How cultural knowledge shapes design thinking - A situation specific analysis of availability, accessibility and applicability of cultural knowledge in inductive, deductive and abductive reasoning in two design debriefing sessions

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Abstract: This paper challenges the 'core design thinking and its application' as outlined by Dorst (2011) and uses a dynamic constructivist notion of cultural-cognitive performance to analyze aspects of a design thinking process (Clemmensen, 2009; Hong & Mallorie, 2004). Based on a qualitative analysis of some of the events in the DTRS11 data set and using the theory of Dorst on design thinking as well as Hong & Mallorie's socio-cognitive theory of cultural knowledge networks, the paper shows how it is possible and useful to analyze design thinking from a cultural perspective. The results show that cultural knowledge, either as *shared knowledge* by the cross-cultural team or *group specific knowledge*, influences the Dorst design thinking equations across all the 16 episodes analyzed in DTRS11 data set. Furthermore, most of the design discussions were approached by the designers as problem situations and were approached in a backwards manner, where the value to create was known; however, the designers were using available cultural knowledge to figure out the unknown *what* (products/services) and *how* (working principles of why something would work or not work). In conclusion, the paper demonstrates a novel approach to understand how design thinking can be efficiently understood as a culturally situated practice.

Keywords: culture, cognition, design-thinking, abduction, creativity

1 Introduction

In this paper we explore assumptions about 'core design thinking and its application' as outlined by (Dorst, 2011). We do this with a focus on how cultural contexts shape design thinking (Clemmensen, 2009; Hong & Mallorie, 2004). Our contribution is towards a dynamic and situation specific analysis and model of how cultural contexts shape the unfolding of design thinking, exemplified with data from the DTRS11 data set.

Dorst's core design thinking 'equations' help formulating a clear and easy to follow analytical scheme, and they provide an overview of how thought processes can lead to innovation and "outside the box" thinking. However, as Dorst himself acknowledges, his approach is problematic, as design thinking cherishes multiple perspective and rich articulations over simplification. In line with Kimbell (2011), we argue that a significant flaw in much thinking about design thinking is the oversimplification of the creative thought processes to be unaffected by cultural contexts. Kimbell's paper on "Rethinking Design Thinking" emphasizes cultural components and external factors, which are hard to simplify without losing their meaning and therefore credibility.

Our preliminary findings on how cultural context influence design thinking may hold significant promise to inform the DTRS11 community. An appropriate way of analyzing this is by going beyond the lens of our initial predefined code book based on Dorst's core design thinking equations, and focus exactly on how culture play parts in the present data. This includes analysis of stereotypes, and the role of the facilitators (who are different in cultural background from the western designers).

Our choice of theory for analyzing how the cultural contexts shape design thinking is the dynamic and situational social-cognitive theory of culture (Hong & Mallorie, 2004), which has been adapted to IT design (Clemmensen, 2009; Pineda, 2014). This theory suggests that people can have more than one (and sometimes conflicting) loose networks of domain-specific cognitive structures (implicit theories, beliefs) at a time. Which one of these is activated depends on what situational constraints are salient. Thus, the situation will determine which cultural cognitive system is *accessible, available and applicable* in the given situation. A Chinese-European will tend to think like a Chinese person when in a 'Chinese situation', and reversely, think like a European when primed by European icons, text, etc. The dynamic and situational social cognitive theory of culture is highly relevant in an analysis of the DTRS11 data, as it may be used to understand for example the group of Western designers' available cultural knowledge (including their stereotypes of customers/users and Eastern facilitators), the priming of their thinking by the design artefacts and material, and what is socially appropriate to say and do in the different design situations.

In the rest of the paper, we present the theory, method, findings and discussion of our analysis of two of the design videos from the DTRS11 data set. We use qualitative analysis informed by our reading of Dorst (2011) for core design thinking, and Clemmensen (2009) and Hong & Mallorie, (2004) for exploring the dynamic and situation specific application of knowledge in design by various participants. We analyze examples of core design thinking in relation to specific cultural aspects of the situation and the designers' cultural background. We propose an initial framework for exploring how culture shapes design thinking in dynamic and situation specific ways.

2 Theory

2.1 Dorst's core design thinking

Dorst (2011) suggests that in order to describe and understand design thinking in its many variations, it may be useful to attempt a high level simple or 'sparse' description of design thinking. Though rich descriptions are important, as design unfolds in a dense context, we may learn something from thinking about basic reasoning patterns that humans use in problem solving in design, or what Dorst calls core design reasoning patterns. In particular, we may learn something from comparing different settings of the knowns and unknowns in design patterns and the ways designers reason about these. These are what Dorst refer to as design thinking 'equations'.

Dorst argues that the most important or core design reasoning pattern is *abduction*. This is what signifies design thinking or productive thinking. It is different from classic problem solving in that the outcome is value rather than results (e.g., 'truth') of a mainly deductive or inductive analytical process. Dorst (2011) suggests two equations for abduction. The first kind of abduction is closed problem solving, *abduction 1*, where the designers does not know what thing or design artefact or service that they are discussing, but does know the working principle that will help achieve the aspired value. According to Dorst this is a common way of working for professional designers.

