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Applying "Design Thinking" in the context of media management education

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Abstract "Design Thinking" – a cross-disciplinary and user centered method – is an approach towards the discovery of solutions and sparks innovative thinking in many ways. It also can be argued, that designers put themselves in the place of the user rather than co-creating with the consumer. Innovation is one of the current keywords across many industries, and many attempt to find new solutions to daily problems. Design Thinking as method allows to understand user needs and understand their principle problems in daily life. The design process uses intensive collaboration in cross-disciplinary settings and is divided into the exploration of the problem space and the solution space to achieve new ways of solving existing problems. Design Thinking has to integrate into the innovation process and into organizational structures right from the beginning. It constitutes a complement to classical analytical processes for problems that require lateral, not linear thinking. This article reviews the practical application of this energetic methodology in the academic context and presents some hands-on examples. The course series has been established by the Entertainment and Media Management Lab. (EMMi Lab.) at the Tampere University of Technology (TUT) and was held in cooperation with students from the University of Tampere (UTA), and the Tampere University of Applied

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Sciences (TAMK). One course has been held in cooperation with the University of Applied Sciences Magdeburg-Stendal, Germany. This article describes how to train students especially with strong technical background and analytical mind-sets in the development of innovations in the field of media, foster creative thinking, and achieve problem solutions beyond the current state of the art. We present the basic curriculum, course structure, goals & objectives, applied methods, settings, and theoretical aspects of Design Thinking. Our experience and reflections on conducting the courses concludes this article. The article shall be an introductory guide for anyone who intends to organize a similar course in the university context.

Keywords Design thinking · Media management · Innovation management

1 Introduction

Recent years have seen a considerable increase in public discussion related to creative problem solving, creative industries and innovative environments. In the vivid discussion, terminology and paradigms have become mixed in a confusing fashion. One of the hot terms of the day is design, with its many incarnations, such as Design Thinking, service design, information design and design for social innovation. Not particularly many papers depicting Design Thinking as a teaching approach seem to surface, particularly ones with more comprehensive theoretical treatment given to the pedagogical and historical basis of the term. Thus, it is first imperative to discuss the concept of Design Thinking, considering the connection it has to other related concepts and particularly pedagogical approaches. To discuss the Design Thinking methodology in this fashion, it is first necessary to explore, how the approach is defined and perhaps more importantly, why it seems contemporary as a strand of business management. After this definition, the approach can be discussed theoretically with conjunction to modern learning and knowledge creation approaches.

To define the concept of Design Thinking, it must first be considered as a series of different strands, as portrayed by different disciplines and research interests. The early considerations on the concept date to the early works on design methods (e.g. M. Asimow [4], J. Jones [31] and C. Alexander [3]) problem solving (or creativity) methods (e.g. W. Gordon [27], A. Osborn [46]), and science of design(e.g. H. Simon [57]). The discussion around design thinking and design methodology was not unified in scope or perspective, however. Authors such as C. Alexander [2] and J. Jones [30] clearly rejected the state of the inquiry as unnecessarily trying to fit everything into formal frameworks and dissociating from the daily reality of design practice. Toward the 1980's, the interest clearly turned into more formal journals and conferences on the subject matter, particularly developing the Engineering Design and Human-Centered-Design. Also concentrating on the practice of design, like design studies, design issues, and research in engineering design. Many subject-related conferences like Environmental Design Research Association (ASME) [22] series of conferences on Design Theory and Methodology started also during that time. Thus, historically the idea of Design Thinking is not entirely new.

Design Thinking as we know it today, goes back to an initiative that developed at Stanford University starting in the 1980s (see [16] and [12]). The current Design Thinking practice at Stanford is summarized well in the d.school bootleg [15]. The method attempts to solve the problem to develop innovations based on consumer demands and comments in the fields of products, services, or other relevant tangible or intangible matters. Design Thinking bridges the gap between a designer's approach to problem-oriented creation and an engineer's analytic approach to solving problems. It can be considered as a method between

'artistic creative thinking' and 'rational analytic thinking'. Its focus is consumer orientation and concrete problems of daily life and the improvement of particular shortcomings in products, services, or processes by creative thinking. Design Thinking is cross-disciplinary and requires a thoughtful process in the establishment of teams with multidisciplinary background and the conduction of phases. A more practical approach is presented in [28].

The method Design Thinking has been adopted for the course entitled "Frontiers of Media Management" organized by the EMMi Lab. at the Tampere Univ. of Technology (TUT) [21] that was conducted in cooperation with University of Tampere (UTA), the Tampere Univ. of Applied Sciences (TAMK), and in 2012 in addition with a partner university in Germany – the University of Applied Sciences Magdeburg-Stendal. The course had a volume of 8 ECTS and was established as a blocked course conducted throughout several weeks with specific workshop times. The course included self-learning exercises, additional group homework, and project work for students. The location of the course was either at the innovation facilities at TUT, or in the premises of the Tampere New Factory (Demola) to provide an opened space setting to foster creative thinking and innovative approaches. Figure 1 depicts a typical course setting.

In the planning phase, we aimed at structuring the course along the various design thinking phases, as illustrated in Fig 2. The Design Thinking phases allow conducting specific teaching sessions that are required to conduct the course. We extended the standard phases, by a phase called 'self-learning', where student had to acquaint themselves with the thematic of innovation, Design Thinking and media industry business. We found that this extension allows a better understanding of the context of Design Thinking. Although the methodology is picked up quite quickly by active application, a theoretical briefing before the first session allows concentrating more on the creative process itself. During the empathize phase students have to understand the context a consumer is acting in, and which needs and desires constitute her personal motivation. In the following define phase the students explored the problem space to define and frame the actual problem. In the ideate phase the teams apply a number of creative methods to explore solutions to this particular problem. The developed solution is low-fi prototyped (prototype phase) and tested with real-users to gain insights on the user perspective on the developed solution (test phase). If flaws or shortcomings are discovered in either of the phases, students require turning back to a

Fig. 1 Creative Design Thinking space

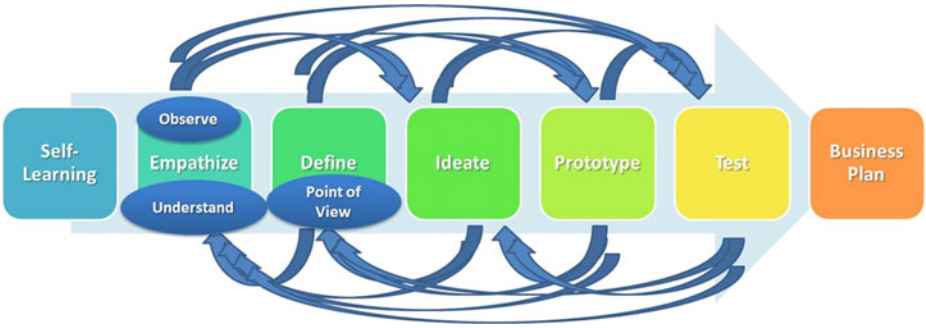

Fig. 2 Principal Design Thinking phases developed by Stanford and extended by Plattner (see [15] and [1]). The phases of self-learning and business planning have been extended by us

previous phase to try different approaches to solve the problem. Thus the course could not be organized as strict sequential process, but had to offer enough room to transit forth and back between phases to come up with new and sometimes surprising solutions to the problem. At the end of the course students had to work on the development of a business plan for their prototype. This is not part of the Design Thinking phases, but forces the students to come up with a finalized concept eventually and test it against a business context.

In the preparation phases of the course we faced a number of challenges. Despite of a wide range of literature that describes Design Thinking from both theoretical and practical viewpoints, we like to point out the following issues, which we will address in detail in the following chapters:

- creation of the right setting, right feeling, environment, and creative space required for this type of course;
- addressing the problem of being specific enough in the definition of the design thinking challenge, that students are able to find a good starting point while being open enough to a variety of solutions;
- collection of the course and reference materials to be handed out to students, so that they would be able to grasp the context of this methods, the primary consumer needs in media, as well as the notion of innovation;
- attracting an ideal mix of students, with the right balance of cross-disciplinary backgrounds and specializations;
- selection of the right tools, resources, IT infrastructure, and materials for students, to support the different design thinking phases;
- creating the team spirit, awareness, and right attitude that students require to be able to complete the course;
- developing a challenge that attracts students, fosters their creative thinking, and allows them to empathize with the consumer;
- establishment of a course across one term, that follows the Design Thinking phases, and allows to traverse back between each of them;

The aim of this article is to give a practical hands-on approach to develop a Design Thinking course within a university course for students in existing curricula. The article is based on the lessons learned from the Design Thinking course held in 2011–2012 at TUT. These cases have been published at conferences (see [34] and [35]), but a more extensive version can be found within the scope of this article. This article describes organization issues, practical issues, gives a practical scheduling of lectures, describes home works for

students, challenges, reference materials, and suggests solutions to many pitfalls. The article rounds up with the presentation of practical cases seen from the students' and teachers' perspective. For prospective teachers, we especially would like to pinpoint to [15] and [17] as essential readings before planning a course.

The article is structured as follows: Section 2 shall introduce the theoretical concepts of Design Thinking as a methodology fostering innovation, cross-disciplinarily and focus on real-life problems; Section 3 provides a more practical viewpoint on implementing a course; Section 4 provides a blueprint for the implementation of a Design Thinking course; Section 5 presents a sample case study for a Design Thinking course and thus a very practical view on the process; Section 6 discusses the implementation of the course, links it to the theoretical aspects and suggests solutions to occurred problems. This article is an extended version from the two publications [34] and [35].

2 Design thinking as learning approach – Methodical and historical considerations

The question of how design fits the scientific sphere in terms of problem statements and epistemology has also been central in the development of design thinking. In the past, the following considerations have been made, while discussing various learning and problem solving approaches. Within the scope of the next paragraphs, the main contributing ideas to Design Thinking are shortly presented:

- wicket vs. tame problems in social or science settings;
- optimization/effective vs. satisfice/non effective problem solving approaches;
- consideration of limits of knowledge in problem solving behavior;
- visual thinking process in problem solving;
- learning organizations and knowledge centric companies.

