INTERNATIONAL CONFERENCE ON ENGINEERING AND PRODUCT DESIGN EDUCATION
8 & 9 SEPTEMBER 2016, AALBORG UNIVERSITY, DENMARK

SOCIAL INNOVATION AND TECHNOLOGY IMPLEMENTATION IN PRODUCT DESIGN ENGINEERING

Marcela VELÁSQUEZ-MONTOYA
Department of Product Design Engineering, Universidad EAFIT, Medellin - Colombia

ABSTRACT
Colombia is considered by many experts as an important emerging market. Its economy frequently has an annual growth rate above 4%. However, according to the World Bank, 30% of the population lives on less than USD $1.90 a day [1]. Since 1999, Universidad EAFIT in Medellin, Colombia, has been the only university offering a Product Design Engineering (PDE) undergraduate program in the country. Starting in 2012, the Design Project 6 (DP6) course has focused on understanding relevant aspects of designing for "bottom of the pyramid" (BoP) communities in Medellin, allowing students to propose product/service solutions for social needs. In this course, faculty and students have been working with different government organizations and other institutions, such as non-profit foundations, in order to understand real needs in their context. Over the course of the semester, students are guided by a community-based design method using different techniques, including the Human-Centred design and the IDEO Design Kit [13] [14]. An important challenge for students is not only to propose a solution for a contextualized social need, but also to implement ubiquitous technology or use the Internet of Things (IoT) to increase the efficiency of the BoP project and thus contribute to the scalability of their initiatives. This article describes the methodology used in DP6 and PDE student experiences in the course, showing that involving them in design projects with a high degree of social experience is key to ensure more inclusive social development and an integral education.

Keywords: Social innovation, design project, IoT, ubiquitous technology.

1 INTRODUCTION

1.1 Social Innovation

There are a large number of definitions for innovation in the existing literature. In general, as Phills et al. (2008, p37) [2] explain, there are two main approaches: one explores the processes that produce innovation, while the other looks at innovation as an outcome. The concept of social innovation is born of the ongoing debate and critique on traditional innovation theory's focus on material and technological inventions, scientific knowledge, and the economic rationale of innovation [3]. Bock et al. (2012, p59) [3], distinguish three main interpretations of social innovation, which underline the social mechanisms of innovations, the social responsibility of innovations, and the innovation of society. Meanwhile, the Stanford Social Innovation Review defines social innovation as "the process of inventing, securing support for, and implementing novel solutions to social needs and problems" (Phills et al., 2008, p36) [2]. Finally, Murray et al. (2010) [4] define social innovations as new ideas (products, services, and models) that simultaneously meet social needs, while creating new social relationships or collaborations. In other words, they are innovations that are both good for society, and also enhance its capacity to act.

1.2 Bottom of the Pyramid

The metaphor of the pyramid has historically been a representation of how societies across different eras and cultures have been organized. The base of the economic pyramid, often called the "bottom of the pyramid" (BoP), has traditionally been comprised of the poor, the powerless, and the unorganized. Globally, almost four billion people live on less than USD $2 per day. Their economic importance in

society is easily forgotten, as social relevance is typically gauged through the power of the purse. Nowadays, BoP sectors are moving from being economically marginalized, to gradually integrated into the productive and entrepreneurial markets [7]. Several thought leaders, including C.K. Prahalad [5], and Stuart Hart [6], have presaged the potential of this expanding market, and have conceptualized and developed new models of conducting business that consciously target this large demographic, often by involving new technologies and innovations [6]. However, regardless of location, many BoP markets are plagued by failing or nonexistent infrastructure in aspects related to central human needs (e.g., transportation, communication, water, and electricity). These deficiencies typically result in problems of food, shelter, safety, and "unfreedoms" [8].

