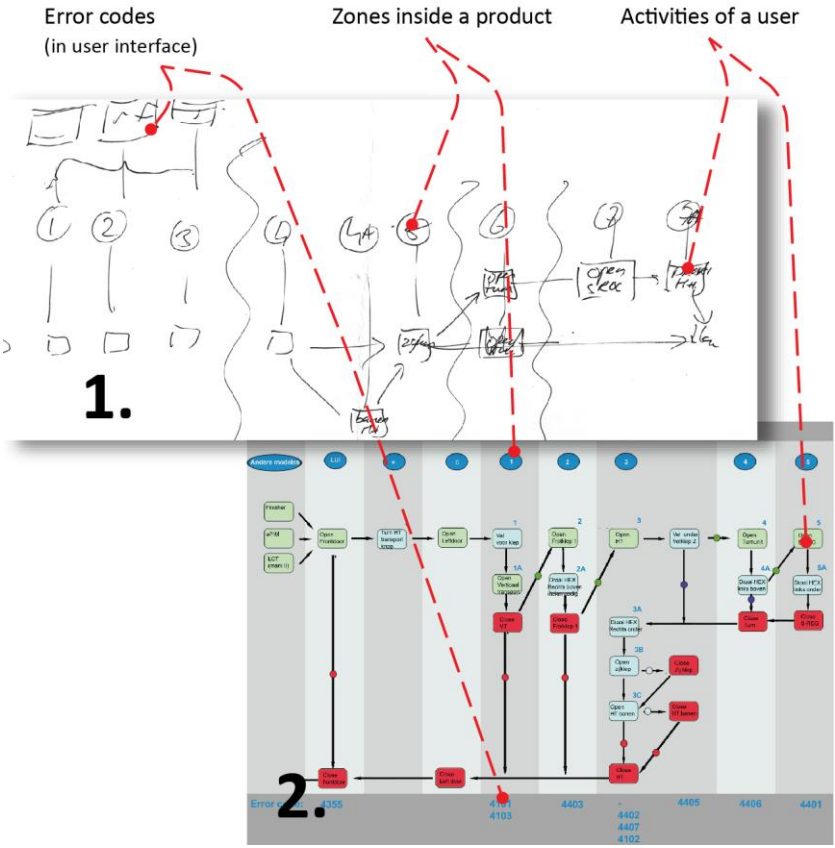

Figure 3 On top (1) a sketch is shown of a map that was used in a multidisciplinary team meeting. It provided the means to swiftly sketch ideas for solving a problem, cross disciplinary. The developed language proved to be fruitful, as the team stuck to these kind of maps, eventually developing it into a large map (2) that depicted the relations between physical 'zones' inside the product; software code for specific error scenarios and the activities of a user.

The map developed and matured over time, however remained 'open-ended' until the end of the meeting. The in-between sketches and digitally drawn versions of the map had 'white spots' that still needed to be filled in; areas that were still subject of debate. Put differently, the map was an essentially mutable object that is ongoing adapted to new insights and had

to be co-created. It was a boundary object par excellence, sitting amidst practices, but not a static object as the object is coming into being while progressing. The sketches, with their low fidelity, have an 'unfolding ontology' (Knorr Cetina 2001): the object is never fully accomplished but rather "continually 'explode' and 'mutate' into something else, and that are as much defined by what they are not (but will, at some point have become) than by what they are"(ibid.:p.182).

As becomes clear from the situational descriptions above, these sketchy boundary objects proved their value mainly while the various disciplines were actively involved in a multi disciplinary design process with the aim to identify solutions to the problem at hand.

Category 3: The essence of an idea

The third category resembles the previous one, as it concerns representations that have a low fidelity and can be quite abstract. Consider e.g., hand drawn and computer drawn sketches that are deliberately 'iconified', or 3D models that depict a similar abstraction (see Figure 4). However, these representations lack the open-ended nature of the previous category. Rather they represent the essence of an outcome of a team decision, after considerable discussion. So, despite the abstraction and low fidelity, the aim of these representations is different to the crude sketches of Category 2: they represent the 'essential idea' a team agreed on - and nothing else!