The problem areas associated with design practice and the limitations of planning in problem solving were also scrutinized by Rittel et.al. He presented a key concept of "wicked problems" to separate the "tame" problem areas of science from more complex, socially constructed problems, the domain of designers [53]. Another position was also taken by Simon, who saw design and other practice-oriented disciplines (engineering among other things) as "the science of the artificial"- an important area that itself should be given its careful, systematic consideration from its own epistemological grounds. Simon specifies this systematic inquiry in design by specifying its distinguishing features from natural sciences. In his view, due to a condition of "bounded rationality", optimization approaches don't necessarily work effectively with all problem areas, given the system complexity. Approaches that "satisfice" instead might be more effective for more ill-defined problems (excerpted from [57]).

This outlines an important conceptual split in terms of intent that is useful for understanding the modern constructs of Design Thinking on a deeper level. In Simon's view, there should be a pragmatic program of science related to artificial constructs, the objects and fields of technology. The distinction is made to separate the scientific, foundational research and that of constructing artificial solutions and artifacts to approach certain problem spaces in a certain point of time. Due to cognitive limits, the condition Simon calls "bounded rationality", optimization is not seen as the approach that allows for best scenario problem solving [57]. In other words, the limits of knowledge in problem solving are taken into account in problem solving behavior. The condition of bounded rationality leads to "satisficing" instead of optimization – concentrating on what is good enough at the moment.

More recent definitions of Design Thinking can be traced partly in these mentioned strands of design inquiry, but perhaps oriented more toward business and engineering as the area of application. Arguably McKim and his "Experiences in Visual thinking" and the "Express, Test, Cycle", an early conception of the iterative nature of design [42], are one of the key influences in modern Design Thinking. For example the "Ambidextrous Thinking" class in Stanford design program was built, extending McKim's visual thinking process to a more holistic whole [23]. Other strands that have influenced the modern business-oriented Design Thinking can be found in Schön's reflective practitioner and related works on learning organizations [56] (which can be considered an important part in the later trend of "nimble organizations", for example the agile movement). The Japanese knowledge-centric company concepts, for example Nonaka & Takeuchi's Knowledge-creating company [45] can be considered influential in terms of the multidisciplinary teams and dynamics ideas that are integral in the modern definitions of Design Thinking.

2.1 Definition of the modern design thinking concept

The modern design thinking in the 2000's seems to be very business management-oriented concept that ties the different previously introduced strands of design thinking (or knowledge management for that matter) inquiry to a more coherent innovation-centric agenda. It is quite clear that the creative class and designers among other practitioners are hailed as the role, environment and process models of a modern innovative company. These aspects are clearly promoted in recent business management works, particularly by authors such as Florida (creative class) [24], Pink (motivation and creative work) [51], Martin (integrative, modern business curriculums) [40] and Brown (Design thinking in business) [9].

The teaching approach called "Design Thinking" in this paper is effectively a widely discussed phenomenon in the end of first decade of the 2000's that integrates influences from the mentioned strands of design inquiry and particularly from the business angle. This approach is notably promoted by Stanford d.school (along with their joint project with HPI School of Design thinking in Ulm, Germany) and Martin of the Rotman School of Management in Toronto, among others. What is common first of all to the approaches in these two instances, as well as derivative programs is a multidisciplinary aspect, outlined for example by Brown from the design firm IDEO. He defines design thinking roughly as "'a discipline that uses the designer's sensibility and methods to match people's needs with what is technologically feasible and what a viable business strategy can convert into customer value and market opportunity" [50]. This conveys a common, rough and tri-disciplinary underpinning– the idea that design thinking as an approach combines domains of business, user-centered design and technology in a collaborative fashion to produce particular, innovative and user-centered outcomes. A similar set of values and focal points is presented for example by Fraser [25], Sato [55] and Lindberg et al. [33].

Design thinking is often described as an idealized process model, usually of iterative or non-linear nature in the modern publications. Brown divides Design Thinking into activities in three interrelated, non-linear activity spaces: inspiration, ideation and implementation. He portrays loosely examples of activities associated with these spaces – ethnographic user research, brainstorming techniques, iterative prototyping and collaborative business development - in his article [8] taken further in terms of practical consideration in the IDEO design thinking toolkit. The idealized process model outlined by Stanford d.school and HPI school of Design thinking, commonly referred to as the Design thinking process, is an iterative process with six interdependent phases outlined in Fig. 2 [1]. The model aims not to be a linear model, but rather characterizes roughly, much like Brown's interpretation, the activities associated with certain spaces within the full design process.

T. Lindber et al. [33] summarize the purpose of each of the phases. Understand refers to a team effort to gather and work information on a problem in order to understand a certain problem domain, to become more knowledgeable of the nature of the problem in question. In the Observe phase the team members potential users and other stakeholders involved in the problem space are interacted with to empathize with their conception of reality, examining their problems, habits, attitudes and needs. This allows the members of the team form concrete observations and to develop shared understanding of the subject in practice. Based on the understanding, the team forms a Point of View, i.e. they define what problem or aspect they wish to concentrate on. Based on this focus, Ideation then starts to produce alternatives, ideas and proposals are formed around the agreed point of view, using various creativity techniques. Some of the ideas and proposals can then be taken to the Prototype phase, in which concrete mockups of the chosen form are produced. These are then tried out in practice in the Test phase to evaluate possible solutions. The process iterates on the feedback cycles, to refine the solutions closer to practically viable outcomes [52].

2.2 The value proposition of design thinking for business management education

To assess the suitability of Design Thinking as teaching approach, the foundations on its value have to be argued for in the domain of application. Applying Design Thinking to media management education, and particularly the very recent developments in the field such as ambient media, it must be understood that traditional approaches and problem-based learning through case methods don't necessarily function well due to the lack of relevant case studies. One way to assess the value proposition of design thinking in this domain, however, is to approach the issue from the management studies perspective. In this section, arguments are presented to lay the groundwork for the specific aspects of value that make the approach pedagogically suitable.

Business management education has recently been under some rather heavy critique, particularly in terms of practitioner vs. academic concepts area. Martin in his "Future of the MBA" [44] presents a rather comprehensive review of the central critique laid out on the state and nature of traditional MBA education. These compromises:

- Competitiveness critique (as discussed by Pferrer & Fong in [44]),
- Radical structural flaw critique (discussed by Mintzberg in [44]),
- The Ivory tower critique (discussed by Bennis & Toole in [44]),
- De-professionalization critique (discussed by by Pfeffer & Fong in [44]), and
- The Vicious hermeneutic circle critique (discussed by Ghoshal in [44]).

To summarize, to build on arguments on whether the management education is valuable for the attendee, if the institution currently only validates instead of developing, whether management as a profession can be explicitly trained and tested with the current educational institutions and approaches and whether the current practitioner/educational institution interplay is fruitful for business and the society [44].

The authors of [44] also set to portray their vision (or blueprint) for the future MBA education with an argument related to the nature of the skills high value managers should possess. "The [high value] skills of the 21st century manager are tacit in nature – the competitive edge is essentially formed by skills that cannot be turned into explicit algorithms" (in [44] p. 41). Tacit and explicit conceptual split is effectively Polanyi's concept, that was in the late 1990's revived by I. Nonaka & H. Takeuchi [45] in their "Knowledge Creating Accompany". Much in the same vein with them and the subsequent theorizing on the tacit-explicit problem in knowledge management and organizational learning research,

[6] argues that the value-add of management education should be particularly on those hard-to-explicate skill sets that allow managers to identify, label and approach problems they're ill-defined and complex in nature – wicked problems [44].

Martin sees a concept rather similar to Stanford's Design Thinking as the suitable approach for developing the skillsets valuable for the contemporary managers. He approaches Design thinking, defining it as the dynamic interplay balancing between analytical mastery and intuitive originality [37]. To illustrate the ability in conjunction with how valuable information, or in his concepts "knowledge" is, he considers Design Thinking as the ability to maneuver along what he calls the "knowledge funnel". He furthermore sees Design Thinking as a form of thought that, when mastered, offers lasting, long-term business advantage [37].

Martin's "knowledge funnel" is essentially a continuum of stages – mystery, heuristic and algorithm [37]. These stages essentially represent the sophistication of the idea, in conjunction to their scalable business value. The first stage of the funnel represents the exploration of mystery – a stage in which open-ended ideas and questions that take infinite forms are explored [37]. This roughly corresponds to what is often called the "fuzzy front-end" (FFE) of innovation in research related to new product development or intelligent organizations. Kim & Wilemon posit, that pre-development (FFE) is an important stage in new product development that begins with an opportunity for further idea development activities (ideation, exploration, assessment) and ends with a resource commitment to a particular project [32]. FFE often eludes definitive formalization as a concept, as the activities associated with it are often dynamic, unstructured and traditionally tend to low formalization [32]. Essentially Martin and Kim & Wilemon agree on the notion that the initial phase is the one that enables one to find several low-cost opportunities for problem areas (in [37] and [32]). Moldovenau characterizes the first stage as prelinguistic intuitions – something acknowledged, but not explicated [44]. This is a notion worth considering at a later stage, when considering the pedagogical aspects of the Design thinking process.

Martin's second stage, heuristics, presents a working hypothesis or a structure that allows understanding of the phenomenon or problem space by simplification [37]. Moldovenau sees heuristics on the other hand, are "open-ended prompts" – rules of thumb to think or act in a particular way that don't guarantee a certain result, but might be better on average than not acting in such way [44]. When heuristics are defined and formalized further, they might become a fixed, generally applicable formula, third stage of the funnel by Martin that he refers to as "algorithm" [37]. Moldovenau refines this thought by pointing out that algorithms are certified production processes, that guarantee a given result, provided there's no intervention or anomaly that prevents the designated procedure [44]. To put it short, Martin's concept of Design thinking seems to refer to a meta-discipline that describes skillsets needed to take general, valuable but raw ideas and concepts to more refined, actionable forms of knowledge.