The second kind of abduction is open problem solving, *abduction 2*, where the designer neither knows the thing to be designed or the working principle, but only the aspired end value. Dorst argues that this is what designers do when they do conceptual design, e.g., when there is no familiar working principle or design method that can be guide the design. In such situations, the designer has two unknowns in the equation, which is a different situation from the everyday routine closed problem solving in abduction 1. In this second type of abduction, 'framing' can be used. Framing applies analogies from other design thinking scenarios with similar aspired end value to the problem at hand, in order to identify the working principle and thing to design in current design scenario.

Dorst points out that even though design thinking may be described as abductive reasoning, it is a mix of different ways of thinking, as designers use a lot of inductive and deductive reasoning to come up with, and rigorously test and evaluate ideas to assess whether a proposed design solution will work.

2.2 The dynamic constructivist theory of culture

The dynamic constructivist theory of culture is different from an essentialist view of culture. It does not see culture as a holistic entity, but rather as a set of loose and developing knowledge networks or domain-specific cognitive structures including theories and beliefs. Hong & Mallorie (2004) argues that domain and situations interact with more essentialist aspects of culture. People may hold more than one cultural meaning system, even if such systems may contain conflicting cultural knowledge, e.g. conflicting cultural models of how to use design products (Clemmensen, 2009). In any given situation, the individual uses the knowledge that is most accessible. Hence the accessibility, availability and applicability of particular cultural models of technology use will determine the experience of using the product. The concepts of accessibility, availability, and applicability are taken from the theory of knowledge activation, which underscores that cultural knowledge must be activated by something in order to be used. Hong, Benet-Martinez, Chiu, & Morris (2003) argue that acculturation can make specific cultural knowledge systems become available. Furthermore, prolonged exposure to a culture may increase the chronic accessibility of the shared knowledge in that culture (Hong, et al., 2003). The accessibility of each cultural knowledge system may thus vary as a function of situation. Applicability, also sometimes referred to as appropriateness, has to do with the feasibility of acting out or focusing on specific culture-related behaviours in a given social situation. This again depends on whom you are with, what they know, and what norms for behavior are present.

3 Method

We analyzed two videos from the DTRS11 dataset (Christensen & Abildgaard, 2016), using qualitative analysis informed by our reading of Dorst (2011) for core design thinking, and (Clemmensen, 2009; Hong & Mallorie, 2004) for exploring the dynamic and situation specific application of knowledge in design by various participants. We could not analyze the videos of actual co-creation workshops that took place in China with Chinese users because of our lack of understanding of the Chinese language. Hence, we investigated the debriefing sessions that took place immediately after each of the co-creation workshops, depicted in Fig. 1. These were V07: Debrief of co-creation workshop day 1 (CC1), and V14: Debrief of co-creation workshop day 2 (CC2).

The debriefing phases in V07 and V14 are critical to the whole design process because this is where the designers empathize with the actual Chinese user. Based on the insights generated in the collaboration with the users, the designer defines the problem statement, and a guiding statement that focuses on insights and needs of a particular user, or composite character developed in interaction with the user. In this phase all the varied findings about individual users are put together and evaluated in light of the design themes (i.e., health, environment, self-reliance etc.) defined in Phase one of the design process.

Figure 1 demonstrates the interaction among the three main groups that participated in the co-creation workshops, Scandinavian designers, Asian consultants and the Chinese users. The overlapping areas in the Venn diagram Figure 1 depict the cross-cultural interactions between the designers and the consultants, and the Chinese users and the consultants. When the Asian consultants were moderating the co-creation workshops and actively interacting with the Chinese users, the Scandinavian designers were only making observations and had no active interaction with the users due to lack of understanding of the Chinese language. After each workshop there was a debriefing session where the Asian consultants debriefed the Scandinavian designers about the workshops in English.

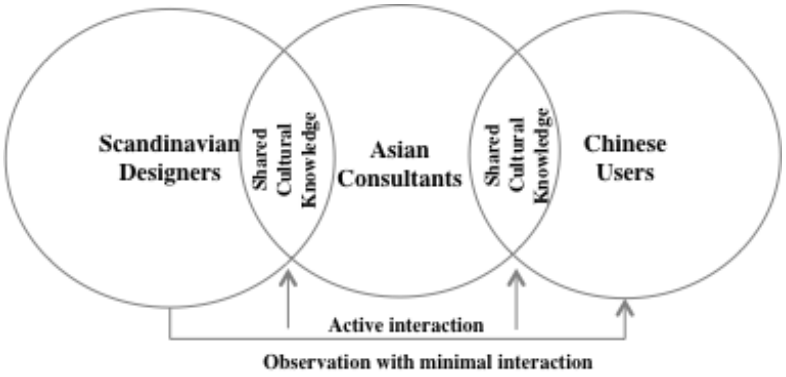

Figure 1: Shared cultural knowledge in the co-creation and debriefing workshops.

3.1 Participants

Two cultural groups were present in the videos we analyzed: Asian consultants and Scandinavian design team members. Out of the five Scandinavian design team members, two were external stakeholders who were not as actively involved in the above videos as the three core designers. These stakeholders participated in one of the co-creation workshops. The core design team consisting of three designers had been working in the same department the last four years. The three normally worked together on different design projects and knew each other well.

The three Asian consultants had expertise in Chinese markets. They were not part of the whole design process, but became part of the project during the field trip to China. They participated in the meetings on equal terms as the design team members. They were familiar with design thinking approaches and they aided in the translation of Chinese to English, as well the translation of cultural diversities and traditions. Two of the consultants were also moderators for the two co-creation workshops.

