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DESIGN LED INNOVATION

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ABSTRACT
For the last three years a course has been offered to MEng students in their third or fourth year of studies called Design Led Innovation and New Venture Creation. The rationale for offering the course was a combination of demand for design orientated options as well as the desire to deepen students' understanding and experience of the process of realising their ideas and ventures commercially. The premise for the course is that successful design-led innovation depends on blending customer insight and technical inventiveness to create value for customers and users as well as commercial value for innovative firms and their investors. Students are coached intensively in interdisciplinary teams by design experts, engineers and entrepreneurs to develop a project into a business proposition. The project ideas are formed in response to the positing of a meta-theme. Students are exposed to key concepts in design, creativity tools and the disciplines of human-centred design as well as strategies for introducing new products or services to a market and developing the necessary value networks. A key outcome of the course has been the emphasis necessary for ensuring that the process of preparing a new venture is considered and acted upon. This has been realised by means of intensive tutoring by experienced and practicing entrepreneurs. This paper reports the student experience along with the series of interventions that have been necessary in order to develop behaviours compatible with turning technical inventiveness into potentially viable innovation propositions.

Keywords: Innovation, commercialization, design, entrepreneur, enterprise

1 INTRODUCTION

Following the Cox Review [1] which called for the development of more interdisciplinary education that blended engineering, design and business disciplines, Design London was created in 2007 by Imperial College and the Royal College of Art. Design London's purpose has been to design and deliver an interdisciplinary academic and experiential programme for undergraduate and postgraduate students that bring together engineering and business school students from Imperial College's Faculty of Engineering and its Business School and design students from the Royal College of Art. Students combine a structured academic programme on design led innovation and business management with project based learning, as well as an experiential programme involving internships and potential business incubation of the new ventures emerging from the most innovative project activity.

For the last three years a course has been offered to MEng students in their third or fourth year of studies called Design *Led Innovation and New Venture Creation* and in the last two years a second programme has been introduced on *Advanced Design Led Innovation and Enterprise*. The rationale for offering the courses was a combination of demand for design orientated options as well as the desire to deepen students' understanding and experience of the process of realising their ideas and ventures commercially [2]. The premise for these courses is that successful design-led innovation depends on blending customer insight and technical inventiveness to create value for customers and users as well as commercial value for innovative firms and their investors. Students are coached in interdisciplinary teams by design experts, engineers and entrepreneurs to develop a project into a business proposition. The project ideas are formed in response to the positing of an issue relating to a meta-theme. Students are exposed to key concepts in design [3, 4, 5], creative problem solving tools and the disciplines of human centred design as well as strategies for introducing new products or services to a market and developing the value networks necessary for their successful commercialisation. Students are also encouraged to apply for the business incubation offered by Design London. The relationship of the course and the incubation process that follows is crucial in that students are able to see the concepts,

tools and techniques taught on the programme be applied in practice. They are coached by recent graduates who are now launching their business ventures; and it provides the Design London team with case studies and insights that can be fed back into the taught programme. A key outcome of the course has been demonstrating the importance of considering in totality the process of identifying a compelling need for a new product or combined product and service system, the ideation and development of such a system and the design and launch of a new business venture.
In this paper we review the scope of the programme offered and analyse the student experience along with the series of interventions that have been necessary in order to develop behaviours compatible with turning technical inventiveness into potentially viable innovation propositions. Since its inception Design London's programmes in Design Led Innovation have been delivered to over 1200 students from Imperial and the Royal College of Art, and the specific courses referred to here are now delivered annually to over 150 students from Imperial's Faculty of Engineering. Design London has launched 10 new business ventures to date which have successfully commercialised their products or raised follow on investment to bring their innovations to market. All but one of these ventures involve students who have completed the programme. Students report that: the experience of the programme has enabled them to more effectively integrate the learning of other courses and disciplines from their studies at Imperial by re-examining and practicing the knowledge they have acquired; provides them with transferable skills and through their project work, evidence of their ability to frame and resolve problems through design that make them more attractive to employers; has encouraged them to consider and in several cases realise an entrepreneurial pathway.