Another dilemma in Design thinking is posited by Martin through the concepts of management theorist James March. Companies dealing with knowledge have to balance between "exploring" (obtaining new knowledge) and "exploitation" (generating value from existing knowledge) activities [37]. Martin argues, that Design thinking imbues an important third mode of reasoning to complement existing two-face modes of reasoning, intuitive and analytical thinking (or validity and reliability). He calls this, using Peirce's concept, "abduction" or "abductive thinking" [37] This portrays this essentially as the logic of hypothesis creation – how to define heuristics to explain a current mystery [37]. The roots of abductive reasoning stem from the American pragmatist philosophers, William James, John Dewey

and subsequently Peirce, that Martin uses as his reference. According to Martin, Peirce's abductive logic resides in the initial conception of what might be – in this sense, it is modal instead of declarative logic [37]. In Peirce's reasoning, new ideas cannot be proved by inductive or deductive reasoning to be true or false [37], hence there has to be a third mode that allows for a "temporary conception", or "working hypothesis" prior to the matter.

2.3 Pedagogical considerations for the design thinking in media management education

Effective learning and particularly understanding can be conceived as one of the key characteristics of modern learning research [6]. Instead of memorizing and recollection, the focus is in understanding whole concepts, their meaning and the ability to utilize these concepts in novel settings [11]. Effective learning refers thus to the ability to understand and to effectively work with concepts: the abilities to plan tasks, to recognize patterns, to construct arguments and explanations, and to form analogies to other problems [2, 6]. Distinguishing factual recall (the claimed outcome of "traditional" learning approaches) and understanding (the target of effective learning) can be difficult, however. A central difference outlined in literature is the concept of transferability of knowledge. This refers to the ability of the learner to apply the learnt subject matter to other contexts [7]. These can both be considered characteristics of the previously described Design thinking process: Metacognitive skills related to the negotiation, articulation and working with concepts is encouraged, and the learners are challenged to display these skills avidly to work on the common goal.

The focus on understanding in learning requires more careful consideration on the processes of accumulation and creation in teaching approaches [50]. In the contemporary outlook of learning people actively search for information and build new knowledge and understanding based on their existing knowledge and beliefs. In this sense, it is critical for the teacher to understand the learner's conceptual level and background to form effective approaches to teaching ([7] and [61]. A practical challenge in this vein in the Design thinking-based course would be the evaluation of the starting level and common concepts of the different learners. On the other hand, multidisciplinary approach can enable the learners to endure the lack of a common conceptual framework, and instead make them accustomed to construct a shared one based on the project context. In multifaceted problems, collaborative work and "cross-cultural" communication in the less radical sense can be commonplace, and thus skills enabling more efficient communication can be particularly valuable. Moldovenau & Martin consider abilities related to communicating concepts important for managers [44].

A common example of a teaching approach built on the concept of effective learning is problem-based learning (PBL). In this approach, the learner approaches the concepts via solving related, realistic problems and trying alternative solutions ([6] p. 76, and [7]). The real-world problem aspect is clearly present to some degree in the design thinking methodology, with certain differences compared to the traditional examples of PBL approaches used in management education, case-based-learning. A necessary aspect of problem-based learning is a realistic situation and problem space. In order to be effective, problem-based learning should take place in a situation that is similar to the future context of application. The basis for this is the situational nature of learning – concepts are best learned in and effectively related to the context in which they are learned [11]. According to studies by Bransford, et al. 1999 collaborative work on problems can contribute significantly to effective, actual learning and cognitive [7].

Nonaka & Takeuchi in their "Knowledge-creating company" [45] present a model for organizational knowledge creation. They conceptually consider two types of knowledge – tacit and explicit – and believe that the creation of new knowledge depends on an iterative cycles of interaction between these two types of knowledge. The authors present a model, often referred to as SECI model, is divided into four modes of knowledge conversion. The model is presented in Fig. 3.

2.4 Who is THE 'Typical' Design Thinker?

Many ought to argue, that Design Thinking is a method for people having a background in design, this is not the case in reality. Design Thinking is not solely for artists, nor designers, nor for people with another background in creative fields. Design Thinking is cross-disciplinary, with particular personality traits. These five personality traits have been discussed in [8]:

- empathy,
- integrative thinking,
- optimism (which we will replace by facing complex challenges),
- experimentalism, and
- collaboration.

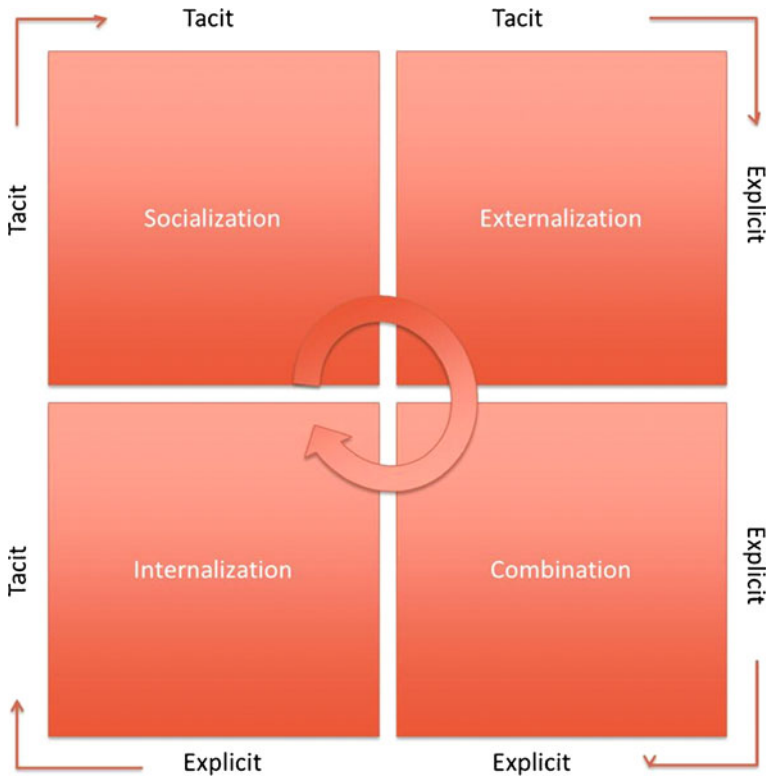

Fig. 3 Knowledge-creating company (from [45])

These traits are essential to select a successful Design Thinking team in a university or industrial setting. Empathy relates to the skill to "observe the world in a minute detail [… and to …] notice things that others do not and use […] insights to inspire innovation" [8]. People with the ability to think integrative and cybernetic allows the generation of new solutions going beyond existing alternatives – or lead to solutions that would not emerge from an analytical process. This personality trait leads to solutions that were not thought of before. Optimism is another trait a design thinker should possess. Nevertheless, in contradiction to [8], we believe the key trait is facing complex challenges, rather than only optimism. Facing complex and seemingly impossible to solve problems, the ability to cope with them, and face the challenge to explore solutions that no one yet has thought of is the key trait instead, independently if the person is and optimist or pessimist. However, each design thinker has to be opened for experimentation to try to find new solutions. The ability to scrap results to make a new experiment, and the relation to solve problems by experimentation characterizes a design thinker. Thus the ability to switch between solution space, and problem space and re-experiment, re-design, and reflect over the total process allows the emergence of fully novel solutions. The last trait is collaboration, a design thinker has to be able to collaborate and be opened to work in a cross-disciplinary team. They require to be opened to ways of thinking in other domains, and the ability to be opened to go alongside with other disciplines. As we discussed, the stronger design thinkers are in these five traits, the more Design Thinking will lead to fruitful results. Our discussion is based on [8], where more details concerning the various traits can be found. Nevertheless, we did not agree with the trait of optimism, and replaced it with facing complex challenges. Based on the above-mentioned analysis, in addition to emphasizing on methodology, the design thinking course should provide corresponding supportive settings to encourage, foster and nurture the development of all the five personality traits inside course participants and inherently let design thinking benefit their every aspect of life after course in a continuous manner.

3 Issues in implementing a design thinking course

Several practical and theoretical considerations of conducting a Design Thinking course are compiled in the MindMap in Table 1. The details are discussed within the scope of this section.

The theoretical approach towards Design Thinking has been exhaustively discussed in the previous section. However, to put theory into practice is another point. Within the scope of this section, the more practical components are discussed. Many more issues are depicted in Table 1 illustrating a mind-map that compiles many more aspects. The following were the main key-issues:

- framing the course objectives, theme, and goals;
- breakdown and scheduling of the design thinking cycle into useful lecture units;
- creation of an adequate location and environment to enable communication and idea finding;
- provision of resources and IT infrastructure including prototyping tools;
- compilation of a set of lecture materials and handouts;
- selection of course participants and building an opened team; and
- getting the didactics and pedagogics right and avoid standard pitfalls.

