

DESIGN EXPERTISE IN THREE DIFFERENT COLLABORATIVE PRACTICES

Maaïke KLEINSMANN (1), Rianne VALKENBURG (2), Janneke SLUIJS (2)

1: TU Delft, The Netherlands; 2: The Hague University of Applied Sciences, The Netherlands

ABSTRACT

The work field of designers is changing drastically. A designer is not only a creator of products and technical artifacts, moreover he is an entrepreneurial designer who inspires and enables business innovation on a strategic level.

The essence of design is the creation of a vision about tomorrow's world with all its aspects. Important here is that all different aspects need to become connected via collaboration with many different stakeholders. Only if this is done successfully, value for all stakeholders is created and the innovation will become a success. This makes collaboration a crucial aspect of today's innovations.

Since we do not have much knowledge about the nature of this collaboration, we questioned in this paper if we could specify and identify design collaboration. We interviewed 33 practitioners in various fields about the application of their design expertise. We found three different collaborative practices with their own identity because they differ with respect to their knowledge sharing and – integrating processes and because design expertise is used differently.

Keywords: design collaboration, design expertise, innovation, interviews

Contact:

Dr. Maaïke Kleinsmann

TU Delft

PIM

Delft

2628 CE

The Netherlands

m.s.kleinsmann@tudelft.nl

1 INTRODUCTION

The work field of designers changes radically this decennium (see e.g. (Antonelli, 2011); Valkenburg and Sluijs, 2012)). First, a designer is not only a creator of products and technical artifacts, but he is an *entrepreneurial designer* who inspires and enables business innovation on a strategic level (Van Berlo, 2012). This is not only the case in small and medium sized companies, also large companies more often involve designers in strategic sense making and by doing that design becomes an integrated part of envisioning, strategy formation and strategic decision making (Stevens, 2013). Another development that we see is the changing context of problems that are solved by designers. Today's problems are growingly complex, incorporating multiple interconnected aspects and stakeholders that all have different values (Den Ouden, 2012). These developments enforce companies to collaborate in innovation networks, which changes the nature of innovation teams. The teams are more dynamic in nature and often stakeholders are only involved during parts of the innovation process in which they create a part of the solution. To streamline these dynamic processes, designers and design researchers started to explore new methodologies to deal with this changing context. An example of such an approach is *co-creation* that aims to integrate social, economic and environmental phenomena into a comprehensive design solution.

Within the world of design, design consultants like Brown anticipated proficiently on these developments. In his book '*Change by design*', Brown (2009) showed how Design Thinking could be the major lever for change by using design as a systematic tool for managing the innovation portfolio and by applying it to major problems in society. Brown provides insights in the application areas of Design Thinking and he shows what design tools and techniques could be applied in order to solve abstract and multifaceted problems. In order words, he shows how *design expertise* could be used to enable multifaceted problem solving (Lawson and Dorst, 2009). Also management scholars and managers gained interest in design expertise, because they discovered the success and the possibilities of it. This results in many publications -in for example Business Week- about the positive effect of design driven innovation. Management Scholars adopted the term Design Thinking as a new paradigm to increase their creative power, because designers are creators of alternatives, which is a valuable addition to analytic thinking in their current business. Boland and Collopy (2004) for example see Design Thinking as the instrument for *shaping new alternatives*. Martin sees *balancing between knowledge exploration and exploitation* (Martin, 2009a, pp. 23) and *refining the status quo* (Martin, 2009a, pp. 30) as core activities of Design Thinking and he sees *integrative thinking* (Martin, 2009b) as the core capability.

From these developments, we concluded that design is not only about products and systems. The essence of design is the creation of a vision about tomorrow's world with all its aspects. Important here is that all different aspects need to become connected via collaboration with many different stakeholders. Only if this is done successful, value for all stakeholders is created and the innovation will become a success. This makes collaboration a crucial aspect of today's innovations.

In this paper, we question if we could identify and further specify design collaboration. We interviewed practitioners in various fields on the application of their design expertise in collaborative settings. The paper starts with a literature review about design expertise and design collaboration. It continues with the research method, which is followed by the results and discussion.