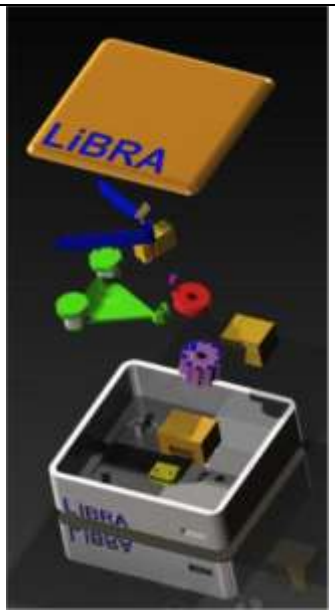
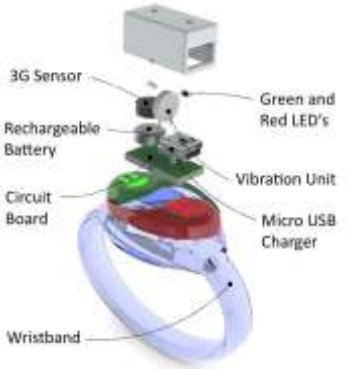
2 ENGINEERING STUDENT COURSES

2.1 Design Led Innovation and New Venture Creation

This course explores how successful design-led innovation depends on blending customer insight and technical inventiveness to create value. It examines value from the perspectives of customers and users as well as commercial value for innovative firms and their investors**.** The course aims to build students' knowledge, skills and expertise in design-led innovation as well as providing them with insights into the challenges of introducing novel products and services to market. It stresses the importance of for innovation within an organisation as well as for those considering starting their own business. In the first part of the programme students are introduced to key concepts in design, creative problem solving and the disciplines of human-centred design and the design of service experiences. They learn about systems design in terms of the interrelationship of socio-cultural, socio-political and economic systems with technological systems. The second part of the course focuses on new venture creation where students learn about markets and market dynamics, entrepreneurial market research, commercialization of innovation and business case development.
Students are formed into interdisciplinary teams to undertake a project activity and are coached by a combination of designers and design entrepreneurs to develop a project into a new business proposition. The project brief is introduced early in the term to allow groups to carry out initial research and then capitalise on later course content as and when relevant to reinforce the structured and academic teaching with early application of this new learning to embed their new knowledge. Teams are first required to research the problem domain and then frame a specific problem they will resolve. They must then develop a brief for a systems based solution that addresses the needs of different stakeholders in response to the systemic problem they have identified. They then must conceive and develop an innovative solution exploiting the learning in human-centred design methods, systems and service design, as well as with regard to its commercialisation. They should then test their concept through entrepreneurial market research before building a compelling business case for investment which is presented to an academic and practitioner panel.
At various points during the course, we bring in Design London incubator ventures, a world class engineering firm such as IBM, Arup, Dyson or Max Fordham Associates, design practitioners and researchers from the Royal College of Art's Helen Hamlyn Centre, all of whom present their work and demonstrate how various components of the course work in practice. The final assessed fifteen-minute presentation takes place on the final day of the course in two parts: presentation of the brief and then presentation of the combined design response and business plan. Their final report address all three components and is submitted a month later for assessment. The summaries given in Table 1 are

provided to demonstrate the scope and nature of the problems identified and the solutions proposed in response to a brief on Medication Non-Compliance. The course narrative is illustrated in Figure 1.

