Competencies and qualifications for industrial design jobs: implications for design practice, education, and student career guidance

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This study aims to understand the various job titles currently used in the ID profession and their corresponding recruiting qualifications. It compares the qualifications among the various design jobs in the product development process, and between different types of design organizations. Finally, the implications of the discoveries to design practice, education, and student career guidance are discussed.

Keywords: industrial design, design education, design practice

Industrial design, as an integrated profession, covers a wide range, including engineering (technology, techniques, material and processing), ergonomics (operation, safety, usability, sensation), business (marketing, management, planning, corporate identity), aesthetics (form, visualization, style), and even involving social, environmental, and cultural issues (Giard, 2000; ICSID, 2003; IDSA, 2003). Design educators and professionals are always concerned with the issue of industrial designers' competencies. However, the quality of ID graduates is not regarded as up to a level expected by employers (Kaufman, 1998), and there seems to exist a gap between what students learn at school and what they are required to do in practice after graduation (Ball, 2002; Yeh, 2003). The possible reasons for the ID graduates' lack of relevant qualifications could be as follows. First, the extent and content of industrial designers' work are currently different from those in the past, but there is little updated information about ID

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employment in the job market. Therefore, before they graduate, ID students are not well prepared to equip themselves with the knowledge and skills required for employment. Furthermore, the argument about whether designers should be educated as generalists or specialists continues without a conclusion. Finally, ID programs in universities recruit students with diverse backgrounds from senior high schools. As a result, the ID students' abilities, aptitudes, and career goals may vary considerably.

ID programs recruit not only students with artistic abilities, but also welcome those with talents in science to pursue their careers in design. Students with a science orientation are thought to be especially suitable for the design and development of interactive products in the digital technology or entertainment industry (Adams, 2001). In addition to the required design courses, ID departments also provide multiple electives covering engineering, ergonomics, management, arts, and computer-related courses. On the one hand, these courses help students to understand various design tasks in the product development process. On the other hand, those courses broaden students' vision about other design related fields, such as product planning, design management, mechanism design, CAID, human–machine interface, etc. Therefore, the design jobs that students with diverse backgrounds may choose as their career may vary considerably. In addition to being educated as industrial designers, ID students can specialize their career pursuit in the areas of product planning, design management, mechanism design, CAID, interface design, etc. However, if students would like to choose the above-mentioned design fields as their career, they need to know what competencies they need to prepare for. Some ID students raise the following questions: ' I'm creative, but I am not good at form giving or model making. What design jobs can I be employed in after I graduate?' 'To be competent for those jobs, what qualification should I have?'

The qualifications for ID jobs are useful information to students to select courses in order to be prepared for a future professional career. Such information is also useful to design professionals for reviewing their own competencies. Furthermore, it is also useful to employers for hiring or promoting industrial designers (Yeh, 1999). Many previous studies have been conducted to identify the required competencies of industrial designers. Most of them are based on such a general or extensive perspective that the amount of required competency sums up to 43 to 60 items (Lin, 1995; Yeh, 1998; Siegel, 2000; Yeh, 2001). However, there has been little information about the competencies needed for different design tasks in the product development process and various design organizations. Therefore, this study aims to better understand the employment opportunities for the ID profession and their corresponding recruiting qualifications. To do so, it compares the qualifications among various design jobs in the product development process and between different types of design organizations, such as in-house design departments and design houses. Due to the extensiveness of the ID profession and the great differences in student backgrounds and aptitudes, the result of this study could be a significant reference to guide ID students in career planning.

The rest of this paper is divided into four sections. Section 1 outlines the work content and the required competencies of industrial design practice. It further introduces the nature, content, changes and challenges of design education. Section 2 presents the research approach adopted and discusses the results with respect to the following five issues: (i) classifications of job titles, (ii) recruiting qualifications, (iii) comparisons of qualifications among the three job categories and each job title, (iv) comparisons of overall qualifications between in-house design departments and design houses, (v) comparisons of qualifications for each job category between in-house design departments and design houses. Section 3 discusses the implications for industrial design practice, education and student career guidance. Section 4 presents a summary and conclusions.

