INTERNATIONAL CONFERENCE ON ENGINEERING AND PRODUCT DESIGN EDUCATION
6 & 7 SEPTEMBER 2012, ARTESIS UNIVERSITY COLLEGE, ANTWERP, BELGIUM

DESIGN EDUCATION: EMPIRICAL INVESTIGATIONS OF DESIGN THEORY IN PRACTICE IN SPECIFIC CONTEXT

Dipanka BORUAH[1] and Dr Amarendra Kumar DAS[2]
[1]Research Scholar, Department of Design, Indian Institute of Technology Guwahati, India
[2]Professor, Department of Design, Indian Institute of Technology Guwahati, India

ABSTRACT
The present extent and content of designers' work has changed from those in the past. Green and Bonollo mention seven phases in the product development process. The global market becoming increasingly competitive; it has become necessary to integrate design into the concept-to-market process and encouraged designers to participate in decision-making for product planning and positioning. While one considers the underdeveloped or developing countries, above considerations need to be modified in the local context and cultural perspective. A new product begins as an idea or a concept and product developers are interested in lean product development to get products faster and at a lower cost to market. The constant change in markets and technology require companies to meet new challenges. Developing new products and improving existing products forms an important step in meeting this challenge. However, this set of knowledge base may not be able to satisfy contextual situation and design students from underdeveloped and developing countries have to understand the stark context of the use of their product. In these places, even people without formal education solve variety of problems through innovation. A designer can learn a lot from this and needs to contribute by integrating design to make these innovations a marketable product. Understanding of various needs of the user and market forces constitute integral knowledge for the design students for initiating new product development based on innovation. The paper discusses research work to evolve a method to assist in bringing these innovations to global customers through design.

Keywords: Design education, design practice, grass root innovation

1 INTRODUCTION

Design is supposed to solve various problems of human kind and make life comfortable by applying findings of science and technology. However it require the knowledge of users of various products and services and user centric design is important. However, in absence of design education and designers, most of the developing countries have not been able to successfully implement the findings of science and technology to benefit society. In design and technology, people combine practical and technological skills with creative thinking to design and make products and systems that meet human needs. *'Design is a creative activity whose aim is to establish the multi-faceted qualities of objects, processes, services and their systems in whole life cycles'; design is the 'central factor of innovative humanization of technologies and the crucial factor of cultural and economic exchange.'* The technology transfers from developed countries to developing countries have led to design transfer as well. This has resulted in losing the design capability of these countries and benefits of grass root innovations has not been able to benefit the people, not to talk about bringing these innovations to global customers. People without formal education also solve variety of problems through excellent innovation in developing countries in grass root levels.

1.1 Design Education

Design education involves teaching of theory and application in the design of products, services and surrounding environments. Various theories on design education have been propagated and are included in curriculum. In practice, design encompasses various areas/ disciplines; industrial, communication - graphic design, user interface, web, packaging, fashion, information, interior etc.

Design education is supposed to be grounded in a social framework, based on certain assumptions. While academic decisions are to be taken, instruction designers and educators have to constantly make decisions regarding content to be learned and means of learning. Currently, many educational decisions reflect the dominant culture perspective. Design means "to invent and bring into being". Design deals with creating something new that does not exist in nature. Design research process involves the analysis of the use and performance of designed artifacts to understand, explain and to improve on the behaviour aspects of artifacts. The contrast between design education and professional real-world practice and, by implication (redesign) between academic and practitioner have proceeded in a unilateral direction.

1.2 Innovation and differentiation

Innovation involves thinking differently, creatively and insightfully to create solutions that have an impact in terms of social and economic value. Innovation is critical for creating competitive or collaborative advantage, problem solving to address the challenges of our times, improving governance, and generating intellectual value. It can redefine everything – from products, processes, and services to individuals, organizations, the public and private sector and institutions. The innovation is implemented when the product is launched on the market or when the process is started up by the company.