Table 1. Examples of student work

Inara – Targeting medication non-compliance in oral contraceptives In response to the task of solving a non-compliance related issue in the healthcare sector, Inara identified and researched the consequential field of combined oral contraception pill (COCP) users through interviews with pregnant teenagers and doctors. More than 200,000 unintended pregnancies in the UK are a direct result of COCP non-compliance, resulting in huge personal misfortunes as well as significant financial costs. In response, this group developed INARA, a patented lip-stick shaped device capable of holding a month's supply of COCPs as well as reminding the user to comply. In addition, there is a complete web-based system built around the user providing guidance and support. Cooperating with global healthcare companies will enhance Inara's research capabilities and means to commercialise our product. INARA aims to decrease unintended teenage pregnancies amongst its users by 60%.	
Libra – Targeting medication non-compliance for diabetes in working professionals This project addresses the expensive issue of medical non-compliance by focusing on diabetes in working professionals, as the complications resulting from non-compliance are very serious; ranging from fainting to falling into a coma. The non-compliance issues were found to arise when the sufferer was in a working environment and did not have the time or did not feel comfortable testing. These very important issues were tackled by creating a device which together with your Smartphone, could easily test a diabetic's blood glucose level, quickly and discretely and send back results to be displayed on a Smartphone application. The Smartphone application would then store the test results on the Libra website, which gives quick and easy access to doctors and endocrinologists that regularly see the patient. The data could then be sold to medical researchers interested in diabetics, with the consumers always staying anonymous or being able to opt out.	
Medicom – Targeting medication non-compliance for Type 1 Diabetes in Schoolchildren Currently, 1 in 400 school children have Type-1 Diabetes. Over 6,500 are discriminated in schools every year. Over 80% exhibit very poor compliance in hbA1c levels and the costs to the NHS and government due to the non-compliance of diabetes in schools is over £300 million. GLO is designed to meet this currently underserved need. The system consists of: • A non invasive blood sugar monitoring system. • An interactive wristband to be worn by the child. • External servers to provide communications with the devices above, data storage and records. • Personal computer online interface operated by the school nurse/teacher. • Mobile communication system via text message or app.	

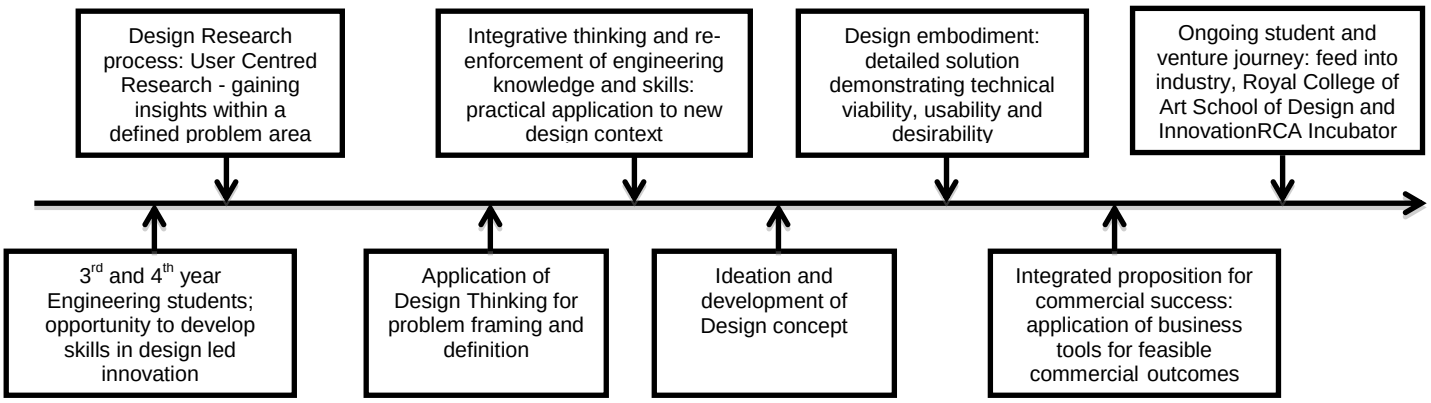


Figure 1. Design led innovation and new venture creation course narrative

2.2 Advanced Design Led Innovation and Enterprise

In the advanced programme, students are introduced to a series of meta-themes on energy, resource and waste, food security and sustainability, and health and wellbeing in an ageing population. They are then able to select a theme and develop their own ideas for a project brief based on their unique framing of a specific issue within their chosen theme. The advanced programme requires that students have completed the first Design Led Innovation course and builds on this learning with in depth analysis of systems design, human centred design techniques, project management and finance. It is assessed in the same way as the other course and both involve 30 hours of formal teaching in the lecture theatre with ca. 90 hours of project activity and coaching.

