THE 5C MODEL

Silje Alberthe Kamille Friis[1], and Anne Katrine G. Gelting[2]

[1]Teko Design & Business, VIA University College, Herning, Denmark, sakf@gmail.com;
[2]KEA, Copenhagen School of Design and Technology, Copenhagen, Denmark, ankg@kea.dk

ABSTRACT

During a design process, designers produce knowledge in many ways. An ever-expanding field, design continuously includes new approaches from other fields such as anthropology, business, and innovation, which are implemented side by side with traditional design approaches e.g. prototyping, and sketching. As teachers of philosophy of science and design methods at a design school, we are invested in the following question: *How might we expand design students' understanding of the many ways in which knowledge is produced during a design process? How can we help students actively experience the approaches and reach a new level of conscious action when designing?* Informed by theories of design thinking, knowledge production, and learning, we have developed a model, the 5C model, accompanied by 62 method cards. Examples of how the model has been applied in an educational setting are provided, explaining how and why the model and method cards work in practice.

Keywords: knowledge production in design, design methods, design education

1. INTRODUCTION

1.1 DESIGNING AS A MEETING PLACE

In 1969 Simon proposes that the science of design can form a fundamental meeting place, a common ground of intellectual endeavor and communication across the arts, sciences and technology. Engineers and composers, who cannot benefit from talking about the content of each other's work, can share their experience in the creative, professional design process (Cross 2001). Within the last two decades Simon's proposition appears to be verified by an array of new, multidisciplinary approaches to complex problem solving within the field of design. Under headers such as 'design thinking' and 'strategic design' practitioners and researchers advocate design as a way for dealing with complex problems within diverse fields such as business, the environment, and health care (Dorst 2011; Curedale 2013).

In this paper we present a theoretical framework for understanding the different ways in which designers produce knowledge in design work. Based on existing theory addressing the *type* and *orientation* of knowledge production we have developed the 5C Model, which is particularly well suited for what Curedale (2013) in reference to design thinking defines as *"[…] a people centered way of solving difficult problems. It follows a collaborative, team based cross disciplinary process"*.

The model is accompanied by 62 method cards, which exemplify five categories of knowledge production. The methods and tools derive from a broad array of disciplines.

In other words, the 5C Model springs from multiple disciplines and serve multidisciplinary teamwork.

1.2 OBJECTIVES

The 5C model is developed in an educational context with the aim to help design students understand different ways of producing knowledge in practice and reach a new level of conscious action when designing. In addition we want to provide them with a 'language' for speaking about it. The model was developed while teaching 5th year design students philosophy of science and further developed in relation to a design methods course in 2011.

1.3 THE LAYOUT OF THE PAPER

The paper starts by presenting the theories informing the 5C model, the model itself, and the five knowledge production categories. Next follows a brief outline of the design methods course, the teaching approach, and the empirical data gained from teachers' logbooks and course evaluations. Finally, a discussion leads to the conclusion.

2. THE CONSTRUCTION OF THE 5C MODEL

2.1 KNOWLEDGE PRODUCTION

Much ambiguity exists in relation to the nature of knowledge (Basadur 2005) and the definition and understanding of knowledge undergoes constant development and change (Darsø 2003). The goal of design research in design practice is to create 'robust' knowledge, which can lead to new applications and innovations (Friis 2007). The term 'knowledge production' thus refers to knowledge, which is produced in the context where it arises and where uncertainty is a condition (Siggaard 2000). It is characterized by being context-driven, problem-focused, and interdisciplinary, which is similar to Mode 2 type of research (Gibbons, Limoges, Nowotny, Schwartzman, Scott, and Throw 1994) and learning and knowledge production are seen as two processes closely related (Siggaard 2000).

