THE PEDAGOGY OF PRE-BRIEF ACTIVITIES FOR INDUSTRIAL DESIGN UNDERGRADUATES OPERATING AT THE 'FUZZY FRONT END' OF NEW PRODUCT DEVELOPMENT

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ABSTRACT
The processes of strategic innovation embedded into the so-called 'fuzzy front end' of new product development are successfully employed by global corporations. This paper describes teaching activity and pedagogic research at Loughborough University, UK that has aimed to provide industrial design undergraduates with enhanced knowledge and abilities to enable them to operate at this fuzzy front end - both for their own design projects and when seeking employment. An unusual aspect of this area of design education is that it is about thinking and actions that take place before any traditional design brief. It is upstream of the brief, or 'pre-brief'. Hence the teaching promotes the intellectual capacity to find problems rather than solve problems. Action research and evaluation research has been used to investigate pedagogic issues. Empirical evidence suggests that students can be taught to successfully operate at this fuzzy front end, and that these students employ relevant strategies to enhance innovation during the early stages of personal design work. There is also evidence from industry that indicates that the students' enhanced abilities will be in demand upon graduation.

Keywords: industrial design, design education, pedagogy, new product development, fuzzy front end, user research, problem finding, brand

1 INTRODUCTION

1.1 Review of fuzzy front end activities
Fuzzy front end (FFE) activities touch on operations such as research and development, branding, user research, and market research. They are components of a company's strategy for successful new product development (NPD). The term 'fuzzy front end' is used as the activities occur at the start of the longer processes of NPD and are sometimes rather ill-defined and unstructured [1].

FFE activities are commonly practiced around the world in big corporations like Procter & Gamble. Its processes and activities are researched and investigated to pursue understanding and to improve profitability and innovation in the companies. The literature on NPD, FFE, innovation strategies etc. is persuasive with models and case studies of success (and failure) in NPD and the role of FFE processes [2], [3], [4], [5]. Some of this literature highlights the role of design, often including the activities of industrial or product design. The core role of industrial design in NPD has traditionally been to ensure that once a design brief has been set then the best possible product is realised. Of course, from its very name, the FFE is about what happens before a design brief is written (i.e. 'pre-brief'). Literature on NPD and FFE also reveals something about how design thinking, processes and activities can contribute to the overall processes of the FFE [6], [7], [8].

There is a growing area of interest in the professional practice of design as a tool for strategic innovation. Companies like IDEO exploit 'design thinking' as a tool in early NPD activity. Tim Brown of IDEO is a particular advocate of this [9].

The book 'Creating Breakthrough Ideas' [10] tells the story of how anthropologists and designers have collaborated over the past couple of decades to the benefit of the product development industry. Much of this collaboration has been connected with the development of design-related user research strategies associated with the FFE of NPD.

An area of investigation that seems thin is how design education needs to prepare students for these new and different activities and processes which may face them in professional practice.

1.2 Review of the pedagogy of FFE activities in university design education

There are design courses, or parts of design courses, which are predominately about subjects such as innovation, management, business, and NPD strategies. Many of these are at graduate, masters level and based in the USA and Europe at institutions such as the D-School at Stanford, USA and Delft University of Technology, in The Netherlands. In the UK there has been a recent growth in development of these types of cross-disciplinary masters courses at universities such as Cranfield, Northumbria, Loughborough, Royal College or Art, and Imperial College. Often, a feature of these courses is to examine and educate about the place of design in business, or to educate designers about how early NPD is actually approached and carried out in modern commerce and business.

Undergraduate industrial and product design education has a focus on design activities which are nearly always about 'problem solving'. This is about taking a stated set of problems, or problematic issues, usually in the form of a design brief, and setting out to 'solve' the problems through the creation of artefacts. This is what industrial or product design is seen to be about.

The emphasis in FFE NPD working is less about problem solving and much more about identification of opportunities that may be profitable, described as a Product Opportunity Gaps (POGs) by Cagan and Vogel [6]. It could be said that 'problem finding' is more important than problem solving.

