Industrial Design Education: Taming Technology to Enhance User Experience

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Abstract

Background The world we live in today is dramatically different than the world at the turn of the century. Over the past two decades, new technologies and social change have provided opportunities to radically reshape the way we live, work and play. The cellphone, the internet, wireless communication and miniaturized sensor-based technologies have profoundly altered our daily lives. But how well have we done as designers to take advantage of these changes? And how well have we done as design educators in leveraging these technologies to the benefit of our students and society? Industrial Design is very much a discipline in transition. As designers and design educators we have the opportunity and responsibility to reposition and redefine the role of Industrial Design as a key strategic vehicle to reshape the future. But how do we find space in an already packed curriculum to interject substantive new material without losing the core values of the discipline. The term "Taming Technology" in the context of this research refers to the designer's goal to create products, systems, and services that are accessible, effective, and meaningful for their intended audience and user base.

Methods This empirical research traces 20 years of active engagement in design curriculum development. It builds from the evolving role of industrial design in modern society seen through the eyes of two designers/design educators from distinctly different generations and distinctly different cultural backgrounds who have integrated research from the field tempered by their experience in both design education and practice.

Results The result is a new curriculum designed to postion ID students to effectively leverage new technologies in support of human centered design in response to recent thinking in industrial design practice together with changes in social trends and their implications for business and industry.

Conclusions The current iteration of this design curriculum integrates key contextual drivers that differentiate the design profession from many other disciplines that focus more exclusively on optimizing the utility and performance of the technology itself. The research begins to build a set of recommendations to serve as guidelines representing best practices for integrating new technologies into the design curriculum while maintaining a clear focus on enhancing user experience.

Keywords Design Curriculum, Interactive Technology, Storytelling, Visual Communication, User Experience

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1. Introduction

In January 2017 the World Design Organization (WDO) released a new definition of industrial design (WDO, 2017) that refers to the designers' goal to create products, systems, and services that are accessible, effective, and meaningful for their intended audience and user base. The goal of this research is to build a new educational model for industrial design to leverage new technologies to more effectively address these challenges.

1. 1. Advent of Interactive Technology

The designer's toolbox has undergone three significant evolutionary steps in the past 20 years (Budd, 2011). First, if we step back to 1995-2000, the primary set of tools for an industrial designer was typically comprised of 6 or 7 elements including: sketching, model making, ergonomics, materials & manufacturing, drafting, graphic design & layout and perhaps a basic understanding of marketing. Most design projects focused on ideation, detail design and specifications for production.

Second, with the widespread public access to the internet circa 2000, the focus of design began to shift quickly and a much more extensive set of digital tools was rapidly evolving. The industrial designer's toolbox then included additional tools for photo manipulation, computer illustration, 3D computer modeling, 3D anthropometry, rapid prototyping, and programming for the internet (Heskett, 2002). The new tools and new skills enabled us to complete traditional tasks more quickly and efficiently and allowed us to do new things that had never been possible before such as computer modeling combined with CNC machine tools to automate production (Martegani and Montenegro, 2000) while access to the internet helped us to change the way we communicate. Many industrial designers who were quick to adopt the new tools became the pioneers of a new generation of digital designers.

And third, the world as we knew it was shrinking. The marketplace was no longer local or national but now global. The implications were dramatic and we were standing on a new playing field. It was now essential to understand diverse user needs and requirements, and frame them with agile prototyping or risk losing your customer base. This change led to an entirely new set of design tools from user experience to interactive technologies (Budd et al, 2003).

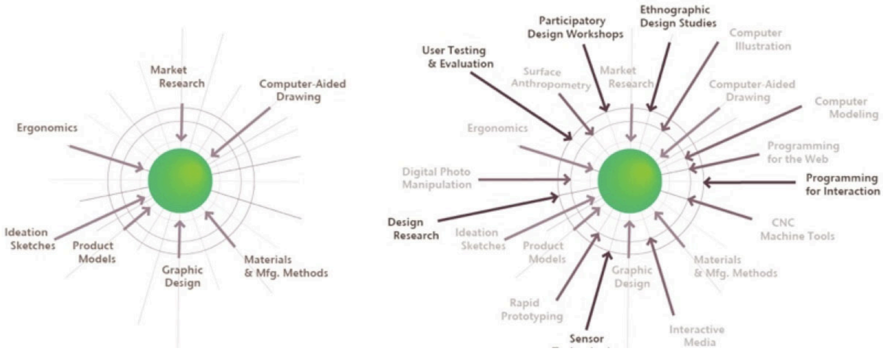

Figure 1 The designer's toolbox evolved dramatically with the advent of digital technologies (Budd, 2011)

1. 2. Business and Industry Discover Interactive Technologies

As Norman said, for all new technologies it will take a while for us to figure out the best manner of interaction (Norman, 2010). Initially business and industry took a “wait and see” approach and were very slow to adopt the sudden growth in the area of interactive technologies. The electronic industries of the 90’s were predominantly driven by large scale manufacturers who had little if any interest in a niche market created by a growing cluster of artists and designers who were enamored of the rapidly growing potential of sensor-based technologies.

