Input and Output for Usage
Curriculum for Interaction Product Design

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Abstract: At year 2008, Ming Chuan University in Taiwan started a digital interaction design program trying to integrate different core techniques from School of Design and Information. The goal is to interpret interaction design from design proposals to working prototypes. The projects developing processes have been analyzed in this paper. The research results showed that interaction installations are not equal to interactive product; however, interaction design is not interface design because some don't even need any visual interface. The differences of interaction design aspects from the departments participated will be analyzed and explained accordingly. We would like to pose the question that, over its development of interaction technologies, what changes has the "interaction design" paradigms brought to the discipline of designing everyday product? Moreover, what should be the curriculum of interaction product design program in industrial design education?

The paper presents an overview of a recently implemented interaction design program within art and design education, and also compares the program to other programs worldwide. Through the comparisons of established interaction design curricula (e.g. Designing interaction at RCA, London; Designing for Interaction at TU Delft and the other schools in US, Europe and Asia), we suggest a framework for planning an interaction product design curriculum. The main contribution of this paper is to set the stage for an urgently needed discussion on how design education needs to adapt to the emerging contexts we are actually designing for today.

Key words: Interaction and Interface Design, Design Methodology, Design Education, Human Behaviors, Perception, and Emotion

1. Introduction

"Interaction" is a fuzzy term. Who's the Expert? Which theory is true? There is no fixed answer until now. Industries need interaction talents, but few schools have programs focus on interaction design. It is hard to find multi talents with both information and design thinking from existing educational system because these two professions speak different languages. From the aspect of information engineers to interpret interaction is the logistic processing of how people manipulate or touch a device. They want to know the entire process for

variables could be eliminated or programmed. On the contrary, designers usually focus on the expression of instinct concepts, creativities, aesthetics and forms. Interaction supposes to be two-way and two-sided; therefore, designing interaction device is to add up both left and right brain apogee at the same time. There are two possibilities to achieve this, to train up a person with both abilities or to work in an integrated manner.

For training up a person with both abilities, Ming Chuan University (MCU) in Taiwan has experienced a game design program between Department of Digital Media and Information Engineering at year 2004. The practice of this program is both departments offer 4 courses each for their students. However, teachers and students from both sides feel frustration because students from Information department have no idea about visual aesthetics and designers feel difficulties to write logistic scripts. At year 2008, MCU started another Digital Interaction Design Integration Plan trying to integrate different core techniques from School of Design and Information. By matching same subject as experiencing platform this time, students contributed their specialties and help each other to solve problems. For design to work in an integrated manner in such situations, designers need to have an understanding of each other's disciplines. Therefore, there are 34 speeches and 3seminars held to provide a basis to share understanding. **24 interaction design projects** presented from participated students (Product, Media, Visual Communication, and Information Engineering). The initiate concepts, input processes, techniques, and outputs of 24 projects were also categorized and analyzed to introduce the mindset and culture of different design aspects. The research results showed that interaction installations are not equal to interactive product; however, interaction design is not interface design because some don't even need any visual interface.

The usages, functions, and mass production concepts are in the blood of every product designer. The impact of information communication Technology (ICT) and Ubiquitous computing (Ubicomp) represent huge upcoming challenges to designers. From the information of the presentation of 24 design projects, we found how product design students' projects are suffering with the techniques to perform a physical output. As O'sullivan & Igoe mentioned that the most provocative projects are ones that don't just sense the world; they also change it. In general, physical output be more difficult than input because it often requires electrical (as opposed to electronic) and often mechanical skills (O'sullivan & Igoe, 2004). With the advent of the Ubicomp, (weiser, 1991) movement and the current development of mobile and wearable computing, interaction design has become a discipline that not only has to relate to system development, but also has to relate to product design and development (Edeholt & Löwgren, 2003). The impact of ICT and Ubicomp also represent huge upcoming challenges to designers. Edeholt & Löwgren (2003) mentioned ICT integrated in completely new ranges of products. The range of integration starts with crudely adding traditional ICT functionality on top. The prototypical example is a fridge with a display on its door (Electrolux and Ericsson, 1999). On the next level of integrations, ICT is integrated in order to support technology. However, an even more advanced level of integration would be if ICT and technology were integrated in entire new kind of products. And just as the products, per se, must be developed beyond mere hybridization of contemporary product, we believe it is due time to discuss a more advanced way of integrating the different design disciplines and methods needed in design education.