3.2 Material and procedure

The analysis focused on the discussions among the designers, stakeholders and consultants, in the debriefing meetings CC1 and CC2, held after each of the co-creation workshops.

Table 1. The 16 episodes analyzed.

Videos	Duration	Content	The 16 episodes
V7: CC1 debrief co-creation	18 mins	Sharing observations, translating and explaining the different post-it clusters that were written and put on one of the walls by the workshop participants as well as the moderators. Explaining some of the participants' characteristics and statements, trying to draw insights about how the participants conceive of leisure time, family relations, and general ideas about the theme of "Health" and "Good life".	1. V7, 009 - 015 2. V7, 021 - 035 3. V7, 038 - 051 4. V7, 055 - 080 5. V7, 096 - 119 6. V7, 140 - 158
V14: CC2 debrief co-creation	78 mins	Sharing and discussing observations and notes with each other from the workshop, and slowly beginning to connect some of the insights to the overall design project themes and concepts.	7. V14, 056 - 071 8. V14, 072 - 085 9. V14, 093 - 112 10. V14, 128 - 140 11. V14, 143 - 151 12. V14, 232 - 246 13. V14, 273 - 304 14. V14, 314 - 328 15. V14, 420 - 440 16. V14, 683 - 692

In these two videos the Asian consultants, Scandinavian designers and Scandinavian stakeholders shared observations and notes from the co-creation workshops, by doing activities such as brainstorming, problem solving, re-interpreting the personas of the Chinese users, and evaluating user responses to the questions based on overall project themes and concepts. Given the collaborative nature of these meetings, the designers and consultants were constantly talking aloud, thereby providing a rich, ongoing, external record of their thinking and reasoning. We selected 16 episodes each of 2-10 minutes for our analysis, see Table 1. The criterion for selecting the episodes was to have the two cultural groups actively participating in the discussion.

3.3 Coding/analysis

All the selected episodes were coded for Dorst equations. The coding was based on Dorst' model of design thinking: WHAT (thing) + HOW (working principles) leads to RESULT (observed). Table 2 shows the equations proposed by Dorst (2011), which we used in our analysis of the design thinking process.

Table 2. Dorst (2011) equations.

Type of design reasoning	Dorst equation
Induction	WHAT + ??? leads to RESULTS
Deduction	WHAT + HOW leads to ???
Abduction 1 (Closed problem solving)	??? + HOW leads to VALUE

Abduction 2 (Open problem solving)	??? + ??? leads to VALUE
Framing	WHAT + HOW leads to VALUE FRAME

In a second part of the analysis we applied a framework from a dynamic constructivist approach to the study of culture (Hong & Mallorie, 2004). For each identified design thinking method (i.e., induction, deduction, abduction) we further analyzed whether the participants were having cultural knowledge available, whether they were making it accessible, and if it was appropriate in present cultural and design context. We call this the triple A: Availability, Accessibility, and Applicability, see table 3.

Table 3. The triple A of a dynamic, situation specific concept of culture. Adapted from Hong and Mallorie, 2004; Clemmensen, 2009.

Triple A	Definition
Availability	Existence of cultural knowledge structures (i.e., including stereotypes of customers/users and Eastern facilitators)
Accessibility	Getting primed to access the cultural knowledge structures
Applicability/Appropriateness	Appropriateness and/or feasibility of culture-related behaviors in situational context (i.e., in context of setting design goals)

4 Results

4.1 Overall results

Overall, our qualitative analysis of the 16 episodes indicated that abduction characterizes the design thinking process. A combination of inductive and deductive thought processes was incorporated as part of the abductive thinking process. Abductive thinking was heavily shaped by cultural knowledge. In figure 2, we show how culture, either as cultural knowledge shared by the whole cross-cultural team or group specific cultural knowledge, shaped the Dorst problem solving methods in design thinking across the 16 episodes.

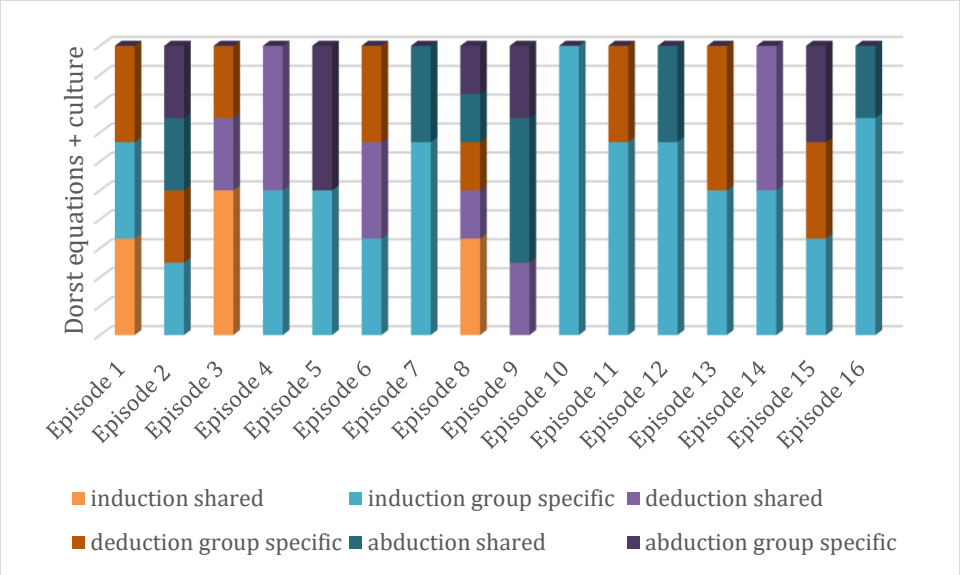

Figure 2: Distribution of group specific and shared cultural knowledge across 16 episodes of design thinking.