2.2 A NEW FRAMEWORK FOR UNDERSTANDING KNOWLEDGE PRODUCTION IN DESIGN PRACTICE

Four of the five approaches in the 5C Model are defined in response to the mode of knowledge production: *How do we produce knowledge?* And the orientation of the knowledge production: *What do we produce knowledge about?* We argue that in design practice, there are two different modes of knowledge production: one is by physical experience; the other is by mental processing (Basadur 2005). Also, the research can direct its focus to two distinct 'areas': one is to produce knowledge about the existing situation; the other is to produce knowledge about the future

situation (Simon 1969; Liedtka 2004). The two dimensions are organized in a vertical axis and a horizontal axis resulting in a diagram (Figure 1) with four different types of knowledge production: 'Collect', 'Comprehend', 'Conceptualize', and 'Create'.
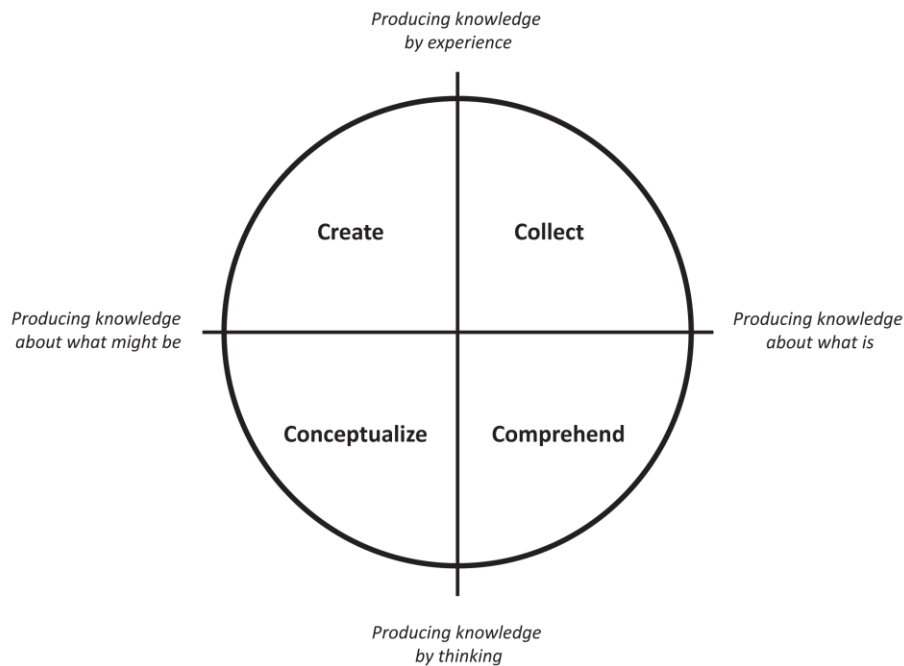

Producing knowledge by experience

Create   **Collect**

Producing knowledge about what might be   *Producing knowledge about what is*

Conceptualize   **Comprehend**

Producing knowledge by thinking

Figure 1. Four different approaches to producing knowledge in a design process: *Collect, Comprehend, Conceptualize,* and *Create*

2.3 PRODUCING KNOWLEDGE BY EXPERIENCE OR BY THINKING

There is ample support for the dual nature of acquiring knowledge. Going back to Descartes and Kant, Basadur (2005) provides an extensive summary of theorists through the times, who have divided cognition into two fundamentally different components: the sensory and the intellectual, the experiential and the theoretical. Thorndike talks about 'learning by trial and error' and 'learning by ideas' (Thorndike 1931 in Basadur 2005). Kolb emphasizes the importance of using experimental learning to complement theoretical learning (Kolb 1984 in Basadur 2005), and Eisenhardt and McGrath suggest that in highly novel situations, experimentation is necessary since no theoretical basis for cause-and-effect exists (Eisenhardt 1998 and McGrath 2001 in Basadur 2005).

Nonaka & Takeutchi (1995) likewise classify knowledge in two categories: One is explicit knowledge, which can be articulated in formal language, manuals, and theories. The other is tacit knowledge, which is hard to articulate with formal language. It involves intangible factors such as personal beliefs, perspectives, and values. Thus it is embedded in and best communicated through experience.

The vertical axis of the 5C model adheres to Basadur's division of knowledge production into the two modes of 'experience' and 'thinking'. 'Experience' means to physically engage with the world, to produce understanding by using the senses, for instance by observation or by trying something

out. 'Thinking' means to understand things mentally, by reflecting, analyzing, and organizing information in one's mind to 'find things out' or create new theories (Basadur 2005).