2 THE RELATION BETWEEN DESIGN EXPERTISE AND COLLABORATION IN DESIGN

The research on design in its early years used to have a strong interest in investigating what designers SHOULD DO, and provide design methods to support. Halfway through the 1980s the emphasis yields towards observational studies on what designers in practice REALLY DO. Research on the development of this design expertise mainly focused on the difference in design skills of novice designers versus expert designers. It showed for example that expert designers structure and integrate their design knowledge with the use of schemata, whereas novice designers lack the expertise to create such guiding principles (Lawson, 2004) (Sonnetag, 2000). Expert designers are also good at prioritizing criteria that they see as most important, based upon the (complex) information available (Cross, 2003). According to Petre (2004), expert designers are good in setting aside the 'noise' of contextualized formulations of the design problem. They are able to reduce the design problem to its

fundamentals and address how they can achieve their final goal. These aspects make expert designers good in an adequate problem scoping and work focused towards the design solution through co-involvement of design problem and its solution (Dorst and Cross, 2001).

These studies on design expertise have focused on individual designers. However, also research has been done on collaboration in design. Work on design collaboration has addressed social skills such as conflict resolution, negotiating roles and responsibilities, and managing client relations (Lauche 2007). Kleinsmann et al. (2012) made the connection between design expertise and collaborative design by identifying design collaboration skills, which are defined as: “*the skills needed to share and integrate design knowledge to execute a design project collaboratively, which entails the integration of domain knowledge, procedural knowledge, and experiential knowledge.*”. Kleinsmann et al. (2012) showed in a study on multidisciplinary teamwork that expert designers adopted a goal-oriented approach by prioritizing and sharing only the most important knowledge, being knowledge that allows them to reduce the problem to its fundamentals. Their best teams exhibited as a distributed knowledge system and they relied each person knowing their task properly and not everyone needs to know everything in order to succeed in a design project. They proposed a preliminary typology of design collaboration skills similarly to the model of design expertise by Lawson and Dorst (2009). The highest rank of this typology is the expert integrator. The expert integrator “*understands the design information available and is able to create a transactive memory system with team members. This makes the knowledge integration process effective and efficient. This results in an integrated knowledge and a design concept that embodies the knowledge of the different team members.*” However, Kleinsmann et al. (2012) did not specify the particular design skills necessary to become an expert integrator. Furthermore, there is not much knowledge on which skills and how these skills are used in real life projects in industry. Therefore, in this study we are interested if we can detect design collaborations skills and – if so – how they intertwine with design expertise.

The aim of this research is to see if we can identify design expertise in (different) collaborative practices. Therefore, the research questions of this study are:

- (1) Can we identify practices that distinguish themselves because of the different knowledge sharing and – integrating practices needed within that certain situation?

And if so:

- (2) Can we further specify what design activities are used to enable collaboration?

3 EMPIRICAL STUDY

To get a better understanding how design expertise is used in industry, we decided to interview people. To structure the interviews, we designed a card set. Reviewing aspects known that expert designers typically do, we found 119 activities in literature that together describe design expertise. Note that we tried to be as complete as possible in our literature review. Yet, we are not claiming that this list of 119 activities is a complete list and that activities that are not on our list could not be design activities. While analyzing this list of 119 activities, we noticed that although the wording of some activities differed, the meaning was (almost) the same. We grouped the activities with the same meaning and sometimes we reformulated the activity, so that it covered the meaning of the underlying activities as saliently as we could. Examples of these activities are: “*recognize situations and apply experience on it to bring the innovation project further*”, “*visualize together to create a shared understanding*”, “*create a rich design conversation with different stakeholders*”.

This resulted in a set of 48 activities that collectively describe design expertise (each card consisted of the description of one design activity of design expertise). Additionally, a drawing related to the activity was put on the card to provoke storytelling (see Figure 1). This design of the cards allowed enough structure to create a common language among the respondents, yet they also provided room for interpretation. During the interview we allowed the respondents to add one or more cards to the card set.