1 Industrial design practice and education

1.1 Work content of ID practice

The current extent and content of industrial designers' work are different from those in the past. Green and Bonollo (2002) note that there are seven phases in the product development process (product planning, task clarification, concept generation, evaluation and refinement, detailed design of preferred concept, communication of results, and preparation for production). Among them, five phases (from task clarification to communication of results) are identified as the industrial design process. In the past, most companies placed designers near the end of the product development sequence of activities, which significantly reduced designers' potential for contribution to corporate goals and strategies. As the global market is becoming increasingly competitive, some international corporations, including Acer, Apple, Philips, Sony, etc. have adapted a holistic design program to integrate design into the concept-to-market process and let designers participate in decision-making for product planning and positioning (Blaich and

Blaich, 1993). Another way to deal with this competition, as adopted by SAMPO, a Taiwanese electrical appliance company, is to divide the industrial design function into two sub-units. One is responsible for product planning, concept generation, and form giving, where designers with more creativity and aesthetic sensitivity are employed. The second is responsible for detailed design, coordination with tool makers and the production department to ensure the quality of samples and final products, where designers with better understanding of materials, processing and manufacturing are employed. This means that the extent and content of industrial designers' work are now extended beyond the traditional ID process, to both ends of the product development process, that is, the product planning and preparation for production phases as addressed by Green and Bonollo.

Due to recent global competition, corporations have reviewed their product development processes and introduced new technology, procedures and multidisciplinary teams in order to shorten the time-to-market for new products. This trend has changed the traditional work content of industrial designers, so that designers must now be closely involved in the entire design-to-market stream of activities, and interact and intensively communicate with other disciplines. Moreover, introducing new design technology and process, making use of digital tools (Tauke, 2003) and emerging design specializations (Sethia, 2001), such as interactive design and experience design, have forced industrial designers to adjust and update their competencies. However, there is little updated information about the current job market for ID employment, and ID students are not well prepared with the knowledge and skills required for employment when they graduate.

1.1.1 Required competencies of industrial designers in general

The organizations such as ICSID, IDSA, and the U.S. Department of Labor provide information about the required competencies of industrial designers. The ICSID (2003) suggests that a comprehensive ID education program should at least educate students in three categories of competency: 1) *generic attributes*—problem solving, communication skills, adaptability to rapid changes, etc.; 2) *specific industrial design skills and knowledge*—design thinking and design process, design methodologies, visualization skills and knowledge, knowledge of product development processes, manufacturing, materials and processes, design management, environmental awareness, model making, etc.; 3) *knowledge integration*—strategies of system integration. The IDSA provides a detailed checklist written by Siegel (2000), including 44 technical skills and 10 categories of personal skills, so that students who would like to choose industrial design as their career can evaluate themselves. The U.S. Department of Labor (2003) defines the work activities and value, required knowledge, skills, ability and interests for the occupation of commercial and industrial designers, and provides weights for each item.

Some scholars also have discussed the issues (Archer, 1965; Ballay, 1991) or provide evidence (Lin, 1995; Croston, 1998; Yeh, 2001; Yeh, 2003) about the competencies of industrial designers. Vinke (2002) defines a competency as 'the ability of an individual to select and use the knowledge, skills and attitudes that are necessary for effective behavior in a specific professional, social or learning situation.' Lewis and Bonollo (2002) claim that (product) designers not only need the individual cognitive skills and overall skill displayed in execution of design process, but also require other skills, such as negotiation with clients, problem solving, acceptance of responsibility for outcomes, interpersonal skills and project management. In addition to design professional skills and knowledge, an industrial designer needs to have general competencies, team spirit, and the personality to accept challenges. In addition to traditional skills required by the profession, in the next decade an industrial designer should have knowledge relevant to marketing strategy, market analysis, product planning, mechanism and structural design, CAID for the various design tasks, an active attitude, communication skills in foreign languages, and international views (Yeh, 2001). Ideally, each industrial designer should be equipped with every competency mentioned above. However, those competencies are extensive and numerous, so it is not possible for all ID students to be capable in every item. In order to be qualified for design tasks at various stages, the competencies of industrial designers vary, depending on different roles played in the product development process.

