Future History | AIGA Design Education Conference 2004

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Challenges for the Future: The Convergence of Artifacts and Information

> "The boundaries between hardware and software, device and interaction, 2-d/3-d/4-d have blurred considerably and will only continue to blur and blend. The new product development model is one of collaborative design, with individuals representing various fields of knowledge working together on the conception, design and implementation of user interfaces."[1]

Introduction

This paper is focused on the challenges for the future as graphic design educators, and on the conference topic as it relates to the future of design education. Specifically, the topic discussed is related to the conference theme of "educator as explorer and director of things to come", through the influences of technology on the field of graphic design due to recent advances in (and the proliferation of) computing technologies. The computer as a general-purpose electronic object has been around since the ENIAC's debut in 1946, and 1984 brought the computer into mainstream consciousness through Apple's introduction of its Macintosh. Computers and computing technologies are changing the world through the ways we live, work, and play, and their influence is apparent in its effects on the fields of graphic and product design. Computing technologies have created a new kind of design that is forming at the intersection of artifacts (3D) and information (2D). Currently this area of study is known as interaction design, and is defined as the interface between man and machine or the integration of computers with the objects in our world. "Twenty years ago computers were expensive tools for professionals or games machines for enthusiasts. Today they appear in all aspects of our daily life, from mobile phones to microwave ovens, from exercise bikes to sewing machines."[2] Most succinctly, it is defined as "what humans do with computer based systems and what those systems do in return."[3] It is a complex discipline that requires a multidisciplinary skill set - its practitioners require knowledge of graphic design, industrial design, information science, psychology, and computer science, to name a few. This paper will explore issues related to this confluence, will focus its discussion on computing technologies influences on the nature of 'product'[4], and discuss how the lines between graphic and product begin to blur. It will then conclude with a discussion on the educator's responsibilities to train designers within this overlap.

Interaction Design vs. Digital Industrial Design[5]

On November 19th 2003, the interactiondesigners.com listserv generated a lengthy discussion surrounding the impacts of computing technologies on the nature of product, as many design professionals debated the difference between 'interaction design' and 'digital industrial design'. The discussion was sparked by the announcement that the Industrial Design and Graphic Design Professional worldwide organizations, ICOGRADA and ICSID (AIGA and IDSA's respective international counterparts), were merging and the interaction designers wondered where their position among these relationships fell. A question was posed to the interactiondesigners listserv that inquired what interaction designs relationship was with graphic and industrial design, and why

they were not included as a distinct discipline in this worldwide merger. A statement was posed by Molly Steenson, an Interaction Ivrea Professor, which generated a great amount of debate:

> "Bill Moggridge at last weeks' Ivrea symposium indicated that interaction design is a sort of digital industrial design."[6]

The discussion escalated from this inquiry into the differences between interaction design, industrial design and graphic design. What is the relationship between these disciplines and how is it changing? What similarities and differences do they share?

Interaction's Roots in Design

Although Interaction Design has roots in many disciplines -- graphic design, product design, architecture, art, ergonomics, computer science, cognitive psychology, sociology, cultural anthropology, media arts, mechanical engineering, electrical engineering, software engineering, hardware engineering, marketing, business, manufacturing -- this discussion is focused on its relationship with industrial and graphic design. In order to begin the discussion it might be helpful to begin by defining the respective disciplines as they relate to interaction design, and discuss some similarities and differences among them.

