CREATING IMPACT FROM INDUSTRIAL DESIGN RESEARCH: CASE STUDIES FOR APP, EXHIBITION, VIDEO, WEBSITE, CARDS AND AWARD

M. Evans

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1. Introduction

'Publish or perish' is still very much the watchword for career progression in research-led universities, despite a broadening in the scope of academic disciplines and, in particular, the expansion of university-based vocational education. In the United Kingdom, design disciplines entered mainstream academic research with the 1992 Further and Higher Education Act that enabled vocationally focused polytechnics (where the design disciplines were largely based) to become universities [National Archives 2015]. With university status came the ability for institutions to award their own PhDs and undertake research that was linked to the allocation of government funding.

As accountability for public expenditure has increased, the notion of impact for 'non-academic beneficiaries' has become central to applications for research funding in the UK [EPSRC 2013]. In 2014, the Research Excellence Framework (REF) introduced impact into its funding formula with a weighting of 20% for Impact Case Studies; the number of submitted being depended on how many staff were included in an institution's Unit of Assessment e.g. 45 or more staff were required to return six case studies plus one further case study for every additional 10 staff [REF2014 2013] For the 2014 REF, impact was defined as 'an effect on, change or benefit to the economy, society, culture, public policy or services, health, the environment or quality of life, beyond academia' [HEFCE 2013].

In a climate where the funding of design research places increasing emphasis on impact, the aim of this paper is to identify ways in which this can be facilitated through a range of media that are particularly well suited to the field of design. Whilst references are made to the context and methodological approaches used, the topic of the paper focuses on the interplay between these and impact of the outputs. Outputs from the author's research in the form of video, website, app, pdf download, award, cards and gallery exhibition are identified and discussed. Independent corroboration of the credibility of such outputs necessitates a process that is inevitably different to the peer review of academic journals but can, arguably, be equivalent or similar. In the case studies featured, the role of peer/expert review was undertaken by professional associations, a national design centre and international design award jury. The case studies identify routes to impact through resources that support the commercialisation of new technology; collaboration between industrial designers and engineering designers and communication during product development/design education.

2. Concrete Innovation - exploring the commercialisation of 3D concrete printing

A core capability of the industrial designer is the translation of emerging technologies into tangible/desirable product solutions that meet commercial and human-centred needs. Having developed an innovative 3D concrete printing process at Loughborough University [Lim et al. 2011], a project funded by the UK's Engineering and Physical Sciences Research Council was undertaken to explore how designers could respond to the manufacturing opportunities afforded by this emerging technology to produce desirable and commercially viable products.

Seven designers were engaged in an action research project that progressed from technology familiarization to concept generation, design development and design specification. The design brief at the core of the data collection was to design street furniture benches for civic and educational use. An additional layer of data collection was added to the project by evaluating the use of topology optimisation to explore the impact of this technology on form-giving and material utlilisation. An image of the concrete printing machine used for the research can be seen in Figure 1.

Figure 1. 3D concrete printing machine

On completion of the project, extensive design-based material had been produced by the research subjects (seven designers) through the use of action research. This enabled reflection on the strengths and weaknesses of designing for the new technology and an indication of how it differed from more established production techniques. The full extent of the material produced as part of the data collection can be seen in the three the display panels produced for the project in Figure 2. These include the three images for each bench design as digital sketches, computer aided design renderingsand physical model. The integration of action research with a relatively large volume of high quality outputs proved to be a rich source of empirical date.

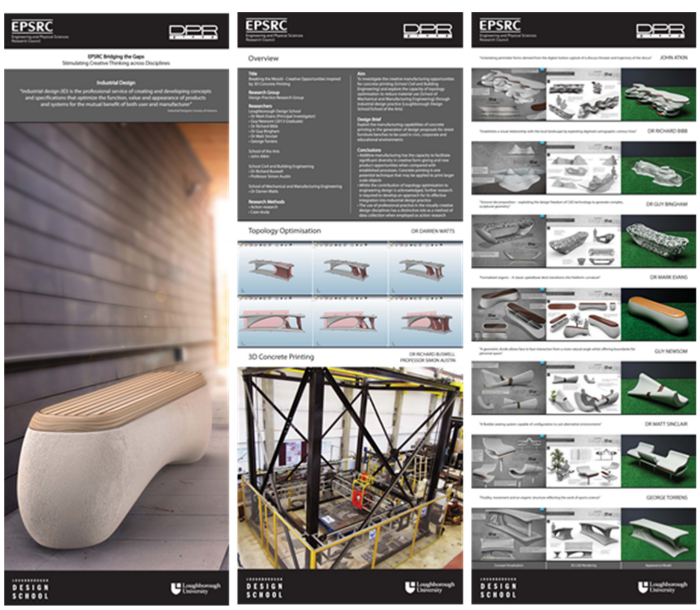

Figure 2. Display panels showing the range of material produced during the project

