Human-centred Design Workshops in Collaborative Strategic Design Projects: An educational and professional comparison

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RESEARCH

Abstract
It has been found that the implementation of Human-centred Design (HCD) methods in the Fuzzy Front-End is not likely to lead to diversification in educational product planning exercises, where time lines are short and executors lack experience. Companies, interested to collaborate with Master-level Industrial Design students on strategic design projects, should have realistic ambitions with respect to innovation and value creation. Moreover, diversification is not the only generic growth strategy to gain competitive advantage. Value can also be created from developing new products for existing markets, or creating new markets for existing products. On the contrary, companies who aim for diversification in their generic growth strategies, may not always end up with a complementary 'high valued' design outcome. From a learning perspective, the understanding of HCD methods created awareness among students and companies that respect and empathy for the end-user are important for enriching their design processes, and as such increasing the chances for diversification in subsequent projects with clients. This study also compares the implementation of Human-Centred Design (HCD) methods in a *professional /collaborative* and an *educational/collaborative* strategic design project.

Key words
user-centred design, human-centred design, co-creation, design-led innovation, front end of innovation, positioning maps, diversification

Introduction

This article discusses innovation within the context of 'Design Thinking'. Design thinking is essentially a human-centred innovation process that emphasises observation, collaboration, interpretation, visualisation of ideas, rapid concept prototyping and concurrent business analysis, which ultimately influences innovation and business strategy. The objective of this article is to develop an educational framework for teaching innovation, involving consumers, designers and business people in an integrative process, which can be applied to product, service and business design, based on Human-Centred Design approaches.

As competition intensifies, product complexity increases and technological differentiation becomes more difficult (Cova and Svanfeldt, (1993). Within the context of integrated product development, formulating an effective product strategy and a design goal is one of the greatest challenges of the innovation process; however effective management of the Fuzzy Front End (FFE) may result in a sustainable competitive advantage (Koen et al., 2001)

A User-Centred Design (UCD) approach, whereby the needs of potential end-users are assessed in the product development process, can then be important for achieving a company's strategic and innovation goals. However, the main problem is that too many projects suffer from insufficient market input, a failure to build in the voice of the customer, and a lack of understanding of the market place (Cooper, 1999). Furthermore, it has been noted that limited and inadequate market research, resulting in problematic translation of 'engineers' wishes' into 'customers' needs', is a key factor of failure of innovations (Panne et al., 2003)

As a response, user involvement is seen as a way to obtain valuable input from end-users. According to Kujala (2003), involving end-users in research and design activities can have diverse positive effects: on the quality or speed of the research and design process; on a better match between a product and end-users' needs or preferences; and on end-users' satisfaction.

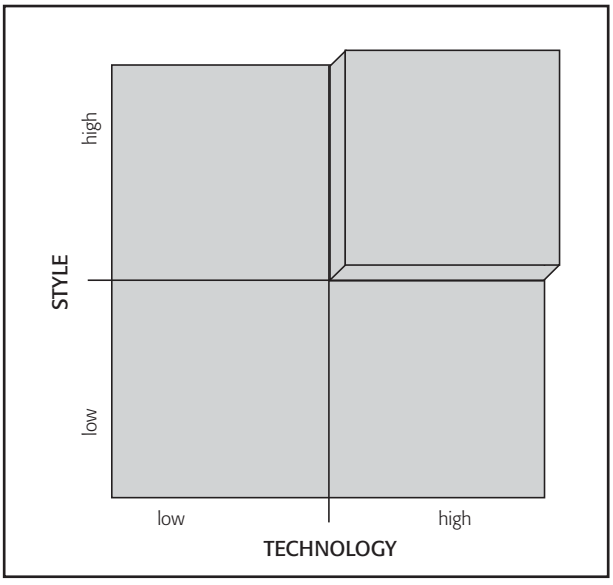

Figure 1. Value creation is established by positioning a product or service in the 'Upper Right Quadrant'

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Research aim

As the global environment is continuously changing, organisations and businesses are compelled to permanently seek the most efficient models to maximise their innovation management efforts through new methods and paradigms, which efficiently serve existing and new markets with new and/or modified products as well as services (Christiansen, 2000) Hereby, Ansoff's Product-Market matrix is a frequently used model to position generic innovation strategies.

Considering the four generic growth strategies (Ansoff, 1968), this article aims to argue that the implementation of UCD methods in the Fuzzy Front-End (FFE) is not likely to lead to diversification in product planning exercises conducted in an educational setting, where time lines are short and executors lack experience, as exemplified in this 4th year collaborative strategic design project. However from a 'Design Strategy' and 'Value Creation' perspective, end-user and other stakeholder's input can be valuable, if not decisive, in promoting a company's products and services to the 'Upper Right Quadrant' of the 3-D 'Style' versus 'Technology' positioning map (see figure 1), (Cagan and Vogel, 2002).

The concept of value creation in products and services

In their investigation of what it takes to create breakthrough products, Cagan and Vogel concluded that one of the key attributes that distinguishes breakthrough products from their closest followers is the significant value they provide for users (Cagan and Vogel, 2002). Taking it one step further, the more value in a product, the higher price people are willing to pay, with the price increasing more rapidly than the costs, resulting in a profit margin, significantly higher for higher valued products. After all, as Drucker (2001) has pointed out, *'customers pay only for what is of use to them and gives them value'.*

Boztepe (2007) has categorised user value according to utility, social significance, emotional and spiritual value. Utility value refers to the utilitarian consequences of a product. Social significance value refers to the socially oriented benefits attained through ownership of and experience with a product. Emotional value refers to the affective benefits of a product for people who interact with it. Spiritual values are human values, which address fundamental issues concerning health, vibrancy and viability at work. Similarly, Sanders and Simons identified three types of values related to co-creation, which are inextricably linked. These values are monetary, use /experience and societal (Sanders and Simons, 2009)

According to Dewey (1938), experience is not something *that is totally internal to the individual, but instead,'an experience is always what it is because of a transaction taking place between an individual and what, at the time, constitutes his environment'* (p.43). Experiences are context- and situation- specific; which means they change from one set of immediate circumstances, time, and location to another. In a similar way, value changes as cultural values and norms, and external contextual factors, change (Overby at al, 2005)

In summary, consumers are willing to pay a higher price for product purchases that connect with their own personal values, although monetary value is important in determining market penetration strategies (Cagan and Vogel, 2002)

Innovation perspectives and the development of new products and services

The predictive nature of innovation with respect to the development of new products and services justifies the exploration of the following innovation approaches: User-Centred Driven, Design Driven, Market/Consumer Research Driven and Technology Driven.