As illustrated by figure 2, cultural differences appeared and disappeared during the debriefing sessions, depending on the accessibility, availability and applicability of cultural knowledge of the team members. In all the 16 episodes there was active participation of the two cultural groups (i.e., Asian and Scandinavian). Below we present results from the in-depth analysis of two of these episodes (no 1 and 9) to illustrate how cultural knowledge shapes induction/deduction and abduction.

4.2 How cultural knowledge shapes deduction and induction

To illustrate how deductive and inductive design thinking is shaped by cultural knowledge, we analyzed episode 1 from CC1 (V7, 09-15), see appendix 7.1 for the full transcript.

4.2.1 How deduction is shaped by available cultural knowledge

In episode 1, the Asian consultant W uses his *available* cultural knowledge to deduce that the Chinese user's behavioral data suggests that he lives a healthy life in the traditional Chinese way. This kind of thinking process is deductive as W is drawing conclusion about the user's personality based on the marketing data and the behavioral characteristics of a typical Chinese user:

So, eh, I think there was one guy who, the younger guy, who I think leads a slightly more disciplined life, I mean like, he's not married, he's not, you know, has his own family and whatever. He talks about things like sleeping early, going to bed by ten, waking up really early by six, you know, because your body starts to detox at eleven a clock. [V07, 09]

The Dorst equation for deduction is WHAT+HOW=??? (Dorst, 2011). To fill in the equation, the WHAT and the HOW is the data about the user (WHAT) and the Chinese cultural stereotype (HOW), and these together leads W to formulate hitherto unknown (part '???' of the Dorst equation), the design team's aspired value of what is a healthy user. Dorst (2011) points out that deductive reasoning is a gold standard of reasoning for scientific discovery, and that even in design

rigorous deductive reasoning is necessary to inform justification of the value to be created by the designer.

However, the content of the Dorst equation for deduction in this example is shaped by what cultural knowledge is available to those doing the deduction. Hong, Benet-Martinez, Chiu, & Morris (2003) argues that what makes cultural knowledge available is acculturation, and we know that W has been hired as a cultural expert on China, so he is well acculturated and has this knowledge available.

4.2.2 How deduction is shaped by accessible cultural knowledge

W may very easily come to think about Chinese medicine in the situation, because prolonged exposure to a culture, i.e., acculturation, increases the chronic *accessibility* of the shared knowledge in the culture (Hong, et al., 2003). In addition, the available knowledge becomes *accessible* to W because he has been primed by the team's ongoing discussion about the design theme 'health' and Chinese users.

W makes this cultural knowledge *accessible* to his Asian and Scandinavian team members by repeating the deduction that the user sleeps early and gets up early (WHAT), this demonstrates the aspect of traditional Chinese medicine in the user's life (HOW), as the user is letting his body detox at night while sleeping, the magic, (the unknown ??? aspired health behavior).

That's actually a little bit of eh: (.) traditional Chinese medicine, that's part of the concept. Your body starts to work itself eh actually: from that time which is eleven at night, your body should start resting before that, so you need to go to bed before that, so that, you know, it can work its magic. [V7, 011]

W is a bicultural individual who has been exposed to two cultural meaning systems, Asian and Western. Such individuals may provide particularly clear demonstrations of the interaction between availability and accessibility (Hong & Mallorie, 2004). The accessibility of each knowledge system appears to vary as a function of situation. In the above example, W has the cultural knowledge available (Chinese culture) and he makes it accessible because the situation (design discussion about concept of health for Chinese users) primes him to discuss the user behavior and its meaning in the Chinese cultural context. Hence, he makes the purely Chinese culture specific knowledge about 'Chinese medicine' accessible to the team members. The deduction process will be meaningless without the cultural knowledge being available and accessible.

4.2.3 How deduction is shaped by appropriate cultural knowledge

To make the cultural knowledge *appropriate* to the design context, W makes shared cultural knowledge *available* and *accessible* by using deduction to explain to the Scandinavian team members that if one was in a western context one would sleep at twelve or one, but within a Chinese context going to bed before the magic hour of detox is essential (WHAT), and, since the user is traditional (and follows the Chinese medicine concept) (HOW), the concept of being disciplined appears to be an *appropriate* way to think about a health and relaxation in life (the unknown ???).

So people like us who sleep at twelve. Sleep at one, you have really bypassed that magic hour of where we can actually get that. So…[V7, 013]

Hong (2004) explains that applicability or *appropriateness* refers to the feasibility of culture-related behaviors in context; the expression of appropriate cultural knowledge in a situation is influenced by the cultural knowledge systems held by partners in the social interaction, the nature of the interpersonal situation, and general behavioral applicability, and more. W is in a situation where most of the others in the design team do not have any Chinese cultural knowledge systems available so he discusses relaxation/health in a Western context to further explain what the concept of 'Chinese medicine' means and signifies in life of a traditional Chinese person. The design team is cross-cultural, so W uses shared cultural knowledge about young people in the West staying up late and AM mentions the trend of partying as an example of relaxation in Western context to make an analogy to 'Chinese medicine': had the user been a young person like the design team members, the user would have been partying after midnight. Furthermore, W is hired as a consultant, so he needs to be polite, and cannot really say more about the partying behavior, so he ends without finishing the sentence, leaving further interpretation open. In this way, W is repeating his deduction, but from a Western perspective, and by letting cultural knowledge shape the content, W makes the deduction *appropriate* for design thinking in the situation.