3 APPLICATION

3.1 Interdisciplinary Teams and Transferable Skills

Students are taught in classes of between 45 and 75 and divided into interdisciplinary teams of typically 7 students drawn from the different engineering departments present at Imperial. The teams are assigned coaches from the Royal College of Art's Helen Hamlyn Centre who are typically recent graduates of the RCA's Innovation Design Engineering department and are now research associates with the centre. The coaches from Design London and these research associates are complemented by practicing designers and designer entrepreneurs from the incubator and other firms. The combination of different disciplines, team working and an external coach provides a highly dynamic learning environment, and appears to enhance the creativity of the teams and their capacity for effective problem framing and ideation. The experience of the coaches is important in helping the students understand the systemic nature of the problems they are trying to address and to dig deeper into the underlying systemic issues, as well as in considering the important commercialisation issues that will effect the design of the solution. Team formation is important and we have learnt through experience the need to closely monitor the formation of the teams and identify any problems early on so as to reshape, even replace members of the teams in order to ensure the learning outcomes we are seeking.

3.2 Interdisciplinary Teaching

The teaching of business and management studies to students who have little or no experience outside of the academic environment is known to be problematic with little in terms of a frame of reference for them to apply this knowledge. Moving from classes in fluid dynamics or thermodynamics to market dynamics is difficult. Similarly the arithmetic of accounting compared to the mathematics they are taught, is not intellectually challenging even if the concepts of business case development are subtle and often difficult for students to comprehend and apply. Our experience of introducing the key concepts of business and management as part of a design project appears to resolve these specific challenges. When a group of students has developed their design concept they are challenged to define the market it addresses, the nature and size of the segment, the value proposition and competitive pricing models. To reach that price they need to examine the cost structure in terms of fixed and variable, as well as the value chain involved in taking the product to market and the expenses

associated with their route to market. From their projected business volumes they must develop a cashflow statement and are introduced to concepts of equity and debt financing. All of these as well as other business concepts are more accessible as students can apply them to their project, their design concepts under review, and they do so somewhat competitively. Teaching business and management to students with case studies of firms that may be unknown to them, or by using simplistic examples, is much less engaging they report, than relating it directly to their own innovation. Design as a process enables engagement in topics which may previously have been of little interest or appeared hermetic, but now become not only open to them but engage them in a compelling new way.

3.3 Assessment

The courses are recognized within the Faculty of Engineering as highly attractive to the students and the numbers participating have grown each year as shown in Table 2. Each cohort of students completes a detailed questionnaire to evaluate the content, teaching and the perceived value compared with other courses as well as to their future career. They are asked to comment on aspects of the programme that can be improved to enable continuous development of the programme, and leaders of other engineering programmes sit in the courses as part of the evaluation and development process as well as reviewing the outputs of the project work. Table 3 summarises the evaluations and in the following section we review the findings of this analysis and student comments.