Industrial Design: Contributions to Interaction Design through Physical Form

The term "Industrial Design" was coined in the early 20th century in order to describe the creative role that was performed during the process of developing industrial (mass-produced) objects. Industrial designers are people who perform a creative problem solving process in order to develop the products we use everyday. "They determine the way a product looks, feels and how well it functions."[7] Industrial Design's professional organization (IDSA) defines Industrial Design to be: "the professional service of creating and developing concepts and specifications that optimize the function, value and appearance of products and systems for the mutual benefit of both user and manufacturer. The industrial designer's unique contribution places emphasis on those aspects of the product or system that relate most directly to human characteristics, needs and interests. This contribution requires specialized understanding of visual, tactile, safety and convenience criteria, with concern for the user. Education and experience in anticipating psychological, physiological and sociological factors that influence and are perceived by the user are essential industrial design resources."[8] [9]

The strongest link between product design and interaction design is simply in how we interact with objects in the world. The form of an object influences a user by providing clues as to how it operates, which is summarized in Donald Norman's succinct statement: "Information is in the world."[10] He postulates that the information a person uses to operate an object is a combination of the objects inherent *physicality*, and ones interaction experiences with other objects in the world. This speaks to the well-known industrial design mantra "form follows function", and speaks to this hopefully existent relationship between the form of an object and its intended function. This existed long before computing technologies, and is a fundamental principle upon which industrial design operates. The primary relationship between a human and an object prior to interfaces was through physical form -- a toaster, toilet, shower, chair, book, automobile, and wood planer all (hopefully) contain clues as to their operation. An industrial designers job is to provide these clues. These ideas are explained by Donald Norman in his book "The Design of Everyday Things", where he focuses the discussion on the frustrations of our interactions with everyday things and provides numerous examples of poorly designed everyday interactions including experiences with doors, stove burners, bicycles, automobiles, slide projectors, and light switches.

Another way that industrial design connects to interaction design is in the area of *human factors and ergonomics*. This area of industrial design analyzes the relationship between a users body and an objects physical form. It answers questions such as 'How comfortable is that phone to hold?', 'How comfortable is that chair to sit in?', and 'How well does that object fit in your hand?', Automotive engineers analyze a cars interior in order to make exterior views accessible, seats comfortable, and controls reachable for approximately 95% of users that will encounter them.

Marc Rettig, a well-known interaction designer and recent Carnegie Mellon Interaction Design Visiting Fellow, provides a pre-computing example of desireable interaction design by exemplifying a wood planer for its physical properties. He posits it is an object created with desireable interaction intentions. Most of the *desireable qualities* sought in the creation of this object are the same properties desired in the creation of interactive objects today. These include an objects usefulness, usability, desirability, affordability (to the right people), appropriate complexity, appropriate styling, appropriate transparence in function and use, appropriate adaptability, and "good fit" with people, context, activity, result.[11] It is interesting to note the similarities between the creation of an object, and the creation of an interaction.

In addition to the more functional aspects of design discussed above, product styling also communicates important information to a products user. Semantics are inherent in both the graphical and physical form of a product, and are extremely important components in an objects creation. This is not separate from a forms function, although not always fully integrated. It will not be discussed further in this paper (as it warrants its own paper), and is mentioned in order to clarify that this impact is not neglected nor minimized as an essential design component and contribution.

Graphic Design's Contributions to Interaction Design through Informational Form
Just as traditional[12] product design contributes in the 3-dimensional realm, traditional graphic design contributes in 2-dimensions. As the physical form should make a product useable, desireable, and understandable – so should the graphical form. Essential principles of establishing good 2-dimensional form are found in information design. This includes establishing good informational *hierarchies* and *layering* the information in a way to help create clear content navigational structures. Because interactive products are highly complex, establishing clear and consistent *navigation* is imperative in ensuring usability.

Another contribution is through typography to ensure a product's *legibility*. This is increasingly important as many interactive products get smaller and smaller and people's eyesight remains the same.

Graphic Design's Contributions: Information Design In 3 Dimensions
An interactive product design process begins with the products contained information/content, a desired experience, or access to certain product functionalities. When one visits amazon.com, they want to find information on a certain book, musician, or video. If one visits eBay, they want access to information on a particular auction. If one wants to make a phone call, then it is functionality that is desired. Each interactive product design process begins with these features in mind. Content, function, and experience are used to shape and construct categories based on informational similarities and differences. This hierarchy is established through analysis, with an end result of an information structure in the form of an information architecture. This information architecture then sets up the products navigation in order to provide clear, consistent access to the information or function.