Edeholt & Löwgren (2003) also compare interaction and industrial design to highlight the challenge that design for Ubicomp poses to the two areas. The basis for the challenge is that Ubicomp comprises both tangible and virtual material, both spatial and temporal dimensionality, and both visual and experience aesthetic quality. "This new integration takes use qualities as the point of departure, and pragmatically employs the technology needed in order to augment our daily life, as we want to live it, rather than demanding us to adjust our lives to requirements posed by the technology." (Edeholt & Löwgren, 2003).

Input and Output for Usage

Old knowledge of using a product is based on turn it On & Off by hands. Nowadays, information signals could be used in various ways, volume of sound is an information to turn on a light, or your body temperature can provide signal for operating air-conditioner. Therefore, signals are ubiquitous. The point of view to transform signals into usable data and information is important. Game designer, Chris Crawford has definition: *interaction* is "an iterative process of listening, thinking, and speaking between two or more actors." Most projects can be broken down into these same three stages: listening, thinking, and speaking---or, in computer terms: input, processing, and output---or in product design terms: **input, usage, output**. In Figure 1, We modified the traditional layer decomposition of interactive software system from Dourish (Dourish, 2004) and the concept of physical Computing given by O'Sullivan and Igoe (D. O'Sullivan and T. Igoe , 2004). At the bottom, the most primitive layer is the user concerned product. Input transducers (sensors), such as switches and variable resistors, convert heat, light, motion, and sound into electrical energy. Output transducers (actuators), such as motors and buzzers, convert electrical energy into the various forms of energy that the body can sense (D. O'Sullivan and T. Igoe , 2004) .

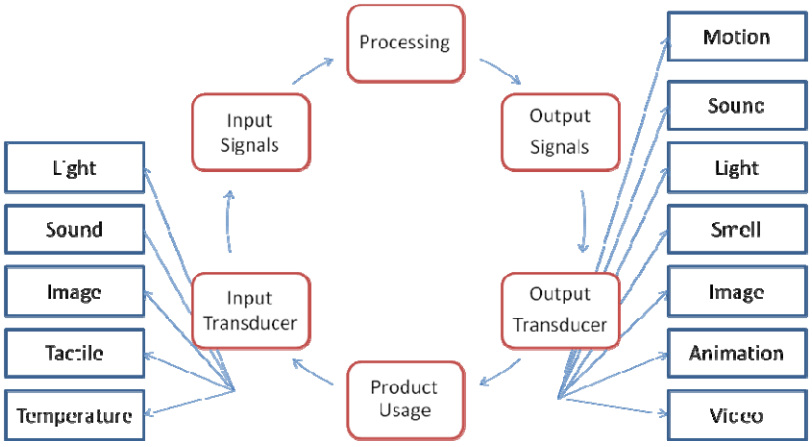

Figure 1. the structure of input and output for usage

The discussion in this paper is interaction design program in the development of industrial design based on requirements given by the real world rather than the virtual. Through the comparisons of established interaction design curricula (e.g. Designing interaction at RCA , London; Designing for Interaction at TU Delft and the other schools in US, Europe and Asia), we suggest a framework for planning an interaction product design curriculum. The main contribution of this paper is to set the stage for an urgently needed discussion on how design education needs to adapt to the emerging contexts we are actually designing for today.

2. Mindset/culture between interaction design, product design and communication design

24 interaction design projects presented from 4 departments participated (Product, Digital Media, Commercial, information Engineering). The different core competences and traditions are as shown in table 1. According to the specialties of four different departments, students with 24 projects were divided into 4 groups, which have different design perspectives and contents as following:

Product- Remote Car, Toys, robot, etc., which are not necessary through PC to input and output.