With the Post-Fordism production (Imbesi, 2012), it allowed room to grow for a cluster of small start-ups eager to establish a toehold in a new disruptive marketplace. Some of the more recognizable companies include: Sparkfun, Adafruit and Seeed Studio. Collectively they were able to develop a critical mass that fueled the growth of the “Maker Movement” (Dougherty, 2012) and the related crowdfunding pools for the new hi-tech revolution including commercial groups like Kick-Starter and Quirky as well as educational start-ups like Venture Well.

Many of these new ideas were not as successful as anticipated. This underscored the need for more clarity in identifying the value and potential market for new concepts before investing heavily in development. This in turn identified the opportunity for exploration of the “fuzzy front-end” (Sanders &Stappers, 2008) and validation of concepts prior to major high-risk expenditures on detail development, manufacture, and distribution. In the words of Bill Buxton (2007), it was now critical to get both the design right and the right design.

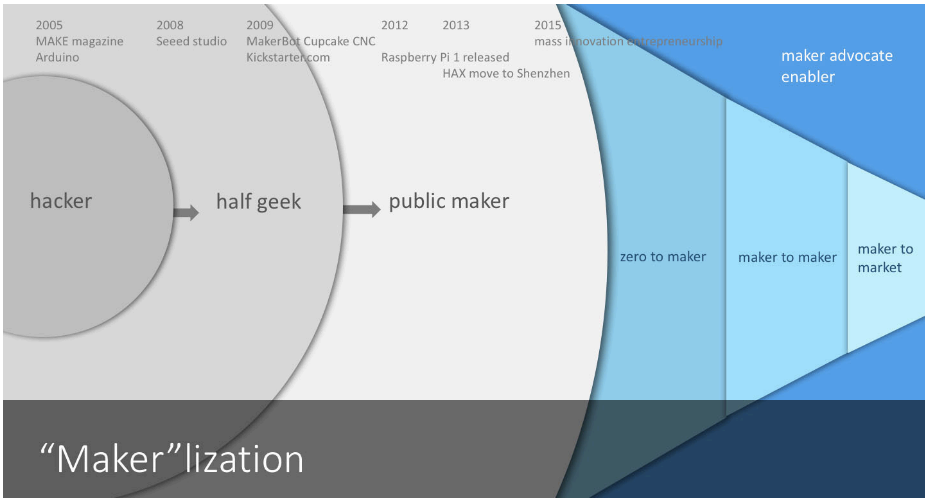

Figure 2 The Maker Revolution precipitated a disruptive change in the the sensor–based technology market

1. 3. Challenges for Academia in a Disruptive Age

The growth and evolution of wireless technologies combined with the rapid introduction of low-cost miniaturized sensor technologies spawned an opportunity for exploration and development of an entirely new field of interactive products and technology. The new field initially drew interest from electronics engineers, who were interested in development and optimization of the hardware technology, and computer scientists who were interested in the programming challenges of the new wireless systems. At the same time, we began to see the emergence of a diverse range of new combined academic disciplines interested to optimize the application of smart technologies for their own specific needs. Some of the more popular hybrid programs include: Human Computer Interaction, Computational Media, Digital Media, Media Arts, Interactive Arts, and Physical Computing. But this new generation of digital smart products were much more complex than the traditional electronic appliances we were used to and although there was significant market interest in smart technologies, it was not obvious to most user how the products worked and/or their capabilities (Norman, 2011).

Over the past 10 years as smart technologies have begun to move into the mainstream, it has become apparent that the development of these new products and technology requires a unique combination of skills and knowledge not commonly associated with any of our more traditional technical disciplines (Moggeridge, 2007, Kolko, 2010).

The rapid growth of smart technologies has also led to significant job opportunities but again a high percentage of new jobs related to the design development of smart products necessitate a combination of skills and knowledge in the areas of design research, user studies and user-centered design in an effort to enhance the user experience not commonly associated with either the technology based disciplines like engineering and computing or the art-based disciplines such as digital media. As a result the field of industrial design has a distinct advantage and is uniquely positioned to take on the challenge of smart technologies and products.