In figure 2, earlier mentioned innovation approaches are mapped according to Rationalist-Historicist and Empirical-Idealistic dimensions to demonstrate their relationships. Knowledge, which to certain degree can be applied independently of a specific setting, is referred to be rational. Technological developments and market

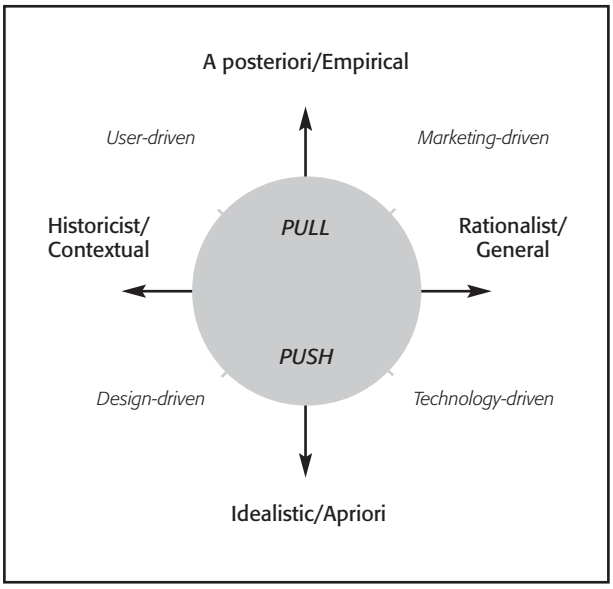

Figure 2. Classification of innovation perspectives according to Rationalist-Historicist and Empirical-Idealistic dimensions

structures are influential in how the product, system or service is being divided into interconnecting entities. A historicist view on innovation represents a more constructivist conception of the process as a whole, where an iterative cycle of concept development and testing of solutions are characteristic. To illustrate the above, Ansoff's perspective on innovation strategy (Ansoff, 1968) can be seen as an essential tool for directing market and technological research, whereas Mintzberg's strategy model suits a context-based user-or design-driven innovation process better (Mintzberg, 1987)

In terms of research and information gathering, a priori (idealistic) and a posteriori (empirical) data are gathered and synthesised, as well as which actors are involved. These opposites are considered as equivalent to the push and pull models of innovation. The description is polarised in order to contrast the different models of innovation, where the real world would reflect a continuous transition between the extremities described in this paper.

5 User-centred versus design-driven innovation

Significant efforts in this recent literature have been concentrated into investigating a specific approach to design, usually referred to as *User-Centred Design* (Chayutsahaij and Poggenpohl, 2002), (Vredenburg et al., 2002), (Veryzer and Borja de Mozota, 2005). This approach implies that product development should start from a deep analysis of user needs. In practice, researchers spend time in the field observing customers and their environment to acquire an in-depth understanding of customer's lifestyles and cultures as a basis for better understanding their needs and problems (Belliveau et al., 2004)

Design-driven innovation, which plays such a crucial role in the innovation strategy of design intensive firms, has still remained largely unexplored (Verganti, 2008) One of explanation is that its processes are hard to detect when one applies the typical methods of scientific investigation in product development, such as analyses of phases, organisational structures, or problem-solving tools (Brown and Eisenhardt, 1995), (Shane and Ulrich, 2004). Unlike user-centred processes, design-driven innovation is hardly based on formal roles and methods such as ethnographic research.

Design-driven innovation, which mimics Technology-driven innovation, may be largely considered as a manifestation of a *reconstructionist* or *social-constructionist* view of the market, where the market is not 'given' a priori, but is the result of an interaction between consumers and firms (Kim and Mauborgne, 2005), (Prahalad and Ramaswamy, 2000). Hereby, users need to understand the radically new language and message, to find new connections to their socio-cultural context, and to explore new symbolic values and patterns of interaction with the product. In other words, radical innovations of meaning solicit profound changes in socio-cultural regimes in the same way as radical technological innovations, which solicit profound changes in technological regimes (Geels, 2004)

Currently, design-driven innovation is starting to be explored and discussed (Bucolo and Matthews, 2011). However, the industrial applications tend to be design-led innovation accomplished through user-centred design research methods. Besides this, design curricula are also in the midst of discussion and change. Although user-centred design methods are being taught, it is often difficult for students to bridge the gap between research and design.

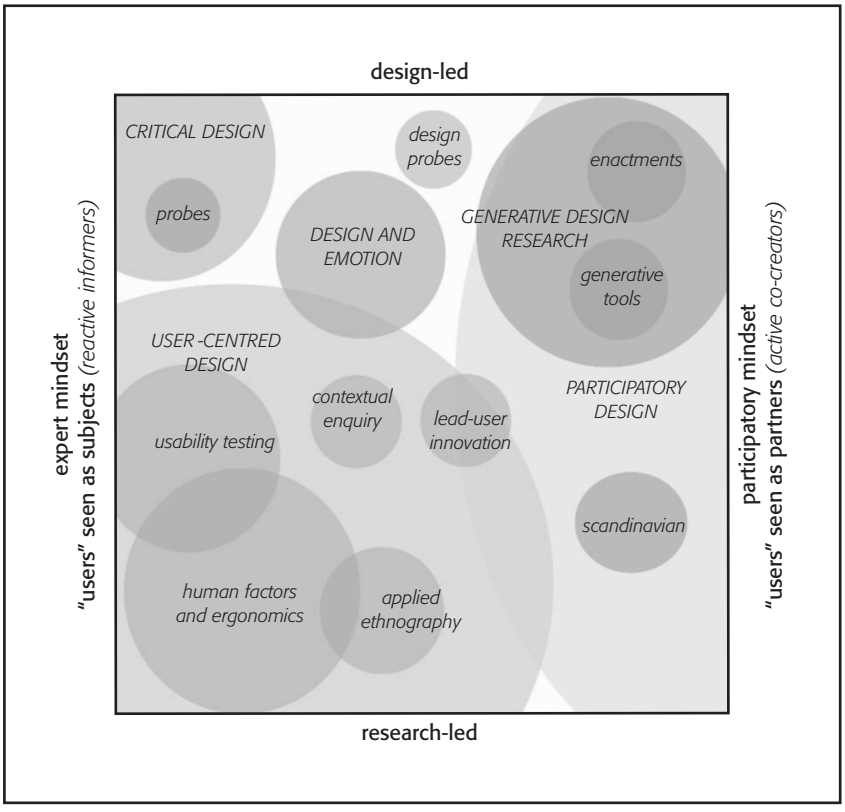

Figure 3. A map of Design Research and Practice

Students tend to take a design-driven innovation approach, because they find it difficult to extract and incorporate user involvement in the 'later' designing stages.