For our study we interviewed 33 people within industry. The set-up of the interview was as following (see Figure 2): (1) we asked the *biography* of the person interviewed. This enabled us to put the interview in a context, (2) we asked the respondent to select the cards, which described activities that are *essential* for design expertise, (3) we let the respondent select the ten cards that are most *unique* for design expertise. (4) We requested a detailed *explanation* of these ten unique activities and how the respondent used the particular activities in daily practice, resulting in *rich storytelling*.



Figure 1. A picture of the card set



Figure 2. Our research approach

All interviews were transcribed for further analysis. For data analysis, we used NVivo—a software tool that supports coding interviews as part of qualitative analysis (Lewins and Silver 2007).

The first step of the data analysis was making a map of the contexts of collaboration in which our respondents operated. We did that by analysing the biographies and by analysing the contextual examples that our respondents provided us with. This resulted in the description of the characteristics of three different collaborative practices. The second step of the data analysis was determining what design expertise our respondents applied within these collaborative practises, resulting in a rich insight into application of Design Thinking.

4 RESULTS

4.1. Distinguishing three collaborative practices

While analysing the collaborative situations within our sample, we could distinguish three different practices. These three practices differ in the focus and dependency of the tasks, the organizational context and the collaborative network. This section explains the collaborative practices within these forms.

The first practice that we distinguished is collaboration within a *multidisciplinary design team*. Within this form a design team with different backgrounds is creating a product or a system together like for example a design engineering team consisting of engineers with different backgrounds has to create a technical system. Or a product development team existing of people from different disciplines like Marketing, R&D and Sales that has to create a product or product service system. Both knowledge sharing and knowledge integration are important here, because of the high task dependencies. This makes collaboration within this practice intensive. If there is no collaboration there will be no product like an Interaction Designer phrased it: *“I think it makes a project stronger by having people from different disciplines and different views. It creates a conflict as well, but if you only have designers you can’t finish a project. The same if you have engineers, you can probably build something, but in a lot of cases it will not be appealing. And if you have a project manager, you can talk a lot about it, but yeah, it won’t happen.”*

The second practice that we distinguished collaboration within a *business (network)*. Here someone in a business shares his vision to other people in the business network. Knowledge sharing is the dominant process in this form of collaboration since the collaboration processes are sequential in nature. It can be that a design expert (or team of experts) creates THE design vision for the project and delegate this vision to others who have to work it out in detail. Another option is that the management

team develops the business vision for the company and shares this vision throughout the company or extended business network. As a Strategy Manager describes the collaboration: *"As discussed, first and foremost I think it's about creating belief by imagining the future, because you have to sell the project internally. Whatever you do in the future, you have to sell it. Selling is not easy because there are always priorities, budgets are constrained, there is not enough capacity, time is limited. So before you find a sufficient basis for working, you have to make others in the company to share your beliefs that it is a necessity to start projects."*

The third practice collaboration within an *eco-system*. Within this practice one cannot speak of a team since the group of people involved changes throughout the process. These dynamic teams do not fit one company, since there is a whole network of stakeholders. Sometimes these stakeholders are partners within the project and sometimes they have a stake in one part of the project since they are for example users of the innovation to be created. So maybe parts of the collaboration in this practice could better be rephrased by *participation*. Within this practice, knowledge sharing and –integrating practices are diverse in nature, due to the dynamic character of the collaboration. There exist eco-systems that are involved in (social) innovation projects in which stakeholder dialogue is an essential element. And there are ecosystems that are involved in the change of entire systems. Solving contextual complex problems is essential here. Collaboration in this context is explorative by nature like a Design Consultant mentions in the following quote: *"...And that is: listen to stakeholders, engage with them. Facilitate conversations. I think designers are also by their nature, and this I don't know why, I like to know an opinion here, why is it that I am convinced of an obscene inaction designers be on the one hand arrogant bastards and on the other hand great facilitators and integrators. And I think it is the integrator element. I think design is fascinated by a blank page. I think it's also fascinated by bits that it then brings to synthesis. You see what I mean? And I think that is where design works in big co-creative processes, because one of its challenges is the blank page. The other challenge is to synthesize many different elements into a whole. I get the feeling design is about whole making rather than part making. So that whole process of listening to stakeholders and users, having engagements themselves, pulling out the necessary information, but then integrating it into some form of whole is part of this..."*