It is realised that a designer will naturally be expansive and open in her/his problem solving, once provided with a brief. In these, often early, stages of design many more problems tend to be discovered. The problems usually become more, not less, complex and seemingly difficult to solve. So, a designer does normally have certain abilities to find problems and to see 'bigger pictures'.

Central to industrial design thinking is the user, the person. Products, systems, services are designed for people. Industrial design education obviously deals with users and people, but perhaps not as much as it should? Too often it seems to be dominated by issues like technology and appearance.

A brief trawl through the prospectuses of UK universities will reveal many product/industrial design courses which are embedded in engineering schools or faculties. The curricula of these courses often include words such as: 'technology'; 'engineering'; 'manufacture'; and 'styling', but rarely words such as: 'people'; 'psychology'; and 'meaning'. Even those design programmes which are within Art & Design schools and faculties are rarely explicit in identifying 'people' in curricula outlines. When design programmes do deal with people it is often from a 'scientific' standpoint through statistical or anthropometric ergonomics. The understanding of people's behaviours and motivations is no doubt an issue which design educators would agree is important, but it also seems to be something that has limited explicit teaching in undergraduate design programmes.

The case seems to be made for design education to expand a designer's role to include 'problem finding', to identify opportunities and to do this at stages in the NPD process which are before a design brief is set, and to take a wholly user-centred approach to these activities. The pedagogic issues and investigations described in this paper are not really about user-centred design research activities that are, or should be, part of design activities that follow a design brief, i.e. 'post-brief'.

At Delft University of Technology most design students will be introduced to user research activities through what the educators call 'Context Mapping' [11]. The aim is to investigate a user scenario or experience through processes of observation and interview and then build up a picture, or 'map', of that experience. By doing this designers can gain empathy and understanding and then utilise this in further, deeper investigations with users in focus group type work.

Siu [12] and [13] reports on work with engineering design students in Hong Kong, investigating how design research has been integrated into project work. There is a focus on fostering problem-finding, as well as problem solving, abilities amongst students.

At IIT Institute of Design, USA, user research activities for professionals and students have been investigated. Alexis [14] describes approaches to design research where formulating user insights from efficient observation of user behaviour can mean that useful outcomes are achieved without excessive expenditure in time and resources.

University-level product design educators are becoming more interested in the role of user-focused design research in their teaching activities and programme development. Lopes [15], Lofthouse [16] and Rodgers & Anusas [17] all describe their experiences of asking design students to undertake user-

centred research activities, mostly some form of rapid ethnography. Independently, they confirm its benefits in students becoming more empathic with users and gaining insights into relevant behaviours.

1.3 Background of design teaching at Loughborough University

The Department of Design and Technology at Loughborough University, UK, as the name suggests, has developed an approach to teaching product and industrial design which is diverse, multi-disciplinary and includes significant elements of applied technology. The teaching also emphasises 'design-and-make' as important in learning. The Department has evolved these design teaching approaches over several decades and is one of only a few institutions in the UK to have established its reputation for this model of design education.

Loughborough industrial design students are naturally cross-disciplinary in their approach to design problems and conduct much of their design project work in small groups or teams. They are used to liaising with specialists in other academic and professional disciplines such as ergonomics, engineering and business.

Our industrial and product design courses have been quite 'traditional' in the sense that they have been about solid and thorough design problem solving, following the delivery of a design brief. The activities of user-centred design research and pre-brief NPD processes were rare in the Department prior to around 2002.

Several 'drivers for change' emerged during the 2001-2004 period. To the author and his colleagues, these pointed to the need to develop new curriculum and module level teaching for their design programmes [18]. Briefly these 'drivers for change', both internal and external, are outlined.

Significant shifts in the activities of the industrial design profession became evident after the turn of the Millennium. There was movement towards use of user research to drive product development. The use of strategies such as co-designing became more common. It was also becoming more common for design consultancies to get involved in branding and strategic innovation, to offer forecasting and research services to clients, not just downstream design solutions.