Design-driven innovation versus innovation through co-creation

A third perspective on non-technological push approaches to innovation is that of co-creation (sometimes referred to as co-designing). This perspective can also be considered to be co-design-led innovation (Sanders, 2011)

The map of design research and practice as shown in figure 3 (updated from the map in Sanders, 2008) can serve as a framework on which to compare the three perspectives: User-centred, design-led and co-creation. The map is defined and described by two intersecting dimensions: approach and mind-set. Approaches to design research have come from research-led thinking (shown at the bottom of the map) and from design-led thinking (shown at the top of the map). The research-led perspective has the longest history and has been driven by applied psychologists, anthropologists, sociologists, and engineers. The design-led perspective, on the other hand, has come into view much more recently. There are also two opposing mind-sets evident in the practice of design research today. The left side of the map describes a culture characterised by an expert mind-set. Designers and researchers here are involved with designing for people. They consider themselves to be the experts, and they see and refer to people as 'subjects', 'users', 'consumers', etc.

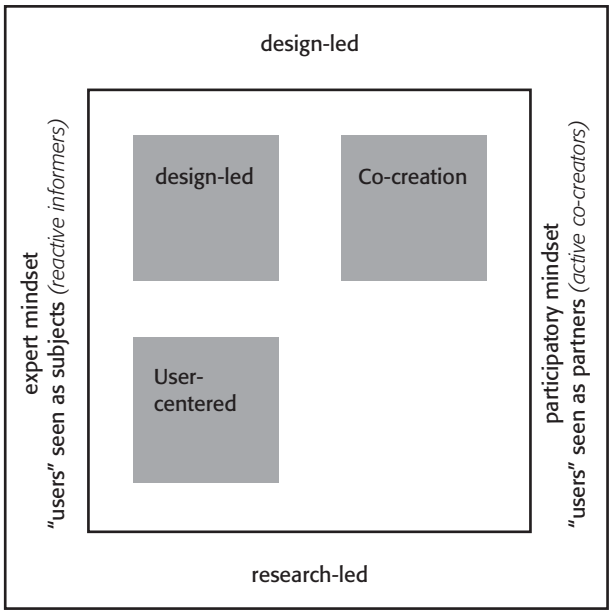

Figure 4. Framework for positioning the three perspectives on non-technologically driven product development processes

The right side of the map describes a culture characterised by a participatory mind-set. Designers and researchers on this side design *with* people. They see the people as the true experts in domains of experience such as living, learning, working, etc. Designers and researchers who have a participatory mindset value people as co-creators in the design process. It is difficult for many people to move from the left to the right side of the map (or vice versa), as this shift entails a significant change in mindset of who should drive and make creative decisions in the designing of products and services. The change in mindset is partly cultural.

If we strip the map of the design research tools and methods it serves well as a framework for positioning the three perspectives on non-technologically driven product development processes (figure 4). The user-centred perspective uses research-led approaches coming primarily from marketing and the social sciences to make incremental improvements to existing products or product lines. The design-led perspective uses design thinking and has the potential for significant innovation but it does not value the input of potential end-users as being participants in the early front end of the process. The co-creation perspective puts the tools and methods of design thinking into the hands of the people who will be the future end-users (and the other stakeholders) early in the front end of the product development process.

Design and research approach

Structure of Empirical Study

The structure of the empirical studies was divided into two stages. In the first stage, nine 'educational' strategic design reports from the M.Sc. Industrial design program at the Norwegian University of Science and Technology (NTNU) were analysed based upon the following criteria:

- Client criteria and constraints: This covers: nature, size and business activities of the client company, etc.
- Involvement of internal/external stakeholders and end-users.
- Approach: Processes and methods used in the workshops.
- Results: This mainly elaborates upon the insights gained during the workshops and how these have been implemented in the follow up product planning and designing activities.

The analysis of the strategic design reports was carried out through a procedure of 'Explanation Building'. In the second stage, a closer comparison was made between the 'Monitoring Fish Health' project *(educational)* which was one of the nine student cases analysed above and the 'Living with Type 2 Diabetes' project *(Real-life Industrial)*.

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In both stages, sources of evidence were generated based on the specific observation and analysis of participative co-design/co-creation activities among various stakeholder groups, which were described in the strategic design reports. Complementary interviews were conducted with the respective stakeholders, who were involved in the UCD sessions. In this 'case study research' (Yin, 2003), a comparison was made on how various methods were instrumental in determining the level and type of innovation and to gather insights with respect to the use of co-creation methods for product planning and goal finding in the Fuzzy-Front-end of innovation.

Educational Strategic Design Project

In this educational strategic design project, first year M.Sc. Industrial Design students acted as consultants and were required to formulate a design strategy as well as materialise the strategy into a product and/or service for different companies. In support of design research activities, students were subjected to a short but intensive hands-on workshop on co-creation methods, tools and techniques early in the semester. The students worked in groups of two or three in a design studio setting. In the initial stages of the project, students planned a series of participatory design sessions with various groups of stakeholders to support their strategic and industrial design process. UCD as well as co-creation methods, which were suggested and later on implemented included, for example: Observations, Function Mapping (Moolenbeek, 2008), Bulls Eye Collage, Participatory Design through Making and Acting (Sanders and Stappers, 2008), Storytelling (Sametz and Maydoney, 2003), What-If Scenario Building, etc. Students were free to choose what kind of approach and what kinds of tools and methods made sense based on their client and the challenge they were faced with.

Comparison between an Educational and Real-life Industrial Project

In this section, a comparison is made between one of the nine educational strategic design projects, namely the 'Monitoring Fish Health' project and a past real-life industrial project, where professional researchers and designers worked with Roche, a healthcare service provider.

In comparison to the first round of educational, strategic design projects, more in-depth interviews were conducted with the various stakeholders in the 'Monitoring Fish Health' project, including customers, suppliers, collaborators, veterinarians, financial supporters, scientists and legislators. Stakeholders, who were involved in the co-creation sessions, were grouped into three parties. These parties were respectively; fellow students representing consumers, the service provider, responsible for 'Monitoring Fish Health' project and the other stakeholders as previously mentioned. All workshop sessions were filmed for documentation purposes.

Concerning the 'Living with Type 2 Diabetes' project, a case study report was developed on the Co-creation process and activities with the respective company, which operates in the healthcare sector, and its stakeholders. The project comprised of a research preparation and implementation stage. In the preparation stage, the following activities were conducted:

- Background study of the respective company.
- Formulation of objectives.
- Design of the research process.

