The Educational Design Ladder:
Creation of a Multi-Discipline Design Thinking Program

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Abstract

As global industries change and technology advances, traditional education systems may no longer be able to supply companies with graduates possessing an appropriate mix of skills and experience. The recent increased interest in Design Thinking as an approach to innovation has resulted in its adoption by non-design trained professionals. This necessitates a new method of teaching Design Thinking related skills and processes. This research investigates *what* (content) and *how* (assessment and learning modes) Design Thinking is being taught from fifty-one (51) selected courses across twenty-eight (28) international universities. Their approaches differ, with some universities specifically investing in design schools and programs, while others embed Design Thinking holistically throughout the university. Business, engineering and design schools are all expanding their efforts to teach students how to innovate, often through multi-disciplinary classes. This paper presents *'The Educational Design Ladder'* a resource model, which suggests a process for the organisation and structuring of units for a multi-disciplinary Design Thinking program. The intention is to provide 21st century graduates with the right combination of skills and experience to solve workplace design problems regardless of their core discipline.

Keywords: Design Education, Learning Design, Design Knowledge.

1   Introduction

Similar to companies around the globe, many educational institutes are required to compete internationally, and therefore are investing in education systems that emphasize leading through innovation [1]. Design enhances the outcomes of numerous innovation activities, bringing benefits such as increased quality of goods and services, improved production flexibility and reduced material costs [2]. For these reasons, design is increasingly being viewed as a vital and important strategic business resource [3]. The ability to innovate requires a company to evolve, adapt, be flexible and constantly improve in order to survive and thrive [4]. Wrigley and Bucolo [5] explain that as firms build awareness of different innovation strategies, tools and processes and their capabilities, the ability to adopt and embed

these approaches within their organisation requires changes at all levels of the business. This demands requires not only strong management leadership but also employees with the right skills and attitudes that nurture and embrace a business culture of innovation and change. To meet these demands and develop the correct capabilities and skills to operate in 21st century companies, new learning approaches are required nationally and internationally across all fields of study. The UK Design Council [6] states, "A supply of differently skilled people drives innovation". Skills that are increasingly valued by companies in all sectors include creativity, flexibility and adaptability, communication, management and leadership that can be deployed within teams and the entire organisation [6]. Experiencing multidisciplinary teamwork in an educational setting can broaden and expose students to skills and knowledge from outside their own disciplines in a safe learning environment. Increasingly universities are investing in design schools and programs to embed a style of Design Thinking and approaches throughout the curriculum. Business, engineering and design schools are all expanding their efforts to teach students how to innovate, often through multi-disciplinary classes [1].

The purpose of this paper is to present current curriculum design content, assessment examples and learning modes from twenty-eight (28) international institutions that are teaching Design Thinking from multiple discipline perspectives. Five different levels of Design Thinking were found, separated by the differences in unit content, assessment and learning modes. From these levels, *'The Educational Design Ladder'* model is proposed as an approach for the organisation and structuring of a Design Thinking program across disciplines. This model is to act as an educational resource, suggesting content, assessment and learning modes for each of the five steps of the model, to either create one unit or multiple units within a university wide Design Thinking program.

1.1 The Shift of Design Thinking

The complex concept of Design Thinking has been documented and debated largely over the past half century. It is broadly described as a style of thinking, the study of the cognitive processes that are subsequently manifested in design action [7]. Dunne and Martin [8] distinguish design from Design Thinking, describing Design Thinking as the way that designers think: the cognitive processes they use, as opposed to the objects they produce. It is generally considered as the ability to combine empathy, creativity and rationality to analyse and fit solutions to the context. The concept of Design Thinking within the academic dialogue of design has been around for more than thirty years with predecessor Schon [9] in education and Lawson [10] in architecture, who both in their respective ways describe and reflect upon *how designers think*. Buchanan [11] created a new conversation around wicked problems in design, arguing that designers' deal with problems that are ill defined, so the creative re-definition of the problem is part of the professional skill. Some strategy problems have been labelled as wicked problems, for example, if a problem involves many stakeholders with conflicting priorities, or if there's no way to evaluate if the solutions will work. More recently Design Thinking has been closely related to innovation and has become widespread in both design and management circles. The discussion has changed as to how business can use Design Thinking, and has recently become somewhat of a trend in the executive and management research realm and popular business press. This change is strongly supported by IDEO (a design innovation consulting firm) and the Stanford D-school (Insititute of design at Standford University). Where, Design Thinking is conceptualised as a specific way of evaluating and using design methods by non-designers. The shift of Design Thinking through theory and practice has seen it change from design science into a mindset [12].