1.3 Universities as actors of societal transformation

The social problems of the BoP should be understood in the context of the 21st century, an era of enormous societal change involving ageing populations, mass urbanization, social exclusion, high rates of unemployment, and environmental challenges [9]. Educational institutions –and more specifically universities– represent the main actors of societal transformation, because they train the future workforce and the leaders of tomorrow, setting "knowledge" as the primary production factor in the global economy [10]. This transformation is structured by the implementation of new learning strategies, and the generation and implementation of diverse knowledge experiences, in order to educate professionals suited to the world we live in. It is well-known that learning has shifted from the mere transmission of information in the classroom, to providing relevant experiences and projects in real-life contexts for the students themselves [11]. According to Cunha et al. (2015) [9], the emphasis should be on the social purpose of innovation, the need to deal with social changes, and the critical role of networks and social innovation labs for innovation diffusion. There are many global examples of universities creating networks that have led social innovation. These include the Graduate School of Business at Stanford University and its Centre for Social Innovation; Carnegie Mellon University's Heinz College, which created the Institute for Social Innovation; and Tilburg University, which manages the Tilburg Social Innovation Lab. In Colombia, Universidad EAFIT in Medellin, has created EAFIT Social, a multidisciplinary centre in which all institutional interests converge to develop and implement social innovation and entrepreneurship initiatives.

2 SOCIAL INNOVATION AT UNIVERSIDAD EAFIT

Given its socio-economic, political, cultural, and even geographical circumstances, social innovation projects exist all over Colombia. For Universidad EAFIT, it is vital to have a commitment to the society it inhabits.

2.1 Product Design Engineering

Since 1999, Universidad EAFIT has been the only university offering a Product Design Engineering (PDE) undergraduate program in Colombia. PDE is a 5-year bachelor's degree program that combines different professional fields –engineering, design, production, management, and marketing– aimed at developing new products that meet market and industry needs. Design Project (DP) courses are the core of the PDE program, not only because they integrate knowledge from all other classes in the program, but also because here students learn best practices and experiences from three tutors in three different fields. This means that each DP course, depending on its main teaching focus or objective, has three tutors participating at the same time. The main objective of this is for students to understand all the different disciplines involved in developing new products and services. The engineering side of the course includes an emphasis on training based on real industry and social problems. PDE undertakes diverse projects in order to build a bridge between the needs of society, industry, universities, and government; in this way, the program seeks to contribute to social development.

2.2 Developing Social Innovation initiatives

Etzkowitz and Leydesdorff (1995) developed the concept of the "Triple Helix" of university-industry-government relationships [15]. They suggest that the basis of knowledge and its role in innovation can be explained in terms of changes in the relationships between university, industry, and government. Additionally, they highlight the emergence of the university as a leading participant in the economic development of its region [15].

3 DESIGN PROJECT 6: DESIGN FOR THE COMMUNITY

This section describes the Design Project 6 (DP6) course, its methodology, and its positive impact on students and their learning experiences through the development of a social innovation project that implements different technologies.

3.1 General Context

Since 2013, DP6 has focused on understanding relevant aspects of designing for BoP communities in the city of Medellin, allowing students to propose product and service solutions for social needs. In this course, faculty and students have been working with different government programs and organizations, as well as private and public non-profit organizations. Each semester offers a different opportunity to decide which government institution and real social needs in the city students will try to understand. Over the course of the semester, students are guided by a community-based design method using different techniques, including the Human-Centred design and the IDEO Design Kit [13] [14]. An important challenge for students is not only to propose a solution for a contextualized social need, but also to implement ubiquitous technology or use the Internet of Things (IoT) to increase the efficiency of the BoP project and thus contribute to the scalability of their initiatives. The objective of the course is "contextualization": the integration of market and social needs, framed in the development of a product or service, through the use of technology as a source of innovation for the community. In terms of social context, students need to take into account (i) the political context, (ii) the transfer of knowledge in social interventions, and (iii) the role and articulation of stakeholders and other relevant actors. The market context should take into account (i) aspects of social marketing, and (ii) the application of basic marketing concepts. Following in the footsteps of the students' previous knowledge and the academic pre-requisites of their 3rd year, the project should include technology components that support user-product/service interaction. The project integrates different technologies at different levels, including ubiquity and IoT, to validate the user need and to think in terms of the broader social impact and not just the personal or individual impact. The integration of technology, products/services, and social needs may occur bringing together the various disciplines within engineering, including design, electronics, electrical, and mechanical. During this course, students understand and learn in parallel the technology and how to apply it to their product/services concepts.