In the implementation stage, the following activities took place:

- Preliminary investigation.
- A meeting to prepare for the field research activities.
- The workbook phase.
- The in-home research sessions.
- Analysis.
- Participatory analysis workshop.
- The final workshop.

Results and Analysis of Participatory Workshops in an Educational Context

A detailed description and comparative overview of how the participatory workshops were managed and executed within each of the projects is shown in table 1.

Even with the broadening of the approach to design, it can be generally observed that fundamental tensions between design-driven and user-centred driven innovation are prevalent (Veryzer and Borja de Mozota, 2005), (Verganti, 2008). In five of the nine projects, a 'New Product – Existing Market' strategy was targeted, whereas two projects aimed at creating a new market for the companies' based on existing products and technologies. In addition, two companies adopted a 'natural' diversification strategy, as they were contract manufacturers and do not have a history in developing their own products. The two reports showed that end users were not very much involved in the product /service idea generation process with respect to these contract manufacturers. Establishment of design goals and generation of concepts mainly took place through discussions among company management and design students, based on a conjecture – analytical design approach (Bamford, 2002).

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	Client criteria and constraints	Involvement of internal stakeholders	Involvement of end-users	Involvement of external stakeholders	Approach taken	Results
Heating systems for the future	The client is open to various forms of innovation and design input within the context of their business activity, which is heat production	YES, different departments (finance, marketing, development, purchasing, etc).	NONE	NONE	Co-design led with internal stakeholders, comprising of various exercises, such as: ▪ Bulls-eye method ▪ Visualisation of values ▪ Future (vision) mapping, ▪ Scenario-based interviews	Insights to develop visions and design concepts: Water-based heating system, Multi-purpose and portable heat pump and Modular, decorative heating panels. Unclear how uses were addressed for the service providers, such as suppliers, contractors, etc. across the three concepts.
Energy Control Systems for the Future			NONE	NONE		In conjunction with the development of personas and interviews, the design brief and problem definition were reformulated. Focus towards user-centreedness combined with a lack of design directives from the company led to weak physical 3-D concepts, but an interesting interface concept.
New Thinking in Bridge Design	The client is interested in a stage-wise future development of bridges. However, many constraints were communicated concerning production, assembly and management of suppliers.	NONE	YES	NONE	Co-design led with end users: ▪ Functional mapping ▪ Collages ▪ Future mapping ▪ Designing from context {32}	Input from the workshop provided mainly insight for the near future development of bridges. A design-driven innovation approach has been adopted, as it was difficult for users to concretely comment on how the system and elements should be designed and developed over time.
Bridge and Identity		NONE	YES	NONE	User-centered with end users ▪ Stakeholder Analysis ▪ Observations ▪ Informal Interviews	An emphasis was placed on consistent identity development as well as a design driven approach in the ergonomic development of the "overall" bridge with various stakeholders in mind
Sweets	15 year-old adolescents were defined as a target group	NONE	YES	NONE	Co-design led with end-users ▪ Informal Interviews ▪ Co-designing	Interesting spread of ideas and design cues. However there was a miss-match between workshop results (cues) and development of concrete design concepts

Monitoring Fish Health	The client is open to innovative concepts concerning all forms of remote operations and monitoring systems for the aqua-culture industry	YES	YES	YES	Co-design led with all stakeholders	Insights for concept development of a fish health surveillance interface from various stakeholders. Two main developments are achievable: ▪ The creation of an interface to improve usability and accessibility among end-users and external stakeholders based upon accessibility of complementary services ▪ The development of technology, just to facilitate information flow between various programs and the service provider's services. However, an integrated service solution with improved usability, accessibility and compatibility has not been achieved yet.
Multi-functional Outdoor Fireplace	NONE. The client's aim is to optimise unused manpower and machine capacity	YES	NONE	NONE	Research led and client centred	A standard design driven "Product Planning and Goal Finding" exercise
Load Crosser	The client's aim is to optimise unused manpower and machine capacity related to sheet metal construction	YES	NONE	NONE	Research led and client centred	A design driven exercise, based upon iterative rounds of functional prototyping and testing
Social Game Play – LEGO	Development of design directions and concepts around the theme "Social Game Play"	NONE	YES	YES	Co-design led with end-users ▪ Positioning robot images on a spectrum. ▪ Creating a favourite robot. ▪ Developing a Storyline around a favourite robot. ▪ Focus group discussions with teachers about social play.	Workshops provided a good foundation for the development of design ideas and concepts. The following objectives were met: ▪ To identify product attributes for social play with robots. ▪ To find out how boys visualise and adapt robots. To gain insight how boys interact and stimulate social play. Adaptation and customisation of robots were found to be essential in stimulating social play.

Table 1. A comparative overview of the analysis of the educational workshop sessions

As summarised and mapped onto Ansoff's Product-Market matrix (Ansoff, 1968), overall results indicate that Human-centred Design (HCD) methods may not be directly applicable for establishing a diversification strategy in an educational setting, where 4th year design students were for the first time subjected to co-creation tools and methods.

However, the design outcome of these industrial projects (see figures 5 and 6) suggested that students were capable of producing innovative design concepts by proposing products or services to be positioned in the 'Upper Left and Right Quadrants' challenging new technologies and style (= ergonomics and form).

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Companies who have the interest to collaborate with students on design/product innovation projects should have realistic ambitions with respect to value creation. Instead of being fixated or aiming too hard for diversification, they should also consider that value can be derived from developing new products for existing markets, or creating new markets for existing products.

A Comparison between the 'Monitoring Fish Health' and the 'Living with Type 2 Diabetes' projects
The comparison is presented in the form of case studies and substantiated through "Explanation Building".

Case Study: Monitoring Fish Health
Background
The co-creation workshops focused on the context of 'Sea-based Fish-farming', where students addressed problems and solutions related to monitoring fish health for an information service provider. The service provider is a knowledge-based company, developing information and communication services (including the needed communication infrastructure) for the off-shore fish-farming market that is yet unknown by the industry. The services were given on a subscription basis. Since the benefit of the services were not fully understood by the market (i.e. the market is 'under developed'), it has been important for the service provider to develop the services in close co-operation with the users and other stakeholders.

As a spin-off from Telenor[1] Research, the service provider's good experience working with graduate students on challenging and less concrete projects, provided the opportunity to test or introduce new services/thoughts to the market, which the company does not want to be associated with if they fail. So it say: it makes it safer as a serious actor to test uncertain thoughts/services through student projects.