1.2 The Danish Design Ladder

The Danish Design Ladder (Figure 1) developed by the Danish Design Centre [13], is a four-step model used to measure the level of design activity in Danish businesses based upon their attitutes towards design. The higher up the ladder, the greater strategic value design has within the company [13]. Used as a framework, it aims to demonstrate the extent to which design may enhance creativity, innovation and competitiveness. Through design intervention programs the value of design is questioned, challenged and slowly shifted further up the ladder over time. This progression should see a business stop focusing on specific design projects and view design as a strategic part of the buinesss. The higher a company is on the ladder, the greater the strategic performance design will play. The four steps illustrate four stages of design maturity:

Step One: No Design - no tangible approach to design

Step Two: Design as Style - relevant in aesthetic consideration such as style, appearance and Ergonomics.

Step Three: Design as Process - considered as a process or method in product or service output, only embedded in the initial stages of development, design solution is procured externally and is adapted to the requirements of the end-user using a multi-disciplinary approach.

Step Four: Design as Strategy - integral to company's continuous renewal of their business concept as a means of encouraging innovation. Process is fused with the company's key objectives and plays a role in every stage of development.
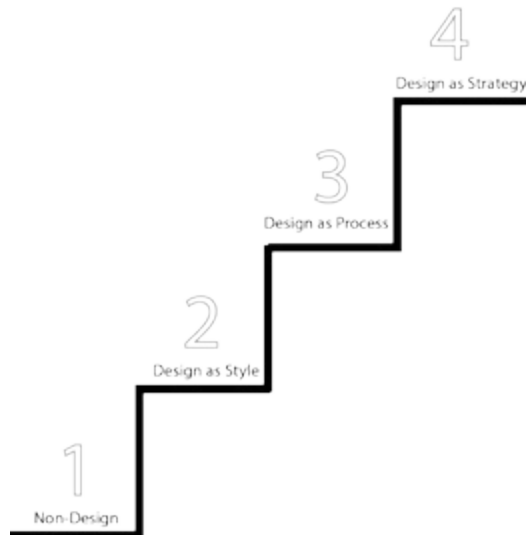

Figure 1 Danish Design Ladder [13]

1.2 Design Thinking in Education

As the business landscape evolves worldwide, universities are attempting to keep up by teaching and supporting multi-disciplinary approaches to solving problems. Business Schools and Design Faculties have developed courses to teach Design Thinking and Innovation. Wong [14] states "Design Thinking brings creative techniques to business…but no one can agree on how to teach its methods". Wong continues on to say graduates trained in Design Thinking are emerging from interdisciplinary master's programs that integrate design, technology and business. However, the argument continues on how Design Thinking should be taught,

questioning if design should take a more business approach or if business should integrate more creative thinking approaches [14]. The quote below is the vision of the first two schools of Design Thinking, the d.school at Stanford University in Californian Silicon Valley and the D-School of the Hasso-Plattner-Institute in Potsdam, Germany.

"We believe great innovators and leaders need to be great design thinkers. We believe Design Thinking is a catalyst for innovation and bringing new things into the world. We believe high impact teams work at the intersection of technology, business and human values. We believe collaborative communities create dynamic relationships that lead to breakthroughs".

The d.school was launched in 2005 and was designed to ignite creativity and collaboration. These schools educate students from different disciplines like engineering, medicine, business, the humanities, and education to work together to solve big problems in a human-centered way. Programs within the course are co-taught by professors from design and business departments and bring students from different universities for cross-disciplinary project work. Collaboration is practised with people from different areas such as companies, start-ups, schools, non-profits, and the government. Another approach to Design Thinking is dual degrees in Business Administration and Design, such as the MBA and Master's in Design at Illinois Institute of Technology. Furthermore, short courses on Design Thinking and Innovation have also become popular, providing a sought-after mix of multi-disciplinary skills. By allowing design students to experience working with business, science, technology and engineering the gaps in knowledge between individual team members are bridged. Working across faculty also provides more opportunities to engage in real world projects, giving valuable practice and professional development through providing a deeper understanding of a real-life project management, expectations and professionalism.