Table 1 MindMap of practical and theoretical considerations in conducting a Design Thinking course

Design Thinking course					
Goals and objectives	Team Processes	Defining the challenge	Resources and IT Infrastructure	Didactic aspects	Problematic issues
Course context Course theme Context background & theory Design Thinking theory Framing the context & theme Innovation theory Defining the course content Course vision Problem and solution space exploration No analytic thinking required Multidisciplinary Creating the atmosphere Current state-of-the-art Industrial players Media management knowledge Theoretical foundation of the context Rules of Design Thinking Human centeredness Ambiguity preservation Fostering communication Re-design Tangible ideas Flow of ideas & creativity	Creation of autonomous teams Multidisciplinary approaches Selection of course attendees Design Thinker personality The 4 Obstacles Accepting team members Accepting yourself as peer Setting ideas free Personality development Development of a design thinking team Results & performance measurement Team performance measures Review of team results Personality traits	Everyday life problem vs. analytical problem Openness vs. closeness Required domain knowledge Design oriented formulation 'Grand' social- or human driven problem Pool of industrial problems	Space & environment Off-Campus Innovation labs Social space also beyond the course Designed workspace: tables, charts, etc. Social and collaborative 'hang-out' environment Distance working equipment (if required) Learning materials and readings Course theme & context materials Design Thinking materials Information about how innovations are handled in a particular industry context Timing & schedule Course scheduling Team building & introduction lecture Theoretical course components Practical course components Design thinking phases Sub-division in lecture units Definition of home-works and group-works On-site group works & workshops Prototyping tools & materials Resolution vs. abstraction Paradigmatic vs. parametric prototypes Diverging vs. converging communication Communication goals Media models framework	Learning methods Project based learning Education without theory Learning by doing Problem solving orientation Methods for each design thinking phase Creating vision Guiding the problem solving process Exploration of the problem and the solution space Encouragement for exploring ideas Avoidance of censorship and critics "Let's try it" approach Iteration of ideas From teacher to coach and trainer as part of the team	Wrong challenge definition Wrong exploration of the problem/solution space Focusing and framing the problem too late Analytical approaches

Table 2 illustrates the various Design Thinking phases, and goals and outcomes of each phase. The standard Design Thinking phases were extended by a self-learning phase, and a business planning phase.

3.1 Defining the goals and objectives

The initial step in starting-up a Design Thinking course is to define the goals and objectives of the course. This includes mainly defining the course context integrate the rules of Design Thinking into the course definition. It's useful to define a concrete theme for the course to be able to create a more graspable vision for attendees, as well as to define the general thematic frame. This relates to the description of the background of the particular course theme (e.g. media management, ubiquitous computation, urban informatics) to provide the essential background information and required theories and knowledge about the current state of the art. The definition of the general context of the course helps at a later stage to define the Design Thinking challenge, as well as to attract industrial players for the definition of challenges. Obviously, in a general university setting students are coming from different backgrounds and enter the course with different background knowledge. To overcome this shortcoming, it is essential to be prepared to teach participants more about the thematic focus and provide the essential background knowledge. Despite some argue (see e.g. [52]), that Design Thinking courses shall avoid the teaching of theories and rather focus on project based learning, it might be difficult to realize in particular university settings. As e.g. at technical universities with varying students backgrounds, some particular themes are difficult to address without teaching any essential background information covering the courses' theme. Another option is to design the course on a very general level, where the context of the course is rather broad. In this case students can easily identify with the theme (e.g. shopping experience, home entertainment, health care for the elderly, …) therefore it's not essential to provide additional theoretical lectures about the course theme. Nevertheless from our practical experience it's advisable to place the course under a particular theme and provide the essential background knowledge which can be acquired by the students within the courses. We also believe that the theories of Design Thinking shall be taught, that attendees have a tool-box of methods available which they can use in other contexts at a later stage in their career (e.g. in creating industrial workshops, in their later work-life, or to further explore problems and solutions in other settings).

While creating the goals and objectives of the course, it's very essential to keep the rules of Design Thinking in mind [43]:

- human centeredness: human-centered design activities;
- ambiguity preservation: out-of-the box thinking and letting ideas diverge;
- re-design of prototypes: evolution alike iteration and re-examine solutions of the past;
- tangible idea creation: creation of tangible objects (prototypes) for exploration;
- fostering communication: multidisciplinary communication on the basis of tangible objects; and
- creating a flow of ideas fostering creativity: "let's try it" and exploration of the problem and solution space.

This shall manifest in the creation of the vision, which shall challenge students to go beyond commonly thought solutions to problems. For the teacher it's always essential to keep in mind, that the students shall explore the problem space, as well as the solution space rather than approaching the problem analytically. This is especially important when applying Design Thinking in the context of technical universities, as the main teaching method is in solving problems analytically – thus exploring the solution space based on a given problem, but not the

Table 2 Overview of the Design Thinking phases (compiled and excerpted from [15]) extended by business planning and self-learning

Self-Learning	Empathize	Define	Ideate	Prototype	Test	Business Plan
• Reflect	• Observe	• Actionable problem Statement	• Flaring	• Rapid prototyping	• Real Life Testing	• Resources
• Learn	• Engage	• Focus	• Going wide for concepts and outcomes	• Testing	• Re-Definition	• Realization planning
				• Re-Definition		• Financing
Learning the problem domain	Understand and empathize with the consumer	Provides focus and frames the problem	Source for prototypes	Quick and rapid prototyping	Letting consumers interact – don't tell	Developing a business plan
Learning the Design Thinking process	What needs and desires do users have	General vision for the group	Step beyond obvious solutions	Learning about failures	Observation	How can an idea be turned to business?
Innovation training	Identify for whom do design for	Reference for evaluating ideas	Team creativity	Conversations with a real object	Improvement of prototypes	Which funding is required?
Self-reflection & discussion of the method and the problem domain	Which emotions to trigger/guide the consumer	Guides the innovation efforts	Unexpected areas for exploration	Testing and improving possibilities	Particular prototypes should answer concrete questions	How marketable is the idea?
Basic training in methods & techniques	What are the thoughts and values	Fuels brainstorming – "how can we solve...."	Wide range of innovations	Solution based process	Find out latent and new needs	Business model and practical visibility
	Which kinds of stories do they tell	One solution for one group of people	Beyond obvious solutions			Business processes
	How do people act in situations	Not many solutions for everything	Pushing the team brain boundaries			
	What helps us to know their experience	Inspiring people of what you do	Sketches, scenarios, stories, involve consumers, tell stories, PowerPoint, …			
	• What do people do?					
	• What do people think?					
	• What do they need?					

problem itself. To overcome the analytical way of thinking it's a good idea to involve students with other than rather technical backgrounds and create true multidisciplinary teams. However, this depends highly on the practical arrangements of the university and the possibility to attract students with different backgrounds. If the creation of a real multidisciplinary team is not possible, the course needs to be outlined as such, that students come clearly away from their analytical way of thinking and start to explore both – the problem space and the solution space – and iterate through possible solutions. Thus during the creation of the goals and objectives of the course, it's always essential to keep this issue in mind: the main goal is to create an atmosphere where a flow of ideas (even the craziest ones) are created, prototyped, and iteratively improved. The goal of the course is the development and creation of tangible ideas solving human centered problems, which are iteratively improved via user-tests. In most technical universities analytical problem solving is pre-dominant, thus students have to be motivated to actually explore the problems, scrutinize these, and probe with consumers the validity of these. This needs to be already clearly outlined in the course goals and objectives to define the pace and atmosphere enabling attendees to be creative and go beyond the state of the art of solutions and find currently un-thought ideas to solve the problem.

It is also useful to provide theoretical knowledge about what actually innovations are – how they are defined, created, commercialized, evaluated, and managed. This helps to tie the course to a more practical business oriented setting, as e.g. innovations are handled differently in various industrial contexts (e.g. innovation in media, innovation for software development). By keeping these issues in mind when defining the goals and objectives of the course, attendees will obtain a wide range of knowledge of:

1) how to implement a Design Thinking session in other than university settings;
2) obtain sufficient knowledge and a set of methods to explore the problem space and solution space iteratively within a particular context;
3) know how to deal with innovation in a particular industry from a business, management, technical, and theoretical perspective;
4) and learn the process of Design Thinking in a learning-by-doing fashion and on the help of practical examples.

In our setting, the objectives and goals were to cope with latest trends in entertainment and media management. Skills for problem solving within a cross-disciplinary team shall be learned. Especially in media industries, the continuous creation of innovation and new products is major concern, due to the short product cycles. This objective of this course was to apply Design Thinking in the idea generation phase and empathize with the way how designers think. But it's not solely about designing things; it's also about idea generation and creative thinking. This course especially devoted to innovations in media industry, and especially how ideas to improve media products can be generated. Teamwork, consumer oriented thinking, and creating business out of these ideas is in the foreground of this course. The challenge for students is to generate new ideas in the field of ambient media. Ambient media – or also referred to as ubiquitous media – are media that are embedded throughout the natural human environment. Examples are smart homes, location based services, or smart wallpapers. However, the main aim is to train participants in the method of design thinking by exploring industrial challenges around the topic ubiquitous / ambient media together with industrial partners.

Within the scope of this section, we discussed how to define and set the goals of a Design Thinking course or lecture. The following section describes in further depths, which resources and environment is required to implement the course on a practical level.

3.2 Resources and IT infrastructure

The infrastructure and resources required for a Design Thinking course differ from other types of courses mostly in the space and environment where the course is taking place. Creative thinking and letting ideas flow is rather hardly possible within the context of a dull lecture room or classroom. To create a space which motivates and favors creative thinking is a must. Ideally the space of the course is off-campus, and an innovation friendly environment. Innovation labs, startup lounges, open spaces, or creative spaces are a suitable place to run the course. A social and collaborative 'hang-out' space fosters collaboration and putting students out of the university context. Many Design Thinking schools as e.g. the Hasso-Plattner-Institute (HPI) in Potsdam, Germany equipped their rooms with special working equipment, such as special designed chairs, tables, flip-charts and include working tools for collaboration ranging from writing tools, tools inviting for play, comfortable retreat zones for coffee and lunches. However, this equipment might not be available at many places, or be too expensive to organize in some university settings. A budget solution is to organize common working utensils as colorful paper, pens, posits, glue, large papers, among other utilities that might be utilized by students. The creation of an atmosphere - allowing innovation float and fosters communication - is still the responsibility of the teacher, and many simple solutions allow also becoming a low budget Design Thinking course a success. Thus the space is a crucial element for the successfulness of the course, and has to be well considered.

The teaching location had to differ from the daily university environment, and provide the facilities for applying Design Thinking as teaching method. It should be an opened space, providing a suitable atmosphere for fostering creative thinking. We selected the premises of the New Factory (Demola) in Tampere city. The premises were established as open innovation space for Tampere region. Figure 1 presents a table within the open innovation space. We also utilized a very simple IT infrastructure and resources for prototyping. From the IT infrastructure the course was rather simple organized, and it's main tools were an online moodle, email lists and software tools (e.g. PowerPoint, Adobe Photoshop) used to develop mockups and first prototypes. Sufficient workshop materials, such as different colored/shaped postix, colored paper, colored pens, glue, and other office materials have been supplied.