Objectives
The primary objective of the workshop sessions was to reveal interesting problem areas and business opportunities for the company and its stakeholders and to encourage these participants to be creative and generate new ideas. A toolkit, comprised of a large selection of images connected to the fish farming industry, a list of words for inspiration, post-its, glue, scissors and different shapes in several colours, was introduced to facilitate expression and communication. The application of the toolkit, which resulted initially in visual mappings of content contributed significantly to the clarification of the project goals and objectives.

New Market	▪ Sweets ▪ Social Game Play 'Lego'	▪ Multi- functional Outdoor Fire Place ▪ Load Crosser
Existing Market		▪ Heating Systems for the Future ▪ Energy Control Systems for the Future ▪ Monitoring Fish health ▪ New Thinking in Bridge Design ▪ Bridge and Identity
	Existing Product	**New Product**

Figure 5. Mapping of nine design projects according onto Ansoff's Product- Market matrix

STYLE	*HIGH*	▪ Sweets ▪ Social Game Play 'Lego' ▪ Multi- functional Outdoor Fire Place ▪ Load Crosser ▪ Monitoring Fish health ▪ New Thinking in Bridge Design *(current and near future concepts)* ▪ Bridge and Identity *(current and near future concepts)*	▪ Heating Systems for the Future ▪ Energy Control Systems for the Future ▪ New Thinking in Bridge Design *(Mid- and far-future concepts)* ▪ Bridge and Identity *(Mid- and far-future concepts)*
	LOW		
		LOW	*HIGH*
		TECHNOLOGY	

Figure 6. Mapping of 9 design projects according to Cagan´s and Vogel´s Positioning Map

Research process
Each workshop with the respective stakeholder groups was divided into two parts. In preparation for the workshop, the participants were asked to write down 10-20 words on post-its about what they associate with fish

[1]Telenor is the incumbent telecommunications company in Norway and is mostly an international wireless carrier with operations in Scandinavia, Eastern Europe and Asia, working predominantly under the Telenor brand. At the end of 2010, its 203 million subscribers made it one of the largest mobile phone operators in the world

health. First the participants are asked to place the post-its they had prepared on a map based upon the knowledge they had on fish and fish-related activities. Then they had to elaborate on and communicate their domain knowledge using pictures, words and elements from the toolkit. At the end of each stage, the groups presented their work to each other, followed by a discussion. The second part was even more creative in nature. Based on brainstorming techniques, each group was given a large blank paper and asked to come up with ideas that could solve some of the problems discovered in the making of the previous map. To encourage discussions, participants were encouraged to write ideas on green 'post-it' notes and comments or criticism on red "post-it' notes.

Investigation through a series of consecutive workshops
The first workshop with 'consumers' revealed existing knowledge and concerns around fish health related to the fish farming industry (figure 7). The second workshop focused on idea generation and contextualisation of roles and responsibilities, especially those of the service provider.

Ideas that emerged from the sessions were clustered into five categories. These were technical solutions, user-friendliness in surveillance, preventive and curative health care using telemedicine, documentation and facilitation of purchase through information. The conclusion from the idea development was to make it easier for the fish farmers and veterinarians to detect illnesses early and decrease the damage, as well as to avoid financial losses connected to massive fish health problems.

Figure 7. First workshop with'consumers' revealing existing knowledge and concerns around fish health.

The objective of the third workshop was to explore the needs and wishes of the different stakeholders connected to activities around fish health, as well as discover opportunities attached to fish health based on underlying assumptions and changes with the introduction of new technologies (sensors, communication technology etc.) as well as new ways of working. The other objective was to test some of the ideas that emerged during the second workshop with the service provider (see figure 8).

Results
From various stakeholders' perspectives, the workshops have provided useful insights for idea and concept generation in terms of technology implementation, content and service provision for a fish health surveillance interface. Hereby, two main developments were ascertained:

- The usability and accessibility of the interface has improved through complementary services.

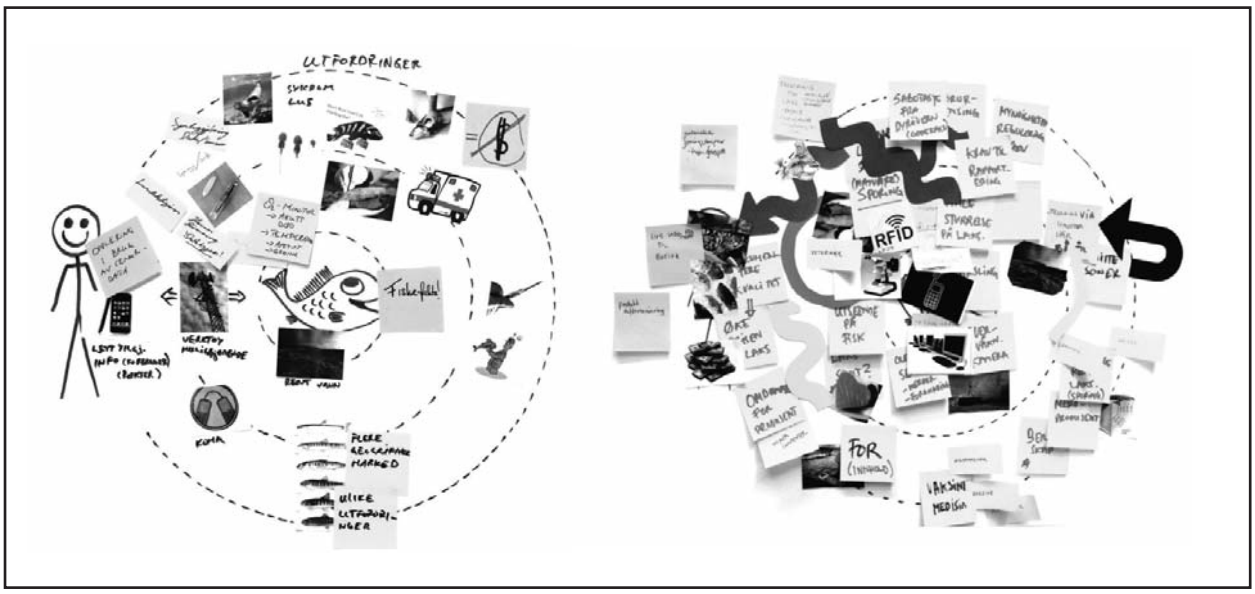

Figure 8. Use of co-creation tools and methods to map out the context and generate ideas

- Technology development has led to increased information flow among stakeholders and complementary services.

However, a high valued integrated solution with improved usability and compatibility among the different programs has not been achieved yet.