4.2.4 How induction is shaped by cultural knowledge

This is followed by an induction process, in which the Asian consultant AM supports W in making the Chinese medicine concept *appropriate* to use. The Dorst equation is WHAT + ??? = RESULT. AM introduces partying late at night as something which is also relaxing and something which western people do (WHAT), but traditional Chinese people will not do and traditional Chinese person cannot relate to partying (???), when talking about health and relaxation (RESULT).

But that's interesting here, since how about partying? But I think it kind of (INAUDIBLE), because the other people couldn't relate it with, and they felt that (INAUDIBLE) (.) [V7, 014]

Towards the end of the episode W performs inductive reasoning about the user behavior to conclude that the user does appear to be aligning to the cultural stereotype of traditional introvert Chinese male [and not aligning to the party going young male in Scandinavia or China]

Yeah. But I also suspect given my - my reading of him, I don't think he's very hard core in partying… [V7, 015].

W suggests that since the user is following traditional Chinese medicine for health and wellbeing (WHAT), he must be an introvert (???), because he appears to be a person who would fit the stereotype, hence he would not enjoy partying as a way to relax (RESULT). A dynamic-situationist cultural theory interpretation could be that of a kind of negotiation situation (Morris & Gelfand, 2004); what W is doing could be that he is trying to keep the Chinese cultural knowledge now *available* to the design team highly *accessible* to the designers by using himself as a role model in the design work, and *appropriate* by using the analogy to partying again.

4.2.5 Summary

In sum, both deduction and induction are shaped by the availability, accessibility and applicability of cultural knowledge in this episode. The content of a Dorst equation for deduction in this example is shaped by what cultural knowledge is available to those doing the deduction, primarily W, who is the Asian culture expert and has this knowledge easily accessible. However, in the situation W needs to repeat and explain his deduction by making cultural knowledge accessible to the Scandinavian design team members, and make it appropriate to use in the design context by using

shared cultural knowledge about young people in the West. The content of a Dorst equation for induction is similarly shaped by cultural knowledge about both WHAT they are talking about and the end RESULT of the design thinking about health/relaxation.

4.3 How cultural knowledge shapes abduction and framing

To illustrate how abductive design thinking is shaped by cultural knowledge, we analyze episode 9 from CC2 (V14, 093-112), see appendix 7.2 for the full transcript.

In this episode, the team leader E asks a question to the team with an assumption in his mind and then he *frames* it by reference to an Apple Store example.

093	*E*	*Mmm, and eh, why, do you think it was important to touch the product?*
094	*N*	*Eh, because she also said she wouldn't invest in something like she wouldn't believe. So, she wanted to like, try it out, because that's what - was something like with eh, with the price, like if I don't know, if I'm not like sure, like i wouldn't trust it, so I wouldn't invest too much money in it.*
095	*E*	*Mmm, is it trust of quality or trust in they needed it?*
096	*N*	*The (.) quality*
097	*A*	*Yeah*
098	*K*	*I think it's kind of an idea one of the guys refers to Apple stores, they get kind of this experience that they are (INAUDIBLE) as you get.*
099	*E*	*But it had- did it have to do with trust, or did it like - I might- this is my crazy assumption, but I assume that people trust Apple, but they still go to the store, it has nothing to with trust, it has to do with I wanna be part of it, I wanna aspire to this culture, hang out.*
100	*A*	*But that was exactly what they said*
101	*E*	*Yeah*

This is an example of *abduction with framing*. It is problem solving, as the team members are trying to identify whether the product or the corporate culture is the more important for the design. E asks a question with an assumption in his mind – that physically touching a product has nothing to do with trusting a company - and he explains his assumption by framing the problem as what actions people take in an Apple Store.

In terms of Dorst's equations, the design team is using *abduction 2 with framing* to build a need for a yet unknown product (WHAT is unknown) by using an analogy to what works (HOW is unknown) and framing is used to see whether touching the product or knowing about the company culture in an Apple Store is necessary (VALUE: Trust). However, the analogy itself requires cultural knowledge about the Chinese context to be made available, accessible, and appropriate.

4.3.1 Cultural knowledge comes into play in framing

All the team members based on the *availability* of their cultural knowledge explore the probable reasons if it is important to touch the product or it is the company that bears the trust. Inductive thinking comes into play, while hypothesizing various reasons behind why users would like to touch the product.

One of the Scandinavian team members, A, does not share with E the cultural knowledge – E's "crazy assumption" - that people trust the company, not the products. A reverts to the *available* knowledge about the users that is shared by all in the design team, and try to use inductive reasoning to argue that the FRAMING suggests that the working principle in the Apple Store is knowledge and experience that builds the VALUE of trust.

