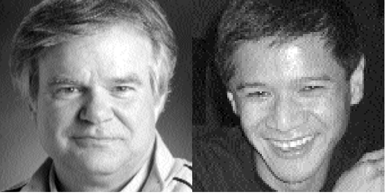

**By Jim Budd, IDSA, and Ron Wakkary**
Jim Budd and Ron Wakkary are associate professors in the School of Interactive Arts and Technology at Simon Fraser University in Vancouver, Canada. Budd's research interests include collaborative product design with a specific focus on the design of interactive products and systems. Wakkary's research includes interaction design and design methods and practice for interactive systems.

## A New Educational Model for Interactive Product Design

# THE INTEGRATION PROJECT

New technologies are fundamentally changing the way we learn, work and play. Technical knowledge and understanding alone are inadequate to deal effectively with many of the implications of new technology. This raises questions concerning both what technology can do and what technology should do. In either case, the products, systems and services we create with new technology are of little value if we do not readily understand what they are, what they do and how to use them.

One of the keys to addressing the complexity of interaction is a balanced understanding of both the technical (utilitarian and performance) issues and human (social and cultural) considerations. To ensure that the solutions to these complex problems meet design expectations, it is critical to integrate an active prototype testing and validation process into the design development cycle.

### Design Education and New Technology

Changes in technology are forcing educators to rethink the role of design education with respect to both business and society. At the Institute of Design in Chicago, John Heskett has been investigating the role of design in everyday life: "Design is simultaneously becoming more specialized in some respects, with more detailed skills in specific areas of application and more generalist ones in others, with hybrid forms of practice emerging.…On another plane is the difference between designers as form givers, determining form in a manner that allows no variation… or as enablers using the possibilities of information technology and powerful miniaturized systems to provide the means for users to adapt forms and systems to their own purposes."

The implications of Heskett's analysis are significant. Design education has reached a fork in the road, and each school will have to judiciously plot its own future trajectory. Currently, there are too many alternatives requiring too many prerequisites for the future path to be clearly evident.

In recognizing the impact of the increasing role of computing in people's lives, Terry Winograd at Stanford University was among the first to identify a design practice whose outcome and focus was a qualitative process rather than a thing or an object. He labeled this new prac-

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Three members of the CreATE team work on ideas for a new visually-based management tool for designers.
(l-r:  Mikki Ho, Jag Poonian and Doreen Leo, missing Tanya Hsu)

tice "interaction design." Winograd identified the need to focus on the perceptual and psychological aspects of human experience by rooting interaction design equally in graphic design, psychology, communication, linguistics and computing science.

Much has changed in the few years since Winograd identified the need for teams with diverse skill sets to focus on the individual user in efforts to provide better solutions to problems associated with desktop computing. Today's networked wireless technology represents a more significant challenge that by its very nature will require multidisciplinary solutions. We now have the capability to embed sensor technology in virtually any product. These pervasive computing devices and ambient technologies will be capable of responding to people in everyday situations. In addition, these devices will be capable of talking to one another or anyone else anywhere in the world. The implications are astonishing; the world as we know it will change.

### Technology, Context and Experience

In 1999, Joseph Pine II and James Gilmore observed the increasing rate at which products were reaching market saturation, a point at which products were becoming a commodity, and suggested that circumventing the typical product price war associated with commoditization—adding competitive value to product or service offerings—would require businesses to shift from a product- and service-based economy to an experience economy, where business caters to lifestyle experience.

Design theorist Richard Buchanan similarly argues for a paradigm shift in all design fields. He has identified a historical trajectory of moving progressively through "four orders of design," from symbolic to things, actions and environment. Patrick Jordan, an expert in the field of human factors, carried this argument one step further, claiming that it will be critical for designers to develop a richer understanding of people in order to design the kind of pleasurable products to meet people's new lifestyle expectations.