There was first hand experience with the author and colleagues of how leading businesses developed new products and services. This revealed new issues such as how leading businesses were likely to be marketing and brand led rather than engineering and manufacturing driven.

There was also a realisation that economic wealth was increasingly not only created by physical products but also by systems and services. This view was in part supported by the actions of the UK government during this period when it developed initiatives to promote innovation and creativity in business. The most important of these initiatives resulted in 'The Cox Review of Creativity in Business' [19] which has proven to be a driver for recent changes in design education across the UK.

1.4 FFE teaching activities at Loughborough University

With the drivers for change so strong and the opportunity to develop our design teaching into new areas the author and a team of colleagues embarked on a programme of new teaching and curriculum and programme development. One of our aims was to offer our students the chance to develop knowledge and abilities that would be valuable in the rapidly changing world of global design. This would hopefully mean that they could be productively employed in the early, upstream processes of NPD - i.e. at the FFE.

The two primary strands to this new teaching were those of user research and brand. These were embedded into a new module. The staff team worked closely together to evolve module content that includes a basic introduction to business and brand strategy, contexts and technology, user research methods to generate observational data and then the analysis and synthesis of that data to generate insights, leading to headline propositions. These propositions would be proposals for breakthrough innovation that would form the essential part of a brief for a design team.

Across a full academic year students are first introduced to the topic and some basic practices of user research and, during the second half of the year, they exploit these newly-learnt abilities in a live NPD project in collaboration with an industrial/commercial partner.

What follows is a basic description of the teaching and learning activities in user research that the author and his colleagues have developed over several years. The primary aims of this teaching are for students to develop abilities in: user research data gathering, processing data to generate user insights, and identifying opportunities for potential exploitation of the insights.

Students work in small groups or teams, of three to five. This offers advantages for managing the teaching but is important and effective for ethical and quality reasons also. The starting point is formulating the context of the investigation. This is about establishing the specifics of the user group and the particular experience or ritual those users are involved with. The data gathering methods tend to be restricted to observation (with photography) and interviewing and conversations to capture user stories. Students keep user research journals throughout the project. Ethical issues are part of the teaching and learning and students are required to adhere to a strict code of practice.

Student research activity is supported by a lecture series from staff and a number of invited presentations from professionals in the areas of ethnographic research, branding, industrial design and NPD.

As data gradually build up from student teams' observation of and talking with users the teaching turns to how to process the data into useful information. A structured set of activities has been developed to tease out insights into user behaviour, supported by evidence recorded in the user research journals. Students are asked to formulate statements of user need, based on the insights. There is an expectation that these insights and needs are unexpected and are not explicitly stated by users. Therefore there is a significant element of student intelligence and creativity that is required to generate high quality, appropriate insights and needs. The final stage of the user research work is for students to generate proposition statements, or identify opportunities, that could be the basis for a potential design brief.

All of the useful outcomes of the user research are communicated in presentation material by student teams or individuals. The first formal outcome required is a board which presents the user 'tribe' or 'persona'. The second outcome is usually a selection of relevant evidence, in the form of pictures and words, which is meant to communicate the essential nature of the user experiences or ritual. The final outcome is the presentation of the processed data into insights and subsequent opportunity and proposition statements.

Students learn that their design research can be regarded as a highly important and productive outcome in its own right. A well presented research folio, rich with visual and contextual material, has proven to be a valuable resource and highly regarded by collaborating companies.

One significant element of the user research, and the live NPD project which follows during the year, has been the focus on non-traditional product issues and opportunities. User research has investigated areas such as recycling, financial services, supermarkets and food. Partnerships with commercial brands and brand holders is seen as an essential part of the teaching, mainly so that we can learn from each other. Industry collaborators include McCain (FMCG food), Amcor Flexibles (structural packaging), Diageo (FMCG drinks), Mars (FMCG food), and Orange (mobile communications). Of note is that partners have been deliberately targeted from producers of non-artefact products.