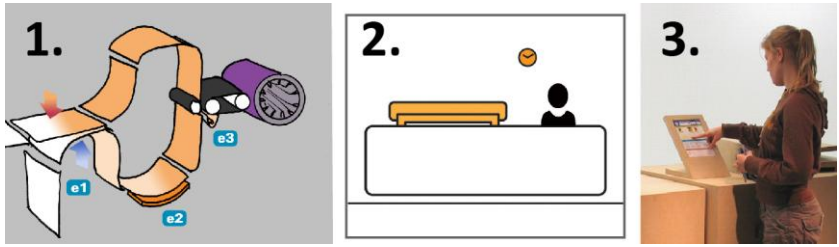

Figure 4 Three examples of representations that were created to summarize the essence of an idea the team agree on. The one on the left (1) is hand drawn and later 'beautified', whereby unnecessary details were erased. In the middle a highly 'iconified' picture is shown, and on the right (3) a photo is shown that was used to explain what was decided on the position of a user interface.

The representation shows the frame for subsequent design and engineering activities, a frame that often needs to be approved by others. The representations depict rightfully what everybody agrees on - across practices, and are sufficiently to the point so that everybody 'gets the picture'. In a way these representations are a visual summary of what happened in the meeting. At the same time, these representations leave open ample space for individual specialists to develop their lines of actions within their own disciplinary practice. Even though at team level a sketch is the closure of a multidisciplinary discussion, for individuals it leaves open ample space to manoeuver.

Despite the apparent lack of details and the low fidelity, actually every detail is meaningful. Much information is deliberately omitted, and thus the remaining details have relevance. For example, in Figure 4 also an 'iconified' drawing is shown. Behind the man there is a clock drawn. There is hardly any information in the drawing, so time is considered very relevant. These kinds of representations not only summarize, but also attempt to prevent misinterpretations. These representations serve as boundary objects over time, establishing a jointly constructed frame for future activities. These sketches therefore come about in a social process that was termed 'future framing' (Smulders & Brehmer 2011), a design process in which the actors aim to develop a satisfactory frame representing the future outcome of their combined work as well as the solution space for their upcoming individual design and engineering activities.

These representations were also used to communicate with others, e.g. management stakeholders. By presenting the core of an idea and nothing else, it is clear what had been chosen and what is still open. They have vigour and charm that ensures commitment and invites to participate as so much is left open for the imagination. We observed that these representations incite open dialogues and ample space to explore new aspects. As such, somewhat paradoxically the representations of this category concern both the end of something in a meeting and the beginning of something new in separate tracks.

Category 4: Even better than the real thing

The last category concerns extremely well crafted representations and models that are aesthetical and pleasing. Consider e.g. photographic renderings of a product; real life models; almost art like kind of scale models; small movies or animations and so on (see Figure 5). The

representations recall so-called concept cars that are presented at car shows, to show possible future models, also referred to as projecta's (Buijs 2012). Not only what is represented is made with great care, also how it is shown is deliberately chosen, providing a kind of future reality how the object should be seen. For example the lineup of products in Figure 5 is geared to highlight that the products will share the same user interface, which was considered a USP for the firm involved. The representations have an extremely high fidelity as these are often better than the real thing they refer to, namely the future product.

Figure 5 Three examples of highly stylized representations of a possible future products. On the left (1) an idea is demonstrated to have one user interface across a range of products. In the middle (2) a proposal for a new package design is shown, to leverage the brand. On the right, a proposal for a new design language is demonstrated. When these representations were made, none of these product they refer to were planned.

Just as the previous category, these visuals and models point towards the future but here represent a very detailed end of a design and development process. These representations serve another goal. Rather than summarizing what has been decided, this is aimed at getting commitment from others, such as getting resources and budget. This category of representations is compelling, clarifying, elegant, coherent, aesthetical, thought provoking. In short: seductive, if not persuasive. All means are employed to ensure that others are convinced something is a good idea. It is not about explaining an idea, it is about ensuring the idea is framed in a particular and preferred way. As such, these representations are basically 'selling' ideas to actors outside the team in social processes aimed at persuading actors from other disciplines or with other roles.