With the availability of extensive material from the design process and product outcomes (benches) that had relevance and a degree of appeal to the general public, the impact strategy involved promoting the project to galleries/museums. There was also an additional agenda for the displayed material and ensuing publicity in generating interest to help find a manufacturer/investor to take one or more of the products into production.
To enable curators to fully appreciate the scope and content of the work, the research outputs were used to create a dummy exhibition that required the production of plinths and supporting information panels. Once set-up in the gallery space at Loughborough Design School, a video was produced that captured the content and of the project and exhibition. The video can be seen at (www.youtube.com/watch?v=qTFUTI39uhE&feature=youtu.be). Images of the dummy exhibition that was set up in Loughborough Design School can be seen in Figure 3.

Figure 3. Dummy exhibition set-up for the filming of a promotional video

Having been able to fully describe the project and nature of the exhibition material via the video, the curators for the UKs National Centre for Craft and Design (NCCD) accepted an invitation to display the work to the public from 12 December 2015 to 28 February 2016. In addition to the public exhibition, the project went on to generate unexpected impact when one of the benches, as see, in Figure 4, received a finalist award in the 2015 International Design Excellence Awards (IDEA).

Figure 4. Award winning bench design

As examples of peer/expert review, acceptance of the exhibition by the curators of the NCCD and the award from the jury panel for the 2015 IDEA represent verifiable examples of impact and credibility. However, an unexpected outcome of the project was the success of the video that had originally been produced to capture the project and present it to museum/gallery curators. Having uploaded the video to the YouTube website to give access to the museums/galleries that had been contacted by email, once in the public domain the content appeared to be of considerable interest, receiving over 38000 views in its first 12 months of posting with no direct promotion other than to the original eight museum/gallery curators.

3. CoLab - a designer/engineer web-based collaboration tool

In an increasingly competitive commercial environment, organisations face pressure to identify and implement efficiency gains. For companies involved in product development, the interaction between industrial designers and engineering designers has been identified as being problematic [Jevnaker 1998], [Persson and Warell 2003] as their dissimilar working methods can generate conflict [Persson and Warell 2003]. In addition to fundamental differences in approaches, another key barrier is that industrial designers focus on appearance and user-interface, whereas engineering designers focus on functionality and manufacturing detail [Kim et al. 2006]. The engineering designer produces detail drawings and CAD geometry for the manufacture of a working product based on quality, performance and cost [Flurscheim 1983]. In contrast, industrial designers produce more emotive, qualitative representations such as sketch renderings and appearance models.

The issue of communication between industrial designers and engineering designers was explored through PhD research undertaken by Dr Eujin Pei (now a lecturer at Brunel University) supervised by the author and Dr Ian Campbell at Loughborough University [Pei 2009]. Following the literature review, data collection commenced through a ten week study with 17 design consultancies specialising in electronic consumer products. The subjects were qualified industrial designers and engineering designers with varying levels of experience. The fieldwork consisted of 45 hours of in-depth interviews and 80 hours of observations. The empirical studies utilised a qualitative research methodology, incorporating semi-structured interviews and the observation of participants during a commercial project. The interviews allowed respondents to fully describe their personal experiences relating to group interaction, reasons for project success and failure and methods used during the project. The data was coded into a spreadsheet which identified 61 problem categories. A coding and clustering technique was then used to condense the results into a matrix using recurrence and importance.

The matrix highlighted the 19 most frequently occurring problems that occurred three or more times which were then categorised into three groups: 'Conflict in Values and Principles', 'Educational Differences' and ' Differences in Design Representation'. With evidence to support that a lack of a common language in design representations was making it more difficult for industrial designers and engineering designers to understand and empathise with each other, the research sought to resolve this by creating a knowledge framework and tool to help resolve the issues.