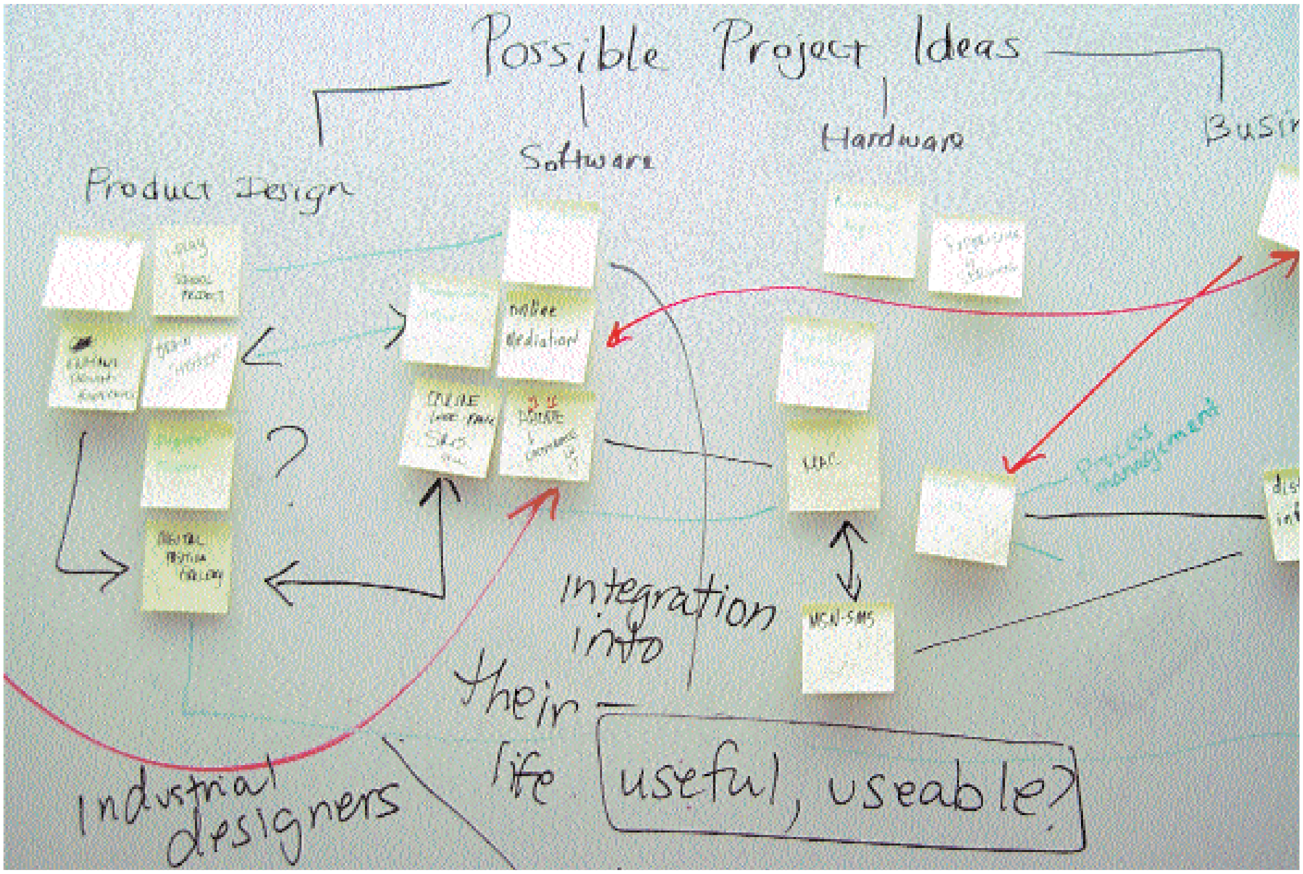
If we combine these factors, it becomes apparent that we are now at the leading edge of technological change that will affect all aspects of everyday life in a profound way. The next generation of designers will need new skills and knowledge to negotiate this new terrain. Design schools must respond to this challenge. Problem-based learning and project-based learning provide useful models. The goal is to develop constructivist, project-based learning environments combined with a reflective practice approach to design.