1.3 Grass root Innovations

Grass root innovators are common people who solve various problems they face in trying situations in their day to day life or faced by other people in the society they live. These innovators are mostly uneducated non-formally trained people having skills for creativity and innovative mind. When we consider Indian context, these innovators solve myriad of problems in the society with very limited resources available with them. This although solves the problem they attempt to solve functionally, this process mostly results in very crude products not always fit for manufacture and marketing. However, these innovators cannot engage designers to bring their innovations to marketable products. Neither have they possessed required expertise to market these innovations. To bridge this gap, various institutions such as National Innovation Foundation (NIF), a wing of Department of Science and Technology, Govt. of India and also RuTAG (Rural Technology Action Group) after scouting and identifying grass root innovators and their innovations, are trying to engage designers for converting their innovations to marketable products and services. However till date there is no foolproof methodology for success in this effort. It is in this context that this research work is important and it discusses the various issues through a case study. This case study is about time consuming and inefficient process of extracting the seeds from pomegranate and solving the need to have an appropriate pomegranate de-seeder. The juicy seeds of pomegranate are used to make fruit salad/desserts or fruit juice. In all the cases whole unbroken seeds are desired without pulp or membrane. An innovator, Mr. Uddhav Bharali from Assam, India designed a very functional motorized domestic scale pomegranate de-seeder as shown in Figure 1. Although it was functional, there was no buyer for the device for various factors mentioned later. If this is improved from the point of view of design, it can serve not only domestic users but fruit juice vendors that are very common in Indian cities.

Figure 1. Innovator's Functional prototype in of the pomegranate de-seeder

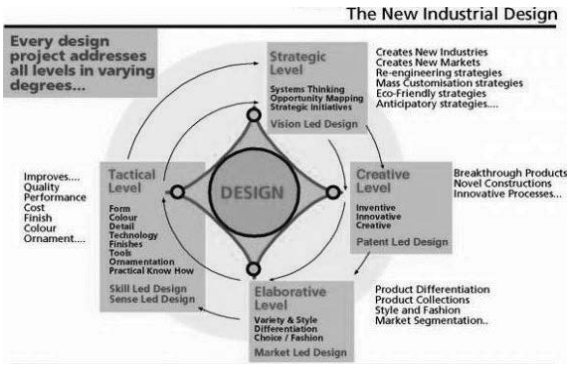


Figure 2. Product planning marketing & recent trends new product development

2 THE IMPERATIVES OF NEW PRODUCT DEVELOPMENT (NPD)

The schematic diagram in Figure 2 illustrates New Product Development (NPD) and is the complete process of bringing a new product to market. The best practices for managing new product development involves design concepts, idea generation, product design and detail engineering as well as involves market research and marketing analysis. After an innovator innovates a product like a *Pomegranate De-seeder* considered in this case study, where innovator has achieved the first two steps namely design concepts, idea generation and partial product design, a professional designer can step in to carry out complete product design to meet various requirements for the category of product and detail engineering for the same along with market research and analysis. Thus designer's work will be complimentary.

3 ANALYSIS OF THE INNOVATORS PRODUCT

3.1 Design analysis

The existing pomegranate de-seeding process adopted in India is slow, low grade, low tech and dehumanizing. Although there are very simple products available in the western countries, these are still not readily available to the users here. Not much research has been carried out to improve the process and tendency of the people in growing cities is to consider the process as unhygienic. A study was conducted to find out in details other factors that are involved and either directly evident or latent. Study of pomegranate de-seeder fabricated by innovator, Mr. Uddhav Bharali has shown that the de-seeder is difficult to clean and thus to maintain hygienic, is fabricated out of materials that are not food grade and electrical connection is not safe for operation. Thus the operator has a hard life, with rigorous competition, long hours and low pay. Traditional existing process of pomegranate de-seeding does not provide comfort to the de-seeder where in many cases the seeds are used for making juice and hence large quantities are required. Innovator's device is also not convenient to use due to lack of consideration for human factors. There is lots of waste of materials during fabrication, since design involves using readily available utensils, exhaust fans etc., where not entire items and fixtures are used, but has to be paid during purchase. There is no arrangement for holding the device to handle during operation or cleaning etc. or when placed on the table. The de-seeder's principle of operation is based on throwing the hemi spherically cut pomegranate by the spinning rotor rotated by electric motor against the circular grid made of PVC rod drilled and clamped to a circular structure fabricated out of aluminium bar mounted on the lower part of the machine along with the electric motor taken from domestic exhaust fan.

3.2 Process of manufacturing

The finding from the study carried out earlier through a visit to the innovator's facilities that manufactures the device revealed that the followings are deficiency of the existing pomegranate de-seeder and its process of manufacturing process in local context based on process of manufacturing employed locally.

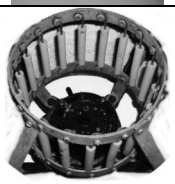
i. Each pomegranate de-seeder is made individually. There is no standard dimension in absence of jigs and fixtures.
ii. Various components are also made individually and there is no serious attempt at standardization of components' exact size, shape and materials since craft process like local black smithy make some of the components. Details of the parts made this way are shown in the Table 1.
iii. Other components are procured off the shelf from various component manufacturers including utensil manufacturers, bicycle components like brake shoes for legs of the device to prevent slippage due to vibration.
iv. Scrape material is used to fabricate the main body covered with low cost plastic lamp hood.