The knowledge framework used empirical data to generate definitions for the key design representations used by industrial designers and engineering designers. It also identified when they were used and the key types of design and technical information that they were used to communicate. This was then translated into a tool that, following the evaluation of a variety of formats, physical card were selected on the basis of portability and convenience.

The cards were developed as sets of red cards for industrial designers and blue cards for engineering designers, with the content for each set being divided into three sections. The red and blue sets differed in the fact that the popularity of use for the design representations was not the same for industrial designers and engineering designers as evident through the data that was collected via interviews. Section one of the cards identified the key design stages of the new product development process (concept design, design development, embodiment design, specification). The front face provided a definition of a specific design stage, with four cards being used to indicate the popularity of use of representations during each of the four stages, with the most popular appearing at the top. Section two described the key design and technical information used by industrial designers and engineering designers during the design process. The front face had a definition of the type of design or technical information, with the reverse showing the popularity of specific representations to communicate the design or technical information. Section three identified the 34 most significant design representations used by industrial designers and engineering designers during the design process. These were grouped into sketches, drawings, models and prototypes. The front face gave a definition of the design

representation and the reverse face included the design/technical information that was embodied in the representation plus the popularity of the representation when used during a specific design stage.
The card-based tool, called CoLab, was validated through semi-structured interviews with participants from 15 design companies and academic institutions. The results indicated that respondents felt that the tool would provide a common ground in design representations and contribute to enhanced collaboration. However, despite the apparent contribution made by the tool, discussions with several prominent UK-based organisations with an interest in the promotion of effective product development, it was not possible to reach an agreement to print and distribute the 114 full-colour, double sided cards, primarily due to cost. However, having acknowledged their positive contribution to engineering education, the Royal Academy of Engineering embraced the approach and provided funding to translate the tool into a free website. Whilst this took the project away from the physical card format as originally envisaged and validated, it did represent an effective means of dissemination. The web tool also included elements of the graphic design solution as devised by Pei [2009] in the PhD.
Figure 5 shows the web page for the four stages of product development, where clicking on one of the stages reveals detailed information about the preferred design representations that are used during the stage (in declining rank order). The red card identifies use by industrial designers and the blue card use by engineering designers. Clicking on one of the listed design representations reveals more information on that specific type.

Figure 5. CoLab web page for the four stages of product development

Figure 6 shows the screen display after clicking on the wording for Study Sketch. This reveals a core card that has a number, image and description. To the right are the red and blue cards that show how industrial designers and engineering designers use the Study Sketch differently; with a rank order listing of preferences for what type of information it is used for in the top table and when it is typically used in the bottom table. Clicking on the wording in these boxes then links to the Type of Information pages and Design Stages page.

Figure 6. CoLab web page for the Idea Sketch

The CoLab tool to support collaboration and communication between industrial designers and engineering designers is available on an open access website at www.colab.lboro.ac.uk with a full record of the project available as an academic publication [Pei et al. 2011].

4. iD Cards - a tool to support communication and understanding during product development

Results from Pei's PhD [Pei 2009] gave an overwhelmingly positive response to the concept of a design tool to support collaboration and communication being produced in a physical format. During a search for more economical alternatives to a playing card-type product as proposed in the original PhD, the commercially available 'Z-Card' fold-out printing format was identified as a potential solution as it was available in a variety of panel formats and sizes. Unfortunately, although the Z-Card product was cost effective, the format was not suitable for the creation of 114 double-sided as used on the CoLab tool.

Whilst a review of the potential for the Z-Card format to be used as an alternative to the 114 double-sided cards was being undertaken, interest in the CoLab tool was expressed by the Industrial Designers Society of America (IDSA) following presentation at their International Conferences [Pei et al. 2007], [Evans 2011]. Its contribution in supporting student and novice designers was particularly well received. Ensuing discussions and validation by the Executive Board of the IDSA resulted in an agreement to produce an IDSA/Loughborough University branded design tool that included the full range of design representations used by industrial designers (when they were used and for what types of information). Significant development work was undertaken by the author to redesign the CoLab tool for the Z-Card format which was re-branded iD Cards. The iD Cards had credit card-size front and rear covers that were printed on gloss card, with the A3 fold-out panel being on paper. Yellow tabs indicated at which stage of product development the design representations were used, with tabs to indicate if they were generally used to communicate design information (red tabs) or engineering information (blue tabs).