Alongside the teaching and learning of user research activities the undergraduates investigate issues of brand that relate to industrial design. This usually takes the form of researching a well-known chosen brand to reveal its character and to create visual resources to communicate this essence. This is taken further in later downstream design realisation activity by requiring that new product concepts are closely aligned to the relevant brand, by matching the product's proposition with the discovered brand values.

2 PEDAGOGICAL RESEARCH TO SUPPORT DEVELOPMENT OF FFE DESIGN TEACHING

2.1 Research methods

The primary research strategy employed during the creation of teaching material and curriculum development was that of action research. This has been supported through regular liaison with industrial and commercial partners and collaborators to provide feedback and evaluation of the developments. Professional reflection has been a continuous activity over the years of teaching and research.

Evaluation research has been conducted to begin to understand the impact of the pedagogic developments. The different groups of students undertaking the teaching modules each year have been surveyed through questionnaires and informal discussion and interviews.

The industry and commercial partners and collaborators have been a source of formal and informal feedback to the author and his colleagues. Comments from discussion of student activity and outcomes

have been fed into the cycles of action research and have directly influenced changes and developments in teaching.

2.2 Empirical research data gathered

This section contains a variety of forms of evidence gathered through the research and professional reflection methods outlined above. The first part includes evidence from industry. This is followed by material gathered from students.

An example of the evidence garnered from our industry collaborators is a comment from a Product Brand Manager at the FMCG drinks company Diageo. When he had viewed ongoing user research data and insights into user behaviour he responded:

"The process of generating insight-propositions is exactly the sort of process we go through and want to see. ... We would pay agencies a lot of money for the work you have been doing and they would struggle to get into the depth that you have."

NPD design outcomes from a project with McCain, the company behind frozen potato fries/chips in the UK, has remained confidential at the request of the company. This is taken as strong evidence that the potential value of the pre-brief FFE activities, as well as the resultant designed outcomes, was high and should be protected for the benefit of the commercial interests of the company.

In a project on mobile phones for Orange the brand and user research phase was undertaken by teams of students and took at least half of the allotted time for the project. The material gathered and the outcomes of this phase were consolidated into a 'research folio'. The Orange product manager who collaborated with the teaching team was invited to the University to view all the student output. Whilst obviously interested in the new mobile phone concepts that the students had produced, the Orange manager was more interested in going through the research folios to examine the insights into users that had been identified. He regarded this as potentially more valuable to Orange than the newly designed phones.

When students tackled a NPD project that was concerned with new chocolate products they undertook user-centred research into attitudes and behaviours that surround chocolate purchasing and consumption. This research work, and the proposals for designed products that emerged from it, were shown to designers and managers of the Design and Disruptive Innovation team of Mars UK. Some examples of their responses were:

- *"The proposition opens up a new market for chocolate and an engaging experience."*
- *"A good example of disruptive thinking used to create a new market opportunity."*
- *"A new market opportunity for chocolate is established."*
- *"A clear insight into the target market."*
- *"Clear boards showing the research and proposition which were well received."*
- *"Several clear insights into Chinese culture and shopping while in the UK."*

Following presentations by industry-leading companies EverydayLives (ethnographic research consultants) and Echo Brand Design (product and brand design consultants for FMCG companies) both companies have expressed a wish to work closely with our students of future projects. The managers in those companies have stated that the work they have seen of the teaching and student output has been highly appropriate and relevant to their professional practice.

Companies now approach the author and his colleagues with proposals for collaboration that are not just traditional design briefs (i.e. "Here is a design problem, can your students come up with some ideas/solutions"). The companies want to tap into the pre-brief design research and thinking that they know that our students are now capable of. Those companies recognise that significant NPD innovation really lies in this area, and want to be part of it.

Regular interviews and questionnaire surveys have been conducted with students taking the FFE NPD module. These have asked students about their reactions to the topic, and its teaching, and how they see it fitting into their wider design practices and future careers. Some sample questions and responses from a representative group of current final years students are included below.