1.1.2 *Required competencies of industrial designers for different conditions*

The required competencies of industrial designers for different conditions might vary. Ho et al. (1997) roughly divide the tasks connected to the ID discipline during the product development process into four stages: planning, designing, prototyping, and engineering. The corresponding design skills for each stage are as follows: 1) Planning Stage: knowledge of market, marketing, design, engineering, and planning; 2) Designing Stage: abilities in ideation, creativity, aesthetics, sketching and drawing, as well as model making, etc.; 3) Prototyping Stage: abilities in making sophisticated prototypes for appearance models, operating models, mechanism models, etc.; 4) Engineering Stage: specialized engineering knowledge of mechanisms, molding tools, electrical engineering and manufacturing. The required professional abilities for the titles of junior designers, senior designers and design managers are different (Wang and Bien, 2001). In addition, industry in the U.S. places more value on creative thinking ability, whereas Taiwanese industry puts more emphasis on skills of computer-aided design (Yeh, 2003). This shows that the required competencies of industrial designers vary depending on different roles played in the product development process, the content of design work, the level of design manpower and the demand of specific country.

1.2 Nature of design education

1.2.1 Overview

According to the above-mentioned content of design work and required competencies, we should consider how design education institutes should adjust themselves in order to cover the extensive and multiple aspects of the ID profession. Due to the rapid development in technology, most of the jobs today will no longer exist in 15 years (Swanson, 2000). Thus, it is difficult for design education to reach the following goal, as mentioned by Buchanan (2000): 'forming a designer who has adequate special knowledge but also possesses the wide perspective that is needed in the complex environment we face today and in the more complex environment that we are likely to face in the future.'

Whether the nature of design education should be generalist- or specialist-oriented is still a debatable issue, and the educational result might cause the industry to be dissatisfied with ID students' qualifications. In contrast to the focus on inquiry for science and hands-on skills for technology, design education derives from arts and crafts education, so it usually trains students with the hands-on experience of visual presentation skills (Giard, 1999). However, design education cultivates students not only with the professional skills of problem solving, conceptualization, visualization and communication, but also with a solid base of understanding about arts, science, technology and humanities (Owen, 1990). Therefore, Levy (1990) stresses that universities should educate talents for future demands, instead of training students' skills, so design schools at universities should emphasize the development of basic knowledge, including understanding analysis, synthesis, interpretation, creation, assessment and criticism.

University education does not need to respond to the industry's demand for training immediately available talent for employment, and as a result, neglect the ideals and goals of a university. Universities should initiate pioneer research and visions to educate students with the abilities to learn and adapt, able to lead the development of the industry. Several scholars also claim that the goal of design education is generalist-oriented (Buchanan, 2000; Kumar, 2003). However, universities not only carry the missions of research, academics and lifelong learning, but also face dual pressure from industry and students' parents. The former expects graduates equipped with excellent competencies, and the latter expect graduates to find satisfactory jobs. Thus, it is not easy for schools to arrange design curricula in order to help students to learn general and special competencies during the limited time period.