Case Study: Living with Type 2 Diabetes

Background

As both a diagnostics and a pharmaceuticals company, a leading health care company is seeking to enable healthcare to be tailored more closely to patients' individual needs.

In 2007, the company established a new group, referred to as New Concept Incubator (NCI), to explore future opportunities for product and service development from a human-centred perspective. The New Concept Incubator group partnered with a design research (DR) firm to identify new market opportunities in the form of products and/or services that could positively impact the lives of people living with Type 2 Diabetes and/or their close family members.

The Living with Type 2 Diabetes project was structured to provide a fist step learning experience for the NCI team members in the mindset of a participatory human-centred design approach and the skills needed for developing relevant products and services for the future.

Objective

The primary objective of 'Living with Type 2 Diabetes' was to develop a deep understanding of the daily experiences of people who are living with Type 2 Diabetes. This understanding would be used to seed the generation of ideas for improving their lives. The research aimed to discover and to understand:

- their lifestyle patterns;
- their family relationships;
- the aspects of their daily routines that were working well for them currently;
- where they struggled and why, i.e., the constraints and pain points that they faced;
- their dreams as well as fears for the future.

Research Process

The project took five months from kick-off to the final workshop. The short case described below explains how the principles, tools and methods for co-designing were applied to the researcher/end-user relationship. It also shows how participatory principles, tools and methods were used to help integrate the efforts of the collaborating firms.

Preliminary investigation

The project started with a one-day hands-on workshop session about the co-designing process. People from the firms took part in the hands-on activities, for example, by making and presenting collages about what it might be like and how it might feel to be living with Type 2 Diabetes.

A wide range of potential activities and scenarios for the in-home sessions that would take place with the people (living with Type 2 Diabetes) were introduced. Together the workshop participants identified the issues that needed to be developed. This included:

- a guide for the informal ethnographic (i.e., shadowing) sessions;
- screeners that would be used to recruit a range of people living with Type 2 Diabetes (e.g., younger & older, male & female, recently diagnosed vs diagnosed years ago, etc.);
- the workbook that would be sent to the recruited participants;
- a workbook that would be sent to family members of the recruited participants;
- a moderator's guide, tools and materials for the in-home sessions;
- instructions for how to perform the various jobs in the in-home sessions and what to bring to the sessions;
- a discussion guide for the in-depth interviews with healthcare practitioners.

The DR team members shadowed two people living with Type 2 Diabetes for one full day each to gain first-hand experiences in living with diabetes. They photographed and audio-recorded the shadowing experiences so that they could be shared with the rest of the team later. The DR team members also read and summarised secondary research relating to Type 2 diabetes and 'lurked' on discussion forums that are frequented by people who

Figure 9. Stakeholders involved in co-creation sessions

have been diagnosed as diabetic. On the forums they made note of the topics and issues that concerned the discussants and the questions they asked of each other.

A meeting to prepare for the field research activities
The second meeting was held with the core team members from the firms in order to finalise all the details of the research plan and materials. DR team prepared for this meeting by creating prototypes of all the research materials, and scheduling in-home visits that were planned for the fieldwork phase. This included workbooks to be sent to the participants, the discussion guide and the toolkits needed for the activities planned for the in-home sessions. The plan was to recruit 20 participants to ensure that 15 in-home sessions could be completed.

The workbook phase
The DR team prepared the workbooks that were sent to and returned by the participants before the home visits. The workbooks served two primary purposes: to gather background information about the participants and to immerse them in thinking about and reflecting upon living with Type 2 Diabetes. This immersion step was very important in preparing them for the participatory activities planned for the in-home sessions.

The in-home research sessions
The research plan, tools and materials were revised based on the input from the second meeting. Before conducting any in-home sessions with recruited participants, the tools and materials were pilot tested and materials revised when needed.

Twenty home visits were conducted. Other family members, such as spouses, were often also available during the session and were very happy to take part.

The visits started by having the people show the researchers around the house, taking care to let them decide how much to show.

The next step in the visit was to review and discuss the workbook with the participant and ask about any answers that were not clear and probe more deeply into key issues.

The next activity was a card sort (figures 10a and 10b). We gave the participant a deck of cards that described issues people may have who are living with diabetes. We asked them to sort the issued cards into three piles representing items in increasing importance. After the card sort, a timeline mapping activity was introduced. We invited the participant to map out their personal diabetes timeline using pictures and words that were provided.

In the final exercise, the participant was given a choice of two ways to express their ideas about their future ways of living with Type 2 Diabetes (figures 11a and 11b).

Each visit took about two hours and was thoroughly documented using audio- and video-recording as well as photography to facilitate sharing the field experiences with all of the NCI team members.

In-depth interviews with healthcare professionals who see many diabetic patients were also conducted. These interviews were exploratory and followed a discussion guide that was designed to be flexible enough to accommodate various types of expertise to emerge.

Analysis
The preliminary analysis took three weeks. The first step was to get transcripts done for the audio-recorded segments in order to have complete documentation for

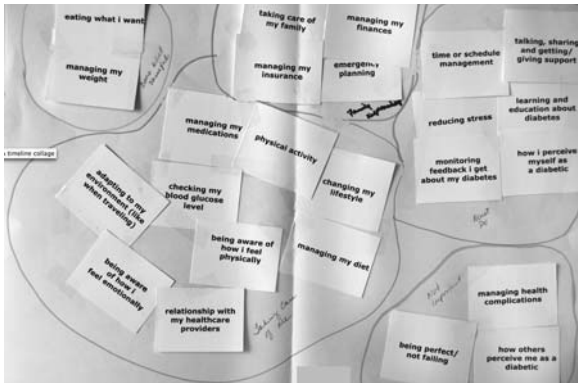

Figure 10a. Participants sorting issued cards into three piles representing items in increasing importance

Figure 10b. Participants map out their personal diabetes timeline using pictures and words

Figure 11a. Participants imagining future products and services with Velcro-modeling

Figure 11b. Participants involved in a future storytelling exercise with puppets

analysis. A database was used to store and organize the workbook entries, the card sort data and the image and word selections from the timeline mapping. The database approach helped the researchers to see the patterns in the data. It was also an effective way to transfer the data to NCI at the end of the project. Surprises and preliminary insights were captured, documented and summarised in preparation for the participatory analysis workshop.

Participatory analysis workshop
DR invited the NCI team members to join the analysis process since seeing it happen and participating in it first-hand is the best way to learn. The co-analysis space allowed the perspectives of all the team members to play a role in making sense of the data and highlighting the key insights. A room full of data was the inspiration for the persona posters that became one of the primary deliverables of the project. DR continued the analysis with more in-depth looks at the issues that emerged in the participatory analysis workshop.