A more problematic issue is to conduct a course over distance, where students do not meet physically. Standard distance working equipment (if required) should be provided, such as video-conferencing tools, online chat rooms, email-lists, and exchange of contact information. But to integrate students in distance courses is a rather challenging task, and it's advised to bring them together at an as early stage. Only after the integration of the teams, it's possible to conduct follow up work in an appropriate way. Nevertheless, Design Thinking over distances are extremely challenging and difficult to conduct.

3.2.1 Teaching materials & reference literature

Despite the general thought that frontal teaching and background materials about the course should be avoided, and the team processes put into the foreground – the creation of a portfolio of learning materials and readings assists students also to conduct workshops and courses at a later stage in their career in life. It also helps to come into the theme of the course, and organize a team spirit from the beginning. However, it can also be argued, that the effectiveness of lectures can indeed be discussed – but basic materials are essential for students. It might be that the particular cases of a Design Thinking course, thus the concentration on practical aspects is sufficient and has many advantages though. The

learning materials and readings preparation is pretty straightforward and is a similar task in comparison to other university courses. The package for students shall contain:

- course theme/context related readings about the special focus topic of the course;
- Design Thinking readings, including materials covering methods that can be applied;
- materials covering how innovations are handled within a particular industry segment or context.

Literature and related works for a Design Thinking course in media management:

- Basic literature that should be read by all students: chapter 1 of the text-book [64], [8], chapter 1 and chapter 7 of the text-book [37], [15], [12], [38], [48], [55] and selected chapters of [52];
- Design, innovation and creative problem solving: [62], [18], and [59]
- General Design Thinking overviews: bootcamp information [15], [12], [37], [38], [48], [55], and practical cases in [17];
- Consumer research, experience, and ethnography: design ethnography [5] and [54]; experience prototyping [13]; design toolkits [1]; empathy and experience [63]; and empathy and probing [41], [29], [60], and [49];
- General and business & management application areas for Design Thinking: chapter 4 of [37], [19], [25], readings from [39], [36], and social applications [10] and general thoughts how to apply the method [47];
- Understanding prototyping and early designs: [20], [14], and [26]; and
- Media industry and innovation: chapter 1, 4, 8 of the text book [64], chapter 1 and 2 of the text book [37].

3.2.2 Selection of prototype materials

The actual media – or resources for communication - are prototypes. These objects act as medium for discussing and elaborating ideas, create new insights, and provide the basis for consumer studies. An excellent compilation of various different abstraction levels, representations, and tangible objects can be found in [20], upon which this paragraph is based (advised readings also include [14], and [26]). Paper prototypes are the simplest way for creating rapid test artifacts, as e.g. described in [58]. When considering the prototyping process, as well as the tools to create it, the following issues have to be considered (compiled from [20]):

- choice of the prototype level of resolution: level of the resolution of the media that representing the object (e.g. sketches vs. detailed computer models);
- choice of the prototype level of abstraction: level of abstractions of the media that represents the discussion object. Thus level of the realistic representation of the object (e.g. ready prototype) vs. an abstraction of certain features of a prototype (e.g. specific functionality of the prototype);
- communication line (diverging vs. converging): in general, prototypes lead to conversion and communication. Design Thinking fosters diverging discussions, e.g. in the ideate phase – or early problem exploration phases. The question if the prototype leads to diverging or converging discussions defines the media type.

– The more parametric the model & the lower abstraction levels & the higher resolution ➔ more convergent discussions (e.g. mathematized media as maps or realistic images);
– The more paradigmatic the model & the higher the abstraction level & the lower the resolution ➔ more diverging discussions (e.g. ambiguous media as posits, or models);

- communication goal (parametric vs. paradigmatic changes): distinguishing between the goal of how the prototype shall have impact on solving the challenge.

– The lower the resolution of the model & the higher the abstract level ➔ more paradigmatic changes, thus more generalized, and broader base for exploring the idea and problem space;
– The higher the resolution of the model & the lower the abstraction level ➔ the more parametric changes, thus more specific, focused base for exploring the idea and problem space;

- understanding of links and relationships between components: the investigation of links and relationships of the complete concept and see how specific components of a prototype interacts is another issue that has to be considered. Hybrid models (thus models combining various media objects) allow the investigation of links and relationships between various components (e.g. some high level parametric mathematic models, and a possible user interface);

3.3 Managing the team processes and didactic aspects

Although the name suggests so, Design Thinking as a method does not require a degree in design to be applied successfully. In fact Design Thinking profits very much from different perspectives introduced by team members from multiple disciplines. In a university context courses should be ideally organized as a collaboration between two or more faculties. If the participants shall be introduced to Design Thinking for the first time, they should be coached by teachers from all faculties to learn about the respective benefit of the process for their own discipline. The first step in building a successful Design Thinking team is to overcome stereotypes such as “designers can draw well”, “artists are creative” and “engineers are good in maths”. Many people see design as a synonym for aesthetics, but in this context it very generally means “creating something for a purpose”. In a typical course setting, we have observed three obstacles you have to master in order to build a successful team.

3.3.1 Obstacle one – Accepting your team-members as peers

Multidisciplinary teams in the sense that people with different expertise collaborate are common. Engineers work with designers and business experts frequently and sometimes closely. Yet usually they stay within their own area of expertise, which the collaborators mutually respect. Even that is not always granted in teams, so we acknowledge that a multidisciplinary team is already a great achievement. But Design Thinking calls for something more: You have to accept the ideas of your team members even in areas where you deem yourself an expert. Especially in phases, where ideas a generated, e.g. by various brainstorming techniques, it is important to hold back the reflex of declaring wild ideas unfeasible. Time permitting, short presentations about each team members discipline might help to build up mutual respect and professional trust.

3.3.2 Obstacle two – Accepting yourself as peer to your team members

This is all about coming out of your own disciplinary comfort-zone. If you develop ideas within your field of expertise, you can double-check them and argue why they are innovative and feasible. If you move on to unknown ground, you might feel that you are not prepared to argue

for your idea. So instead of just stating the idea so others may build on it you keep silent to prevent the risk of feeling foolish. This applies not only to ideas but as well to certain methods or techniques, such as communicating your idea in drawings or prototypes. Overcoming this obstacle is all about giving positive feedback and getting into conversation to get a mutual understanding of the different ideas sketched by team members. In the beginning teachers should frequently remind the teams of the Design Thinking rules. If the course schedule offers enough room for reflection, it can help to discuss a bit about the different technical terminologies the team members are using. A good start is always the understanding of the term design, which has a lot of meanings from "aesthetic pattern" to "system architecture".

3.3.3 Obstacle three – Set your ideas free

In an age that is shaped by the notion of intellectual property it is no wonder that students cling to their ideas. And undoubtedly the ability to stick to an idea and make it fly against all odds is vital to the successful entrepreneur. Design Thinking is about finding those great ideas, but it also emphasizes that they do not come out of the blue. Great ideas are the product of a process that involves discussing and prototyping a plethora ideas to learn from them. Never hesitate to utter something you consider a mediocre idea, because it might be what is needed to inspire a better idea. The final results of a Design Thinking process are always the work of the whole team, as any idea is a consequence of the ideas that were before. The urge to promote our own concepts is understandable, but biases the view on other ideas. It can be useful to trace back the evolution of the final concept as an exercise of reflection to make the team aware of the inter-dependencies during the creative process.

3.3.4 Obstacle four - Personality development

Tim Brown discusses some basic traits of character that make a good design thinker in [8]. He begins with Empathy as the skill to "observe the world in a minute detail […and to …] notice things that others do not and use […] insights to inspire innovation" [8]. The observation shall undertake from different perspectives, such as the user's or a colleague's. Design Thinking demands, but also supports empathy by the suggested research methods and through the constant interdisciplinary conversation in the team. The requirement of Integrative Thinking is harder to grasp. It could be described as the blend of analytic and lateral thinking, but in our opinion it is even more about embracing uncertainty. This has something to do with our minds longing for consistency. Analytical thinking has a tendency to blend out contradictions within complex problems in order to have a consistent model of the problem or system to work on. Integrative thinking means withstanding this contradiction and follow ideas that are based on imperfect models with the Optimism to recursively improve the model in dialogue with possible solutions at a later stage. Tim Brown postulates Optimism as a trait of character of a good design thinker in a very specific way. He interprets it as the belief that even the most complex of problems can be solved better than it is currently. This does not mean that all team members need to adopt an optimistic attitude throughout the whole design process. On the contrary, the ability to adopt a critical attitude if needed can be very fruitful and is in line with the request for empathy mentioned earlier.

As a fourth characteristic Tim Brown names Experimentalism, which means to enjoy making bold changes to existing solutions and a "try often and fail early" attitude. This is closely related to the notion of playfulness and we believe that play is inherent to human nature. At the university, play is slowly catching up to reclaim its ground in contrast to what one could call the "think and construct" approach. Students get told to think through all

alternatives inside their heads first before they actually start acting. It is important to explain to the teams that there is nothing wrong about that approach, it is just not what Design Thinking is about. Design Thinking relies on externalizing and materializing our thoughts and reflecting them in Collaboration, to name the fifth virtue of the design thinker. Tim Brown goes as far as to call for design thinkers to have significant experience in more than one discipline to enable true interdisciplinary collaboration. However in a university context most students will be happy to master one discipline for a start and curiosity beyond their own area of expertise should be enough as an initial requirement.

Obviously not every student will show the full personality profile as outlined by Tim Brown right from the start. Fortunately a well-executed Design Thinking process also favors the evolution of these character traits with the team members.