102 *A* *About they actually wanted to go and see what it was all about*

103 *E* *Yeah*

104 *A* *Because no one knew them, knew their product*

As it happens, A's inductive reasoning about the actual users is supported by strong deductive thinking by the Asian consultant AM, who makes her *available* cultural knowledge about 'lack of trust for the products in china' *accessible* to everyone, by telling that people (WHAT) want to touch the product for knowledge, to know whether it is authentic and to not just trust the second hand knowledge (WORKING PRINCIPLE) and this should be the basis for thinking about what VALUE that can be achieved in an Apple Store in China.

106 *AM* *I think, knowledge, right? You go there, you see, you experience it. You know and you're authentic of knowing rather then just second hand information.*

E makes his cultural knowledge about Apple Stores in the West *accessible* to all by stating that there is not much information about the company at an Apple store, it is mainly the products, and still people trust the brand, suggesting that the FRAMING does define the WORKING PRINCIPLE in an Apple Store as building trust in the company which leads to the VALUE of trust in general.

107 *E* *And I think that is fantastic thing about the Apple store. There is nothing else there, there's photos of products and products. That's it. There's (INAUDIBLE), just a little text, no nothing, maybe just a little price, or whatever.*

Then A induces from the data, another idea about the WORKING principle in an Apple Store, and tells that one of the users actually mentioned that company culture of Apple leads to the liking for the brand.

108 *A* *And our:- one guy in our group also mentioned about the culture, how the Apple and the culture and what they do, influence them liking the brand.*

Then E uses deduction based on another Chinese user (WHAT) who commented on the open and approachable culture of the company Panasonic (HOW) to argue that this is part of 'building the product' – and A agrees that the Apple store as a place for building trust in corporate culture is an *appropriate* framing. They kind of agree that corporate culture is important in one way or another.

109 *E* *Mmm (.) Yeah, and I think that is also, so: good for us, as THE COMPANY, that it actually has an impact to that. The corporate culture will actually be part of, you know, building the product.*

110 *A* *And what parts of the culture?*

111 *E* *So the- so the:- In our group they- yeah, in our group they mentioned openness, for example, and they used an example from- from Panasonic. At Panasonic, even the low level assembly dudes can write a message to the CEO and say, I think this is (INAUDIBLE), approachable. So it means that, you know-*

112 A They take care of their own

The slight disagreement between W and A is perhaps an interesting feature of open problem solving such as abduction 2; though the *available* knowledge about the culture may be quite similar among same culture designers, slight changes in priming in the situation may lead to differences in what knowledge becomes *accessible* and is deemed *appropriate*. A is primed by the data about users, but when it comes to the social situation W's deduction is perhaps more convincing to A than AM's deduction, because W and A share the cultural knowledge about Apple Stores in the west, and have little cultural knowledge about what it means to be in an Apple Store in China.

This is a good example of abduction; they know the value to create in the market (improved quality of life), however the product/service and the working principles are not known, it is very open-ended, a complex problem solving. However, by framing the problem in culturally underspecified context; making it unclear if the Apple store was in the West or in the East, the designers had to make their available knowledge accessible to the team in order to close in on the abduction.

4.4 The situational and dynamic aspect of cultural knowledge in the design process

The dynamic constructivist and situation specific theory of culture argues that culture can be understood as knowledge networks that are activated in different ways, depending on the situation. To illustrate how cultural dynamically and situation specifically shapes design thinking, we have illustrated knowledge similarities in episode 5 (V7, 096 - 119) from the CC1 debriefing workshop, see figure 3.

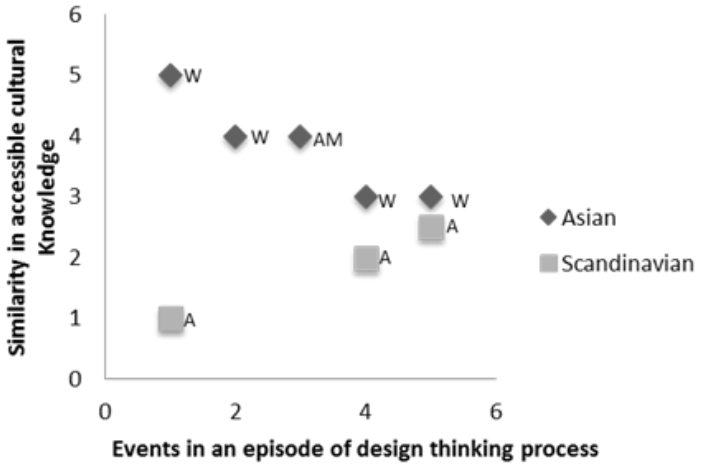

Figure 3: Culture x Situation dynamic interaction in an episode of design thinking (V7, 096 - 119). W: male Asian consultant, AM: female Asian consultant, A: female Scandinavian designer. See Table 4 for a detailed explanation of each event.

Figure 3 illustrates how the accessible cultural knowledge in two cultural groups in the design team, the Asian and the Scandinavian, varies across a series of events 1-5. Initially the knowledge systems diverge, but towards the end of the discussion topic, they converge, and the team reaches a conclusion. The point is that ethnic culture is not an essential feature of Asians or Scandinavians, but knowledge systems that are available, accessible and applicable, depending on how the situation or event shapes the design thinking.

In table 4 we explain each event depicted in figure 3, with a focus on the accessibility of the knowledge. Each row in the below table discussed the culturally *accessible* knowledge of the team members.