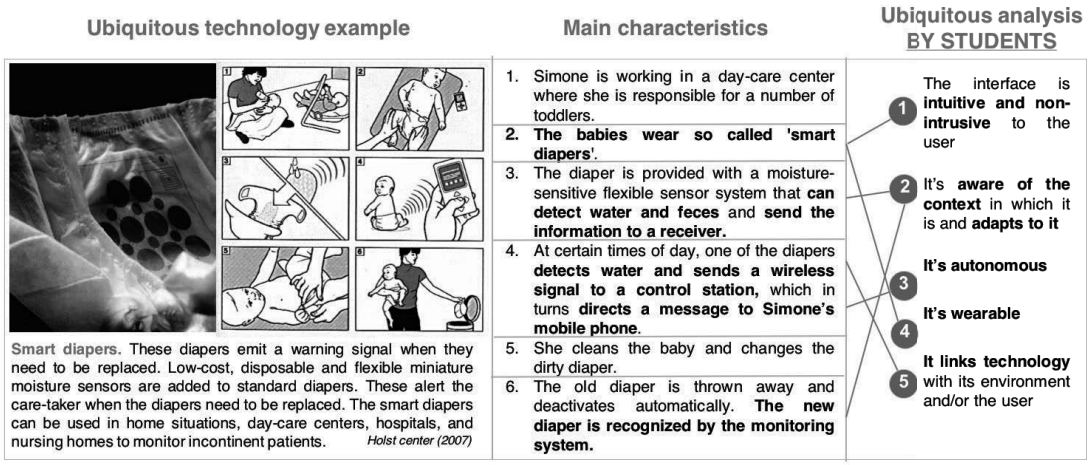

Figure 1. Ubiquitous student guide example

As described to students, IoT and ubiquitous technology collects environmental data through sensors, and analyzes it to make decisions to change the environment through actuators. Information is sent to different actors to make them aware as well. The product/service proposal is said to be ubiquitous if it applies most of the following characteristics: (i) its interface is intuitive and non-intrusive to the user (usually wireless); (ii) it is aware of the context or environment and can adapt to it; (iii) it is autonomous (perform tasks without user intervention); (iv) it can be carried by the user (wearable); and (v) it connects technology with the real environment and/or the user [16]. The DP6 course includes different student guides and activities in order to help students understand the concept of ubiquity. Given that ubiquitous computing is seen as a promising technological path of innovation, tutors select different examples of existing products/services, and others still in concept, to show and

explain the notion of ubiquity and ask students to define whether the example fulfils the characteristics described above and how (see Figure 1).

3.2 Methodological strategies

The specific objectives of the DP6 course are: (1) appropriate relevant aspects of design for communities within the particular context of the city and its main actors; (2) understand and apply existing methods and tools regarding ubiquitous technology and design for communities; (3) plan and execute a design project according to the needs of a specific social context; (4) understand a social need in a real context and propose a product/service to solve a design problem; (5) validate the product/service proposal, by means of technical, user, and product market tests; and (6) communicate the academic process and explain the product/service to the community and private actors. Over the course of 18 weeks, DP6 classes take place both in classrooms and workshops. The course includes mandatory two-hours sessions per week, with direct student tutoring, either individually or in groups. Three tutors are constantly supporting students in their process. They are experts in different areas: (i) user and social context; (ii) mechatronics and technology; and (iii) design. Tutors, guest speakers, and guest experts are also invited and participate in discussions and debates relevant to each group's topic and design phase; these meetings are held in class or during independent work time. The DP6 general methodology consists of three phases centred around the product/service development process. The first four weeks focus on the *Inspiration Phase*: students do field research and apply select tools of the IDEO Design Kit that focus on co-creation. During the *Ideation Phase* (weeks 4-10), students apply select tools of the IDEO Design Kit and the product design methodology following the feedback they received. Then, the chosen alternative is detailed, studying its technical feasibility, the prototype, and the real product manufacturing costs under different scenarios. Students validate the product/service proposal with the community by developing a mock-up (see Figure 2).