When asked to rate their enjoyment of user research activities, in comparison to 'downstream' activities such as concept design and development the most common answer was that they were quite happy to do it, rather than relishing it specifically. The students also rated user research as roughly equal to 'concept idea generation' in its importance to designers.

The students were asked two specific questions, the first about their implementation of user research, the second about their views of its effectiveness. These, and representative replies, are below:

Q1: How have your abilities and training in early, pre-brief, user research been utilised in final year project work?

- *"I conducted interviews and arranged meetings with members of my user market ... Without user research it would be very difficult to know where to start with designing."*
- *"I was constantly looking for insights during the user research stage of my final year project and evidence to back them up. I wanted to ensure I was designing for a purpose and to solve real life problem not just for the sake of it."*
- *"Generating insights and propositions helped give a different approach and make it easier to design for 'someone else'."*
- *"At first I saw it to be a pain but actually it allows you to develop better ideas to solve real problems."*
- *"Gives me more of an idea of how to approach research. How to gain insights and how to progress from there."*
- *"Rather than just throw some ideas down, I tried to find problems that are currently occurred in certain area."*

Q2: What are your views about whether user research activities can lead to better products?

- *"I think they can definitely. Otherwise you are designing what you think people want, rather than what they really want."*
- *"I think that after thorough user research more 'satisfactory' products can be designed. This is because you know exactly what people want."*
- *"Definitely getting a better end result as user research gives you a better understanding of the problem your trying to solve."*
- *"I believe user research activities need to start becoming a much larger part of designing."*
- *"User research allows designers to see problems that can be hard to find."*

3. DISCUSSION AND CONCLUSIONS

The author and colleagues consider that the introduction of design-related fuzzy front end activities has been a successful development of our industrial design programmes and teaching.

There seems to be good evidence from industry and professional practice in the UK that the developments in FFE teaching and curriculum developed at Loughborough University are important and effective. The data gathered from students who have gone through the teaching indicate that their abilities in user research are appreciated and utilised in their wider design work.

This is what can be concluded from the research so far:

- That undergraduate industrial design students can learn to operate successfully at the FFE of NPD.
- That there are successful pedagogical approaches in university-level industrial design education for student designers to develop abilities and knowledge that are highly relevant to the FFE of NPD.
- Successful FFE working is not just about students learning a new set of technical skills. Like many other elements of design education, success seems to be complete when there is a deep understanding and appreciation of the issues behind researching people. It is about values and empathy.
- That, whilst professional practice is good to learn from, it is problematic to adopt it wholesale and without modification into design education.
- That there seem to be issues to do with student designers' natural 'DNA' which may make them either nicely suited to, or quite opposed to, some of the user-centred FFE activities. The pre-brief activities do not suit all industrial design students. Many find it a struggle to deal with the non-visual, non-technical, language-based work and working. However, some industrial design students particularly warm to the activities. They enjoy the contact with outside users and the different intellectual challenges.
- That undergraduate industrial design students can successfully exploit these activities in personal project work - not simply to improve post-brief (downstream) design activities but also in novel approaches to pre-brief thinking and research to generate innovative potential ideas for products.

- That industry and commerce may be ready to accept design graduates with new ranges of knowledge and abilities, because that is how professional practice is changing.
- That design research, in its own right, is to be valued. It can have significantly valuable intellectual property attached to its outcomes. It is also valued in what it offers to students as a lead into innovative product ideas and the ability to defend and develop those ideas.

There are many related design education issues which we do not yet know enough about, and therefore are worthy of further research. One of these issues is about what is going on, with regard to learning styles, during some of the FFE activities and how can design pedagogy be developed to take account of this knowledge. Another interesting issue is the communication of FFE activities, process and outcomes by design students. This may need new strategies, beyond the traditional 'model of a product/artefact' which is common in post-brief, downstream design outcomes.

The author welcomes contact and possible collaboration with design education practitioners and researchers whose interests are similar to those covered in this paper.