4.2 The designers' capability to adapt

While analysing the way our respondents dealt with changing contexts, we concluded that our respondents could act within each of these three collaboration practices. One of the strengths is that they change their collaborative behaviour accordingly as shown in the following quote from the Concept and Design Manager *"Then communicating with others, there are a lot of different phases with that. So one could be these sketches, it depends on who you are communicating with. I mean if I am communicating with another designer or somebody who is part of the innovation process and an inventor then it's a kind of sparring communication. It can be much more unclear or sketchy. Then there could also be building this model to communicate for example things for safety or things like play value or things of engineering. There could also be drawing of engineer-type details to communicate that. Then I do a lot of presentations where I am trying to communicate the overall story. So right now we are working on a project that has to do with fitness and things like that, so I am collecting pictures that show a whole history of how people have moved or how people have used their outdoor space to stay healthy. So there it is a combination of maybe not necessary my sketches but pictures and words to more when I am presenting to the CEO and so on. But most of it for me is, even at that point, all this is part of the process of developing the concept. And even that, presenting it to the CEO, it is still part of the process because even giving that presentation is making me think: what is really critical here, what's really important, what is really important about this concept? What is really different, what is meaningful? What distinguishes it from the competition for example? And her feedback is again part of that conversation. You know, she is one of the stakeholders. Making prototypes is also part of this communication and having children coming to play with us is obviously a continuation of that conversation that rolls the project further."*

In the first part of this quote, the Design Manager describes collaboration in a multidisciplinary team, he continues with communication in a business setting and he ends with communication in a broader ecosystem. What also becomes apparent while analysing this quote is that he used his design expertise different in each situation, which we will further analyse in the next section.

4.2. Design expertise within the three collaborative practices

With the three collaboration practices in mind we looked at the data from the interviews to see if we could distinguish different kinds of design expertise used to enhance collaboration. Our findings on every practice is explained and exemplified with quotes from our respondents.

Design Expertise used within collaborative practice 1: the multidisciplinary design team

From the analysis of the data it appeared that, to make this kind of collaborative practice effective it is important to find crosslinks between disciplines and to connect them by creating a common goal. Connecting is a process of diverging and converging. Our respondents showed that diverging is often not so difficult, but converging at the right moment in time is hard though. The following passage from the interview with a Packaging Developer illustrates this:

[Interviewer] You say: going from diverging to converging is sometimes a bit hard. [Respondent]: Yes, to make the right choices. It can generate quite some discussion between Marketing and Packaging or anyone else. Especially with packaging I think everyone has an opinion about it because everyone thinks: I like it. Or: I don't like it. So it is quite difficult to stay neutral and say: this is what we want to achieve. How are we going to make the choice? Especially with packaging everyone always has an opinion. For instance with the formula most of the Marketeers are no chemists so they believe what the formula guy is saying and they say: I guess so. With packaging it is: I don't like this or I don't like that. It is always the same. It is logical because it is something you see and it is visualised and you like it or you don't like it. So normally you get quite a discussion. It is really different from the formula development.

Bridging different languages enables converging because it helps with the translation and integration of the different disciplinary languages. The following quote of a Project Manager shows the importance of bridging and translating:

(...) for instance you can talk about a piece of hydraulics and in other projects I have translated a piece of hydraulics to electrical components to make sure that my colleague who was not able to understand what hydraulics are but who was more or less an E-guy can step in and contribute to solving the problem.... We have said: this is the way we put it on paper, this is the way we code them so that everyone has a common language which is something you use with everything else.