The final workshop
In the final meeting, the firms met to review the findings and discuss next steps. DR presented the findings and insights using the persona posters and short video clips from the in-home visits. DR also presented many opportunities that emerged from the in-depth analysis. DR then led a participatory workshop to prioritise all the opportunities and discuss the next steps in design or research or both. This workshop also served as an introduction to the ongoing project for several new NCI team members.

Results
Because of the proprietary nature of this project, it is not possible to share design opportunities, specific results or consequent business decisions. However, some insights that helped to guide subsequent efforts in the design exploration of how to address the unmet needs and dreams of people living with Type 2 Diabetes can be revealed.

- People with Type 2 Diabetes (T2D) cannot be lumped into a category. Each individual with T2D is unique.
- 'Self-management' did not appear to be working for many of the participants in this T2D research. Self-management, if it does work, takes a long time to take effect and relapses are common.
- The treatment and management of T2D today focuses on the 'body' at the expense of the 'mind' and the 'spirit'. Psychosocial components of living with T2D are not addressed adequately.
- Many of the participants referred to the 'switch' that needs to be activated/turned on in order for a lifestyle change to take hold. The switch is a transformative experience. Some were still waiting for it to happen. Others brought it up as a defining moment in their experience of living with T2D.

Comparisons of the two case studies
Concerning the 'Monitoring Fish Health' case, the project group came up with new ideas that can be further investigated in the near future. However, the service provider does not see any quick release of services from the project. The ideas introduce both time-consuming software/service development and changes of process/organisation of the customers that take time to introduce.

The process used by the group was new and fascinating for the service provider, because persons from different parties and with varying background were observed co-operating. The process forced the service provider to think in different ways than before, using a 'new' mindset and challenging them to step outside their 'old' setting. One question that arises is whether the service provider will

continue in using their new mindset now that the direct involvement with the student team has ended.
In comparison with the 'Monitoring Fish Health' project, the 'Living with Type 2 Diabetes' case demonstrated a more rigorous process of co-creation. The twenty in-home sessions were carefully orchestrated to ensure that all activities could be accomplished in two hours, for example. Much attention was paid to consistency and efficiency in the collection, documentation and analysis of the data as well, in order that the budget estimate and the scheduled timeline would be met. The short case in this paper described only the preliminary stakeholder involvement that was limited to the end user and his or her family members. This project was only the first step in a much longer strategic effort that is still ongoing, and the next stage was to explore to explore opportunities for new products and services for the people who care for those living with diabetes including physicians, nurses and therapists. And in the stage that followed, the research and design teams returned to both the people with diabetes and to the healthcare providers to get their feedback on preliminary ideas for new products and services.

The 'Living with Type 2 Diabetes' case falls into the New Product for Existing Market quadrant of the Ansoff Product-Market matrix, as was the intent of the research effort. It did, however, lead to a major redefinition for the company as to what 'product' means since the conceptual direction that is now being developed is more of a service rather than a device, which is an entirely new direction for this organisation.

Similarly, the 'Monitoring Fish Health' case also targeted a New Product for an Existing Market. The service provider and stakeholders were fascinated by the group's work, but the challenge is whether the former is able to concretise the insights and ideas in a manner that they can be translated and materialised into a more concrete service/product.

10 Discussion

In support of different types of value creation, HCD can be considered a useful tool in educating companies and prospective design consultants about how end-users and other stakeholders are to be involved in certain aspects of the co-designing process. However, it is recommend that these end-users and stakeholders involved in co-creation workshop activities first identify the desired goals of the workshop in which they will work and to which they will contribute, and also identify the intended benefits of their co-creation activities, and then carefully align these goals and benefits (Steen et al., 2011)

As demonstrated in the 'Living with Type 2 Diabetes' case, considerable effort was spent on setting up the learning experience for the client team members in the mindset of a participatory human-centred design approach and the skills needed for developing relevant products and services for the future. This effort has paid off. The client team members have continued to practice participatory methods with a human-centred mindset throughout later stages of the design and development process.

However in an educational context, interviews with the students have surfaced the following limitations and opportunities for implementing HCD in search of a suitable generic growth and design strategy:

- Nature, history and pragmatic attitudes of some of the companies. For example, in the 'Monitoring Fish Health' project, new ideas were introduced by the project group. However the service provider did not see any future quick release of services from the project. The ideas were both time-consuming and lack a certain level of concreteness for software/service developers to implement.
- Most of the companies have unconsciously influenced the students to focus on the 'new product existing market' or 'existing product/new market' strategies
- Although in some cases a radical product idea is 'in the making', very aggressive time frames for the projects as well as the lack of experience among students to frame and communicate, did not provide a convincing atmosphere for the company to pursue diversification.

On the contrary, companies, who aim for diversification in their generic growth strategies may not always end up with a complementary 'high valued' design outcome, as illustrated through the 'Multi-functional Outdoor Fire Place' and "Load Crosser" projects.

To extend the educational train of thought from a learning experience, it becomes more obvious that Front-End of Innovation (FEI) processes, and HCD methods and tools are to be transferred to students in conjunction with Ansoff's Product-Market matrix (Ansoff, 1968), as well as the 3-D Positioning Maps (Cagan and Vogel, 2002). This will then lead to the following thinking approaches:

- Diversification on its own is not the only generic growth strategy to gain significant competitive advantage.
- Focusing on 'Development of new products for existing markets' or 'Creation of new markets for existing products' as generic growth strategies in combination with a design strategy aimed at the 'Upper Right Quadrant' may lead to significant value creation for companies.

The understanding of HCD methods (both user-centred and co-creation) created an awareness among students, professionals and companies that respect and empathy for the end-user are important aspects to consider for enriching their design processes, as such increasing the chances for diversification in subsequent projects with clients. However, in terms of a more systematic implementation with the ambitions to achieve more concrete results, students still have a long way to go. Lessons learned from real-life industrial project indicate that the human-centred approach takes time to learn and a number of hands-on experiences to master.