An interactive product results in the creation of the graphical user interface, widely known by its acronym GUI. The GUI includes any screen-based access to the information contained within, and is one way that a user interfaces with any information (or functions) wished accessible. Although there are trends toward products containing solely physical navigation and controls (see Ambient Orb discussion later in this paper), most interactive products today contain screen-based interfaces. The navigation through a website, cell phone, digital camera, iPod, computer, microwave oven, and television – are all based on their GUI which is a function of informational hierarchies, layering, navigation, and structure.

HCI

Human Computer Interaction, commonly known as HCI, is a discipline first developed in the 1960s as a response to the advent of computing technologies. The following graph shows the development of HCI associated technologies:

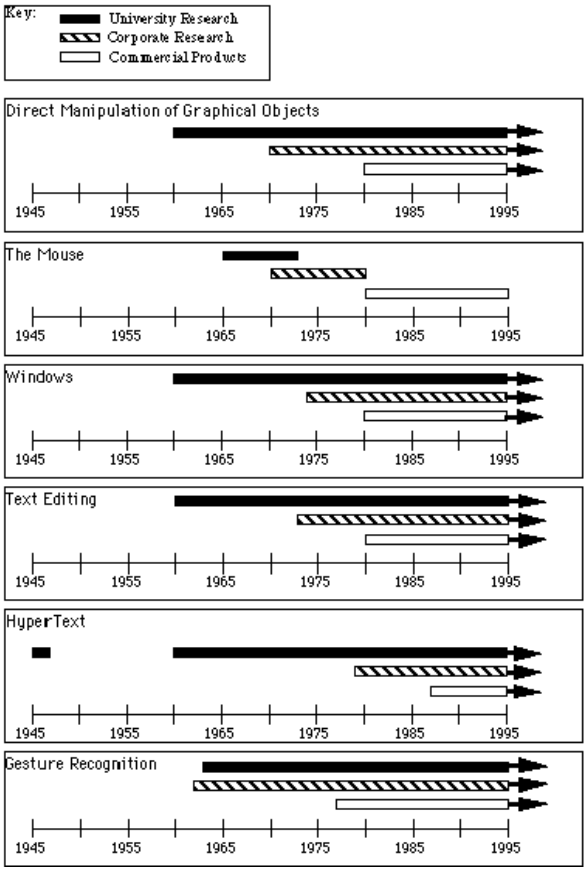

Figure 1: [13]

As shown above, University research on human-computer interfaces begun in the 1960's, and the first demonstration that supported the direct manipulation of graphical objects using a physical device (predecessor to the mouse) was Ivan Sutherland's MIT PhD Thesis, entitled SketchPad. This thesis, completed in 1963, "contained the seeds of myriad important interface ideas."[14] The next big advancement was the development of the mouse at Stanford Research Laboratory (now SRI) in 1965 as part of the NLS project, and in 1968, Douglas Engelbart and a team of 17 researchers at the Augmentation Research Center at Stanford Research Institute publicly debuted computer control

devices. These included the first public demonstration of this computer mouse, along with other interactive control devices including the standard keyboard, a special keyset (similar to the keysets on keyboards today), hypertext, dynamic file linking, and shared screen collaborations over a network involving audio and video.[15] These objects were categorized, and further developed, under this discipline of HCI.