The next example -taken for the interview with a Design Manager - shows how a design tool like the creation of product stories enabled integration of Marketing and R&D: *"The prevailing paradigm within R&D is: give us the time and the money and we will figure it out. I now make it very simplistic but they have an idea, they know what kind of technology they think they can make something nice out of it and so on. So they really like to start with not too many restrictions. Let's get it moving. In the same phase Marketing, but also senior management really likes to know how much it will cost, what they will get, what kind of profit, how much market share and so on. So there is always this sort of collision between people who feel: we should go there and we will have excellent products and people who want to control. Even though I am part of R&D I don't believe anyone of them is right. It's just two worlds colliding. In those phases, what we learned in my practice and we are really experimenting with it, is creating product stories. That is how we name them. Product stories is about having some sort of narrative or visual demonstrator of what the product could be because we know by now it enhances to get some shared understanding between Marketing on the one hand and R&D at the other. That is in the conceptualisation phase.... So the goal is: what we see, what happens is we bridge. How we do that is actually by imagining the non-existent. We visualise, we create narratives of what the products could be. These visualisations or prototypes or whatever serve as a sort of shared practices as we name them. It is something they can understand within their own world, within their own language and can relate to."*

From further analysis of the interviews we concluded that visualising and prototyping are essential elements of design expertise necessary for communicating the common goal, the created connections and the product concept. To characterize the purpose of applying design expertise in this practice we could use the verb *merging* since the expertise and knowledge of the different people working on the project slowly merges into a coherent whole in the project.

Design Expertise used within collaborative practice 2: the existing business (network)

Within this collaborative practice our respondents struggled with the ability and willingness of their management to deal with the ill-defined innovation problem. Our respondents are used to deal with the

accompanying ambiguity. However, their management teams and other stakeholders often have difficulties with its intangibility and uncertainty. In order to make their ideas more tangible they materialize their preliminary ideas with the use of prototypes and visualizations. The design expertise that is most necessary in this practice is using different kinds of representations on the right level of abstraction like the Chief Design Officer mentions in the interview: *“Everything has a different level of representation, depending on the stakeholders. So there is a moment in which it is enough to represent it in such a sketchy way. Depending on to whom you have to communicate. And probably to communicate to a much broader audience perhaps you should even make a movie that is so realistic, that shows life when life is not there.”*

Furthermore, our respondents take on an entrepreneurial role within this collaborative practice. They continuously increase the value of the project or product through discussions with different stakeholders within the business (network). As a Strategy Manager puts it for internal stakeholders and how he uses visualization as representation: *“Visualisation is essential internally because you have to inspire both the product development engineer and the purchasing guy and the representative of the supplier. In an early stage you try to come to that shared understanding of what we try to achieve by using those drawings.”* And *“(…) You try to get a number of decision makers on the same line of thinking because you can have a lot of different interpretations of the words, but as soon as you make it visual, you can have a better discussion on the subject.”* And here an Interaction Designer explains the difference between internal stakeholders and external ones in using prototypes as a representation: *“Sometimes you make different prototypes, because for the stakeholders you might make a more sexy prototype, it doesn’t work, but looks good, and for user research you might want to test some tasks and then you want to have these complete building blocks in place. Let’s say you have a mobile service that also has to send a text message to the user, so that bit might be in place, so that the user can have the full experience. Whereas for the VP it is like, it looks sexy, it has gradients and it shines, you know, it is glossy, so you can continue with your project.”*

In this practice our respondents share a belief that different kinds of representations of the design trigger different kinds of discussions with stakeholders, which are necessary to continue the project or to increase the value of a project. There is an iterative nature to the development of these representations and they are fuelled by the discussions that are triggered because of them. We could characterize the purpose of applying design expertise in this practice by using the verb *taking along*, since different people are invited to contribute or help establish possible futures.

Design Expertise used within collaborative practice 3: the eco-system

Within this collaborative expertise a great belief exists that systematic changes in a certain domain are needed, as the former Director illustrates: *“I mean to me it is a bit like the idea of the architect of life. Without being blasphemous, because I don’t want to be that, but if I think about God as the architect of the world and God’s design and Devine design, this is in a sense trying to bring all the facts together in order to shape a liveable life. Is that design? I don’t know if it is design.”*