2.4 PRODUCING KNOWLEDGE ABOUT "WHAT IS" OR "WHAT MIGHT BE"

Several researchers suggest that design is characterized by an orientation towards what does not yet exist, probably most famously expressed by Simon (1969): *"The natural sciences are concerned with how things are… Design on the other hand is concerned with how things ought to be".* March (1976) categorizes the difference between design, science, and logic: *"Logic has interest in abstract forms. Science investigates extant forms. Design initiates novel forms".*

Based on the work of the philosopher Peirce, Liedtka (2004) argues that science uses the traditional reasoning modes of induction and deduction whereas design is speculative and the mode of reasoning thus abductive: *"Peirce suggested that "deduction proves that something must be"; induction shows that something actually is operative; abduction merely suggests that something may be".*

The theories provide support that there are two distinct areas of knowledge production: One focusing on 'what is', the other on 'what might be'. However, while Simon, March, and Liedtka point to the quest for novelty as a main characteristic of design, design thinking requires research into both the existing and the future situation, thus including deductive, inductive, and abductive approaches. The shift from deductive to inductive approaches was particularly strong in the early 1980s (Bürdek 2005) when new approaches were integrated into design practice (Friis 2007). The horizontal axis of the 5C model divides the orientation of the knowledge production into two distinct 'areas': one is to produce knowledge about the existing situation; the other is to produce knowledge about the future situation.

2.5 THE FOUR CATEGORIES IN THE 5C MODEL

In the following, we present the four different approaches to producing knowledge in design practice: 'Collect', 'Comprehend', 'Conceptualize', and 'Create'. The fifth category 'Collaborate' is addressed in section 2.6.

Collect
One can produce knowledge about the existing situation by physically engaging with the world, for instance by contextual observations and stakeholder interviews. Understanding is derived from what is experienced and can thus be characterized as inductive – moving from the specific to the general level.

Comprehend
One can produce knowledge about the existing situation mentally, by thinking and working in the abstract, for instance by analyzing and organizing information. Understanding is derived from rational, systematic analysis, which might lead to the identification of new insights and problems. There is some overlap to deduction where conclusions are based on general laws and theories.

Conceptualize

One can produce knowledge about the future situation mentally, by thinking and imagining new possibilities, for instance by brainstorming and selecting the most promising ideas in the abstract. Understanding is derived from intuitive thinking and associations, inferring possible, new worlds, which is characteristic of abductive thinking.

Create

One can produce knowledge about the future situation by physically making or enacting new possibilities, for instance by building, sketching, co-creating, and role-playing. Understanding is derived from what is experienced while engaging with materials or acting out the future.

2.6 THE FIFTH CATEGORY IN THE 5C MODEL: COLLABORATE

Initially, the objective of the 5C Model was to illustrate the ways in which designers produce knowledge in design practice and 'Collaborate' was not included. However, complex problem solving takes place in teams which need to find ways to include diverse competencies and perspectives, handle the relations, and decide how to work together (Darsø 2003). We thus decided to include a fifth category and placed it at the center of the diagram to illustrate that collaboration is important in each of the categories (Figure 2).

Collaborate

One can produce knowledge about the team and the team dynamics; for instance by surfacing and mapping the competencies, perspectives, and values of the members, and by making shared guidelines, process maps, and taking time out to work with the relations in the team.
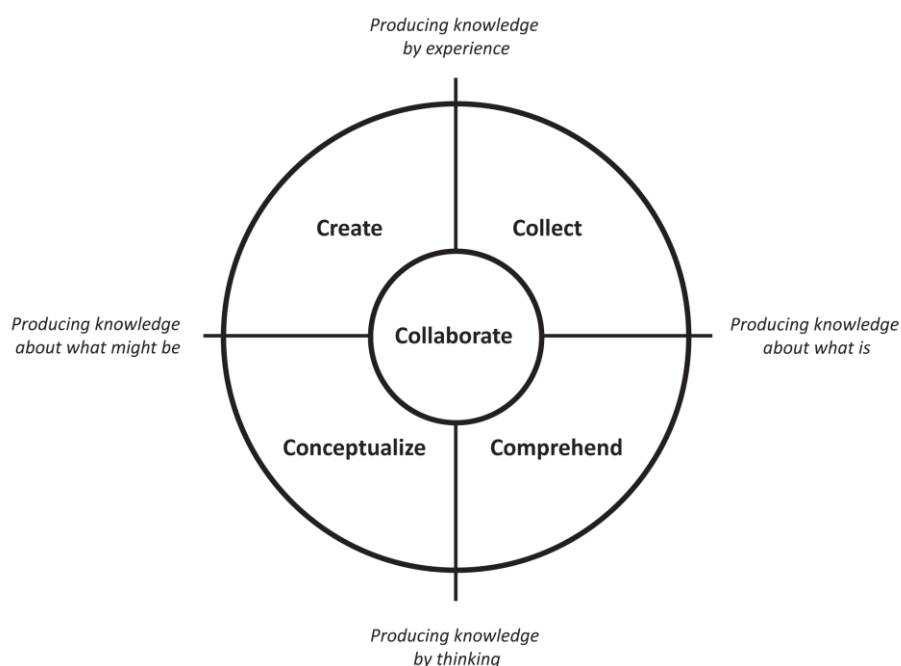