Games- Playing game through keyboard, Wheels, joysticks, etc. on display of computer screen.

Communication- Usually related to public issue, advertisement and arts. Mostly are interactive installations.

Information- System, data base, Software Programmer.

Table 1. List of different thinking aspect from product 4 departments.

Product	Interactive Game	Communication	Information
•Thinking Physically •3D Modeling •Meaning of Form •Human Factor •Usage •Function •Mass-Production •Mechatronics	•Digital Art •Program Multimedia, animation and computer game •Computer Graphic Technique •Interactive Media	•Commercial design •Branding •Advertisement •equipment of art •Graphic •Visual Communication	•Embedded System Design •System Software and Software Systems •Computer Networking •Data Analysis and Applications

Table 2. Input and output interfaces form 24 projects in MCU interaction design projects.

Product (8)			Input	Transducer	Output	
P1	Umbrellas holder	ep	hanging umbrella Touch	sensor	Animation	a
P2	Chess Board	np	playing chess	Ultrasonic, light Sensor	Animation	a
P3	Shinning Cup	np	Cup	Sound Sensor	Light	l
P4+I Save	Energy	np	Lamp	Energy consumption	Animation	a
P5	Relax	np	rubber ball	Temperature sensor	Paint	p
P6	Recycle Basket	np	Can & Basket	RFID	Motion	m
P7	Kids Urinal	np	Urine touch surface	Sound Sensor	Lighting	l
P8	Dance w/Music	np	Glove	Light Sensor	Sound	s
Game (7)						
G1	Deep Blue Game	es	Wii Controller	Infrared ray Led	Flash Game	g
G2+I Color@Color!		es	Joystick		Flash Game	g
G3+I	La Cle'!	c	Keyboard & Mouse		Flash Game	g
G4 Wright	Flight	ep	Bicycle Fl		ash Game	g
G5	Popo Crisis	c	Keyboard & Mouse		Flash Game	g
G6 Megaga		ep	Microphone	Sound Sensor	Flash Game	g
G7	Sky Ocean	i	image	Ultrasonic Sensor	Animation	a
Communication(7)						
C1	Don't Pull	ep	tissue Roller	Infrared, Webcam, Led light Anim	ation	a
C2 Changing		np	Button	Micro Switch	Animation	a
C3	KADA	ep	Bicycle	LED Light, Webcam	Animation	a
C4 Waiting	Table	np	Cup		Animation	a
C5	STOP	ep	Spread Can	LED Light, Webcam	Animation	a
C6	Once upon a Wind	ep	Windmill		Animation	a
C7	Aqua Cell	ep	straw, Microphone	LED Light, Sound Sensor	Animation	a

Information(2)						
I1	Any angle Projector	ns		image adjustment		sys
I2 Fantastic	Adventure	ns	touch	projector, mirror, webcam	animation	sys

As we expected as table 2, the information engineers regarded themselves as system providers, game and communication design from Digital Media and Commercial students can present several input devices to achieve wanted effects of game or animation shown on screen. The interpretation of interaction design from product design students are leaving out the visual interface but encountered difficulties to present working prototypes with interactive experiences on their prototypes. Because physical output such as light, sound or motion often requires electrical (as opposed to electronic) and often need mechanical skills (O'sullivan & Igoe, 2004). Therefore, Interaction product design program is not only just adding the training courses of flash scripting, computer programming but also the electrical knowledge.

However, we also found the boundary of professions are blurring, because we can see product designers are trying to use flash for their output effects and graphic designers in communication group were actually soldering the electric board.