The kinds of changes he refers to is illustrated by the following: *“There is a research done by the economist on the quality of life in a city and 78% of the people that live in the city indicate transportation as their higher need. So better transportation, faster transportation, more effective transportation. In my view the reaction to this in a non-breakthrough thinking could be to focus on innovating the transportation system. There would be innovation of the transport system but that probably would not change truly the old paradigm of life in the city. So the thinking should be: what if we would not need transportation at all? Why would people want to have transportation? It is more a want, based on a must. They must, they have to move. So the thinking would be: if the city would be structured in a different way so that people don’t have to go from A to B to do a number of things. So what about home services? Or what about a different model of working? How stakeholders in a city could reshape the way in which the city is structured? So it is rethinking a non-existent city. Then you see what it means. That I think is a relevant element in my view to have a breakthrough thinking.”*

In order to be able to feed the new paradigm for the city, many collaborative efforts have to take place, because the richness of these many (creative) encounters form the input for the creation of the new paradigm. These creative encounters have an investigative humanistic character as a Staff Member of a Design School for executives illustrates:

“We have the attitude of listening. So [my partner] usually sits with the team and he has this meta-perspective of a lot of things happening which he then reflects back upon in more of an awareness kind

of mode or a higher awareness than before. So you listen to other signals than what has been said.” This is not only done with the team but also with users: *“One thing that we do is we co-create with users. So we keep in touch with the people whom we are actually doing it for. They think along and they represent their problem to us many different times [Staff Member of a Design School for executives]”*.

To really understand the different stakeholders and make their interests and potential value explicit is important in exploring how each part of the eco-system is playing which role in the development of the project. This could be done through different representations that help you to understand what is actually going on or as the Director of an Innovation agency puts it: *“I think a lot of what I do in my work is not solving people’s problems but helping people to understand them better....Through visualisation, through looking at users, through prototyping possibilities. All these design tools and instruments.”*

Our respondents share a belief that uncovering and expressing problems and potential values through visualising and prototyping is an important aspect of exploration of possible partners and solutions within an eco-system. This results in a rich design conversation where value is created because of the contribution of stakeholders in different parts of the project. We could characterize the purpose of applying design expertise in this practice by using the verb *nurturing*, because design expertise is used to take care of the increase of value for every stakeholder that becomes part of the eco-system.

5 CONCLUSION AND DISCUSSION

In this study we were looking for collaborative practices in which different types of collaborative skills are needed. We found three different practices that differ from each other with respect to knowledge sharing and – integrating practices. First, we found collaboration within the context of multidisciplinary teams that together create a product or system. Collaboration is solution driven and this solution is created through intensive knowledge sharing and creation. The collaborative practices that we found here is comparable with the expert integrator that Kleinsmann et al. (2012) identified.

The second practice that we found is collaboration within the context of a business (network) in which different managerial layers have to collaborate. In this collaborative practice knowledge sharing is important and collaboration is focused on sharing (of ideas or vision), not so much on joint efforts (or co-creation). The nature of the third and last practice occurs within the context of an ecosystem that evolves over time. Collaborative practices are dynamic in nature and knowledge sharing and – integration practices are diverse. One can question if all knowledge sharing practices could be termed as collaboration. Sometimes stakeholders only share their knowledge to others, without actively participating in the innovation process. They only participate, so *participative innovation* would be a better term for this part of the collaborative practices in which this is the case.

The second finding of this paper is our respondents showed that they could act in all three collaborative practices. They are able to adapt their knowledge sharing and –integration strategies towards the situation in which they are. This is in line with Schön (1984), who stated that designers are capable of talking to the situation in order to understand the situation and to make changes within that particular situation. We conclude here that this could also be done in a collaborative practice.

Third, we found that within the three practices design expertise plays a different role, since the activities used and the ways particular activities are used differ. Within the multidisciplinary setting it is most important that the knowledge bases of the team members are merged. The respondents used *“Bridging different languages”* to do this. For bridging these languages the respondents used their imagination skills and to create awareness of the project and for creating a common language they used their visualising and prototyping skills. In the second collaborative practice within an existing business network it is most important to taking along the other stakeholders. The respondents showed that the use of different kinds of representations on different levels of abstraction is essential here. These representations differ because they are used in sub teams that differ in hierarchical level and discipline. In order to create a rich design conversation on each level, different representation forms are necessary. Only then value is seen (which is an absolute must to get a GO for the innovation project!) and could eventually be created. Because of the rich design conversations created, there is a co-evolution of problem and solution, which makes this collaborative practice iterative in nature.