2. Integrating Interactive Technologies in the Design Curriculum

Like many other academic disciplines, industrial design has been locked into an historical model that evolved in response to the industrial revolution. It has served us well, however, there is clearly an opportunity to reposition the field to take a leadership role in the design development of new smart connected wireless technologies. The following synopsis tracks our combined experience and the key lessons we have learned in our efforts to build a new industrial design curriculum with a core focus on building expertise to support the development of new technologies.

2. 1. Introducing Interactive Technology from a North American Perspective

In 2002, the School of Interactive Arts and Technology (SIAT) at Simon Fraser University established an innovative program based on a combination of face to face and online instruction to deliver a new curriculum focused on the application of digital technologies. The starting point was to develop a program to integrate interactive technologies in conjunction with key elements of a traditional industrial design studio format.

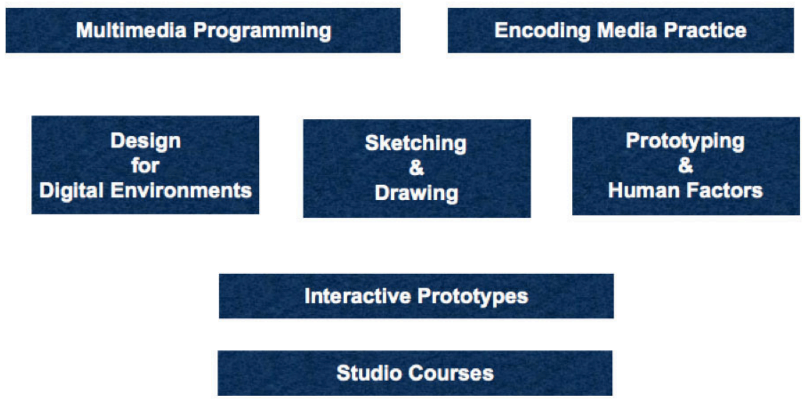

Figure 3 Curriculum Model: Interaction Design Program, School of Interactive Arts & Technology, Simon Fraser University

Working with first generation Arduino boards, the first cluster of students was able to produce a rich set of high level projects exploring new and innovative applications of digital technologies. These students had competent programming skill but little or no visual communication skills and little or no hands-on making skills. And although the product concepts were inspiring, it was very difficult for the students to communicate the vision of their concepts and the prototype execution was limited because of the lack of workshop facilities.

A second implementation in the Carleton University School of Industrial Design took a different format. The School was resistant to integrating interactive technologies into the mainstream curriculum however they were willing to support the establishment of a dedicated lab facility for design development of research projects focused on sensor-based technologies.

Although the lab was built on a shoestring budget in a repurposed janitorial supply room, the facility proved invaluable. Access to resources was always on hand and there was dedicated space for projects in progress. As a result we were able to move beyond the "black box syndrome". Building on their industrial design skills, two teams of students working on research-oriented projects learned to integrate electronic components into fully operational models in rapid prototyped enclosures and were able to go on to produce award winning design submissions and publish their work.

A third iteration took the form of a structured elective course at Emily Carr University School of Industrial Design. From the outset, we were working in a larger, better equipped, dedicated lab with better resources. As we progressed through the course we developed new models to bootstrap technology skills for the design students. One of the best options was to prepare introductory modules that included both hardware and software components to develop projects in targeted thematic areas. For example, in order to equip students to explore new ways to use RFID technology, we provided components including an Arduino Kit + RIFD reader and tags, and a pre-configured block of code that had the capability to read and differentiate between RFID tags along with a short tutorial to explain how to modify the key parameters in the code to custom configure the code for their individual applications.

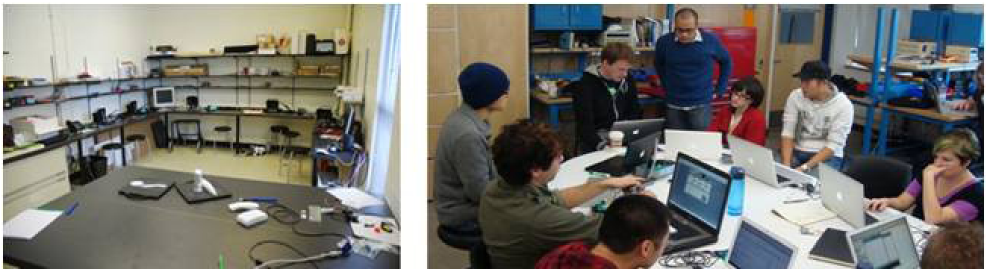

Figure 4 Dedicated Lab Space: 1st Lab, Carleton U, on the left. 2nd Lab, Emily Carr U, on the right

The primary take-aways from this course were the benefit of storyboarding ideas to clearly communicate the project intent and opportunity in the early stages; the prepared kits to help focus on the design challenge; the quick tutorials to handhold students through relevant examples; and the understanding that user experience tends to be more critical than optimized functionality for user acceptance. In addition, the ability for a student to quickly and successfully "make" his or her own operational prototype proved to be highly motivational and helped to accelerate learning.