2   Research Approach

Using internet search engines, education literature and research reports, a search of educational programs, courses and units was conducted across a selection of universities to investigate how Design Thinking is being taught to students in Design and Business around the world. The search began with Bloomberg Business Week's, *World's Best Design Programs* [14], which lists thirty (30) courses considered to be leaders in integrating Design Thinking and Business. Further searches were conducted to obtain information about Design Thinking in a number of different disciplines spanning business, management and entrepreneurship. The search of international Universities examined programs and courses around innovation and creativity as well as general management and education programs. This further investigation, resulted in twenty-one (21) courses which were not listed by Bloomberg. In total fifty-one (51) selected courses across twenty-eight (28) international Universities were reviewed. Course information was mapped onto a predesigned data sheet (Figure 2) developed by the researchers. The data sheet outlined the institute name, location, school or faculty, course name, unit outline, aims and objects, and assessments. Nearly 90% of the data came from third party resources such as websites, and online publications. The availability of online resources differed across insitutes, for example, often a unit synopsis was available online to describe briefly what and how learning objectives were assessed, however in a few examples the scope of the program and its week-by-week learning activities were posted online also. The reliability of online course material was managed by only sourcing information from reputable sources such as the University's website and ensuring all documents had the University logo or name present. A thematic analysis [15] was then conducted upon the data to identify categories. The analysis process involved coding course content in order to expose common themes [16].

Figure 2 Example of Course in Predesigned Data Sheet

3 Results

By investigating and analysing the *what* (content) and *how* (assessment and learning modes) Design Thinking was being taught five key themes were attained. They include *i)* Theories, Methods and Philosophies, *ii)* Product Focus, *iii)* Design Management, *iv)* Business Management, *v)* Professional Development.

3.1 Theories, Methods and Philosophies

Design thinking, design methods, theories, philosophy and history were covered by three courses, Design and Creative Thinking (Queensland University of Technology, Brisbane), Design Thinking (University of Sydney, Sydney), and Design Theory and Methodology (Delft University of Technology, The Netherlands). These three courses exclusively explore theories, methods and philosophies of Design Thinking, while other courses such as Design Thinking in Business offered by Aalto University (Helsinki) also cover the history of Design Thinking and the evolution of Design Thinking to provide a theoretical background. In these courses Design Thinking is explored as a creative process through theories and methods. It is highly reflective to allow students to review and think critically about their own design processes, in order to create a deeper thought process about the evolution of Design Thinking (thinking about thinking) as a problem solving activity. Theoretical and methodological foundations of design are explored in more depth and current debates on practices are evaluated. Aims of these courses are for students to understand the differences between models, theories and practice of design, think critically about their value and to reflect consciously and critically on design methods. Goals include helping students develop their attitude, behaviour and thinking style as a designer and challenge any existing preconceptions. To develop knowledge of design processes and design research techniques that are common to all design disciplines. Table 1 details the common content covered by these units, the assesment items set and the teching modes.

Table 1 Theories, Methods and Philosphies Unit Overview

Main Topics Covered:	Reflection, Ideation, Design Process, Design History, Defining Design, Creative Thinking (Idea Generation), Problem Solving, Representing and Communication of Ideas, Group Dynamics, Cognitive Emphasis, Inductive, Deductive and Abductive Reasoning, Frameworks, Complexity, Wicker Problems, Analysing, Understanding, Design Contexts, Evaluating Proposals, Visualisation, Experimentation, Prototyping.
Assessment Examples:	Design Charrette, Group Work, Analysis of Design Process, Interview about Designing, Research Journal, Project Work, Reflective Essay.
Teaching Modes:	Lectures, Tutorials, Online Modules, Discussions, Panel Discussion, Case Studies, Active Participation.

3.2   Product Focus

New Product Design and Development was a main focus in a number of courses, most commonly seen in courses within Design Faculties and Disciplines such as Architecture, Engineering and Industrial Design. The aims of these courses included the development of skills such as sketching, physical prototyping, brainstorming, user-focused thinking, aesthetics and the implementation of a design process (discovery, interpretation, ideation, experimentation and evolution of design solutions). Table 2 lists the various topics covered in these product centric collective courses, assesment items and learning modes.

Table 2 Product Focus Unit Overview

Main Topics Covered:	Idea Generation, User Focus Thinking, Aesthetics, Communicating Visually, Iterate and Evolve Design Concepts, Theoretical and Practical Aspects of Design, Sketching, Trendspotting, Presenting with Impact, Form and Function
Assessment Examples:	Design Project for a specific user or design problem (e.g. video game for visual impaired player), Written and Oral.
Learning Modes:	Short Collaborative Design Projects, Workshops, Lectures, Tutorials, Field Study, Individual and Group Challenges.