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Review
Positioning Technology Education in the Curriculum

Title:	Positioning Technology Education in the Curriculum
Editor:	Marc de Vries
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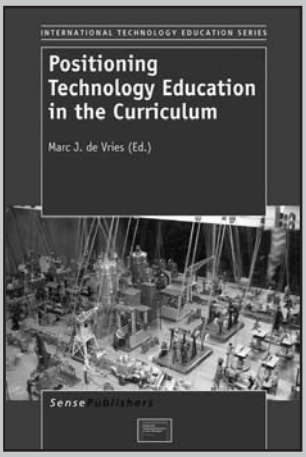
Reviewed by:	Hugh Johnson



This book represents a timely contribution to the debate about the value and cultural significance of technology education worldwide and its position in the school curriculum. The articles are taken from the Pupils' Attitudes Towards Technology (PATT) Conference 2009 where participants were asked to reflect on the way Technology Education should be positioned in the school curriculum. Marc de Vries successfully pulls together a range of interesting perspectives on the positioning of technology education in the school curriculum including:

I. Developmental Aspects.
II. Defining Technology Education.
III. Technology, Engineering and Science Education.
IV. Formal and Informal Technology Education.
V. Contributing to Responsible Citizenship: Ethics and Sustainability.
VI. Teaching Technology as a Contribution to Literacy.
VII. Progression in the Curriculum.
VIII. Positioning Technology Education in Developing Countries' School Curriculum.
IX. The Future of Technology Education in the School Curriculum.

Following the introductory chapter by Marc de Vries, the second chapter by Gene Martin represents a powerful call to arms to address the issues causing the demise of technology education programmes in higher and general education in a number of countries. At a time when design and technology education is at a watershed of its own in the UK there is some comfort to be gained from the fact that the UK is not alone in experiencing similar difficulties to other countries. Martin's view is that it is time to recalibrate the profession's current path and set a whole new direction for it. He suggests teachers' leaders and scholars have a collective responsibility to lead the profession and build a new consensus for it through collaboration and co-operation around a globally agreed research agenda. The following chapter presents a contextualist history of the development of technology education in Sweden highlighting the methodological issues involved in such a study and the need for similar studies to take account of the educational, social, cultural and political contexts in which subjects evolve.

Chapter four and five present some interesting philosophical discussions on the nature of technology and its pervasive nature. The following three chapters look at the relationship between technology education, engineering and science and include a contribution from David Barlex on the development of STEM in the English education system. Joêl Lebeaume highlights the epistemological and pedagogical differences between science and technology and John Williams presents an interesting critique of engineering and technology approaches to developing technological skills as part of general education in Western Australia.

The ninth chapter looks at how technology as a school subject is being developed in Sweden. It discusses the results of a research project aimed at supporting teachers through a collegial co-operative approach and highlights the contradictions between teachers' beliefs about the subject and their practice. Mannikko-Barbutiu reports on a number of projects in Sweden aimed at promoting greater interest in studying STEM related subjects in higher education and encouraging more collaboration and co-operation between teacher education and teachers and better links between school and work life. The findings of The Relevance of Science Education international comparative project are cited which suggests that science and technology are not perceived as compatible with the

late-modern values of the young. The individualistic zeitgeist which permeates much of modern society is identified as a key factor which influences the career choices young people make along with their interests and values. This suggestion raises some interesting questions which are worthy of further investigation if we are to address this potential mismatch and develop technology education programmes that are truly trans-generational.

In Chapter ten, Hantson and Van de Velde look at the development of technological literacy through the COU@work project in Finland. The results reported show the potential for this type of initiative to influence the perceptions of young people and their future career aspirations.

The contribution of technology education programmes to developing technological literacy and responsible citizens capable of questioning the omnipotence of technology and technology determinism is discussed in the following two chapters. Chapter eleven looks at the issue of responsible citizenship and how technology teaching should enable children, as future citizens, to live with technology in a responsible and ethical way and the implications for the way technology education is positioned within the curriculum. Leo Elshof's chapter 'Technology Education: Overcoming the GM syndrome' is a thought provoking treatise on the role of technology in education. He uses the GM analogy to point to the need for a long hard look at the rationale for technology education and the realities of the current situation in many countries across the world. Elshof asks whether we have been fooled into believing own rhetoric by the same compliancy, insularity and short-term thinking that dogged General Motors for so many years? He also questions whether technology education is guilty of 'greenwashing' its image and calls for new constituencies for technology education to be rebuilt around a green agenda.

Contributions from Gerald van Dijk and Didier van de Velde in Chapters 13 and 14 focus on the co-development of language and technological literacy through technology education in both formal and informal contexts. They discuss how technology education programmes can contribute to developing linguistic and literacy skills in learners engaged in design and technological activities. There is an obvious link between the achievement of students in any subject and their literacy skills and, as Dijk points out, there is a clear need for teachers to become linguistically sensitive if they are to contextualise language learning and development into technology lessons in the classroom.

In Chapter 15 the issue of progression is discussed and the results of a curriculum development research project in New Zealand are presented. The authors argue that a constructivist outcomes based curriculum provides a strong direction for the development of technology programmes that can be supported by socio-cultural learning models. The final section of the books looks at technology education in the context of developing countries. Two examples are discussed and in the first Frank Banks discusses developments in Bangladesh. Feng, Siu and Gu discuss the challenges faced in developing technology education in China which appears to be facing similar challenges in positioning the subject in the curriculum to other countries around the world. Whilst the scale of the challenges and the context is vastly different to the United Kingdom, the issues seem to be similar i.e. a lack of understanding about the aims and aspirations of the subject and its place in general education amongst the political élite and a consequential lack of support for the subject in the curriculum and those responsible for school budgets and teacher training. This has led to a loss of professional development opportunities for teachers and the demise of some teacher training programmes. The cumulative effect of this has been to undermine pedagogy and practice further. There are obvious parallels to be drawn here with the current context in the UK.

Conclusions

There are a number of typographical errors which should have been captured by the editorial process and in some instances these affect the readability of the texts. However, this is a text I would recommend to all those involved in, or interested in, the debate about the future of design and technology education in the curriculum. The book contains some thought provoking articles which challenge the reader to consider more deeply their own rationale for the subject and the way they teach it. However, there are a number of contributions that stand out. These include deliberations on the development of technology education in different contexts and thought provoking discussions on philosophical, ethical and cultural considerations.
The contributions by Gene Martin, Leo Elshof and Feng, Sui and Gu, in particular, resonated with me personally because of their relevance to the current debate in the UK.

The impression left by the articles in this book as a collection is that technology education is under threat in many countries but there is some comfort to be found in the fact that the challenges are similar. The themes running through this book deserve further discussion and research and go some way towards setting the research agenda Gene Martin called for in the opening chapter. It highlights the need for strong leadership for the subject at

local and national levels and the need for a wide ranging debate about the future form and direction of the subject per se. It also points to the need for pragmatic action to re-educate society about the benefits of technology education in all its forms if the subject is to continue to play an important part in the general education of children in the future.