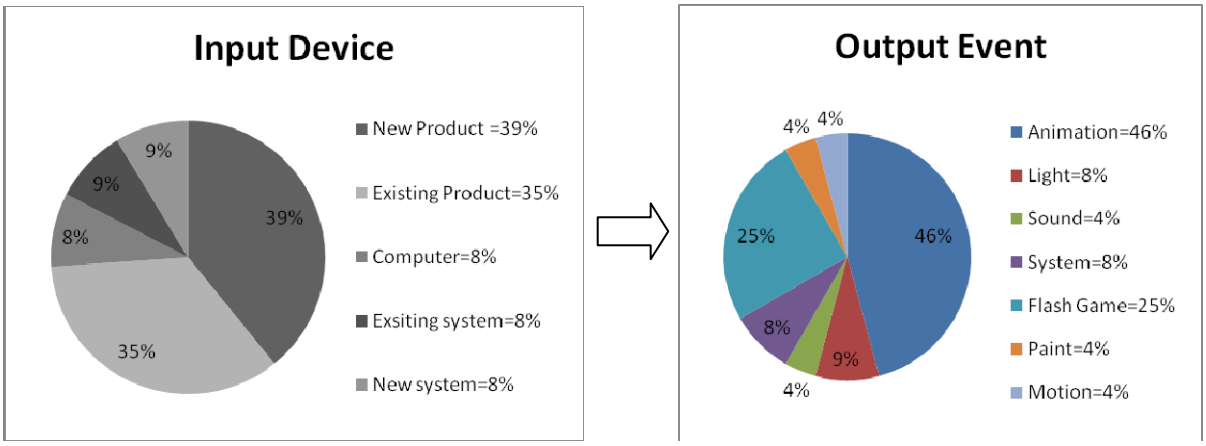

Figure 2. Percentage of innovation design in input device and output event.

The 24 projects have indicated several situations and perspectives. First, there are 39% of new input devices that are not computer keyboard or mouse. However, 46% of animations plus 25% of flash games for output which means to build output transducers is an obstacle due to the limitation of existing programming and Mechatronics knowledge. Especially product design groups, they have the most difficulties to accomplish real interaction contacts. Second, Game and Communication groups went directly to build physical equipments from existing components in order to perform interaction activities, e.g. C1, C2.

Finally, the project management is urgent needed to integrate same concept. For example, P2, C4 and I2 could actually work together to achieve a stage of final prototype for production. We can conclude two issues which are digital output transducer technologies and project management are two main issues occurred in MCU digital interaction design integration plan.

3. The fit of an interaction design curriculum

The radical design movement, e.g. as practiced at RCA (Gaver & Martin, 2000; Dunne, 1999), focus on other aspects than the interaction with technology as such, which have been the primary focus for interaction design. To them and to some game design, friction, ambiguity and the physical product can be a central part of a concept. The radical design movement use design as part of an aesthetic, cultural and technological research discourse (Holmlid, 2007). **However, good concepts usually couldn't be materialized when encounter technology obstacles.** In the process of bringing out design, tools are relatively important. In fact, the more mature ICT becomes, the more it will be able to offer tools for designers to built up interaction prototypes and enter our everyday world in a sensible way, e.g. students participate in MCU interaction projects remodeled Wii as their tool to create digital art. Therefore, a stable medium that allows to remodel such as Wii or joystick could be applied as a technique rather than consumer product. Block Diagram from LEGO NXT could be very easy tools for product designer to program for prototyping. The need to be strong programs in industrial design schools that focus on interaction is obvious. Whether you are designing toys, furniture, cars, consumer devices, or even accessories such as clothing, bags, or shoes, there are more and more interactive components being added to them all the time (Malouf, 2007).

In this section, the fit of an interaction design curriculum are referring to the concept, method and studio which are base on the three different perspectives of industrial design proposed by Edeholt & Löwgren (2003). "The artist demands total personal freedom of intuitive expression, the analytically skilled project leader who believes that mastering the design process will do the trick, and the technology freak sees opportunities everywhere without being hampered by established engineering rules and know-how." Having a concept, we call that "art" which is different and segment from mass-production product. Methods are also important which can be learned. Studio or workshop courses are the integration and developing of creativities which is influenced by concepts and methods. (See Figure 3.)

Concept Class (artist): the ability to see the needs of a general user; focus on what to design rather than how to design.

Methods Class (technology freak)： New tool such as block diagram with Input/ Output, variables and samples is easy for visual designer to program because it is just drag and put. Webcam image detecting technique is widely used to build product prototype. Learning new tools provide new functions that make new design possibilities.