In 2011 at Georgia Tech we began a major curriculum revision to develop focused design strength in curriculum and research in three priority areas by leveraging exisiting ties to technical strengths across the campus (Budd, 2011). One of those streams was Interactive Product Design with a goal to build stronger ties to computing and engineering disciplines. Building on the previous lessons learned we established a state of the art teaching and research lab at the outset to provide support for design development in interactive product design.

Figure 5 Interactive Product Development Lab in the School of Industrial Design at Georgia Tech

We also developed a new pedagogical approach of separating a project into two distinct elements – a "looks like" model that embodies the user requirements and a "works like" model focused on technical development. Students are encouraged to flip back and forth between the two models to reinforce a focus on the overall design goals. This iterative process also proved beneficial for trouble shooting while at the same time accelerating learning. On the down side we discovered sequencing issues. More and more faculty were beginning to integrate projects with some level of smart technology into their studios and the students were finding themselves engaged in projects using interactive technologies before they even had a chance to take an introductory course. This realization forced us back to the drawing board to rethink the program structure.

2. 2. Introducing Interactive Technology: An Alternative Perspective from Halfway Round the World

In 2013, Hunan University took a similar step to establish a first freshman course with a similar focus on introducing interactive technologies. This course had a very different set of dynamics with 150 students in one room at one time, with one instructor.

Figure 6 Hunan University: Freshman Interactive Design Class 150 students in one class in the same space with one instructor

The objective was to use Arduino as a playful tool to introduce product design and the concept of "interactivity". There was a particular emphasis on assisting students to connect concepts of ID, IxD & HCI and break the typical design students' notion of an electronic product as a "black box with magical functions". The course was split into three sections: individual making with quick "fun" projects; technical discovery behind the fun; and then extended themes with relevant industrial applications. Simultaneously the students worked on an interactive installation in teams on their own time, which were ultimately presented as part of an interactive exhibit.

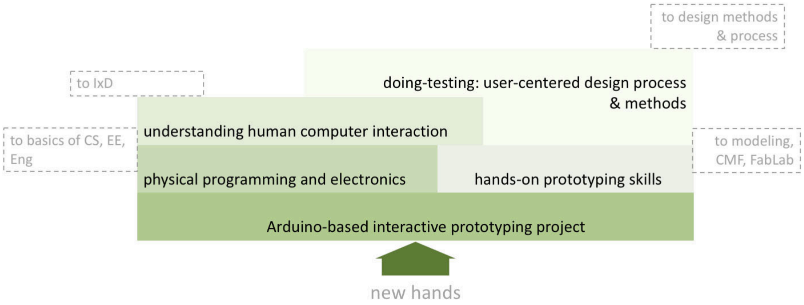

Figure 7 Initial Freshman Curriculum, Hunan University

This class provided the students, especially those raised in urban areas, with the basic making skills to support more advanced studio projects and introduced concepts to raise their interests in 'interactivity'. On the down side it was apparent that it would have been more advantageous to sequence this course following a design history course and an introduction to industrial design or a freshman studio. The class size was also prohibitive. There were too many students to support their design ideas thoroughly.

In juxtapositon to the freshman course, a second iteration involved a series of courses at the graduate level developed as part of a two and half year 1+1 Master's Program between Hunan University and Queen Mary University London (QMUL)

The QMUL Master's of Art and Technology (MAT) program is a one year master's degree with rich teaching resources in Electrical Engineering and Computer Science. The challenge was to re-design the Hunan elements of the curriculum to add interaction design and user experience design, while at the same time motivating the enrolled industrial design students' interest in programming and digital media to encourage them to take the advanced study in London.

There were three key classes developed at the Hunan campus in Shenzhen. The first was a short-term workshop taught by a QMUL visiting instructor using digital audio components to trigger sound clips and different sensors, to hack a daily life object and empower it with interactive capabilities. The second focused on ethnographic user studies leading to the development of a design intervention. The third was a game design course focused on programming and the introduction of artificial intelligence in electronic games

On the plus side, students in this program develop broader vision, the ability to do light coding, and the ability to communicate well with engineers in the work environment. Industry values cross-disciplinary knowledge that links design and computing. On the down side, programing is still the most controversial part of the curriculum for design students who also need more practice to digest the various technologies they learn from different classes.