The key pieces to this puzzle include teamwork; the need to develop a working knowledge of new technologies; the need to develop an understanding of the way people live, work and play; and, perhaps most important, the need to prototype and validate the new design concepts.

**Teamwork:** As designers consider more knowledge about the product cycle during conception and planning, the act of design becomes a more complex activity. As a result, product design is frequently done by teams of professionals that include social scientists who are trained to study the characteristics and qualities of human experience, along with designers and engineers. Although the necessity to work in teams on complex design problems is recognized in business and industry, the education system has been slow to follow. Initiatives undertaken at Stanford University, Arizona State University and the University of Illinois at Chicago have validated the success of multidisciplinary teams working in industrial design education.

**Understanding new technology:** We have seen a similar pattern in our abilities to assimilate new technologies into our education system. Pervasive or ubiquitous computing requires the integration of multiple technologies, including software and hardware, and an understanding of human-computer interaction. There is a need to foster a multidisciplinary team-based approach to overcome this hurdle. In order to address the increasing emphasis on the design of functional products within education, design students will require a stronger foundation in the basic elements of technology.

**Understanding people:** The third piece of the puzzle is the necessity to develop a more thorough understanding of people and the quality of human experience. Elizabeth Sanders, president of Sonic Rim and an adjunct faculty member at Ohio State University, argues that "the people that we design for are the real virtuosos of the 'experience domain.' They are the ones who will create their own experiences." Accordingly, she suggests it is



Small interdisciplinary teams of students design, prototype and field test their own ideas for innovative applications of new technologies.

essential that we use new tools to encourage and engage these ordinary people in the design and development process to help us learn to better satisfy their needs. The late Paul Rothstein, former professor at Arizona State University, developed a research and design method called "a (x4)" to provide designers and educators with a tool to develop design scenarios about user experience. These tools and techniques are providing designers with a better understanding of the implications of lifestyle changes. They are also providing the key to new participatory design methods—to engage the prospective audience throughout the design development process.

**Prototyping and validation:** The final step is the ability to integrate the individual pieces. The only way to do that is to place the product in the hands of the prospective users. Industrial design has long recognized the importance of prototyping. In addition, the development of effective intelligent interactive products and systems is a complex process with significant social implications. Without prototypes to support the viability of new concepts, many ideas will remain unsubstantiated and highly questionable. For these reasons, prototyping should be an intrinsic part of the development process for this new generation of interactive products and systems.

### Bridging the Disciplines

Our research demonstrated that an interdisciplinary approach was needed to effectively address these complex problems. It would also be necessary to work toward a well-balanced understanding of both the technical and the human considerations. In effect, this pointed to a new curriculum built around a core combination of design, information technologies and human-computer interaction, with additional support in the areas of cultural studies, electronics and business. The dilemma was the logistical nightmare of adding all of these requirements to an already overloaded design curriculum.

For the past four years, we have been building the infrastructure for a new interdisciplinary university program to equip a new generation of undergraduate and graduate students with the knowledge and skills to tackle the full potential of interactive products, systems and services. Initially, this program was the central component of the new Technical University of British Columbia, which started in 1999. In 2002, the program became part of the larger Simon Fraser University where it is now part of a department known as the School of Interactive Arts and Technology.