When folded-out, the cards reveal embedded information for eight types sketch and drawing on one side (Figure 7); and eight types of model and prototype on the reverse (Figure 8).

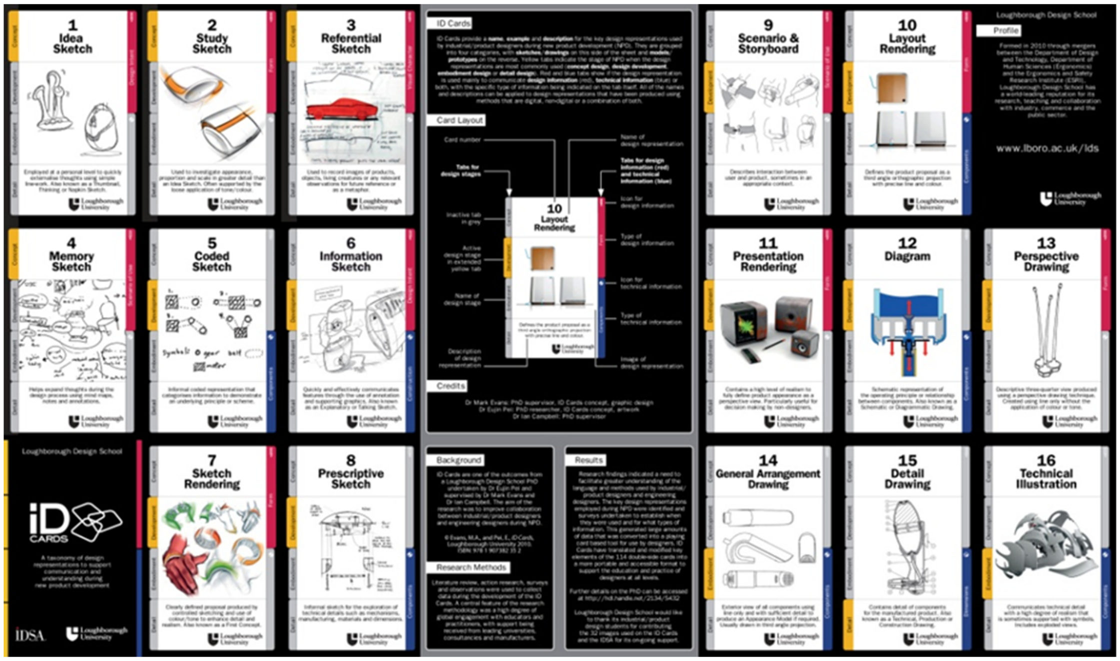

Figure 7. Folded-out front sheet of iD Cards

Figure 8. Folded-out rear sheet of iD Cards

The collaboration with the Industrial Designers Society of America (IDSA) facilitated the printing and distribution of 5000 iD Cards to it members in the USA and a further 6000 to design students in the UK. Acknowledgement of the contribution of the iD Cards was made when they were selected as a finalist in the 2011 International Design Excellence Awards (IDEA). A key feature of the way in which the iD

Cards are presented is the way that the large amount of information is folded and compacted to into the credit-card format as seen in Figure 9.

Figure 9. Folded iD Cards

In response to on-going demand for the iD Cards, an open access PDF version was launched on the web site of the Design Practice Research Group at Loughborough University (http://www.lboro.ac.uk/media/wwwlboroacuk/content/lds/downloads/research/researchgroups/design practice/IDSA%20iD%20Cards.pdf) and, in 2013, funding was made available by the Higher Education Funding Council for England to translate the iD Cards into a smartphone app. Following an interaction design exercise by the author, the iD Cards app was launched as a free download from iTunes and Google Play in January 2014. By October 2015, there had been over 10000 downloads of the app and over 2400 views of the supporting video which is available on YouTube at www.youtube.com/watch?v=ZgvjhywMSwY&feature=youtu.be. Figure 10 shows the app being used to compare the capabilities of design representations and an example of how the side-swipe function reveals details from the side tabs can be seen in Figure 11.