1.2.2 Content of ID education

ICSID formulated the exit profile of a general design graduate as follows: 1) *primary cognitive abilities*—critical, innovative, lateral and creative thinking; motivation and curiosity; perception of design problems; conceptualization of new design solutions; 2) *secondary cognitive abilities*—oral, graphic, and symbolic communication; research and discovery; discipline of ethics and morality; psychology and philosophy of designing; competence in the design specialization; 3) *skills*—design methodologies; materials, processing and model making; computer-aided design and other software; 4) *social context*—grasp of the cultural heritage; teamwork, collaboration and leadership; entrepreneurship and continuing education; 5) *subject matter expertise*—knowledge of the subject matter and context for design; fundamental scientific principles and their application; basic laws, principles and design practice in the subject (Kumar, 2003). According to the above distinction of the major/secondary cognitive abilities, it seems that the competencies of perception and solution of problems, creative thinking, curiosity and motivation are more important than the design professional skills, such as visual communication and model making or design specializations of an ID student.

Most ID students are required to practice studio projects in order to experience the design process of task clarification, concept generation, evaluation and refinement, detailed design of preferred concepts, and communication of results (Lewis and Bonollo, 2002). The output generated from each stage includes design briefs, concept sketches and mock-ups, refined sketches and models, technical drawings, detailed component drawings, presentation drawings, refined models, etc. The emphasis of most industrial design programs seems to be educating students with the skills of creativity, form giving, sketching and model making. Moreover, creating beautiful objects to impress their teachers becomes the final goal of many design students (Giard, 1999). However, the content and level of creative and visual presentation skills required at different design stages are not similar. For example, the creative content and presentation skills required at the planning stage are not similar to those needed at the prototyping or engineering stage. If some ID students are creative, but they are not visually oriented or sensitive to styling, what is their niche in the design practice?

1.3 Changes and challenges of design education

1.3.1 Overview

Changes and trends in the ID profession have stimulated some significant transformations in design education (Sethia, 2001) and altered the value and core of the traditional skill sets for an industrial designer. There are five trends of the industrial design practice to affect education: 1) Emerging new technology increases use of digital media, and has changed the presentation methods of sketching, rendering, model making and technical drawings; 2) The boundary between design disciplines is fuzzy, which makes it necessary for designers to understand other design fields and interact more with other disciplines; 3) There is a need for interdisciplinary teamwork involving not only the traditional issues of physiology, materials and technology related to product development, but also user research and lifestyle trends before the product development and social, psychological and ideological issues; 4) The expanded definition of products concerns not only the specific functions for individual products but also the system composed of various products and the interfaces among parts; 5) There is an increasing dependence on online resources, and the internet has become a tool to deliver teaching, learning, interaction and communication among students, faculty and practitioners (Tauke, 2003). Those transformations have to be carefully brought into formal ID education in order to help students be well prepared for the changes. Otherwise, design graduates would face such problems as feeling unready, lack of self-confidence, business awareness and professional skills (Ball, 2002).

However, compared with the development of design practice, design education has developed more slowly over the past decades, and many design schools continue to teach their students with the traditional design skills, knowledge and processes (Kaufman, 1998). The emerging areas in recent years, such as computer aided industrial design (CAID), rapid prototyping (RP), online learning in design, interaction design, interface design, experience design, sustainable design, universal design, etc. have not been extensively brought into the formal design curriculum. In addition, only a few design schools are aware of the trend toward interdisciplinary teamwork in the real world, and have design students work on design projects with students and faculty from departments of business, engineering and social science. Moreover, the recruiting of prospective design students is essential to the development of design practice and the quality of design education (Owen, 1990).

1.3.2 ID student recruitment

ID programs recruiting students with diverse backgrounds from senior high schools are facing a new challenge in design education. For example, there are currently 10 general universities and five technological universities providing ID programs in Taiwan. These two types of universities recruit students in three ways: the entry exams, recommendations and selections, and applications. Therefore, it is a common situation to have students with technical skills in design (arts, crafts, advertising, interior design, etc.) or non-design backgrounds (tool making, electronics, mechanical engineering, etc.) from the vocational high schools as well as academic-oriented students from general high schools in one classroom. This mixture of students with diverse backgrounds not only challenges the teaching ability of faculty, but also generates pressure on student learning.