HCI educational programs are often aligned with computer science programs and thus are developed in a more technical environment. Based in computer science, they often focus on what can be done technically with neglect to the 'human side' -- the influences of design, psychology, human factors, and ergonomics -- of object/system creation.[16]

Continued efforts in developing HCI into the discipline of interaction design as it is known today occurred in the early 1980's through contributions from many people. Most notable in establishing this are Bill Moggridge, trained as an industrial designer and co-founder of IDEO, and Bill Verplank, who has affiliations with Xerox Parc, IDEO, and Interval Research Corporation. "In the early 1980's, while working on the GRiD Compass, Bill M. first recognized the need for the equivalent of industrial design for software interfaces and began using 'Softface' to describe it (being a contraction of software and interface). Being an industrial designer, I think he may have been more concerned with the form of the interface, than with the behavior (at least at the time). It wasn't until the mid-1980's, when Bill M. began working with Bill Verplank, that they began to focus more on the behavior and started calling it Interaction Design."[17] Some people also trace the origin of interaction design to 1989, when Gillian Crampton Smith begun the Computer Related Design (CRD) masters degree at the Royal College of Art in London, where designers would apply their traditional skills to the development of interactive products and systems.

Interaction Design Today

Interaction design as a discipline today is still evolving, and as such, it draws from many disciplines, and is being taught in many different ways in many different types of programs. Some of these include programs of Art and Technology, Media Arts and Science, Cognitive Science, Computer Science, Industrial Design, Graphic Design, and Architecture. It is defined most succinctly by Stanford's HCI program to be "what people do with computer-based systems (and objects) and what the systems (and objects) do in return"[18]. It is the kind of design that has emerged as a result of the omnipresence of computing technologies and their integration into/with objects. It is concerned with the design of both physical and virtual things, and can include the design of objects, systems, environments, and services. Users and their needs are placed at the center of the design process, and the end result is for a clear, efficient, and simple interaction between the user and the system. Important things to consider while designing include form, ergonomics, use, function, experience, system, and behavior. "Interaction design seeks to establish a dialogue between products, people and physical, cultural and historical contexts; to anticipate how the use of products will affect comprehension; and to determine a form that is appropriate to its behavior and use."[19] Skills and disciplinary contributions necessary for this field include knowledge from graphic design, industrial design, architecture, art, ergonomics, computer science, cognitive psychology, sociology, cultural anthropology, media arts, mechanical engineering, electrical engineering, software engineering, hardware engineering, marketing, business, and manufacturing.[20]

Interaction design combines elements of 2-dimensional display, 3-dimensional form, and 4-dimensional time in order to create design solutions. As opposed to graphic and product design, it operates within the virtual realm, is behavior focused, and explores some new aspects of design including the design of services, experiences, and behaviors. It is concerned with relationships

between elements -- between objects, between screens, between humans, between humans and objects -- introducing elements of navigation and hierarchies over time.

Interaction Design in Education

Interaction Design in education is at the beginning stages of development, and in this infancy different aspects are being taught in many different programs and schools. In the US, perhaps the most notable program is the Media Lab at the Massachusetts Institute of Technology, which was established in 1985 to address the convergence of computing, publishing, and broadcast as it related to the communications industry. The growing focus of the Media Lab today is on how electronic information overlaps with the physical world, or the integration of atoms (the physical world) with bits (the virtual world). The Media Lab was established as a research center that operates at the boundary between academia and industry, and operates without regard to traditional divisions among disciplines. The lab hosts over 30 research groups, 5 research consortia, 5 special interest groups, and a handful of institute wide programs. Of these research organizations, there are a growing number that are of interest to product and graphic designers. Among these are Hiroshi Ishii's Tangible Media Group and John Maeda's Simplicity Initiative. The mission of Ishii's group is "to design seamless interfaces among humans, digital information, and the physical environment"[21]. His group is focused on projects that address the interlinking of physical forms with digital information.