3.4 Defining the challenge

The definition of the challenges shapes the core of each Design Thinking course. The challenge should allow a consumer centered approach in problem solving and acts as the center of group activities. It's a tricky and challenging task, and to define a well framed challenge, we have to discuss a few aspects beforehand. A wrong understanding about the method of Design Thinking leads to a faulty definition of the challenge and will guide students wrongly. The following considerations should be made before formulating the challenges:

- 'grand' social- and human driven problems;
- analytical 'scientific' problems vs. everyday life problems;
- pool of practical industrial problems;
- openness vs. closeness;
- required domain knowledge;
- design oriented problem formulation;

Design Thinking addresses everyday life problems – around designing services, products, and innovations. Its approach is human centered and consumer driven. Thus the challenge can be designed around 'grand' social and human driven problems in everyday life. This could be around everyday problems, such as shopping experience or how the experience of consumers can be intensified by a design oriented solution: the more 'grand' the solution - the higher the motivation of the team. Though challenges that solve the all the problems of the world might not be focused enough to let a concrete solution emerge. It's obvious, that consumer driven methods have their limitation, and concentrating on particular facets of the problem space is essential. Students shall be enabled to explore the problem space, discuss and empathize with the consumer to elaborate the actual problems of the challenge. When attempting to create a too large problem space by keeping the challenge to wide, the opposite of the desired effect can happen. Thus it's rather hard to focus the problem down and explore the solution space efficiently. A common miss-understanding is the fact, that analytical 'scientific' challenges are rather hardly being solved by applying a user-centered approach. This could include challenges that require lengthy scientific research to proof the correctness of the solution. The process of developing a new medication and its lengthy research work including laboratory experiments might not be the right challenge to solve. A more practical formulation of everyday problems, as e.g. finding the solution for Alzheimer patients might be a better approach. To define a more opened challenge, which allows the exploration of the actual problem with methods involving the consumer might be a more appropriate way. A closed challenge, allowing yes/no answers or already guide the participants of the course

into a certain solution alters the ideation phases and leads already directly to solution rather than letting the actual problem examine. Depending on the background of the team, which might many times not as multidisciplinary – or skilled in the domain knowledge of the challenge might also limit the definition of the challenge. Especially in common university settings where many students might have similar study backgrounds the challenge might need to be more focused or adjusted to the domain knowledge. Some of the challenges also don't allow the formulation as actual design oriented problem and limit the outcome, as the challenge cannot be formulated appropriately nor explored by methods empathizing with the consumer. Another way to cope with a too wide challenge is the re-focusing in the phase of exploring the problem space, thus after the exploration of the challenge. However, this requires careful skills from the teacher side to guide into right directions.

There are many important issues around the formulation of the challenge. Within this section a solely few concerns, limitations, and guidelines are stated. It requires a bit of thoughts in creating an appropriate challenges which can be solved within the scope of a course. One other approach is to create a pool of challenges from external stakeholders, such as industrial partners and include these, as they are actual real-world problems. As many times shown (e.g. in [52]) novices are sometimes the better problem solver in daily industrial problems. Current management structures in companies don't allow disruptive ideas to be tested – which could be overcome by novices in the field, which in particular the focused way of thinking as professionals don't have.

4 Suggested timing and schedule of a design thinking course

Another issue is the correct timing and scheduling of the course. In principle the schedule should fulfill the following requirements:

- follow the Design Thinking phases and allowing traversing back to earlier phases;
- team building and introduction lecture;
- theoretical course components;
- practical workshop alike course components;
- fulfilling the needs of the specific university environment; and
- providing the essentials for enabling Design Thinking.

To teach Design Thinking the course requires that students will need to work together for a couple of hours on the various aspects and challenges of the course. Thus, to integrate the teams it is essential, that the course is organized as a kind of 'block course' with regular meetings ranging up to full day schedules. Without this alignment it is rather tricky to get students together as teams, and efficiently let the Design Thinking phases prevail. Home-works are possible, and can integrate the teams further on, as it's simply a nice team experience. The main work within the context of the various Design Thinking phases shall still be performed in on-site group works and workshops. This avoids letting students run into the typical pitfalls e.g. in ideation or prototyping phases and fall back to analytical problem solving approaches, rather than letting ideas float. This section is excerpted and an updated version from [34] and [35].

It is advised to arrange at least 5 learning events, where each one is organized as a block. In our particular cases, the course was arranged in 5 teaching units, where each event had a duration of up to 4-5 h (except the first lecture. Each unit involved practical works, presentations, and workshops. However, it's advised to keep the lectures opened, as none of our sessions solely was held for 4–5 h. Most of the sessions were prolonged. The first

event was of shorter duration, as solely practical matters where discussed. Between each learning event, students had to do homework which they had to organize by themselves in groups. The amount of work for each homework was approximately 8 h when the course was held with lecture breaks in between (e.g. face-to-face lectures each week).

The different learning events followed the phases of the overall design thinking cycle, extended by the phases of self-learning and business planning. The "empathize phase" was performed in form of a student homework (homework 3). Within one lecture the "define" and the "ideate" phase has been performed in form of a workshop during the lecture. The "prototype phase" was performed in form of student homework (homework 4). Due to a lack of time, the "test phase" could not be performed within the scope of this course, but was replaced by a homework exercise (homework 5), where students had to evaluate, reflect, and develop a business plan.

4.1 Lecture 1 – First gathering (approx. 2 h)

- objective: general introduction, gathering of interested students, forming of groups, and division of presentations;
- content: presentation of the general course goals, administrative issues, scheduling of learning events, and presentation of student presentation topics;
- homework 1 (self-learning presentation): preparation of general presentations about design thinking within student groups;

The first gathering should bring students together, and get known to each other. Small group exercises allow integrating the teams on a better. The teams should be already formed according the cross-disciplinary viewpoints, to allow a better Design Thinking experience in later phases. The topics for self-learning should be presented and assigned to particular student groups.

4.2 Lecture 2 - Student presentations and design thinking "Test-Run" (approx. 5 h)

- objective: presentation of the theoretical aspects of design thinking and performing a design-thinking test-run to train students in the new method;
- content: student presentations of background materials about design thinking, general discussions about the method, design thinking 'test-run', and division of design thinking challenges;
- method: student presentations (10 min plus discussion/presentation topic), acquisition of the essential knowledge how to perform design thinking as a creativity method in a learning by doing style;
- homework 2 (design thinking 'test-run' report): compilation of the results of the design thinking test-run into a report;
- homework 3 (user-study): preparation of a user-study via interviews, observation of the design thinking challenges to understand and conceive the actual problem by selecting a method from ethnographic studies;

4.2.1 Design thinking "Test-Run"

The main purpose of the second learning event should be to train students in the method of Design Thinking on a practical example – a Design Thinking "Test Run" as self and learning by doing experience. At the introduction at the beginning, it's advisable to organize a simple

warm-up game, where students should introduce each other and gain trust within the teams. It should relax the atmosphere to build two teams. In this phase it is very important to divide students according their background and place them in multidisciplinary teams to enable an opened environment. As the concept of the course is based on practical works, a small design challenge that can be performed within a 3 h should be given. A good example challenge is e.g. to let students work on how an innovation space can be improved where the course takes place: the challenge is to improve the facilities whose goal is to provide an opened innovation space that fosters creativity and thinking beyond the edge. How can the space be created more creatively and friendly for the people working here with ubiquitous media? Students have to observe and interview the workers of the open space, and develop paper mock-ups how the environment could be made more innovation friendly. Several phases of Design Thinking should be touched and the theories of the phases should be explained through self-experience and reflection. As result, students have to create a report how to improve the innovation space and how to create a new experience for the employees. Table 3 illustrates the schedule for the "Mini-Design-Thinking" session, and Fig. 4 shows the 'prototype' of an improved opened space for an innovation environment.

4.2.2 Ethnography based user study

Especially for the user-study it is very essential to investigate methods that are simple enough for being taught to students for completing the user study. They should be well suited to understand the consumer, stimulate unexpected findings, be flexible enough, be holistic, allow a contextual inquiry, and fit to the phases of the Design Thinking methodology. Therefore we focused on the collection of ethnographic holistic methods that allow precise documentation and planning and can act as guidelines for observing, defining, and framing the underlying problem. In literature keywords would be "holistic design", "design probes", "contextual inquiry", "experience prototyping", or "design ethnography". For investigation of these methods, we pinpoint to the following literature resources as reference: [1], and [54]. These resources acted also as literature for student for investigating these methods and should apply in the empathizing phase, as well as later in the evaluation phase. Within the scope of this course, we utilized the IDEO HEAR toolkit during the empathizing phase. It helped the students to ponder the implications of their ideas in further detail with the help of the other supplied background literature. As students varied in backgrounds, it

Table 3 Schedule for a 'Mini-Design-Thinking' session

16:00-16:30 Introduction
• (10 min) Warm-up Game 'introduce each other'
• Form teams (multidisciplinary, with 'strangers'…)
16:30-17:30
• (5 min) Challenge Presentation
• (55 min) Observe & Interview
17:30-18:20
• (10 min) Introduce Point –of-View
• (10 min) Define Common Point-of-View
• (30 min) Ideate
18:20-19:00
• (60 min) Prototype
• (30 min) Presentations

Fig. 4 Design Challenges Given as Home Work

was clear, that a first time ethnographic study will by far be perfect. The intention of this homework was rather to familiarize students in the way how to perform the task as such. The given references acted as basis for discussions what was helpful, insightful, hindrance, or boring in addition to the actual results and the process. The approach was to revise what has been done in further depth, and how to apply these techniques better in future studies.

4.2.3 Introduction and presentation of challenges

At the end of the course, the design challenges should be presented. Students should be divided into groups (if the previous groups did not work well), and each group should focus on one challenge. As homework, students have to empathize with the consumers and create an evaluation from the consumer viewpoint by applying the methods mentioned above. The results are to be presented in the following lecture. To avoid any straightforward solutions, the challenges were designed to restrict the idea finding process and did not allow any common solutions (e.g. no mobile solutions or no public screen solutions were allowed) listed in Table 4.