Summarizing the findings

Four categories of representations are discerned that each have contributions as boundary objects in a social dynamic setting of actors, inside and outside teams. Thereby the fidelity of these objects varies across these settings. Consequently, we instilled that the 'right' fidelity of a representation is situational dependent where the situation is formed by the involved boundaries and aim of the social interactions. In Table 1 an overview of our findings is presented.

Category 1 *When every detail counts*	Category 2 *A little sketch will do*	Category 3 *The essence of an idea*	Category 4 *Even better than the real thing*
High fidelity	Low fidelity	Very low fidelity	High fidelity
No abstraction allowed	Sketchy	Iconic	Carefully crafted and expressive
Preoccupation with failure	Preoccupation w. problem solving	Preoccupation with converging	Preoccupation with commitment
Sensemaking	Designing	Future framing	Gaining commitment

Table 1 Comparing four categories of representations of the intended product that serve as boundary object

The category 1 representations like integrated prototypes are used inside the team when the team experiences doubt and/or uncertainty around an unexpected situation. Or that someone presents e.g., a newly devised or adapted module that needs to be reviewed by all in context with other parts and modules. Such events initiate processes in which teams resort to those representations that best show their collective work at that moment in time and that hardly show any abstraction from that. While assessing the situation, the specialists have a preoccupation with failure, looking for clues that hint at problems or may provide explanations why something doesn't work. They set the problem at hand. Of interest is that the representations pre-eminently refer to *past activities.* For example, a prototype is representing what all team members did in the past and represents those past design decisions that brought them in the situation they are in. The social cognitive process aptly can be named a sensemaking

process: the "retrospective development of plausible images that rationalize what we are doing" (Weick et al. 2005).

By contrast, category 2 representations like 'back of the napkin' sketches are used when a problem is well understood and the team engage in solving it. The low fidelity of the representations is needed because the team needs to invent, explore and adapt solutions swiftly; reflect on these and -if necessary - dismiss them. The representations need to be understood by all and are often abstract and refer to both past activities (such as existing parts) and future activities (such as new parts that need to be developed). Representations serve as boundary objects among the disciplines and permanently are in flux and adapted to the latest insights and ideas. Layers of information are added. This category of representations is closely related to the findings of Ewenstein & Whyte (2009) and Knorr Cetina (2001) on the unfolding ontology of epistemic objects. These representations are deployed when team is in the process of developing a solution for a problem, i.e., when the team is designing.

Category 3 representations fit very well in a process in which the robustness of possible lines of action is tested. These representations on the intended product summarize and capture the core of the idea, and consequently provide an agreed on frame for future activities. The process of summarizing is somewhat different from the design process, as the focus shifts from developing solutions to expressing 'what we agreed on what we will create'. Of interest is that these representations capture the essence and nothing more; they have what Weick named the 'charm of the skeleton' (Weick 2004: p.43). The 'skeleton' of a good idea has a vigour and a charm that Is persuasive so that individuals can commit themselves; leaves open sufficient space for individuals to explore solutions and is sufficiently constrained so that everybody knows the generic line of thought. This class of representations embodies a frame for future activities without explicitly spelling out what individuals need to do. We see this social process as 'future framing' (Smulders & Brehmer 2011), rationalizing current and future activities.

Category 4 representations seem to have much overlap with the previous category, as these expressive representations also provide a future frame and are the outcome of a design process. However, the aim for these representations are fairly different. The persuasive representations are geared for gaining commitment of others, who are not part of the team. Consider for example management stakeholders who provide budget and

resources and sales & marketing actors. Or consider potential future clients. Even though an idea is just premature, it is shown as if it is fully developed so that others commit themselves. A language is used that is easily grasped by all involved. It is harder to explain and reflect on the added value of for example a project description of 100 pages, compared to an expressive picture that 'sais it all'.

Conclusions and implications

The research question we explored in this paper is: what representations have boundary spanning capabilities, how and when? The focus we had was on representations of the intended product. Our findings show that the concept of 'boundary objects' is fruitful to study and explain knowledge work, at least in NPD. What we added to the existing body of literature is that the fidelity of representations that serve as boundary objects inside teams has a relation with the social process a team is in.