Figure 2. The 5C Model

2.7 A MULTITUDE OF MODELS

Multiple models of design thinking have emerged within the last two decades (Dorst 2011). A good question is what sets the 5C Model apart? The model is developed in an educational setting, not a market setting like many of the existing models, with the main purpose to help design students understand different ways of producing knowledge in practice.

Most models are visualized as linear, step-by-step approaches. For instance the process models 'Four Questions, Ten Tools' by Liedtka & Ogilvie (2011) and the 'Design Thinking for Educators' by the design firm IDEO (2014) (Figure 3). While the authors explicitly state that the models are to be perceived as iterative, the linear movement dominates the illustrations with numbered sequences from left to right.
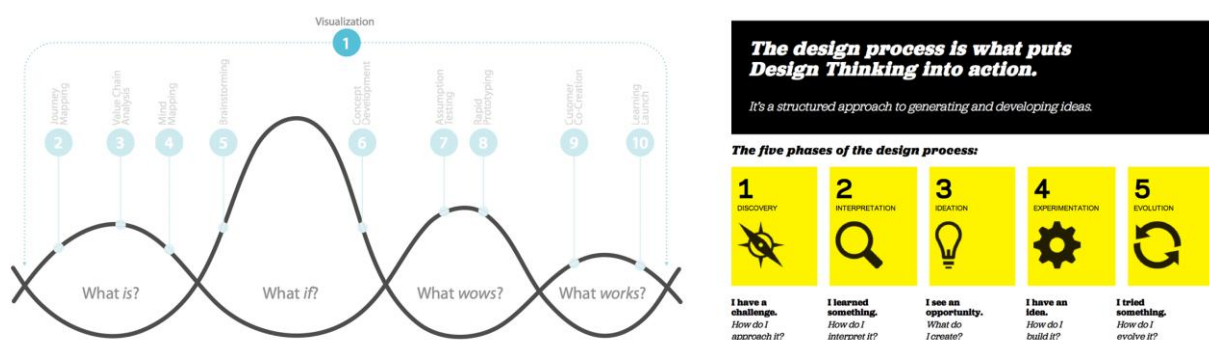

Figure 3: "Four questions, Ten Tools" (Liedtka & Ogilvie 2011) and 'Design Thinking for Educators' (IDEO 2014)

This is not the case in the 5C Model, which is circular and focuses on different types of knowledge production. A project might start in any of the categories. For instance, when working with challenges relating to waste and the environment, one team initiated knowledge production by experimenting with discarded plastic water bags and discovered that they could be used as floating devices. This later led to the idea of producing swimming equipment for beginners.

In addition the 5C Model serves as a tool for dialogue and understanding in relation to individual and team preferences. For instance, a student might revel at thinking up new ideas (Conceptualize) but procrastinate when it comes to investigating in practice whether there is a real need among users (Collect).

2.8 DSKD METHOD CARDS

Each of the five categories in the 5C Model is accompanied by 8 – 14 methods, which exemplify the particular type and orientation of knowledge production. The methods are provided in the form of a physical deck of 62 method cards. The cards are a piece of design in itself. On one side of each card there is an illustration of the method, and on the other side there is a text describing why and how to do it (Figure 4). The cards are numbered and color-coded by category for easy recognition.

Figure 4: DSKD Method Cards (Friis and Gelting 2011)

The layout of the cards is in some ways similar to the IDEO Method Cards (2002), which contains 51 design methods. The DSKD Method Cards differ by including methods from new categories, for instance 'Collaborate', also, the explanation on each card is longer, and different researchers contribute with methods and are referenced. In addition, teams can use the DSKD Method Cards as a tool for building processes together.