A recent article in the New York Times discusses John Maeda's Simplicity initiative, a new initiative designed to address the increasing complexity of interactive objects and systems. It is created to address humans and our relationship to technological objects and systems. He has assembled a team of fellows who are attempting to define 'simplicity' as it relates to products, as well as integrating 'better' design with 'better' technology to produce 'better' results. Its program vision is stated to be "…redefining our relationship with technology in our daily lives. This goes well beyond removing buttons, slimming down screens, and shrinking interfaces to fit into the palms of our hands. It is a radical reexamination of ways to break free from the intimidating complexity of today's technology and the frustration of information overload."[22]

Not discounting professional and research experience, only one (out of approximately 40 full time) Media Lab Professors hold degrees in design – represented disciplines include visual studies, fine arts, documentary film, media lab arts and sciences, and architecture. *[disclaimer: This information was obtained by looking at Media Lab faculty websites and not through firsthand experience. It is not known if, and in what capacity, designers may consult on a variety of projects.]*

The Berkeley Institute of Design (BID) is a newly formed teaching and research entity hosted at the University of California at Berkeley with a mission to foster "…a new and deeply interdisciplinary approach to design for the 21st century: The design and realization of rich, interactive environments which are shaped by the human activities they support. Here "environments" include architectural spaces, products, web sites, and other artifacts that support complex human activity."[23] The BID was formed in 2001 as an offshoot of the Human-Centered Computing (HCC) group at Berkeley. The HCC was formed in 1998 "…as a weekly meeting of faculty with interests in information technology and its impacts. … The goal was to explore how social and behavioral sciences could inform the design of better information systems."[24] This institute is comprised of faculty and students from Computer Science, Mechanical Engineering, Art Practice, Education, Film Studies, Architecture, Business, and Industrial Engineering. Of the twelve permanent faculty, there is currently no involvement from a full time graphic or product designer. *[disclaimer: This information was obtained by looking at the BID*

website and not through firsthand experience -- it is not known if, and in what capacity, designers may consult on a variety of projects.]

Stanford's Human Computer Interaction program captures its philosophical focus through emphasis on interaction design. "By highlighting interaction as the object of design (rather than "interface" or "software" or "product"), we emphasize the interplay of what people do with computer-based systems and what the systems do in return."[25] HCI is a topic that is taught and studied in a variety of departments at Stanford and exists as a consortium that services various departments which have HCI concentrations. Concentration degrees are offered through, and faculty come from, departments of Computer Science, Symbolic Systems, Communications, Product Design, Industrial Engineering and Engineering Management, Mechanical Engineering, Education, Music, Psychology, and Medical Informatics. In addition, Stanford has an Interactivity Lab that is dedicated to HCI work, and whose goal is to "develop new devices, techniques, and theories that support the design of fluent interaction in a ubiquitous computing environment."[26]

The most notable worldwide initiative to address interaction design, and the integration of the physical and digital world, is the Interaction Design Institute Ivrea. The institute opened its doors in October 2001, and combines an Italian masters graduate program with a research institute sponsored by Telecom Italia and Olivetti. It is the only institute in the world developed and based solely around the discipline of interaction design, with its mission to develop "our capacity to innovate new products and services. These services help us interact with each other in new ways-through communications, network and information technology."[27] A primary aim of the institute is "To find new ways to design in the medium of tele-communications - through future concept projects which demonstrate the role of interaction design in the development of services and the devices that allow us to interact with them."[28] Ivrea has ten 'core educators', who comprise of a nice mixture of product designers, architects, graphic designers, software/hardware developers, and visual artists.

A University of California Irvine initiative is proposed to develop a new interdisciplinary school of design that emphasizes the conceptual and theoretical foundations of design. Interaction Design is included among the disciplines, along with Product Design, Spatial Design, and Design Studies. It proposes the study of "principles, techniques, tools, and processes for designing (1) interactions and (2) entities with which and through which people interact." (UC Irvine Proposal, p 19) It goes beyond traditional HCI program approaches to include influences from human factors, ergonomics, communication, cognitive science, software engineering, cultural issues, and others.