Studio Class (project leader): The abilities to explore new possibilities of human-machine, machine-machine or machine-environment such as Wii and i-Pod.

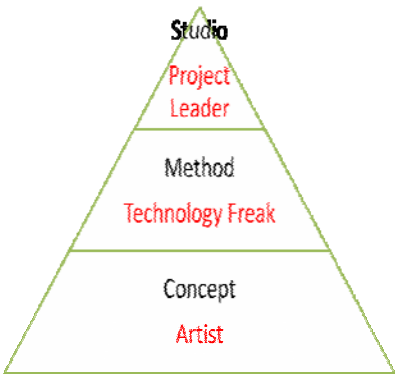

Figure 3. Curriculum structure

3.1 The Established Interactive Design Curricula Worldwide

Under the three-tier structure as mentioned, we investigated schools with programs completely focused on interaction design within design schools in Europe, US and other area. Interaction Design programs offer by Information or other not design-related departments are not included in this research. Table is the list of 11 schools. All of these are specific graduate programs solely in interaction design. Their interaction design

programs are well-structured relatively innovative that worth to be the reference for this research. We started the survey from the list of the D-schools (BusinessWeek, 2007) and also included interaction programs from KU School of Fine Arts (US), SVA (US) ,AHO (Norway), Malmo (Swedish).

RCA, Domus, and Malmo are projects based programs, students learn through directly participate in to the projects. At RCA, The projects can be short workshops introducing new skills, such as electronic and software prototyping, or they can last several weeks and so allow for a more prolonged engagement with a particular perspective. TISCH of NYU offer most varieties of workshop and seminars and the degree requires completion of 60 graduate credits within a three-tier structure. Students will be expected to complete these foundation courses before moving to Tier Two or Tier Three.

Table 3. List of the Interaction program

School		Course modules
(CMD, USA) Carnegie Mellon Master of Design in Interaction Design	2yrs, 60credits	Thesis & Projects Core courses Electives
KU School of Fine Arts, USA MA in Interaction	31 credits	Research (2) Core courses (12) Electives in Design (9) Electives outside of Art & Design(5)
NYU > TISCH > ITP, USA Master of Professional Studies	2yrs, 60credits, three-tier structure.	Foundation (16) Tier 1: Foundation (16) Tier 2 - Workshops and Seminars (40 points) Tier 3: Final Thesis Project (4)
(SVA, USA)School of Visual Arts	2yrs, 60 credits	studio courses, lectures, and seminars thesis projects
(RCA, UK) Royal College of Arts	project based 2 yrs	Workshops & Projects Thesis Presentation
Umeå University, Sweden	project based, 80 weeks, 120 credit	Introduction Human-centered Projects
Malmo University, Swedish	2yrs, 120hp	Thesis project
TU Delft, Netherlands	2yrs, General	Courses Master Specific Courses Graduation Project
Domus Academy, Italy Master in I-Design	project based **11 months (2 semesters)**	Lectures Workshop Thesis
Stanford HCI Group, US Mechanical Engineering (Design Division)		
(AHO, Norway) The Oslo School of Architecture and Design Master of Industrial Design	270 credits and the 30-credit diploma	Foundation level studies(30) Studio courses (24) Elective courses (6) Diploma programming (6) Diploma(30)

3.2 The required and core courses

Among the programs from the schools list above, we structured the courses into three different categories which are Concept, Method and Studio. The courses within the programs were classified and calculated the frequency by percentage of appearing listed as following.

Our "new" curriculum is based in the direct linkage of the result from the established interaction design curriculum. To design input and Output for usage, the curriculum, as shown in Figure 3, consists of a progression of interaction product design courses, and allows students to practice interaction design fundamentals in the solution of the new challenge of Ubicomp world. This curriculum makes extensive use of

interaction techniques and provides previously unavailable opportunities for user experience. As part of the new curriculum, several new courses are in development under product design department. The courses currently being developed on the base of existing product design curriculum are:

Product: Human Factors, Experience Prototyping, Use and Experience, Design management.