3. THE DESIGN METHOD COURSE

3.1 INTRODUCTION

The course title is 'Design Methods'; it is an eight-week course, starting with two weeks of preparation, five weeks of teamwork, and one week of finalizing and evaluating the process. The aim of the course is for students to experience different design methods and how to use these to identify and solve open problems. The projects are not expected to reach a level beyond demonstrating the concept through prototypes and visual material, and students are primarily evaluated on process skills.

Two associate professors conduct the course with approximately 25 2nd year students, who are affiliated with 6 different institutes at the design school: Illustration, Graphic Design, Interaction Design, Fashion, Textile, and Industrial Design. Each team consists of 3 to 5 students from different institutes. They are allocated a physical project space where they can keep everything related to the project for the duration of the course.

In 2011 and 2012 the theme was 'Waste and the Environment' and in 2013 'Handicap'. The students identified challenges and solutions within the overarching, societal theme by using design

methods to investigate the situation. For instance, in 2012 a team identified the challenge 'how might we prevent littering along freeways?' and in 2013 'how might we develop medicine packaging for crippled and weak fingers?' In the latter example, the team invited patients from the Danish Arthritis Association for lunch at the design school. The students interviewed, observed, and photographed the difficulties that the guests experienced while opening the food packages (Figure 5). Especially the unscrewing of bottles was impossible with fingers crippled by arthritis. Through further investigations, the students built new understanding and narrowed down the challenge, leading to the solution; an easy grip packaging and medicine dosage system for arthritis patients.

Figure 5: A photo board acts as a visual reminder of the difficulties experienced by arthritis patients

3.2 EXPERIENTIAL AND ACTION ORIENTED

The format of the course is experience-based: Short introductions give way to students trying out approaches in practice.

At the outset of the course, the students are introduced to the 5C Model and the different categories of knowledge production. In the following weeks, the categories and corresponding methods are introduced one by one starting with 'Collaborate', then 'Collect', 'Comprehend',

'Conceptualize', and 'Create'. In between introductions, the students have 3 – 5 days to work in the team. Teachers are available for supervision and set up presentations where students receive feedback.

3.3 EMPIRICAL DATA

To ensure a variety of perspectives, the two teachers' observations are intersected with the student comments and reflections. The teachers recorded their observations and reflections in a logbook during the courses in 2012 and 2013. The students' observations and reflections were obtained during oral evaluations following the conclusion of the programs. In addition, we have had access to student evaluation reports.

4. DISCUSSION

4.1 RETURNING TO THE OBJECTIVES

In the following we discuss how well the objectives of the 5C Model and the method cards were accomplished in the design methods course. Were the students able to understand different ways of producing knowledge in design practice? Did they reach a new level of conscious action when designing? And did they acquire a new 'language' to be used in the team and in relation to individual process?

4.2 UNDERSTANDING KNOWLEDGE PRODUCTION IN PRACTICE

Observations by teachers and evaluations from students indicate that the 5C Model and the accompanying method cards help students understand the different categories of knowledge production at a theoretical and an experiential level: *"The cards constituted the foundation for performance in our team where we wanted very different things. Without them we wouldn't have lasted a week. I continued for 14 days on my own and the cards helped me progress. It is a stunning tool"* (Oral evaluation 2012). Another student says *"For us, the method cards were the focal point. We planned the entire process by the help of the cards"* (Oral evaluation 2013).

The physical format of the methods seems to help students monitor how knowledge is produced at different points of the process. Figure 6 shows a picture taken by one of the teachers in 2012. She remarks in the teachers' logbook *"Several of the teams have placed the method cards next to the poster, which shows the yields from the investigation so far – (pretty smart – we think!)"*

Figure 6: Students keep track of the method and the knowledge they produced. To the left: 'The Muse', a 'Create' method. To the right: 'Road Map', a 'Collaborate' method

The color-coded categories on the cards enable the students to relate the methods that they apply to the theoretical model and distinguish between different types of knowledge production, making navigation easier (Student evaluation 2012). Also, the students use the method cards to build processes and the 5C Model to illustrate how and when the methods were used in the process (Figure 7).