Table 4: Explanation of the Culture x Situation dynamic interaction illustrated in Figure 3

Events	Design thinking
1	In this episode **W** *accessing* his *available* cultural knowledge about China is describing the commonality of fake products to the team members, he mentions that, in China, people have a hard time trusting the products because cases of forged or dangerous products (e.g., chicken, soy or eggs).
1b	**A**, the Scandinavian designer mentions that she did not have this particular cultural knowledge *available* and hence she was surprised to see Chinese people voicing their concern about the different products and their sources in the co-creation workshop.
2	**W** makes the shared cultural knowledge more *appropriate* for the Scandinavian team members by suggesting that in the West the issue is to choose the healthy food among the available options, whereas in China the challenge is to find real (and safe) food because chances that something will be fake or unsafe are higher.
3	**AM**, the other Asian consultant, shares the cultural knowledge and agrees with W. Amanda further makes her *available* cultural knowledge *accessible* and *appropriate* by using an example of the user needs and aligns it to one of the design goals (i.e., environment). She mentions that food is an everyday product that one could choose to buy from a place you like. However, air pollution is not a matter of choice as we cannot choose not to breathe
4a	**A**, the Scandinavian designer brings in her cultural perspective to the table, arguing that knowing a brand for a long time is good and that one would tend to trust something you always buy and have some knowledge about.
4b	However, **W** makes his *available* cultural knowledge accessible when primed by the discussion about the long history of the brand. He mentions that in China it's quite opposite as people don't necessarily trust reputable brands, since people with knowledge of the brand might suggest that a product is not safe and people will easily loose trust. W suggests that generally "there is a lot of mistrust of government, of brands, producers especially when it comes to food". W uses inductive thinking to hypothesize based on his cultural knowledge that health is a complex issue and not strictly limited to food in China. A bigger concern is the environment in general.
5a	**A** brings in her shared knowledge of the Chinese culture to suggest that in China she knows that people do not trust car dealership that they have heard rumors about. She hypothesizes by using inductive thinking and suggests that it is trust is easier to obtain in a situation where you can try out a product since people can see that the product is real and not fake.
5b	**W** adds his cultural perspective to A's example and suggests that it is not about just trust but also about the health and environment because if a person gets cheated it hurts his belief about society and people in general, and that this affects his overall well-being. All the team member converge on this conclusion.

The episode depicted in figure 3 and table 4 illustrates how the design thinking process is shaped by the appearance and disappearance of cultural differences within the cross-cultural design team. At the end the two cultures are more in agreement, they share the cultural knowledge, whereas at the beginning of the process their views seem to be more divergent. Overall the episode is a good example of abduction because the value 'well-being/health' is known however the designer are discussing to figure out the unknown what (products/services) and how (working principles of why something would work or not work) in the Abduction equation.

5 Discussion

The results indicate how cultural knowledge shapes design thinking within the design team, i.e., the three Scandinavian designers, the three Asian consultants and the two Scandinavian stakeholders. The core design thinking methods of induction, deduction and abduction were

affected by the appearance and disappearance of cultural differences among the team members. Our results are in line with previous studies showing that the interaction between accessibility and appropriateness is directed based on who the person is interacting with in in-group members (same culture) or out-group members (different culture) and may also be primed by cultural stereotypes (Wong & Hong, 2003; Hong, 2000). Design thinking is a sought after problem-solving approach. It uses special methods and tools and is shaped amidst unique mindsets of the designers and users. It is often stated that it is important to listen to the users but more important is to observe the behavior and perceive what users might not be able to tell you (Brown, 2009). However, it is very important to take into account that the perceptions of designers and consultants are often biased by their own cultural beliefs and thoughts.

5.1 Capturing situation specific cultural design thinking

We have argued that culture shapes design thinking, at least as design thinking has been formulated by Dorst (2011). In figure 3 above, we illustrate the dynamic and situation specific nature of how cultural knowledge shapes design thinking within a single episode. The similarity in the cultural knowledge of the team members varies through the discussion in the particular episode, i.e., either the cultural knowledge accessed by the team member is shared by both the cultural groups, or the knowledge is specific to the cultural group of the member sharing the knowledge. For future research, we suggest to look at a whole design project, by applying a similar framework. Our idea is to obtain average ratings of similarity in group knowledge about the currently discussed topic, and obtain these ratings for individual episodes along the whole design thinking process. The ratings of similarity can be obtained by accessing the available and accessible knowledge structures of the team members in each situation/episode and rate them for similarity (i.e., how similar they are to each other). Note that we suggest that the analysis should mainly be based on what cultural knowledge is made accessible, since this can be observed from design work videos such as the DTRS11 videos. Available knowledge, on the other hand, is in the head and hence hard to see in transcripts or videos or observations, and would require other methods like thinking loud or interviewing. Applicable (appropriate) knowledge is also not of much interest in this context, because when designer decide what cultural knowledge is appropriate to apply in the given social situation, their cultural knowledge systems have in many cases already been closely aligned based on design goals. Overall, we believe that examining the variations in activated cultural knowledge across the complete design process will provide insights about design thinking process in general. Further research may consider how situational differences in accessibility might lead to frame-switching, which means understanding the problem with a new perspective and sometimes also to bring in the whole team on the same page by making the point using an example in different context. Another interesting topic is to go into differences in situational applicability of creative design ideas and how these may lead to ‘‘culture sampling: the conscious or unconscious selection of cultural normative behaviors that are most appropriate in a given social situation.” (Hong & Mallorie, 2004). To understand how cultural knowledge is activated, researchers must go beyond participants’ nationality or similar salient cultural features and know much about the situation.