Industrial and Graphic Design programs are beginning to offer courses that direct attention towards this intersection of industrial, graphic and interaction design. The Rhode Island School of Design recently (2000 as an accurate best guess) begun offering both industrial and graphic design studios with focus on interface design. RISD's Graphic Design studios include *'Interactive Instructions'* and *'Interactive Information Design'*. Interestingly, '*Interactive Instructions'* focuses on improving the design of information instructions that assist in understanding the large number of interactive devices and instruments. (Perhaps if the instruments were designed more cohesively, this would not be required or desired.) RISD's Industrial Design HCI studios have a focus on the technological, social, cognitive, perceptual, cultural, and social influences on designed objects.

Another notable Industrial Design occurrence happened in the fall of 2003, when Syracuse's 'Industrial Design' program changed their name to 'Industrial and Interaction Design'.

A Visual Survey of Interaction Design

Graphic + Product Synthesis

A shift is occurring from mechanical based products to interactive ones as computers become imbedded in many of the objects that surround us, including products such as cell phones, digital music players, ATM machines, digital cameras, and computers. "There are already twelve computer chips for every man, woman and child on the planet"[29], and this will only continue to increase. As computing technologies become more ubiquitous, they are influencing and changing the nature of product. Products are no longer discrete physical entities unto themselves, but the influences of systems, services, behaviors and experiences become important components of their existence and must be considered. Products today cannot be viewed as isolated physical entities, but as objects with connected capabilities that enable and expand their outreach.

iPod

Apple's introduction of the iPod is a good example of a product that is not a product in its own right. The success of Apple's iPod lies in the integration of its corresponding software and services in order to make this object and design a successful one. This success is due to the equally important interrelationships of each component in the iPod system: the physical form of the object (iPod physicality), the user interface including the structure of the information and how it is accessed (iPod interface), the relationship to the computer software (iTunes), the ability to download and upload music in how the songs are transferred from computer object to MP3 player (iMac), and most recently the ability to purchase songs through their online music store (iStore). It is the combination of all these components that creates the product system and ultimately the success of the iPod as a product. A New York Times Magazine article discusses the iPod's success as being difficult to assess: it's hard "to nail down whether they key is what's inside it, the external appearance or the way these work together. One approach is to peel your way through the thing, layer by layer."[30] [31]

Cell Phone

Although the iPod may be the best example of successful graphic-product integration, there are an increasing number of objects that require this synthesis. ATM machines, automated checkout machines, VCR/DVDs, and cell phones are all examples of products that require a good graphic-product synthesis. A cell phone is an object that is becoming increasingly important, omnipresent, and complex. Most cell phones come with 100+ page user guides that assist in familiarizing a user with their phone. The graphic-product integration is important, because navigation through the menus is a combination of physical and graphical controls.

Ambient Orb

An interesting new object that connects graphic to industrial design is a new concept developed by Ambient Devices (of Cambridge, Massachusetts) for the physical display of digital information. This object, *Ambient Orb*, connects the virtual world to the physical one through the display of computer-generated information in a physical form -- the orb changes color in response to stock market changes. "The Orb's power lies in how it can reflect the ease with which humans process basic visual information—giving physical form to information."[32] Its application is not confined to the type of information it responds to – people have programmed the Orb to respond to a variety of tasks: "tracking job openings in Atlanta, measuring the flow of visitors to a Boston-based interactive design agency's website, gauging energy use in a New York City apartment, tracking eBay auctions, notifying someone when a particular person is online or a certain number of e-mails have filled their

inbox."[33] Although not necessarily a proponent or opponent of these devices, the omnipresence of networked physical objects is on the rise.

This object is unique in that it is in the first generation of form-based objects to display information. There is no true graphic display in a traditional Graphic Design sense of display but it is information display nonetheless. What is not known in this case (without owning or interacting with one of these objects) is the interaction with its user? Although the physical interface to the device is seemingly simple and easy to understand (you look at the object and associate color with information) – what is not explained in text is how one interacts with this object. Do you simply plug it in? Does it connect to a network? Does it connect to your computer? How does the object receive the information? How do you set the parameters for the information display? A seemingly simple object – may or may not have an intuitive interface. Additionally, this is also an interesting object in that it changes the design question/problem from "How do you display information graphically?" to "How can you display/convey the information?"