Information: Introduction to Physical Computing (Human-Machine Interface Technologies), Interaction Design fundamentals, Software Prototyping.

Digital Media: Cognitive Theory, Interface Design, Content Strategy.

Communication: Visual Communication, Scenarios & Simulations, Branding

Besides, Interaction Design Project, thesis or Professional Practices would be the requirements to complete the degree.

Table 4. List of the core courses and percentage among totally 81 courses from 11 schools with interaction design program

Course Module	Core Course	*List*	Std.	Others
Concept	Interaction Design fundamentals	*3*	3.70%	Philosophy of science, Design as knowledge development, Collective Production, Information Visualization, Designing for Good, Designer in Society, Special Problem in Design, Design in Public Spaces Intro to Mechatronics
	Introduction to Physical Computing	*6*	7.41%	
	Human Factors	*2*	2.47%	
	Design Cognition	*3*	3.70%	
	Branding	*2*	2.47%	
	Use and Experience	*4*	4.94%	
Method Research	Methods	*4*	4.94%	Dimensions of Form, User Observation & Task Analysis, Design Management, Interaction Design Methods
Visual	Thinking	*2*	2.47%	
Cont	ent Strategy	*4*	4.94%	
Scenarios	& Simulations	*3*	3.70%	
	Tools, Skills and Technology	*5*	6.17%	
Content	Interaction Design Project	*5*	6.17%	Graphic Design for Interactive Media, 3 D Modeling
	Interface Design	*3*	3.70%	
	Experience Prototyping	*4*	4.94%	
	Visual Communication	*4*	4.94%	
	Software Prototyping	*2*	2.47%	
	Professional Practices	*4*	4.94%	
	Thesis	*5*	6.17%	

Figure 3. Suggested Courses

4. Conclusions

From the comparisons of 24 projects in MCU digital interaction integration plan and the research of established curricula worldwide, have indicated **that 'interaction design' is not 'interface design', because a VISUAL interface is not necessary needed**. Designers have different interpretation of "interaction design"; they focus on feeling and experience of usage more than images output on screen. Because tools (hardware, software and internet) provided by the development of technologies makes different profession skills could be easily learned and adapted. The boundary of professions is blurring and overlapping. It is not only product design for the form, commercial design for the identity and packaging, digital media for the game and information engineering for the software systems. Form the research of established curricula to find the fit structure, there are significant finding as following:

1. **Problem Finding**

   Finding problems is getting more important than solving it. Preece mentioned that it is about finding ways of supporting people (Preece, 2001). However, people don't even feel any obstacle until we see better way of usage, user experiences. As listed in the method courses, product sketches and rendering used to be the basic techniques. However, scenarios (3.07%) and visual thinking (2.47%) techniques need to be added in the curriculum to strengthen the concept presentation. Besides, strategy about content and design are also has 4.94% shown among 81 different courses. The ability to mapping out problem context is getting more important than sketching out the solution.

2. **Design managements**

   Especially the project management skill is urgent needed to innovated possibilities. But we found that design management is rather important to provide in Interaction Product curriculum but there is only School of Visual Arts (SVA) really put this course in their year-2 curriculums. That needs to have another research for the reason.

3. **Introduction of electronic and programming**

   Good concepts usually couldn't be materialized when encounter technology obstacles. For the past few years, industrial designers offer us good proposals of how technologies could change our life. However, the explanation of how human-machine interactions end up incomprehensible from their prototypes (7.41%). Therefore, to have basic concept of digital/analog input and output technologies, e.g. physical computing are needed in interaction product design education as introduction level. The experience design (4.94%), software design (2.47%), interface design (3.7%) and physical prototyping (4.94%) studio is the integration of perspectives in between product, commercial, digital media, and information specialties. When product design encounters interaction issue, it used to be the presenting ideas as narrative proposals, because it is difficult to make two different side of brain think in one.

Hopefully, by the fit of interaction product design curriculum, many details of design implementation, aesthetics, or functionality can be resolved. Besides, this learning process could allow designers not only to remain open to imaginary extensions, developments, and modification but also achieve with more finished examples.

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