## Tools & Techniques

Examples of useful pre-built components or building-block type hardware and software components to help students get started include:

- **LEGO Mindstorms Robotics Invention System:** The heart of the Robotics Invention System 2.0 is the RCX™, an autonomous LEGO microcomputer that can be programmed using a PC. The RCX serves as the brain of LEGO Mindstorms inventions.
  http://mindstorms.lego.com/eng/products/ris/index.asp

- **LEGO ROBOLAB:** ROBOLAB is an educational program developed as a joint venture between National Instruments, LEGO Dacta and Tufts University to help develop engineering intuition. ROBOLAB uses a powerful combination of LEGO bricks and National Instruments LabVIEW graphical development software to introduce engineering concepts to students of all ages.
  www.ni.com/company/robolab.htm

- **Phidgets:** These 3D widgets simplify software development in interface design and give designers the ability to plug together hardware components and to focus on the programming aspects of interactive product development. Phidgets arose out of a research project directed by Saul Greenberg at the Department of Computer Science, University of Calgary.
  http://grouplab.cpsc.ucalgary.ca/phidgets; www.phidgets.com

- **e-Gadgets:** The EU IST/Future Emerging Technologies Research project seeks to adapt to the world of tangible objects the notion of component-based software systems by transforming objects in people's everyday environment into autonomous artifacts (e-Gadgets). The e-Gadgets range from simple objects (tags, lights, switches, cups) to complex ones (PDAs, stereos), and from small ones (sensors, pens, keys, books) to large ones (desks, TVs).
  www.extrovert-gadgets.net

- **Max/MSP Scripting Language:** Max/MSP is a graphical environment for music, audio, and multimedia. In use worldwide for over fifteen years by performers, composers, artists, teachers and students, Max/MSP is the way to make your computer do things that reflect your individual ideas and dreams.
  www.cycling74.com/products/maxmsp.html

- **Pure Data (PD) Scripting Language:** PD is a real-time graphical programming environment for audio, video and graphical processing. It is the third major branch of the family of patcher programming languages known as Max (Max/FTS, ISPW Max, Max/MSP, jMax) originally developed by Miller Puckette and company at IRCAM. The core of PD is written and maintained by Miller Puckette and includes the work of many developers, making the whole package very much a community effort.
  http://puredata.info

- **Teleo™:** This rapid-prototyping and development tool, developed and marketed by MakingThings, consists of a line of modular and networkable hardware components that can be connected to a computer via USB and programmed and controlled using any one of a number of programming languages. Components range from a variety of input and output modules to motor controller modules and accessories.
  www.makingthings.com/teleo.htm

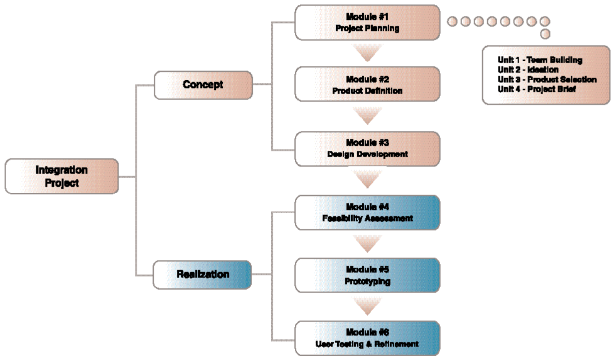
- **NADA Rapid Prototyping of Physical Interfaces:** NADA lets users integrate sensors, graphics, animation, sound and electrical devices as interactive objects and environments. It is a server-like application that provides hardware I/O services to projects being made in Macromedia Flash MX2004 or later and Java™. Because these services are 100 percent network-accessible, a NADA project can use multiple systems connected by a network for incredible flexibility.
  www.sketchtools.com

- **Basic Stamp:** A basic stamp is an easy-to-use microcontroller made by Parallax. The stamp contains a microcontroller, memory, clock and voltage regulator in a package that resembles an integrated circuit. All that is needed to program it is a PC and a 9V battery or other power supply.
  www.parallax.com/html_pages/products/basicstamps/basic_stamps.asp

- **Arduino:** Arduino is an open-source physical computing platform based on a simple I/O board and a development environment that implements the processing/wiring language. This is an open-source project, owned by nobody and supported by many.
  http://arduino.berlios.de