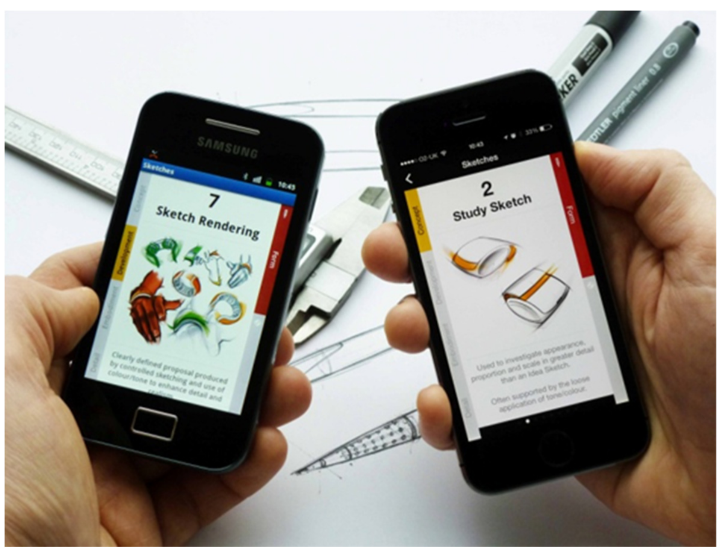

Figure 10. iD Cards app used to compare characteristics of contrasting design representations using Android and iPhone platforms

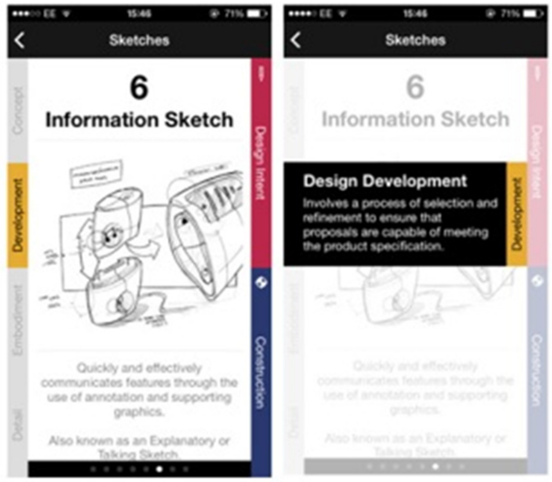

Figure 11. Ghosted main image (right) after tapping on yellow Development tab to reveal additional information

5. Conclusions

The capacity to demonstrate that research can have or has had impact beyond academia is becoming central to funding models, particularly in the UK. This requirement may pose particular challenges for some academic disciplines, but the applied nature of design puts the field in an enviable position.

To maximize the potential for impact from academic research, three approaches emerge from the presented case studies. To avoid unexpected expense and delay, the first involves the need to integrate a strategy for appropriate dissemination within the research methodology. As was the case with the 3D concrete printing exhibition case study, this also ensures that all required materials are rigorously collected throughout the research process in preparation for the creation of the resource.

The second is to acknowledge that when there is an intention to produce resources for designers (educators/practitioners), these must have qualities that are appropriate for a visually literate profession. For those developed by researchers who are themselves designers, this is a relatively straightforward process as they can, in effect, undertake the design activity themselves as was the case with the iD Cards case study. In fact, the author believes that researchers with backgrounds as competent design practitioners are in an advantageous position in this respect due to their in-depth knowledge of the on-going research, capacity to identify opportunities as they emerge and ability to transform the findings into visually creative solutions. Without an embedded design capability, it would be necessary to utilise professional design services which must be justified and costed within applications for funding as in the CoLab case study.

Thirdly, it is difficult to make claims for the relevance and impact of a resource without evidence. Collaboration and validation with professional associations (iD Cards/CoLab) or exhibition curators (Concrete Innovation) can make this process relatively straightforward, providing of course that the resource meets their needs.

As academic design research continues to mature, it is timely to reflect on ways in which outcomes that are of interest to practitioners are disseminated. Whilst this paper acknowledges the significance of journal publication, it questions its validity as an end point, with a need to identify ways and means to translate key findings into an accessible resource. The resources presented in the four case studies required considerable additional and provide evidence for varying degrees of impact. However, at the most significant end of the scale, to have the outcomes from academic research validated, adopted, funded and distributed by the largest and most established professional body for a design discipline, demonstrates the full potential for this approach.

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Dr. Mark Evans, Reader in Industrial Design
Loughborough University, Loughborough Design School
Loughborough University, LE11 3TU Loughborough, United Kingdom
Email: M.A.Evans@lboro.ac.uk