3.3   Design Management

In the Masters of Product Design and Development (Northwestern University, Illinois), half the subjects are devoted to basic business management issues, while the other half of the course work is devoted to advanced managerial concepts in design and development. Meanwhile, the Masters in Product Development (Carnegie Mellon University, Pittsburgh), aims to give students a better understanding of the interdisciplinary approach required to bring successful products to market. To achieve this students are required to select units in Design Engineering and Business. This course is a one year professional degree in Innovation and Design Thinking, and is open to designers, engineers and others in related fields, to become more accomplished practitioners, and leaders of the product development process. This interdisciplinary program is possible as it collaborates with the Department of Mechanical Engineering, School of Design and the Tepper School of Business (Carnegie Mellon University, Pittsburgh). New Product Development (Aalto University, Helsinki), provides students with the core concepts and analytical frameworks concerning the management of new product development from a marketing perspective, within complex environments and global product and service markets. Table 3 details the content taught throughout the collective Design Managament theme as well as the assesment tasks and teaching modes of the units.

Table 3 Design Management Unit Overview

Main Topics Covered:	New Product Design and Development, Managing Creativity and Design, Project Management, Customer-focused Innovation, Marketing Research, Market Identification and Requirements, Opportunity Mapping, Scenario Planning, Capital and Variable Costs, Human Process of Creativity and Innovation, Environmental Requirements, Project Leadership, Corporate Missions, Brand Identity, Analytical Frameworks.
Assessment Examples:	Oral Exam, Project Plan, Research Journal, Intensive Experimentation and Project Work, Reflective Essay.
Learning Modes:	Workshops, Partner with Industry Sponsors, Lectures, Tutorials, Course Readings.

3.4 Business Management

Courses such as Masters of Design Scheme (Hong Kong, Polytechnic University), Strategic Management (University of Sydney), and MBA DesignWorks at the Rotman School of Management (University of Toronto) are examples of elevating Design Thinking into Business Management and Strategy. These courses practice Design Thinking as an alternative to traditional analytical methods used in business. The school of Business at the University of Virginia, teaches 'Design Thinking for Business Innovation' which aims to introduce Design Thinking as a complimentary decision-making processes. While at the Rotman School of Management, students are taught to use Design Thinking as a human-centered approach to tackle complex business challenges. Most of the courses in this category aim to understand the interrelationship between design, business and technology, collectively creating value from all three. The use of Design Thinking is to create innovative solutions and competitive advantages in an organisation context.

Table 4 Business Management Unit Overview

Main Topics Covered:	Strategic Design, Business Frameworks, Service Design, Engaging Stakeholders, System Integration, Design Analysis, Comparative Analyses of Business Opportunities, Branding Strategies, Brand Management, Business Plans, Budgets and Financial Management, Legal Requirements, Feasibility, Competition and Demand, Operational Complexities and Financial Models, Economics, Forecasting, Backcasting, Distribution Channels, Global Logisitics, International Business.
Assessment Examples:	Business Plans, Pitches, Business Strategy Simulation, Exams, Discussion Online, Blogs, Workbooks, Reflective Essay.
Teaching Modes:	Workshops, Industry Projects with Companies and Organisations, Lectures, Tutorials, Study Visits, Online Class Discussions, Group Activities, Individual Research, Self-directed Learning.

3.5 Professional Development

Courses that were placed into this category had a main focus on entrepreneurship, leadership, professional and personal development. The goal of these courses are to help the student develop their own vision, recognise opportunities and execute their innovative ideas in creative design. Explaining innovative ideas must be championed or nurtured to succeed, believing entrepreneurial approaches make this possible. RMIT's (Melbourne) course in Communication Design Entrepreneurship provides experiential-based learning and theoretical frameworks that enable design managers to navigate a course of action in a highly competitive marketplace. Meanwhile the Domus Academy (Italy), offers a Design and Entrepreneurship summer course, as they believe young entrepreneurs with innovative ideas and design concepts are being considered as key divers for the future of business. This course offers the knowledge and experimental use of tools and methodologies to face challenges and connect to the start up of a new venture. These courses aim to build sustainable organisations through individual and organisational leadership. The University of Adelaide, Masters of Applied Innovation and Entrepreneurship, aims to develop and inspire creative individuals with an interest in starting or developing innovative ventures that have the potential to make significant impact on markets, economies and communities. They do this by providing advanced knowledge and practical skills required to assess and implement new ideas, create and mange new projects and create supportive environments that foster and enable innovation. Additionally by adopting a Design Thinking approach, entrepreneurs can create potential innovations collaboraivley to create sustainable strategic advantages with a global outlook. Through professional and personal development plans and engagement with ongoing

peer coaching, these courses aim to provide students with the ability to adapt within a business environment that fosters innovation and manage projects.