3.3 Description of the traditional fabrication process of a pomegranate de-seeder

Normally the facility used for fabrication a pomegranate de-seeder by the innovator as studied in the case study in Assam is cottage industry for fabrication. It is found to be more or less more same all over the country. In other cases black smithy is eliminated and items made in black smithy are outsourced. A black smithy hearth with manual bellows is common where mostly scrape iron material is used to fabricate various parts as listed in the Table 1. These are made using a variety of material

such as iron water pot, iron rod, plastic belt. The pomegranate de-seeder is also connected with electricity in dangerous way where liquid from the seed can easily penetrate the electric motor and can provide fatal shock to the user.

Table 1. Details of the parts fabricated locally through black smithy and material normally procured from scrape

Sl. No.	Item	Visual Image of the Items (Not to scale)	Materials used for fabrication
1	Bolted feeding Lid		Top portion of traditional aluminium water pot of 270 mm diameter.
2	Rotor cum seed separator		80 watt 220 volt AC Exhaust fan. 18 nos. Drilled PVC rod of 100 mm length x 12 mm diameter mounted on 2 mm galvanized wire and clamped onto circular ring made up of 10 x 5 mm aluminium bar; has 120 mm diameter flat propeller. Mild iron C section bar.
3	Filter basket		Iron water pot of 290 mm diameter (lower portion) and 150 mm diameter (Upper portion)
4	Stand		For legged stand fabricated out of Mild steel C section of 25 mm width and flat bar of 20 x 3 mm; fitted at the bottom with bicycle brake pads.

SWOT analysis

Table 2. Analysis of strength, weakness, opportunity and threats of the innovator's product

Strength	**Weakness**
Low cost production. Availability of skilled manpower. Strong process engineering and product engineering capabilities of MSMEs. Growing domestic appliance market. Higher operational efficiency compared to manual process.	Low investments in Design and R & D for improvement. Limited knowledge of product liability and offshore warranty handling. Lack of marketing expertise. Poor quality goods or services.
Opportunity	**Threat**
A new emerging domestic and global market. Moving into new market segment. Redesign to conform to emerging active learning consensus	Entry of a new competitor in domestic market is easy. Competitor can provide a new innovative product or services in similar lines and hence innovator's product will lose market if introduction is delayed.

3.4 Prototyping of redesigned pomegranate de-seeder

Based on the SWOT analysis, the following brief was arrived at for designing a marketable product. Initially CAD modelling was carried out to obtain digital data of the device prototyped by the innovator. This is shown in Figure 3. Taking the dimensions from the digital model of the innovator's product, design was modified to suit various needs of users' including marketing channel by the authors. The design is shown in Figure 4. After CAD modelling, low cost prototyping was carried out using FRP (fibre glass reinforced plastic) component manufacture in various stages. Process involved is shown visually in steps as under in figure 5. After prototype of the redesigned product was available, it was tested for various aspects. Based on actual testing of the product for various attributes, the design was finally modified for mass manufacturing using injection moulding process etc.

Figure 3. CAD modelling of innovator's pomegranate de-seeder

Figure 4. CAD modelling of redesigned pomegranate de-seeder by the authors

Figure 5. FRP low cost prototyping used for experiment

The idea was for local assembly and manufacture through SMEs production facilities. Thus decision making was fairly easy task. The production planning phase for pomegranate de-seeder involves multiple steps. These are however similar to mass production industry such as domestic appliance production industry and in particular to grinder mixer industry. The preliminary design of the pomegranate de-seeder was intended to establish an overall concept for the project and served as guideline for detailed design. As a first step in preliminary design, an attempt was made to design and develop a pomegranate de-seeder suitable for household application with due consideration for ergonomic aspects, portable, washable. In this attempt, it was assumed that if a new looks aesthetically appealing cad modelling based de-seeder having sufficient safety with full overhead cover suitable for users, there will be sufficient demand for it to be manufactured commercially. during the design of individual part, its specific location and function in subsystem in relation to fit in overall system goal needs to be considered, its shape, its material, its surface treatment and interface with the component. At present, great progress has been made in part design, particularly through sophisticated methods such as photo elasticity and finite element methods.