4.3 Lecture 3 – Presentations, point-of-view, common point-of-view, and ideate (5 h)

- objective: presentation and discussions of user evaluations, and performing the other phases of design thinking as workshop;
- students: presentations and discussions of user evaluations, and performing the other phases of the design thinking phases;
- trainer: presentation and overview of the goals of each design thinking phase and methods applicable for the ideation phase;
- methods: presentations, discussions, and creative workshop organization;

Table 4 Design challenges given as home work

DESIGN CHALLENGE 1

• **SHOPPING**

ambient media are media embedded throughout the natural environment. How can the shopping experience (keywords: finding, navigation, payment, personalization, advertising …) for consumers increased with this technology for IKEA (NO mobile phones and public screens allowed!)

• **Documentation**: pictures, notes, method, additional materials, report, presentation …

DESIGN CHALLENGE 2

• **URBAN KIOSKS**

ambient media are media embedded throughout the natural environment. In the future more and more urban kiosks at city points will be available allowing communities to exchange information (keywords: communities, live-events, information exchange, urban computation, co-creation of media, polls, navigation, leaving memories, exchanging personal content). How can the urban 'phone cell' of the future look like? Check out meeting points, museums, public events, …

• **Documentation**: pictures, notes, method, additional materials, report, presentation …

DESIGN CHALLENGE 3

• **CINEMA**

ambient media are media embedded throughout the natural environment. How can the experience (keywords communities, live-concerts, co-operation, advertising, public advertising, navigation, 3D) for consumers increased with this technology for cinema visitors as e.g. Finnkino (please NO DULL mobile phone services or NO DULL public screens!)

• **Documentation**: pictures, notes, method, additional materials, report, presentation …

- content: performing the core phases (individual point-of-view, common point-of-view, ideate) and discussion of the results with all the course members;
- homework 4 (prototyping and presentation): preparation of a user-study via interviews, observation of the design thinking challenges to understand and conceive the actual problem by selecting a method from ethnographic studies;

The idea of this lecture is to assist the students in creating their projects and evaluate their project ideas, user studies, and performed home-works. The goal is to discuss and go through several student presentations, and initialize the ideate phase. A concise plan for the prototypes, as well as to which qualities a prototype should be developed should be discussed. This should include what features or aspects of the selected challenge and ideas the prototype should represent. One of the main considerations is, that the prototype has to be developed for an explicit reason. This allows a better focusing of student homeorks, and better motivation of the involved student groups. Table 5 presents the schedule for this lecture, and Fig. 5 show the student teams working on their preliminary prototypes (Figs. 5, 6, 7, 8, 9 and 10).

Table 5 Schedule for the practical design thinking workshop

-16:30-17:30

Presentations of student homework (Point-of-View)

-17:30-17:45

Define Common Point-of-View

-17:45-18:00

Checkups: Present Common Point-of-View

-18:00-19:00

Ideate

-19:00-19:30

Present Ideate results

Fig. 5 Prototyping Phase

As homework (besides the prototyping as such), students have to reflect on the prototype development, and present the results in form of a presentation in the following lecture. The presentation should include answers to the following questions:

- What is prototyped (clear description)?
- Who is the intended/expected consumer of the prototype?
- For which purpose and for what features/aspects of the challenge or solution are sought to be explored?
- What did the teams learn and reflect from the particular prototype?
- What were the most useful things of the prototype and how did they affect the change of the perception of the challenge or its characteristics?

4.4 Lecture 4 - Product idea presentation and evaluation (5 h)

- objective: gathering of interested students, forming of groups, and division of presentations

Fig. 6 Prototyping phase with colored paper and stickers

Fig. 7 Students discussing their ideas (*top*). Discussion between students and managers in Demola (*down*)

Fig. 8 Image showcasing the hollow structure of the divider where wires can run freely

Fig. 9 Prototype of the Kub for IKEA from Team #1

- content: student presentations of background materials about design thinking, general discussions about the method, design thinking 'test-run', and division of design thinking challenges
- homework 5 (final report an diary): students had to complete a final report in form of a learning diary reflecting the design thinking process and presenting a short business evaluation of their ideas;

The last homework of students is to complete a written final report, which had to answer a few questions to enable them a reflection on the learned. A sort of kind of learning diary is an efficient method to enable a pragmatist inquiry. The follow-up reflection of the practical experiments, workshops, and learning sessions shall lead to

Fig. 10 The imaginary iKiosk from Team #2

reconstruction and learning. The report should be structured into three parts: development process of the concept, group processes, and a small scale business part. The design thinking phases acted as structure for the report. An example set of questions that students had to answer are:

Development process of the concept:

- Why was the concept developed?
- What challenges or opportunities did it address?
- How was the concept developed?
- How was the development undertaken by the group?

Reflection on team functioning and processes:

- What do you consider the most critical/definitive stages in the team work?
- How did your perception of the challenge/concept change during the process and why?
- How could the methods, tools, and insights gained during the project be utilized for new product development?
- How do human centered/design centered approaches differ from usability or HCI methods in new product and service development and why?
- Why is the human/design centered approach significant in innovation, and why is it not important?
- In which kind of situations or challenges would a systematic/open approach work the best and why?

Business evaluation of the product:

- Describe your idea in general teams in form of a product pitch.
- What are the business benefits for the business partner of your product?
- Describe the market, its structure, restrictions, major players, entry barriers, and layout.
- How can the idea be monetized?
- What would be your market launch strategy, and the strengths and weaknesses of your product/service (e.g. SWOT analysis)?
- How would you organize your firm internally and create links to external stakeholders/-business partners?
- Which resources would be needed to monetize/market the product or service?
- How can the service/product be maintained and which resources would be required?
- Could you please outline a very simple financial plan for your product/service?
- What would be a preliminary time-plan for the first years of your newly launched company?

4.5 Lecture 5 – Guest lecture with practical work and course roundup (5 h)

To round-up the course, a guest lecture with a more business viewpoint is enhancing the learning process. A practitioner should review the results of students, and especially assess the business viability of their ideas. In our case we arranged a guest lecture in the thematic area “Marketing with Social Media” has been held. The lecture should help students to get a glimpse how their product can be marketed via social media tools. This lecture was accompanied with a small practical group work, where students had to develop an advertisement concept. The lecture was more of a round-up type and should conclude the course.

5 Case Study 2011: Improving IKEA & designing an urban Kiosk

The first ever round of design thinking course was held in spring 2011, Tampere. The objective of this course was to engage ourselves in and be familiar with the latest trends in entertainment and media management. In media industries, the continuous creation of innovation and new products is a major concern due to the short product life cycles. Time pressure is high and new ideas must be created continuously which is often a very demanding task. The aim of this course was to weave the method of design thinking into the development of ideas phase and empathize with the way designers think. It was designed for developing and exploring new ways of finding ideas to improve already existing media products and get into touch with creative problem-solving methods in a short time and with very fast-paces. Teamwork, consumer oriented thinking and creating business concepts out of these ideas is in the foreground.

The objective of this course was to engage ourselves in the latest trends in entertainment and media management. Especially in media industries, the continuous creation of innovation and new products is a major concern due to the short product life cycles. Time pressure is high and new ideas must be created continuously which is often a very demanding task. The aim of this course was to weave the method of design thinking into the development of ideas phase and empathize with the way designers think. It was designed for developing and exploring new ways of finding ideas to improve already existing media products and get into touch with creative problem-solving methods. Teamwork, consumer oriented thinking and creating business concepts out of these ideas is in the foreground of this course. In other words, instead of merely imparting knowledge and information as always done in traditional curriculum, this course focuses on changing mind-sets of attending students. Such a target is seen extremely difficult to achieve. It demands the course organizer to offer a life transforming experience for the students and even for himself. Meanwhile, this was the first ever round of course implementation in TUT and most students may not be ready to take such a leap. In this context, great challenges are expected to be met by both students and lecturer.

The course has been attended by students with various backgrounds from three universities: Tampere Univ. of Technology (TUT), Tampere University (UTA), and the Tampere University of Applied Sciences (TAMK). A total of 11 students participated in the course, where 7 where originally from TUT, 2 from UTA, and 2 from TAMK. From these students, 2 students were enrolled for BSc. studies, 8 students to MSc. studies, and 1 student on post-doctoral level. The background of the studies varied, and ranged from psychology (1), business (3), media management (2), human-computer-interaction (1), and IT (4).

In the following texts, we first discuss in details the challenges faced by both students and lecturer in the whole process. Then example study cases carried out by course participants are briefly described. The observation made in the course and feedbacks given by course participants will be discussed in the next section which provides valuable insights on the further development of design thinking curriculum.

5.1 Challenges

5.1.1 Prospective challenges from the students' point of view

As a preparation for the course and to insure a suitable environment for the upcoming projects there was first of all a new premise to get familiar with. It was important to acclimatise in a new surrounding with unknown facilities and possibilities. As for the space this course took place in the same applied to the course and background materials which were the basis for all challenges concerning the design thinking methods ahead. The next

step was to create balanced teams of participants with various backgrounds and specializations and finally work together with students outside one's own subject area. These multidisciplinary teams learned about selected methods, techniques and tools to handle each phase of design thinking to complete our tasks and generate new and innovative ideas. The challenge was to realize in which ways the methods of design thinking can be applied and become aware of how it differs from other methods.

The overall challenge for students was to generate new ideas in the field of ambient media. Ambient media – also referred to as ubiquitous media – are all kinds of media that are embedded into the natural human environment, such as smart homes, location based services or smart wallpapers. It is a multidisciplinary field by nature and requires inputs from technology, art, sociology and business sides. Normally, students have only background knowledge of one or two of the above mentioned areas. Thus it is always very tricky if they are able to collaborate and how they work together towards the target when a multidisciplinary team is formed. The willingness to open one's mind as well as the ability to grasp and incorporate new ways of thinking from unfamiliar perspectives are vital and possibly need to be develop in this course. The main tool to accomplish this task was to practise methods of design thinking by exploring industrial challenges around the topic ubiquitous / ambient media.