5.2 Future Research

Ranging from pen and paper to sophisticated design software and full prototypes in a variety of materials, the work of design can be defined partly as an ongoing manipulation and arrangement of material artefacts. In the study of co-design situations it might therefore be useful to study in detail how materials, what Eriksen (2009) terms ‘micro-materials’, shape and choreograph design

practices in a cross-cultural setting. Based on the cultural contextualization in this paper, we suggest that an in depth examination of the material performance of design thinking can be set in relation to the cultural constraints around communication and cognitive frames. Thus we might consider material performances in design as part of cultural knowledge activation. This can further be assessed in relation to the kinds of reasoning in design processes by attending to possible temporal or turn-taking relations between manipulating materials and abductive reasoning.

5.3 Limitations and Scope

Our research has some limitations. First, Dorst mentions the core design reasoning patterns such as abduction to be applicable to the whole design thinking process. However, in our analysis we found that it was possible to identify core patters even in subsections that are parts of the overall design thinking process. Second, our access to the design thinking process was limited by the pre-selected video recordings provided in the DTRS11 data set. For future studies our suggestion is to incorporate data not just from one design team, but several design teams to comprehensively study how cultural knowledge shapes design thinking.

6 Conclusion

Our analysis indicates that core design thinking methods of induction, deduction and abduction are affected by the ongoing appearance and disappearance of cultural difference among design team members. The present paper highlights the need for further research on the interaction between culture and creative problem solving methods in design thinking. The current paper presents a novel approach to the understanding of design thinking in the context of culture. To our knowledge this is the first time Dorst equations have been studied in a cultural context of design thinking processes. Our research findings thus serve as starting point for further research that explores and analyze cultural aspects of design thinking process.

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Appendix A

7.1 CC1 episode 1, (Video 7, segment 009-015)

009	*W*	*So, eh, I think there was one guy who, the younger guy, who I think leads a slightly more disciplined life, I mean like, he's not married, he's not, you know, has his own family and whatever. He talks about things like sleeping early:, going to bed by ten:, waking up really early by six:, you know, because your body starts to detox at eleven a clock.*
010	*A*	*Yeah.*
011	*W*	*That's actually a little bit of eh: (.) traditional Chinese medicine, that's part of the concept. Your body starts to work itself eh actually: from that time which is eleven at night, your body should start resting before that, so you need to go to bed before that, so that, you know, it can work its magic.*
012	*A*	*Mhm.*
013	*W*	*So people like us who sleep at twelve:, sleep at one, you have really bypassed that magic hour of where we can actually get that. So-*
014	*AM*	*But that's interesting here, since how about partying? But I think it kind of (INAUDIBLE), because the other people couldn't relate it with, and they felt that (INAUDIBLE) (.)*
015	*W*	*Yeah. But I also suspect given my- my reading of him, I don't think he's very hard core in partying.*

7.2 CC2 episode 9, China, Co-creation room (Video 14, segment 093-112).

093	*E*	*Mmm, and eh: why: do you think it was important to touch the product?*
094	*N*	*Eh: because she also said she wouldn't invest in something like she wouldn't believe. So: she wanted to like, try it out, because that's what- was something like with eh: with the price, like if I don't know:, if I'm not like sure, like i wouldn't trust it, so I wouldn't invest too much money in it.*
095	*E*	*Mmm, is it trust of quality or trust in they needed it?*
096	*N*	*The (.) quality*
097	*A*	*Yeah*
098	*K*	*I think it's kind of an idea one of the guys refers to Apple stores, they get kind of this experience that they are (INAUDIBLE) as you get.*
099	*E*	*But it had- did it have to do with trust, or did it like- I might- this is my crazy assumption, but I assume that people trust Apple, but they still go to the store, it has nothing to with trust, it has to do with I wanna be part of it, I wanna aspire to this culture, hang out.*
100	*A*	*But that was exactly what they said*
101	*E*	*Yeah*
102	*A*	*About they actually wanted to go and see what it was all about*
103	*E*	*Yeah*
104	*A*	*Because no one knew them, knew their product*
105	*E*	*So it was about excitement*
106	*AM*	*I think, knowledge, right? You go there, you seee, you experience it. You know and you're authentic of knowing rather then just second hand information.*
107	*E*	*And I think that is fantastic thing about the Apple store. There is nothing else there, there's photos of products and products. That's it. There's (INAUDIBLE), just a little text, no nothing, maybe just a little price, or whatever.*
108	*A*	*And our:- one guy in our group also mentioned about the culture, how the Apple and the culture and what they do, influence them liking the brand.*
109	*E*	*Mmm (.) Yeah, and I think that is also, so: good for us, as THE COMPANY, that it actually has an impact to that. The corporate culture will actually be part of, you know, building the product.*
110	*A*	*And what parts of the culture?*
111	*E*	*So the- so the:- In our group they- yeah, in our group they mentioned openess, for example, and they used an example from- from Panasonic. At Panasonic, even the low level assembly dudes can write a message to the CEO and say, I think this is (INAUDIBLE), approachable. So it means that, you know-*