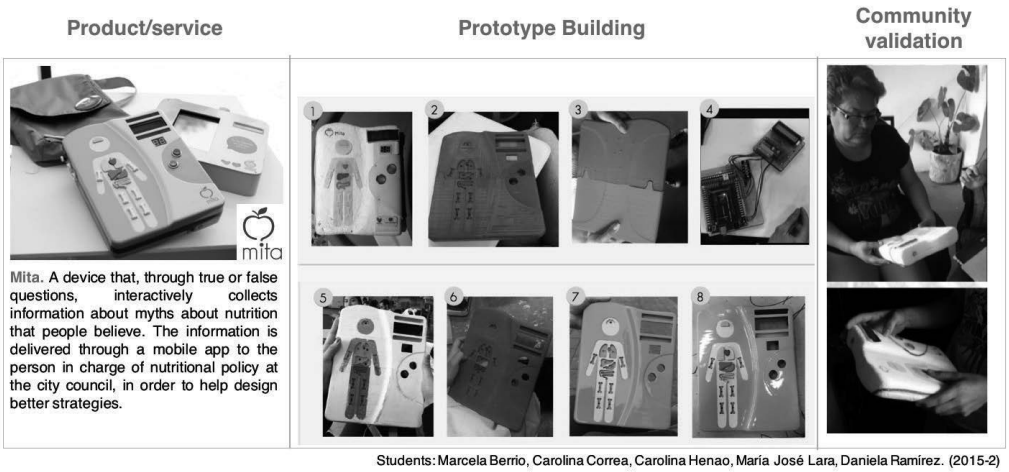

Figure 2. DP6 example

The *Implementation Phase* takes place over the last eight weeks of the semester. During this period, students focus on the construction of a real prototype (at the true scale) and get feed back from the community. At the end of the course, students present the final results to the DP6 tutors, outside experts, the academic community more generally, and the (social) community involved in the project. In addition to this, students invite family and other members, and the general public to a presentation at EAFIT. Students use posters, infographics, and digital aids to better communicate their proposals. They also shoot a video that follows a previously developed checklist in order to ensure that they communicate well their idea to the public. DP6 result videos have been publicly accessible on YouTube since 2014.

3.3 Student experiences

The first phase of DP6 (Inspiration) is particularly intense for many students because some have not been to BoP neighbourhoods before, not do they get to experience dire social needs on a regular basis. At this point of the project, students sometimes get frustrated because when they start a design project, the problem is usually already defined and they do not receive feedback from so many different actors, especially the community, which can be confusing. Furthermore, they need to constantly think about

the community writ large, and not just the final individual user, as they are used to. During the first phase of the project, students need more time to discuss the problem, the community's social needs, and the ways to interact with real users in a real context applying IDEO Design Kit tools. Asking numerous questions about the problem, the user, the product/service, relevant actors, and other important variables, makes this change easier for students. Tutors and guest speakers try to guide the students so that they can make the right decisions given the feedback they have received. During this same phase, technology integration is also problematic for students. They have to think in an integral way about how technology supports the proposed concept, instead of being a gadget or an obligatory element they have to include. After the course, PDE students considered:

- *"Throughout DP6, I was able to strengthen my knowledge of field research and 'getting to know the user.' Not everyday do you get the opportunity to apply what you've learned throughout your college career in real contexts. Personally, I think that these kinds of projects can become more enriching to your professional life than many others, since you get to interact with real people who face real problems, and at the end you can actually validate your solution with them."*
- *"Integrating all the variables, especially technology, to the final solution is not always an easy task for us, but at the end, when you understand how the technology could help your solution, you realize you learn a lot and it will be easier to replicate later in your professional life."*

4 DISCUSSION

Universities are knowledge-intensive social institutions that can address the knowledge-intensive societal challenges of the 21st century by promoting social entrepreneurship and social innovation [12]. This implies that PDE programs must create new strategies for the development of skills in students, and new knowledge in order to create new products, processes, services, and develop novel solutions to address those societal problems. In this way, universities play an important role in terms of local community development in support of society. As Cunha et al. (2015) propose, social innovation projects should focus on providing communities in a specific territory a clear identity so that they can participate in the creation and definition of their regions. With a co-creation strategy, DP6 allows communities to be involved and be part of their own solutions. Given the economic situation in Colombia, getting PDE students involved in design projects with a high content of social experiences is fundamental to ensure both a more inclusive development in the country, and an integral education. For these reasons, the BoP challenge makes a great opportunity for students of PDE and other related fields to put their skills to the test by providing solutions that integrate their capabilities to serve an emerging market need. One important issue in social innovation projects is how to demonstrate that the proposed solutions and programs to such problems have achieved the desired impact. According to Murray et al. (2010), measuring success in the social economy is particularly problematic. Metrics can play a decisive role in determining whether innovations are scaled up, or deserve to be [4]. The answers are never straightforward and are themselves the subject of argument, evaluation, and assessment. Because of time restrictions and the nature of its academic purposes, the scope of DP6 is limited to product validation with the community, but does not extend to the implementation phase. This is a clear area for future research, since it is important to identify academic best practices that push this boundary. The adoption of learning strategies such as "learning by doing" has favoured the ideation, conceptualizing, and manufacturing capabilities of PDE students at EAFIT, and can also yield high quality functional prototypes with high working performance. These discussions have been influenced by the idea of "reflection-in-action", a concept proposed by Donald Schön, who explains that design is not primarily a form of problem-solving, information processing, or searching, but instead a reflexive dialogue between the designer and the materials of the situation he/she is in [12]. The world is becoming increasingly connected; as emerging markets embrace information and communication technologies, we have a tremendous opportunity to harness these into positive social impact. Design has a long history of addressing social responsibility issues, which makes it important to continue this commitment by educating students in the social field.