3. A New Curriculum: Taming Technology to Enhance User Experience

The combined lessons we learned from research and experience indicate there is a set of key elements specific to industrial design that will provide a competitive advantage in our ability to foster innovative design development of new products, systems and services with a focus on user experience. The studio model encourages collaboration, sharing resources and critical feedback. The design curriculum provides a full set of skills to address the requirements of both physical and digital design. The structure of the design curriculum reinforces structured learning with resources to fully prototype the combined physical and digital elements of interactive products and systems. Storyboarding in the early stages is important to support communication and clarity of ideas. From the outset, projects are design driven and focus on ideation to solve problems and enhance experience for identifiable users - not just optimize technical solutions.

Another key element is the realization that sensor-based technologies are in fact relevant to the full spectrum of design studio projects and not just specific to those in an interactive technology stream or program as initially perceived by many of the existing programs focused on the application of new technologies.

Accordingly, our goal was to fundamentally restructure the curriculum by integrating sensor-based technologies as a mandatory core element of the entire design program. A new course, called Introduction to Smart Technologies, was deliberately positioned at the sophomore year which would ensure students had relevant exposure to the history and fundamentals of industrial design prior to dealing with complexities of interactive technologies. Logistically it was also critical to provide key contextual materials including user centered design methods and human factors in parallel to underscore the ID-specific focus on user experience.

Figure 8 The new curriculum at Georgia Tech: Introduction to Smart Products is positioned at the Sophomore level

The details of the course were also built on the learnings from the combined experience as above. The class size was set to 60 students versus 150 students in the Hunan program. The course is taught by 3 instructors with dedicated access to a fully equipped lab during class time plus unlimited access to the lab facilities supported by students mentors in off hours. There is a requirement for all students to have their own personal Arduino Kit. The instructors have created a series of introductory tutorials each followed by quick projects of gradually increasing complexity integrating elements of design ideation, electronics, making and physical computing to build a core level understanding of fundamental principles of interactive technologies..

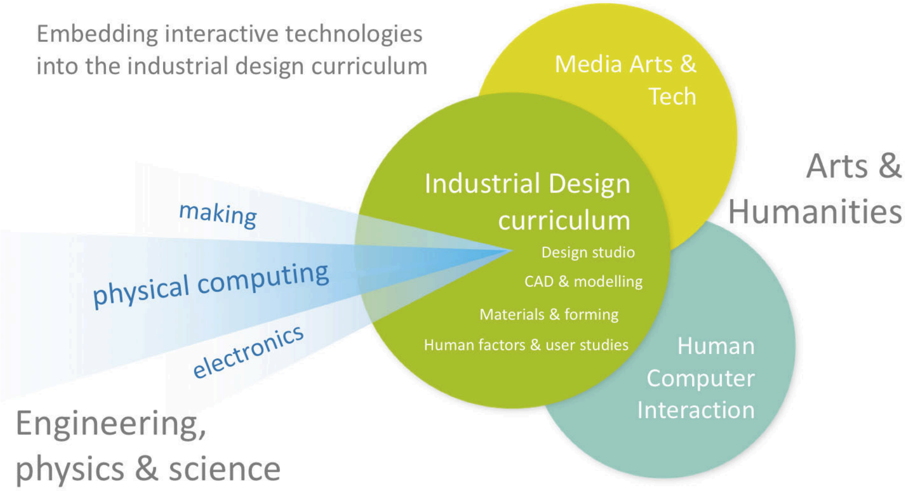

Figure 9 The new curriculum integrates interactive technologies with user-centered design methods, human factors and studio instruction

The introductory course forms the basic building block of the interactive product design curriculum. This means that every student in the program from the sophomore year on up will have a base level understanding of interactive technologies. This course is then followed up with a series of electives including instruction related to more advanced technologies, program coding techniques and further HCI research.

4. Conclusions

What have learned so far? There is a signficant opportunity for industrial design programs to take a lead role in the future interactive technologies play in our daily lives. The ID focus on user experience and human value is rapidly becoming a highly valued asset as business and industry begin to recognize the need to more effectively address the requirements of their customers, employees and other stakeholders involved in their operations.

This new curriculum has been developed as a model to leverage the traditional strengths of the Industrial Design discipline by integrating a robust hands-on understanding of electronics, sensors, IoT, and coding while maintaining a clear focus on the core values of ID's promises. We believe this strategy will provide a competitive advantage and differentiate the capabilities of our students from those in other related technical disciplines.

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