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REFERENCES

[1] Deschamps J-P. and Nayak P.R. *Product Juggernauts: How Companies Mobilize to Generate a Stream of Market Winners*, 1995, (Harvard Business School Press, Boston).
[2] Khurana A. and Rosenthal S.R. Integrating the fuzzy front end of new product development. *Sloan Management Review*, 1997, (MIT, Cambridge).
[3] Khurana A. and Rosenthal S.R. Toward Holistic "Front Ends" In New Product Development. *Journal of Product Innovation Management,* 1998, 15, pp.57-74.
[4] Zhang Q. and Doll W.J. The fuzzy front end and success of new product development: a causal model. *European Journal of Innovation Management*, 2001, 4, pp.95-112.
[5] Koen P.A., Ajamian J.M., Boyce S., Clamen A., Fisher E., Fountoulaakis S., Johnson A., Puri P. and Seibert R. Fuzzy front end: effective methods, tools, and techniques. In *The PDMA ToolBook for New Product Development*, 2002, pp.5-35 (John Wiley & Sons, New York).
[6] Cagan J. and Vogel C.M. *Creating breakthrough products: innovation from product planning to program approval*, 2001, (Prentice Hall, Upper Saddle River, NJ).
[7] Veryzer, R.W. The Roles of Marketing and Industrial Design in Discontinuous New Product Development. *Journal of Product Innovation Management*, 2005, 22, pp.22-41.
[8] Steen M., Kuijt-Evers L. and Klok J. Early user involvement in research and design projects - A review of methods and practices. In *23rd EGOS Colloquium*, Vienna, July 2007 (European Group for Organizational Studies).
[9] Brown T. *Innovation Through Design Thinking*, Presentation at MIT Sloan School of Management,16 March 2006. http://mitworld.mit.edu/video/357
[10] Squires S. and Byrne B. *Creating Breakthrough Ideas: The Collaboration of Anthropologists and Designers in the Product Development Industry*, 2002 (Bergin & Garvey, Westport, CT).
[11] Stappers P.J. and Sleeswijk Visser F. Bringing Participatory Techniques To Industrial Design Engineers. In *Shaping the Future? 9th International Conference on Engineering & Product Design Education*, Newcastle Upon Tyne, September 2007, pp.117-122 (Institution of Engineering Designers and The Design Society).
[12] Siu K.W.M. Nurturing All-round Engineering and Product Designers. *International Journal of Technology and Design Education*, 2003, 13, 243–254.
[13] Siu K.W.M. Guerrilla Wars in Everyday Public Spaces: Reflections and Inspirations for Designers. *International Journal of Design*, 2007, 1(1), 37-56.
[14] Alexis J. *Needs Clusters: a research strategy for accelerating user centered design innovation*, 2006, http://trex.id.iit.edu/papers/alexis_needsclusters.pdf (IIT Institute of Design).
[15] Lopes A. M. Designed Inquiry: The Significance of Research Education for Industrial Designers. In *New Perspectives in Design Education 10th International Conference on Engineering &*

Product Design Education, Barcelona, September 2008, pp.132-137 (Institution of Engineering Designers and The Design Society).

[16] Lofthouse V. Discrete Observation as a Method of Identifying Real Design Needs. In *New Perspectives in Design Education 10th International Conference on Engineering & Product Design Education*, Barcelona, September 2008, pp.180-185 (Institution of Engineering Designers and The Design Society).

[17] Rodgers P.A. and Anusas M. Ethnography and Design. In *New Perspectives in Design Education 10th International Conference on Engineering & Product Design Education*, Barcelona, September 2008, pp.186-191 (Institution of Engineering Designers and The Design Society).

[18] Wormald P.W. and Rodber M.J. Aligning industrial design education to emerging trends in professional practice and industry. *Journal of Design Research*, 2008, 7(3), pp.294-303.

[19] Cox G. *Cox Review of Creativity in Business: Building on the UK's strengths*, 2005, (HM Treasury, London).

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