The skills to be learned were working in cross-disciplinary teams and creating a think tank for developing new approaches of problem-solving ways of thinking.

5.1.2 Prospective challenges from the course organizer's point of view

First of all, as mentioned above, this is the first ever round of implementation for this course. In order to achieve the target of this course and provide transforming experience, lots of creative thinking or even design thinking itself are required for the curriculum organization and arrangement. More specifically, for this course was not meant to be a lecture event as such it had to take place in an appropriated location which supports the intent of this course: innovative and creative working. As well as the right course and background materials the participants were a very important factor which had to be thought about carefully. This course would produce the most remarkable results if there were not just students with the same background and specializations participating. Therefore students from various programmes and different universities had to be contacted and asked if they were interested in such a seminar so it was possible to form balanced teams. During the course taking place there were also numerous challenges for the lecturer as the students had to be given the right tools and training to get to know the method design thinking, make them aware of it and how design thinking differs from other methods. It was difficult to select an appropriate amount of methods and techniques to support students in each phase of design thinking to complete their overall tasks.

Resources & it infrastructure The stage for the Frontiers Course 2011 was Tampere New Factory – Demola, which is an open platform to encourage creative thinking and cooperations between professionals and students of all universities in Tampere region. The aim was to provide a non university-related environment to break through familiar patterns of thinking and open the way for new approaches and creative thinking. Two teams of five and six students have been formed in order to work on two separate projects. So as to achieve great diversity, the lecturer carefully selected participants for each team so that students with technology, business and sociology backgrounds as well as different nationalities are designed to work together.

Time spent & scheduling The seminar was structured in five learning events whereas each time different objectives and working methods took centre stage. Each of the learning events made one

phase of the overall design thinking cycle subject of discussion: empathize, define, ideate, prototype, test. Some of them have been discussed during the seminar, others have been subject of homework assignments. The average duration of such a session was four to five hours. Some of them have been prolonged due to the huge amount of group works, presentations, workshops and exercises. The first meeting constituted an exception regarding length and content because it was simply meant to sort out practical matters and lasted about two hours. Between the single learning events the students had to do homework which added up to eight hours of additional work.

Practical tools that have been applied /Utilized tools (Approach towards prototyping) To accomplish their tasks each team was given free choice of tools they would like to utilize. The practical tools used during the course sessions could be anything that was available in Demola and ranged from computers and mobile phones to flip charts, colored paper, scissor and pens. For encouraging students' creativeness Powerpoint presentations have not been allowed to use as the main means of presenting the results in the prototyping phase.

Teams & team processes This course has been attended by a total of 11 Finnish and international students with various backgrounds from three universities: Tampere University of Technology (TUT), Tampere University (UTA) and Tampere University of Applied Sciences (TAMK)#. 7 students were enrolled at TUT, 2 at UTA and 2 at TAMK. The particular courses of studies differed from each other and ranged from psychology (1), human-computer-interaction (1), media management (2) and business (3) to IT (4). 2 of these students were enrolled to BSc. studies, the majority of 8 students to MSc. and 1 was on post-doctoral level.

For all of the participating students this seminar was a completely new experience. May they already have experienced single factors this course consisted of none of them has ever taken part in a similar project. What made it a mould-breaking experience was the combination of different and partially unknown working conditions like multidisciplinary teams or the fact that it took place in an unfamiliar premise. Each of the students has already worked in teams or learned to apply recently learned methods but what made this seminar extraordinary was the fact that neither the lecturer nor the students were experienced in running this course for it was the first implementation ever.

During the course, a small project called improved open space for innovation is conducted first aiming to showcase students about the whole process. Both teams attended in this project and presented their prototypes in front of the project's customer Demola. Feedback were given to students by both lecturer and managers from Demola. After this test run, two different projects are elaborated: iKiosk and Ikea. More specifically, the iKiosk team had to reply to the following question: How can the urban "phone cell" of the future look like? The second team works on Ikea needed to detect how the shopping experience for consumers can be increase with ambient media. Each team needed to work together and go through the five phases of the design thinking cycle - empathize, define, ideate, prototype and test - one by one as a team in order to achieve the final product and answer their key question. Lots of discussions and work were carried out during lectures as well as self-arranged meeting after the lectures. As important outputs from this course, both teams needed to show their prototypes to every participants and submit a detailed report about the design process and corresponding prototype.

5.2 Project 1: improved open space for innovation

Team #1 identified the major problem of Demola facilities they were going to solve is to cope with the noisy, ergonomically unfriendly and slightly messy environment. A light portable

space divider is developed which also functions as a noise insulator and ambient light source. The idea is that, for example, when an event is held at the New Factory, these dividers can be put around the presentation area so that the people surrounding the area can work at their own peace. The usage of this divider can be versatile and customized to meet different situations.

On the other hand team #2 considered the coldness and factory like environment in Demola as the biggest obstacle for encouraging creativity. Their solution was to provide warm and welcome-type atmosphere to both workers and visitors in Demola by rearranging the layout of facilities and adding many ecorations/label/gadgets with personal touch. This solution was very practical for the moment as no new gadget needs to be developed. In fact, some suggestions had accepted by managers from Demola and they rearranged the innovation environment.

5.3 Project 2: improving shopping experience in IKEA (team #1)

After a field trip to shopping in IKEA, team #1 consider the following problem: people need to write down all the things they are interested in, compare them by walking around and finally collect the things they want to buy in the warehouse in the end of the shopping experience. The concept focuses on this problem and spreads out to improve the whole experience and hopefully make the whole shopping experience more enjoyable especially for first time goers. The overall idea is that a customer walks into IKEA and collects a small cube ("Kub"), which he/she will then use to scan different products that he/she feels interested about. At the end of the shopping trip, instead of the person collecting the products from the shopping area or from the warehouse the consumer goes to a screen, which can be located in the cafeteria area and the user can choose the products that he/she will really want. Once this is done and the products are paid for, the products will be automatically brought to the consumer and the cube is returned and reset for the next consumer to use. As shown in Fig. 9, a concrete prototype of this cube is developed.

5.4 Project 3: iKioski (team #2)

Team #2 came up with the idea of a kiosk that attracts the tourists visiting Tampere area. The kiosk's main functions are offering information on local city activities and helping the user to perform specific tasks. The kiosk conforms to the user by changing the circumstances according to user's personal preferences. These variable circumstances include images, lighting, scent and sounds which help the user to feel like home when visiting the kiosk. In ambient media environment, users will be able to interact with different factors in a ubiquitous way. As the main product here is user experience, the prototype was demonstrated using a theatrical performance showing how a tourist in Tampere benefits from the iKioski in future.

6 Discussion

Within the scope of this section, we would like to conclude the article in a discussion about the course outcomes and our key-observations:

- Analysis of Learning Diaries: This course helped most students efficiently gain first-hand experience on the process of design thinking in a short period. It brings several new elements that benefits students' way of thinking. Based on the learning diaries, the most appreciated benefits are strong involvement of human factor in the design process and opportunity to closely work with people from different

educational and academic backgrounds in the same team. Meanwhile the most challenging part in the design process is also acknowledged by many students and that is when a large amount of sky-high and beautiful ideas need to be narrowed down and refined into one or two ideas which can meet the project target in a realistic everyday life situation.

- Business Evaluation of Results: In this course, the business aspects of prototype "Kub" and "iKiosk" are evaluated by students respectively. The prototype "Kub" was designed to help Ikea offer a happier and relaxed customer shopping experiences, easy and ubiquitous promotion tool and possibility to monitoring consumer behaviors. They plan to sell this prototype and make cash out by several means. First, developers can provide consulting service to IKEA, building a partnership and developing the idea further in order to be integrated with IKEA culture. If such a partnership is accepted, developers can further serve IKEA with "Kub" maintenance service and personnel training program. Licensing is always another choice so that developers make sure that the innovation stays in their hands. Then choice is to sell IKEA a license to use the concept and also sell the same system to other companies or making a exclusive contract with IKEA. On the other hand, the prototype "iKiosk" is expected to be located at very central and convenient location. It provides a robust platform for every business to expand upon. The expected income is divided into two major areas; advertisement and transaction fees. The clients for making advertisements are ranging from leading retail business, public services sector to private use. Transaction fees are charged for providing convenient local services such as phone payment, currency exchange and car or bicycle rent. It is very interesting to notice that, for both teams, the most valuable business opportunities provided by the prototypes not only comes from the prototype itselves but also the services that comes with.
- Team Collaboration Observations: The overall feedback concerning the collaboration of multifarious, intercultural groups with various educational background was a very positive one. The collaboration of these teams improved teamwork skills of every participant and the ways different basic knowledge is exchanged between students. This has lead to many chances of exploring new and uncommon ways of problem-solving. The relaxed atmosphere in a resourcefulness fostering premise opened the way for many new friendships and encouraged students to get familiar with different notions and opinions in order to emerge new ideas and let creativity flow. All participants got the chance to learn new strategies of thinking and consistent further development of ideas in a non-lecture like course.
- Lecturer's Point of view: From the lecturer's point of view it has also been a successful experience since now there is a clear differentiation of the five design thinking phases. This first course implementation helped to outline a structure for the design thinking process especially in the idea finding phase where students are moving towards finding solutions rather than developing their ideas further, define the problem or empathize with the consumers. The awareness of consumer needs has been increased by creating an understanding to empathize with the consumer and focus on his expectations to satisfy these.
- Aspects of Cross-Disciplinarily: Getting to know the way of working in a multidisciplinary team opened eyes for new ways of thinking and understanding other people's notion. This opportunity has emphasized the creation of awareness for holistic point of

views from society, technology and consumer viewpoints. Thinking beyond the limitations made this course possible.

- Aspects of Distance/Remote Cooperation: Most team work was carried out during the lectures and unofficial meetings. The tools which have been used for distance cooperation were emails and GoogleDocs to brainstorm ideas, write the final reports and keep each other up to date.

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