Where Do We Go From Here?

Problem Solving

What relationship do industrial, graphic and interaction design have with one another and what responsibilities do we, as educators, have to acknowledge and train our designers in any overlap? Although the solution is unclear, and the disciplinary boundaries are blurring – what is clear, is that there are problems that need solutions. Since design is a *problem solving* discipline, focusing on the problems that technology poses as opposed to disciplinary boundaries might be a good approach.

Design Methodologies

Since design is unique in its thinking, an approach for design synthesis occurs in identifying *methodologies* used in the discrete disciplines, and employing their practice across curricula in some fashion. Interaction design utilizes industrial design methods such as rapid prototyping, user testing, user focus, functional analyses, and semantic analyses. In an Ivrea symposium, Bill M. discusses the concepts of *user focus* and *iterative prototyping* as two processes industrial and interaction design share. A user focused process is simply one that is developed around a user's needs. Iterative prototyping speaks to the potentially never-ending process of continually refining designs through physical prototypes in order to achieve the best results. He states "Try, try, and try again."[34] And in an essay entitled "Form is Function", Bosse Westerlund discusses the appropriation of industrial design methods for interaction design purposes. He identifies *functional and semantic analyses* as two useful methods for interaction designers to employ.

Systemic Thinking

As we enter into this new kind of design, it is critical to understand beyond the physical and informational characteristics of a product in order to understand the *system*: how it works, who is involved, and what are the influences on that system. As technologies become more integrated into our world, design elements become intangible and there is increasing importance in having methodological tools for representing and evaluating the systemic elements of design. The elements of the system *could* include the problem, the technologies, the relationships, the people, the social influences, and more. We must understand the links, and be able to evaluate their influences on each another in some way.

Collaborative Efforts are Needed

It seems as if interdisciplinary (or transdisciplinary) approaches are necessary and beneficial, and the more informed we are with respect to different aspects of different disciplines, the better. For the

well-known product designers, Charles and Ray Eames, 'there was no difference between design disciplines. There was only the importance of applying good skills and thinking to a shared understanding of a common problem.'

"This broader scope for design has, in turn, forged new connections among disciplines that previously developed in isolation, created new languages that cross older disciplinary boundaries and transform the infrastructure of design, and realized an array of objects and fields of study that we could only dream about in the past."[35]

How do we break down the different concepts, skills, and methodologies in a cohesive way in order to structure and build curricular formats around any necessary change? Although mostly left with questions about what this all means for designers of tomorrow, incorporating this knowledge into our curricula is necessary, because computers are changing products and attention is needed to designing with their impacts in mind. The major disadvantage of incorporating this type of information into a curriculum is that this just means more skills and concepts to teach in the same amount of time within the same number of credits. Where and how do we teach new skills and ideas? Is it possible to add this knowledge to an undergraduate design programs without compromising quality of education and still teach the necessary skills for becoming a product designer today? If all skills cannot be taught, where do we draw the line – which skills do we teach and which skills do we neglect?

Computing technologies influences on design have created many new interesting opportunities and challenges for the fields of graphic and product design, and due to the nature of technology this is a discussion that will not go away. Determining the best way to integrate this is a difficult challenge for all design disciplines today in order to create a practice of interaction design that is a singular discipline informed by many. Although this relationship is complex, there are consequences for designers of the future.

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[3] 2004. [Web document] http://hci.stanford.edu/hci.html

[4] Product is placed in quotes, because it can be used in many different contexts. The notion of product is changing, as it no longer solely stands for physical objects. Websites, experiences, and product systems can be, and are, referred to as products.

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