- **Processing:** This open-source programming language and environment is designed to help people program images, animation and sound. The language is used by students, artists, designers, architects, researchers and hobbyists for learning, prototyping and production. It was created to teach fundamentals of computer programming within a visual context and to serve as a software sketchbook and professional production tool. Processing is developed by artists and designers as an alternative to commercial software tools in the same domain. Processing evolved from ideas explored in the Aesthetics and Computation Group at the MIT Media Lab and is an open project initiated by Ben Fry (Broad Institute) and Casey Reas (UCLA Design/Media Arts).
  http://processing.org

- **Wiring:** This programming environment and electronics I/O board is used to explore the electronic arts, tangible media and teaching and learning computer programming and prototyping with electronics. It illustrates the concept of programming with electronics and the physical realm of hardware control, which are necessary to explore physical interaction design and tangible media aspects. Wiring started at the Interaction Design Institute Ivrea and is an open project currently developed at the University of Los Andes.
  http://wiring.org.co




An online interactive flowchart provides an overview of the modular structure of the course.

Our goal in developing a new curriculum is to foster a better understanding of the need to develop integrated solutions to meet the individual social, cultural, environmental and technical issues associated with emergent technologies. Detailed analysis, advanced prototyping and user field-testing are integral elements of the new curriculum. Typical projects focus on opportunities to capitalize on wireless, networked technologies and fall into categories ranging from software applications and electronic games to hybrid software/hardware concepts for ubiquitous computing devices and/or ambient technologies. Although this course has a face-to-face lecture component, there are no traditional design studio facilities. There is a 1.5-hour lecture per week for the entire class and three 1.5-hour lab sessions for each section of 20 to 24 students. Reference materials and discussion forums are accessible online to complement the lecture sessions. Students also have unlimited access to computer lab facilities.

## The Curriculum

The Integration Project runs for a full academic year, with the fall semester devoted to the concept and the spring semester to the realization of that concept. Students have the freedom to speculate and experiment in the first semester with a clear reminder at the beginning of the second semester to recognize the scope of the deliverables due by year-end. In addition, each team is encouraged throughout the project to identify potential faculty or industry mentors to assist with various aspects of the project.

At the end of the course, each team presents a detailed design concept, which typically includes preliminary models and/or proof-of-concept technical models to substantiate the feasibility of the project. Identifying a concept, reflecting on how it has changed over time, scoping out the feasibility and logistics of producing an operational prototype, as well as field-testing and user evaluations are key elements of the development process.

## Key Issues

The complexity of the technical aspects of prototyping interactive products and systems is a significant challenge, particularly for those in the design community who do not have an extensive technical background in software and hardware development. Our experience indicates that a building block format for these components can help get students started with some degree of comfort.

For many teams, this level of prototyping is entirely new and requires a significant level of support and encouragement. Yet, results of the first class exceeded expectations: all 12 teams successfully produced and field-tested advanced operational prototypes of new product concepts. The requirement for students to engage a third party to review and independently test and evaluate projects they have developed has added a significant degree of motivation to excel. A particularly gratifying result of the course was that 2 of the 12 teams in the first course entered a commercially sponsored entrepreneurship competition with more than 100 entrants, and one of these teams successfully competed to the semifinal round. One of the project teams from the second year of the Integration Project course placed second in Microsoft's Imagine Cup competition.

## Looking Back

Learning to design with new technologies presented several challenges that forced us to rethink our approach to design education. We focused on developing a course that would place the onus on design students to consider technology based on the needs it served. The additional requirement to assess feedback from real users heightened the sense of reality surrounding the project and forced teams to scrutinize the resolution of their concepts.

As the course progressed, it became readily apparent which ideas held merit and which fell short of the mark. There was much to learn from the new process, as the pros and cons of each project were open to discussion. Overall, there was a clear sense that this student cohorts were beginning to develop a better balanced understanding of the relationship between the technical and human issues in their design thinking. ■

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