Table 2. Growth in Students taking programmes

DNVC/ADNE	2008/9	2009/10	2010/11	2011/12
Courses offered	DNVC Only	DNVC Only	DNVC + ADNE	2 x DNVC+ADNE
Student Numbers	28	44	102	185

Table 3. Evaluation by Students - out of 5 (Max)

DNVC/ADNE	2008/9	2009/10	2010/11	2011/12
Overall Satisfaction	4.40	4.45	4.56	4.60
Value	4.10	4.30	4.42	4.51

3.4 Application

The students report that they course enables them to learn about other engineering disciplines as well as the more human centred approach to design and the business disciplines through the project based activity. They are able to apply and reinforce the knowledge they have acquired throughout their own courses by practicing it alongside their new knowledge on the design project. The course provides them a framework to apply their new skills as well as develop a more exploratory and evidenced based approach to the framing of systemic problems and their underlying causes. The exposure to experienced designers and designer entrepreneurs opens up new career scenarios that they may not previously considered, such as applying their technical inventiveness to an entrepreneurial venture of their own. Other students have reported that at job interviews they have been able to demonstrate their discipline specific and interdisciplinary skills more effectively by showing their output from the course and describing their own contribution to it.

4 STUDENT EXPERIENCE

In the modern context, the student experience is important. The following comments are taken from student interviews at the end of the course.

Iain Purves (MEng Mechanical Engineering). Current position: Design Engineer for Loowatt Ltd. The course gave me an insight into how to intelligently identify and approach problems. Something that was not covered so well in my engineering degree. It was inspiring to learn about modern design principles and being exposed to new ways of thinking. Alongside course content, we were worked in interdisciplinary teams with students from other engineering disciplines and together developed project briefs around medication compliance issues. The course has had an enormous impact on my career path after graduating. It has led me to be involved with Loowatt Ltd, a company started in the incubator developing waterless sanitation systems, and is now backed by the Bill and Melinda Gates Foundation. I successfully completed a 3 month internship and was later offered the job full time. It is as diverse and interesting a job as I could have hoped for. Since completing the course and working for Loowatt, I realize that it would be extremely difficult to get anywhere in business without the

careful application of design. Also, I now see design as something that can be used for more than just products; it is necessary when designing the system in which your ideas will exist. Design in business can also take many forms from product development through to business strategy and systems. Without design the ideas we have would remain only ideas, and without thoughtful design the ideas would not see their full potential in a commercial setting.
Timothy Sadler (MEng Mechanical Engineering) I now appreciate a more human centred approach to design, considering the effect that my solution will not only have on the end user, but also the environment and the world around us.
William Hunt (MEng Mechanical Engineering) Through the courses I have learnt the importance of system based design. I had often thought of design as product based but I now understand how the infrastructure around products and the business behind that are just as vital to success.
Jonathan Stafford (MEng Aeronautics) Before the course I tended to think of design as being a separate process, which took place before developing the business case and business model. The course has taught me that the two processes should go hand in hand, evolving with each other.
Robert Bush (MEng Mechanical Engineering) 'The primary take-away from the course is my new ability to take the technical knowledge I have developed in my engineering degree and apply design-led principles to create an innovative, value-added business proposition which meets a deep user need'
Michael Willmott (MEng Aeronautics) 'In my degree we are taught (very well) how to tackle engineering problems and how to logically come up with solutions that are the best engineering solutions possible. This course has helped me to understand that any solution to a problem is going to impact individual users and it has shown me how to frame as well as solve problems'
Other comments which are taken from the interviews and are on our website include:

- "Meeting with real designers and students from the Incubator who are commercialising their own ideas was inspiring"
- "The course transformed my creative thinking and broadened horizons"
- "The extreme user design challenge … felt like we were going through stages of design that should be considered in real life"
- "The course provided a great opportunity and insight into utilising engineering beyond just calculating"
- "I now realise that I have more future (entrepreneurial opportunities than I thought I had"

5 CONCLUSIONS

Students are seeking to apply their theoretical skills to practical design projects and the approach has enabled them to apply their skills in combination with others to address broader systemic issues, practice the framing of problems where they can address the underlining causes with a systemic response, and do so in concert with other disciplines as well as the new skills they acquire on the programme. The result is a greater appreciation of some of those other disciplines, especially the business and management, and an understanding of a much more market driven and human-centred approach to design practice – a practice which blends technological inventiveness with customer and user insight to develop compelling and potentially investible business proposition.

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