We observed that the many representations used throughout multi disciplinary product development have varying fidelity. We categorized these and in Figure 6, a convenient organizing framework is presented. The vertical axis depicts the fidelity of the representation being the degree to which a representation corresponds to the eventual final product. The horizontal axis depicts whether a representation pre-eminently is used inside the team, e.g., to span boundaries between specialists. Or that it is used pre-eminently outside the team, e.g., to span boundaries with stakeholders or other teams. We projected the four categories onto this map, showing (1) that the fidelity of these representations that serve as boundary objects can vary considerably. And (2) that this variation can be observed for representations that are used inside the team and outside the team. Consequently, there is no silver bullet, no representation category that serves boundary spanning independent of its context.

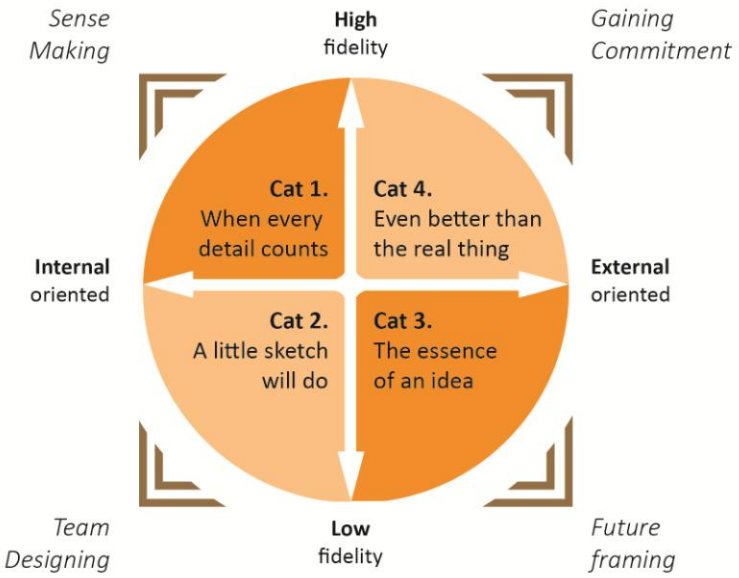

Figure 6 An organizing framework. An explanation is provided in the text. The vertical axis concerns the fidelity of a representation. The horizontal axis depicts whether a representation is pre-eminently used inside the team, or outside. The four categories are shown, with a relation to observed team processes.

The process a team is in is an indicator for what kind of representations are useful to the team members. Consequently the 'right' fidelity is an appropriate fidelity for the social process a team is in:

- If teams are in doubt, experience ambiguity, need to review parts and/or modules they hardly know yet: they need to make sense of the situation. The team engages in problem setting and the best representations get as close as possible to the eventual product, providing much detail and that enable team members to interact with it.
- If teams are solving problems, i.e., designing; representations need to have a low fidelity and are highly abstract. Key is that the specialists must be able to make swift cross disciplinary proposals

that are ongoing improved, changed, and reflected on. These representations unfold in time.

- If teams 'know' where they are heading, they need to converge and explain each other and others what they will do in the future. We name that future framing: construct a guiding frame for all subsequent activities. Representations need to capture the core of ideas and nothing more. They are robust enough to maintain a common identity, yet are plastic enough to adapt to distinctive specialisms
- If teams need to gain commitment of others, representations are needed that are compelling, self explaining, seductive; if not persuasive.

Expressing the intended product is not merely a translation of a preconceived idea in an appealing visual, but co-shapes what the outcome will be. Also, the message conveyed cannot seen apart from the way it is expressed. Thus, there is a 'right fidelity' considering the goals and the process a team is in. The implication of these findings for practitioners in NPD teams, such as managers, designers, engineers and so on, is first of all to get awareness for the impact of representations for team processes. And second, awareness of the impact of the fidelity on these processes. If a problem needs to be solved cross disciplinary, flashy renderings of the intended product will not help at all. The other way round, sketches used for problem solving make much sense to the involved team members, may look as incomprehensible, awkward and unprofessional to outsiders. Using an erroneous category for a specific process will not lead to boundary spanning.

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