Table 5 Professional Development Unit Overview

Main Topics Covered:	Manage Design Process, Integrate Principles of Client Service Provision, Advertising, Marketing, Leadership, Competitive Threats, Innovative Concepts, Change Management, Innovation, Entrepreneurship, Reflective Practice, Professional Development.
Assessment Examples:	Reports, Group Work, Presentations, Critiques, Solve Industry-Based Problems, Business Reports, Class Participation, Exam.
Teaching Modes:	Lectures, Tutorials, Work Integrated Learning (WIL), Digital Lectures, Online Discussion, Independent Research, Activities, Skype, Social Networks, Blog Posts, Wikis, Peer Coaching.

4 Discussion

Courses categorised as Theories, Methods and Philosophies provide the foundation of Design Thinking as a method, for students to gain skills in critical analysis and reflection in order to created their own design process. The next theme, Product Focus, positions Design Thinking as a process for New Product Development, using a human-centered approach to gain user needs and requirements at the project level. The main topics covered and skills built in these courses can be closely related to those seen in Industrial and Product Design, such as sketching, form and function, concept development, aesthetics and ergonomics. The theme of Design Management places Design Thinking into a broader concept, by having consideration of product management, and non-product specifics. These areas include marketing, financial issues, environmental requirements and the management of the launch of a product. Business Management takes this to the next step, using Design Thinking as Business Innovation and Strategy; all parts of a business, from business plans to forecasting are covered in this category. The final step Professional Development, is placed within the context of the individual, course content aims to create leaders who recognise the importance of Design Thinking and understand how to nurture and support ideas to fruition. From these results the Educational Design Ladder was developed and is visualised in Figure 3.

4.1 Educational Design Ladder

Based upon the Danish Design Ladder principels, The Educational Design Ladder (Figure 3) illustrates an educational progression of attitues towards design. Through the five step model students are introduced to the different levels of Design Thinking in order to gain the knowledge and skills to apply design to a range of different contexts and projects. The aim of the ladder is to stage the delivery of Design Thinking content and guide students to the top step, where professional and personal development is to be the focus and a leadership position is taken towards the value of design.

Step one (Foundation Level): Units should provide the foundation of Design Thinking as a process, explained through methodologies, philosophies and reflective practices. This step is required for all students to grasp the history, evolution and use of Design Thinking.

Step Two (Product Level): Units in this step provide Design Thinking in the setting of product design. This step allows students to test methods and processes in a practical context. It should provide a practical application of Design Thinking to

| | tangiable outcomes in the way of products and or services. |
Step Three (Project Level):	This step bridges Design Thinking from a product focus to design management. Design Thinking should be apply to influencing factors such as the market situation and branding desisions.
Step Four (Business Level):	Step four incorporates design, business and technology, as Design Thinking is elevated to business strategy, in the development of new business models and strategic forecasting.
Step Five (Professional Level):	The final step removes Design Thinking from a context and aims to develop a student's personal and professional skills. It uses Design Thinking to demonstrate the importance of developing the correct skills to recognise opportunities and nurture the process of bringing innovative ideas to fruition.
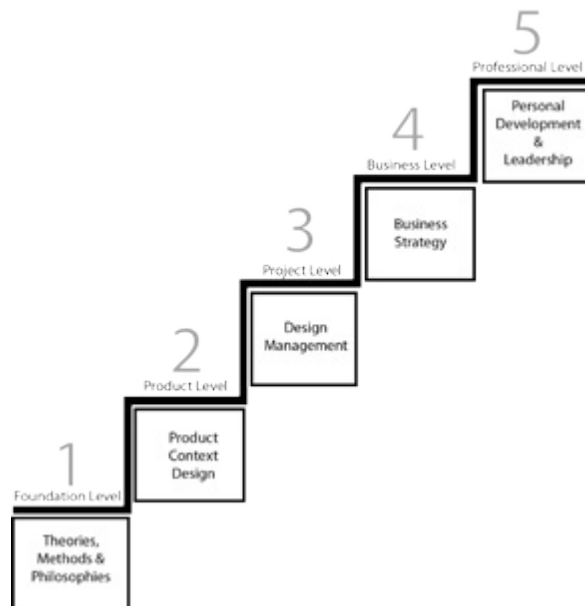
Figure 3 The Educational Design Ladder