REFERENCES

[1] World Bank Group (2015). Poverty and Equity: Colombia Country Dashboard. In: http://povertydata.worldbank.org/poverty/country/COL

[2] Phills, J. A., Deiglmeier, K., & Miller, D. T. (2008). *Rediscovering social innovation*. Stanford Social Innovation Review, 6(4), 34-43.

[3] Bock, B. B., & Fieldsend, A. (2012). *Social innovation and sustainability; how to disentangle the buzzword and its application in the field of agriculture and rural development*. Studies in Agricultural Economics (Budapest),114(2), 57-63.
[4] Murray, R., Caulier-Grice, J., & Mulgan, G. (2010). *The open book of social innovation*. London: National endowment for science, technology and the art.
[5] Prahalad, C. K. (2009). *The fortune at the bottom of the pyramid*, revised and updated 5th anniversary edition: Eradicating poverty through profits. FT Press.
[6] Hart, S. L. (2010). Capitalism at the crossroads: Next generation business strategies for a post-crisis world. FT Press.
[7] Bagatsing, E. *Social Innovation Is Shifting the BoP Market Segment*. Available: http://www.lincolnmartin.com/marketing/social-innovation-shifting-bop-market-segment/#sthash.yJuxYjut.dpuf. [Accessed on 2016, 06, March], (2015) 11 January.
[8] Viswanathan, M., & Sridharan, S. (2012). Product development for the BoP: insights on concept and prototype development from university-based student projects in India. Journal of Product Innovation Management, 29(1), 52-69.
[9] Cunha, J., Benneworth, P., & Oliveira, P. (2015). Social Entrepreneurship and Social Innovation: A conceptual Distinction. In L. M. C. Farinha, J. J. M. Ferreira, H. L. Smith, & S. Bagchi-Sen (Eds.), Handbook of Research on Global Competitive Advantage through Innovation and Entrepreneurship (pp. 1-22)
[10] Rajasingham, L. (2009). Breaking Boundaries: Quality E-learning for the Global Knowledge Society. iJET, Volume 4 (Issue 1, march).
[11] Rychen, D. S., & Salganik, L. H. (2003). Definition and Selection of Competencies: Theoretical and Conceptual Foundations (DeSeCo). Summary of the final report:" Key Competencies for a Successful Life and a Well-Functioning Society.
[12] Frankenberger, E., Badke-Schaub, P., & Birkhofer, H. (Eds.). (2012). Designers: The key to successful product development. P 29-41. Springer Science & Business Media.
[13] IDEO (2011). *Human-Centred Design Toolkit: An Open-Source Toolkit to Inspire New Solutions in the Developing World*. Available: http://www.ideo.com/images/uploads/hcd_toolkit/IDEO_HCD_ToolKit.pdf. [Accessed on 2015, 06, November], (2015)
[14] IDEO.org (2015). The Field Guide to Human-Centred Design. ISBN: 978-0-9914063-1-9
[15] Etzkowitz, H., Leydesdorff, L. 1995. The Triple Helix: University - Industry - Government Relations: A Laboratory for Knowledge-Based Economic Development. EASST Review 14, 14 - 19.
[16] Michael Friedewald and Oliver Raabe. "Ubiquitous Computing: An overview of technology impacts" Telematics and Informatics28.2 (2011): 55-65.