In an eco-system is problem- and value definition are an important aspects, since they are much more ill defined at the start of the innovation project than within the other two practices. In order to get a better grip on the problem and its solution, several types of research is executed. This varies from use

research to research on for example logistics and procedures used in the current situation. In order to do research in a way that creates the knowledge necessary, visualisation- and prototyping skills are utilized.

While analysing the design expertise used in the three collaborative practices we found several activities that our respondents used within all three setting, yet in a different way. For example visualizations are used in the first practice to bridge languages, in the second practice to communicate ideas and in the third setting to do research with. Also the evolvement of problem and solution are used in different ways. In the second practice our respondents used it to persuade people gradually and to get a shared insight, while in the third practice it was used to get a better grip on the content of the eco-system, the problem they are solving and the stakeholders necessary.

In this study, we sought for different kinds of design expertise used in the three different collaborative practices. We found that design expertise is used differently depending on the focus. Being aware of the context and specific type of collaboration practice results in knowing better what the scope and focus is. This will determine the span of influence and it can help in deciding how to apply design expertise and with which purpose.

ACKNOWLEDGEMENTS

The authors gratefully acknowledge the support of the Innovation-Oriented Research Programme 'Integral Product Creation and Realization (IOP IPCR)' of the Dutch Ministry of Economic Affairs, Agriculture and Innovation. We would also like to the participants of our research for their time and openness during the interviews.

REFERENCES

- Antonelli, P. (2011) 'Design Takes Over', *The Economist*, November 2011.
- Boland, R.J. and Collopy, F. (Eds.) (2004) *Managing as Designing*, Stanford University Press.
- Brown, T. (2009) *Change by Design: How Design Thinking Transforms Organizations and Inspires Innovation*, HarperCollins Publishers Inc.
- Cross, N. (2003) 'The expertise of exceptional designers', In Cross, N. & Edmonds, E. eds. *Expertise in Design*, Sydney, Creativity and Cognition Press.
- Den Ouden, E. (2012) *Creating Value for People Organizations and Society*, London, Springer Science and Business Media.
- Dorst, K. and Cross, N. (2001) Creativity in the design process: co-evolution of problem–solution. *Design Studies*, Vol. 22, pp.425-437.
- Kleinsmann, M., Deken, F., Dong, A. and Lauche, K. (2012) 'Development of design collaboration skills', *Journal of Engineering Design*, Vol. 23 No. 3, pp. 203-218.
- Lauche, K. (2007) 'Measuring social skills in design education' In proceedings of: *The 16th International Conference on Engineering Design (ICED07)*. Paris.
- Lawson, B. (2004) 'Schemata, gambits and precedent: Some factors in design expertise.' *Design Studies*, Vol. 25, No. 5, pp. 443-457.
- Lawson, B. and Dorst, K. (2009) *Design Expertise*, Oxford, U.K., Architectural Press.
- Lewins A. and Silver, C. (2007) *Using software in qualitative research: a step-by-step guide*, London, Sage Publications.
- Martin, R. (2009a) *The Design of Business: Why Design Thinking is the Next Competitive Advantage*, Harvard Business Press.
- Martin, R. (2009b) *The Opposable Mind: How Successful Leaders Win Through Integrative Thinking*, Harvard Business School Press.
- Petre, M. (2004) 'How expert engineering teams use disciplines of innovation.' *Design Studies*, Vol. 25 No. 5, pp. 477-493.
- Schön, D.A. (1984) *The reflective practitioner*, New York, Basic Books.
- Sonnentag, S. (2000) 'Expertise at work: Experience and excellent performance.' In Cooper, C.L. and Robertson, I.T. (Eds.) *International review of industrial and organizational psychology*. Chichester: Wiley.
- Stevens, J. (2013) 'Design as communication in micro-strategy — strategic sensemaking and sensegiving mediated through designed artefacts.' *AIEDAM Special Issue on Design Communication*, Vol.27, No.2.

Valkenburg, R. and Sluijs, J., (2012) *The world of the open Innovator*, Published by: The Hague University of Applied Sciences.
Van Berlo, (2012)