The Educational Design Ladder presents a way of organising and structuring design courses in mutli-disciplinary contexts. This ladder was utilised to organise the range of existing units across the author's university. Individual units from the faculties of creative industries, science and engineering and business were plotted onto aligning steps. Only four units had a Design Thinking foucus so remaining units were placed in a broader spectrum. It was discovered that four courses existed on the foundational step, four on the product level step, three on the design management level, two in business management and one in personal development. Through this process, it was revealed that that none of the top steps (3-5) were offered to creative industries students and the bottom steps (1-2) were unavilable to business students. Findings from this process highlighted gaps in content delivery, accessibility and research across the faculties and university wide structure. From the indification of these gaps, new collabortive units have been modified and created based upon the topics, assessment examples and teaching modes presented in Tables 1-5.

A limitation of this study is the nature of the secondary data sources employed. While this research is able to provide a broad overview, it is however unable to reveal the relationship between different courses provided at the different universities and the success of each unit. Intended further research will assess the development and implementation of a cross-disciplinary Design Thinking program within the authors' university, plotting any new and modified units to the Educational Design Ladder. To keep up with the changes in business landscapes, new pedagogical approaches are required to provide students with the correct skills and attitudes that are valued by companies. This study provides a holistic approach to classifying Design Thinking educational content and is the first step in developing any multi-disciplinary Design Thinking curriculum.

5 References

[1]   Beckman, S. & Barry, M. "Innovation as a Learning Process: Embedding Design Thinking," *California Management Review,* Vol. 50, No.1, pp 25–56, 2007.
[2]   Cox, G. "The Cox Review of Creativity in Business: Building on the UK's Strategy", *SME's in manufacturing,* London, UK, 2005.
[3]   Dell'Era, C. Marchesi, A. & Verganti, R. "Mastering technologies in Design-Driven Innovation," *Research Technology Management,* Vol. 53, No. 2, pp 12-23, 2010.
[4]   Morris, L. "Business Model Innovation The Strategy of Business Breakthroughs," *International Journal of Innovation Science,* Vol. 1, No. 4, pp 191-204, 2009.
[5]   Wrigley, C. & Bucolo, S. "New Organisational Leadership Capabilities: Transitional Engineer the New Designer?," In Bohemia, Erik, Liedtka, Jeanne, & Rieple, Alison (Eds.) Leading Innovation through Design*: Proceedings of the DMI 2012 International Research Conference, DMI, Boston, Massachusetts,* pp 913–922. 2012.
[6]   UK Design Council. "Multi-disciplinary design education in the UK," Vol. November, 2010.
[7]   Cross, N. "*Designerly Ways of Knowing"*, Springer: London. 2006.
[8]   Dunne, D. & Martin, R. "Design Thinking and How It Will Change Management Education : An Interview and Discussion," *Academy of Management Learning & Education,* Vol. 5, No. 4, pp 512–523. 2006.
[9]   Schön, D, A. "*The reflective practitioner: How professionals think in action",* Basic Book, New York. 1983.
[10]   Lawson, B. "*How Designers Think The Design Process Demystified"*, Routledge, London, 2005.
[11]   Buchanan, R. "Wicked Problems in Design Thinking," *Design Issues,* Vol. 8, No. 2, pp 5–21. 1992.
[12]   Johansson-Sköldberg, J. Woodilla, U. & Çetinkaya, M. "Design Thinking: past, present and possible futures," *Creativity and Innovation Management,* Vol. 22, No. 2, pp 121-146, 2013.
 [13]   Kretzschmar, A. *The Economic Effects of Design, Danish National Agency for Enterprise and Housing*, 2003.
[14]   Wong, V. "How to Nurture Future Leaders: World's Best Design Schools." Accessed from http://www.businessweek.com/stories/2009-09-30/how-to-nurture-future-leadersbusinessweek-business-news-stock-market-and-financial-advice. 2009.
[15]   Gavin, H. "*Understanding Research Methods and Statistics in Psychology".* Sage, UK. 2008.
[16]   Braun, V. & Clarke, V. "Using thematic analysis in psychology," *Qualitative Research in Psychology,* Vol. 3, No. 2, pp 77-101. 2006.