4 PARTICIPATORY APPROACHES IN POMEGRANATE DE-SEEDER DEVELOPMENT AND TRANSFER OF TECHNOLOGY TO SMALL ENTERPRISES

The mass manufacturing of the Pomegranate de-seeder was carried out at the MSME production facilities. Traditional fabrication workshop based prototype of Pomegranate de-seeder (Figure 3) was followed by redesigned version of Pomegranate de-seeder that was developed at the Department of Design, IIT Guwahati. This version was shown to the representatives of the MSME (Micro Small and Medium Enterprise) and juice vendors in Guwahati as well as big retail market chain in India. All further decisions were taken in consultation with these stake holders for improvement of the device and in true sense, the entire development and production were carried out following a participatory approach, where they were involved as beneficiaries. MSMEs are normally not engaging designers for designing new innovative products and they participated to benefit from being able to introduce a new product through participation in this process. Marketing agency could contribute by sharing the requirement of the customers and benefit by the sale of the product designed to meet the customer's need manufactured by MSMEs at competitive price. Innovator benefited, since he got his royalty after his innovation became a marketable product.

The design and technology transfer did not follow the conventional method, i.e. providing detailed engineering drawing for the product to the actual manufacturer, leaving the onus of manufacturing to them with their understanding. Rather the development process followed by demonstrating of each and every step to the MSMEs physically (to provide actual dimensional aspect) and visually through CAD models. The Pomegranate de-seeder was developed to have own distinctive cultural identity as Indian

product. Retaining form, shape and features of the Pomegranate, people are found to be meeting their own requirement as already seen in the market.

Coming to science and Technology, it is worth to quote Akio Morita, the Chairman of the Board of Sony Corporation, while delivering the First (Inaugural) United Kingdom Innovation Lecture to an invited Audience at the Royal Society, London, on 6 February 1992.

"'S' (Science) does not equal 'T' (Technology) and 'T' does not equal to 'I' (Innovation). To translate my Lecture title into layman's terms it would be: 'Science alone is not Technology and Technology alone is not innovation. Just having Innovative technology is not enough to claim true innovation. I see true innovation to be made up tree key elements which I call: 'the three creativities': Creativity in technology, Creativity in product planning and Creativity in Marketing.

The ideal thing is many individuals and S & T NGO's and other agencies (voluntary and governmental) have achieved significant success in assessing the technology needs of a region and, perhaps up to a point, determined and implemented the technology solution.

5 DISCUSSION

For developing country like India, design and technology transfer for small enterprise is an important aspect. This is also important for globalization of the economy. With increasing competition from countries all over the world, it will be essential to absorb design and technology as well as to develop technology indigenously along with strong design capability. However design and technology developed also needs to be disseminated to the industry. Unless an appropriate methodology is formulated and tasted for design and technology transfer to the industry particularly small enterprise, benefits of design and technology development will not percolate to the all levels of the society. To achieve this various design schools like Department of Design, IIT Guwahati is encouraging its faculty members and students in different levels to take up grass root innovators innovation for value addition through design to convert these innovations to marketable products. This in turn has created contextual products for developing country like India and also helped in creating awareness and interest amongst the design community for solving society's problems that are not attended to by main stream developmental process.

6 CONCLUSION

The research work transpires a need to develop indigenous design with Indian need and context. The design and development of product such as pomegranate de-seeder and process followed as mentioned in this research work would enhance with the participatory approach. A similar functional product with new universal look would get market acceptance and value addition. The small enterprise can benefit from the participatory approach by building its capacity to design new products in house. It also helps in modernization of traditional product by imbibing new process and technology and diversification through design. Students who aspire to be designer of exotic products including automobiles found immense satisfaction when they could see the products they worked on being made available in short duration and made users' life comfortable. Based on the success of these efforts, various developmental agencies are coming forward to engage designers for converting innumerable innovators innovations into marketable products and services and this has shown that a methodology is possible to be formulated that can be more effective than it used to be earlier.

REFERENCES

[1] Bonnollo, E, and Green, L. The Development Suit of Design methods. Appropriate for teaching Product design, *Global Journal of Engineering Education*, 2002, 6(1), 45-50.

[2] Ravi Mokashi Punekar, *Product Planning Marketing & Recent Trends in New Product Development*, IIT Guwahati, 2010.

[3] ICSID (International Council of Societies of Industrial Design). Definition of Design, *http://www.icsid.org*. web. 2004.

[4] Webster's Dictionary and Thesaurus, Book Essentials, 1992.

[5] IGBE (Institute of Brasileiro de Geografia Estatistica), Social Communication. Survey of Technological innovation, *www.ibge.gov.br.* Web. 31 July, 2007.

[6] Morita A., First (Inaugural) United Kingdom Innovation Lecture to an invited Audience at Royal Society, London, on 6 February 1992.