Figure 7: The 5C model and the method cards are used directly in process visualizations. To the left: Visualization of the 5C model. To the right: Method reflection in the logbook

The teachers were surprised when students started to provide ideas for new methods (Figure 8). It indicates that not only do students learn a language, they develop the process language themselves: *"The team […] got lots of material. They clustered the material in categories and came up with a new method. The idea is to pick words from the clusters and add a random word. They*

then make individual sketches based on a sequence of words, and meet to discuss the sketches… a way of brainstorming … fantastic!" (Teachers' logbook, 2012)
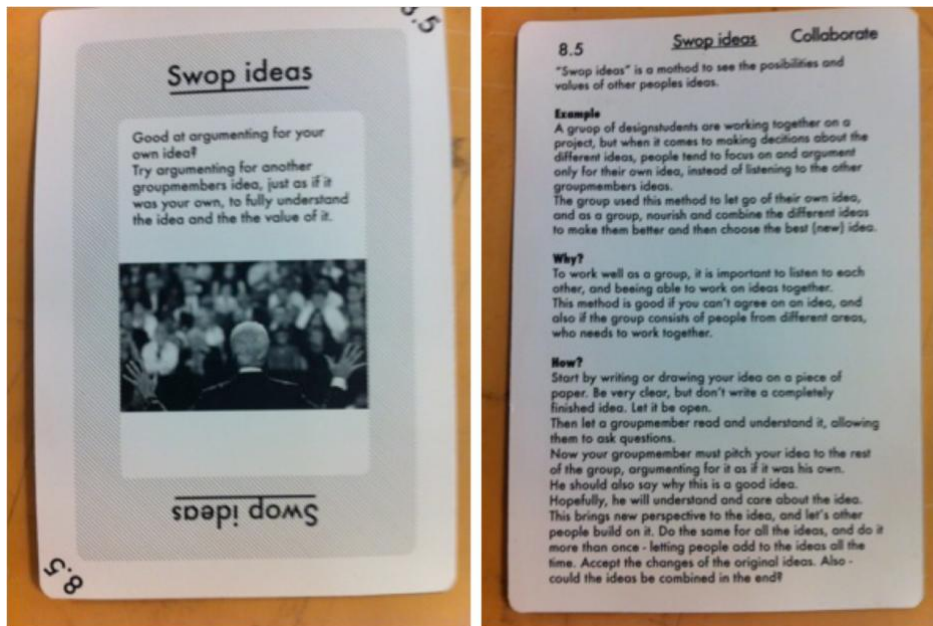

Figure 8: Example of a new 'Collaborate' method developed by students

4.3 KNOWLEDGE PRODUCTION PREFERENCES

While working with the different ways of producing knowledge, the students seem to acquire a new understanding of their own preferences. Observes a teacher: *"One of the teams might be a bit shy and it is difficult for them to get out. They have become aware of this […] and they have spent the day making arrangements. […] I have talked to them and put pressure on them to get out NOW!"* (Teachers' logbook 2012)

The example indicates that the 5C Model and the accompanying methods help students see and understand their own preferences in relation to knowledge production in a design process and are thus encouraged to try on approaches, which are not familiar to them. Say students at the oral evaluation in 2012: *"I have learned a lot about how I work"* and *"I have learned a lot about the roles that I take in a team – and that I am useful in a team. It is amazing!"*

4.4 ITERATIVE OR LINEAR?

As stated earlier in section 2.7 the 5C Model is not linear and a design process can start in any of the knowledge production categories. In the course program however, the teachers present the categories with accompanying methods one at a time. The intention is to not overwhelm 2nd year students with choices from the outset. Also, the course objective is for students to experience methods, and the teachers wish to ascertain that they try out approaches in each category.

Some students find the linear approach frustrating: *"It would have been great to be introduced to all method categories at an earlier stage, so that we could have gone through more cycles of iteration faster"* (Oral student evaluation, 2013). Says another student: *"For some teams it is*

necessary to start with conceptualize and then move backwards – it would have helped us" (Oral student evaluation, 2012).

The findings disclose a dilemma: While the model emphasizes the iterative aspect of design practice and one can start in any of the 5 categories, the educational approach has turned linear, making some students frustrated and impatient in relation to the project at hand. This is a dilemma, which has to be addressed in future courses.

4.5 CROSSING THE BARRIER

Observations and evaluations from the design methods course point to an initial lack of motivation among students to engage with the method cards. Even though they are only in their 2nd year, they seem to think that they already know the different approaches to producing knowledge. One of the teachers record at the beginning of the program: *"It is a challenge to get the students to take the method cards seriously. Tuesday I went around to a number of teams and told them to get the cards out of their bag – "cards on the table!" There is a tendency to talk about them, criticize them, and not look at them thoroughly … "cause we already do that!" Today I notice that more students have started to use them, to choose methods and throw themselves into the Collect methods. I think it is actually looking good!"* (Teachers' logbook 2012)

Evaluations indicate that students find reading the methods 'tedious'. However, once they cross the barrier, the methods become useful: *"It has been a bit heavy to go through all the methods – but learning rich"* (Student evaluation 2012).

One might reflect that the students in this particular circumstance are not "adequately different" to fully benefit from the model and method cards. They belong in the same design school, are in the same age group, and have similar backgrounds. This is supported in the evaluations where students suggest that the course should be multidisciplinary, including Business and Engineering students, and stakeholders such as public and private organizations. Also, international, cross disciplinary but otherwise similar courses for 2nd year students show a high level of motivation from the outset to actively use the methods (Friis, 2014).

5. CONCLUSION

Findings indicate that the 5C model and the method cards act as a framework, which empowers the students to experiment with and reflect on how they produce knowledge in practice, individually and as a team. The methods provide the students with the freedom and responsibility to actively construct the process, an aspect, which motivates them. The physical format of the cards supports team communication and helps establish a link between the theoretical framework and practice. Surprisingly, the students not only experiment with the provided method cards, they also produce new methods and share them by relating them to the 5C model, indicating an expanded interest in and understanding of knowledge production in design.

6. REFERENCES

Basadur M. and Gelade G. (2005) Modelling Applied Creativity as a Cognitive Process: Theoretical Foundations, The Korean Journal of Thinking & Problem Solving, 15 (2) Seoul, Korea.

Bürdek B. (2005) Design. History, theory and practice of product design, Birkhäuser Architecture, Basel, Switzerland.

Cross N. (2001) Designerly Ways of Knowing: Design Discipline Versus Design Science. Explorations in Design Studies, paper prepared for the Design+Research Symposium, Politechico di Milano, Italy, May 2000 (2001: MIT Online)

Curedale R. (2013) Design Thinking Process and Methods Manual, Design Community College Inc., CA: Topanga

Darsø L. (2003) Is there a formula for innovation? Translated from "En formel for innovation", Børsens Ledelseshåndbøger, Denmark

Dorst K. (2011) The Core of Design Thinking and its Application, Design Studies, vol. 32, Elsevier

Friis S.A.K. (2007) Conscious Design Practice as a Strategic Tool, DPU (Department of Education at Aarhus University) and E-Types A/S, Copenhagen, Denmark

Friis, S.A.K. (2014) Including Diversity in Creative Teamwork in Design Education, International Journal of Design Creativity and Innovation, Taylor & Francis

Gibbons, Lomoges, Nowotny, Schwartzman, Scott and Throw (1994) The New Production of Knowledge: The Dynamics of Science and Research in Contemporary Societies, SAGE Publications Ltd., London, UK.

IDEO (2014), Design Thinking for Educators, www.designthinkingforeducators.com (29.09.2014)

Jensen, H.S. (2000) A History of the Concept of Knowledge, Working Paper LPF 2000

Liedtka J. (2004) Design Thinking: The Role of Hypotheses Generation and Testing, article in Managing as Designing, Ed. Boland, J.R, and Collopy, F., Stanford University Press, CA: Stanford

Liedtka, J. and Ogilvie, T. (2011) Designing for Growth: A Design Thinking Tool Kit for Managers, Columbia University Press, NY: New York

March L. (1976) The Logic of Design and the Question of Value, Reproduced in 1984, N. Cross (ed.), Developments in Design Methodology, John Wiley & Sons, Chichester, UK.

Nonaka I. and Takeutchi H. (1995) The Knowledge Creating Company: How Japanese Companies Create the Dynamics of Innovation, Oxford University Press, New York, USA.

Simon H.A. (1969) The Sciences of the Artificial, The MIT Press, Cambridge, USA.