The challenge that design faculty face is how to teach and evaluate students with different levels of design skills and diverse aptitudes in one class. Skaggs (2002) claims that the aptitudes of an industrial designer are the visual, creative and flexible thinking styles, and students can learn design quickly and easily if they have these aptitudes. However, he further points out that some creative students might not be visual, and some visual students might not be creative. ID programs tend to recruit students with art, science or engineering aptitudes; however, these students do not necessarily have all three thinking styles. Using the standard criteria to evaluate the performance of ID students neglects the fact that students with different backgrounds might have various learning approaches, personalities, interests, aptitudes and capabilities. Once encountering frustration in learning design, students may doubt whether they can become good industrial designers and feel uncertain for their future. Above all, responding to the extensive aspects for the ID profession and students with various backgrounds and aptitudes, it is important to guide the ID students to plan their career.

2 Evidence

With a perspective on career guidance for the ID students, this study aims to understand the various job titles currently adopted in the ID profession and their corresponding recruiting qualifications. It compares the qualifications among various design jobs in the product development process and between different types of design organizations. The implications of the discoveries to design practice, education, and student career guidance are discussed.

2.1 Data collection and analysis

Job opportunities available in the ID profession announced in 20 major job searching websites (the URL for each website is listed in Table 1) and the classified ads in two major newspapers (China Times and United Daily News) in Taiwan were collected from June 2002 to January 2003. Content analysis was conducted to analyze the recruiting qualifications required by each job. The steps for searching job titles were as follows: 1) First, the following key words were used to search: a) Industrial Design: ID, product design, product styling, styling design, 3D design, CAD engineer, CAID engineer; b) Mechanism Design: mechanism engineer, mechanism design, structure design; c) Planning or Management: design research, design project management, product planning, concept development, concept research; d) Package: package engineer, package

Table 1 Twenty major job searching websites in Taiwan used by this study

Job Searching Websites	URL
China Times Job Bank	http://www.ctjob.com.tw/
Yahoo 104 Job Bank	http://tw.job.yahoo.com/
104 Job Bank	http://www.104.com.tw/
pc home Job Bank	http://job.pchome.com.tw/
138 Job Bank	http://www.138.com.tw/
Career Employment Information	http://www.career.com.tw/
1111 Job Bank	http://www.1111.com.tw/
TransAsia Job Bank	http://www.9999.com.tw/
Taipei Job Bank	http://www.esctcg.gov.tw/
Taichung Job Bank	http://www.04job.com.tw/
att Job Bank	http://www.att.com.tw/
United Job Bank	http://udnjob.com/
myjob Job Bank	http://www.myjob.com.tw/
jobsDB	http://www.jobsdb.com/TW/B5/default.htm
ABC123 Job Bank	http://job.abc123.com.tw/
Seeder Job Bank	http://jobs.seeder.net/
Taiwan ReJOB	http://www.rejob.com.tw/
1212 Job Bank	http://www.1212.com.tw/
Design Republic	http://www.designrepublic.org.tw/jobs/n_job.php
Hinet Employment Information	http://career.hinet.net/

designer; e) Graphics or Interface: human–machine interface, GUI graphics design, product graphics. 2) Next, for a broader search, the following key words were used: design, designer, development, research and development, styling, industrial product, product, creative. 3) Then all searching results were listed to eliminate repetitions. 4) Finally, each job title was classified and the frequency for each recruiting qualification was counted.

2.2 Results

2.2.1 Classifications of job titles

Table 2 lists the classifications of all job titles in the ID profession. In addition to the term 'industrial designer,' the job titles for the ID profession include the words of 'product/merchandise,' 'development,' 'form,' 'three dimensional, 'appearance,' 'creative,' etc., for positioning as designers or engineers. Table 3 shows the classifications, amount, and ratio of 13 job titles in the ID profession. A total of 265 job opportunities in the industrial design profession grouped into 13 job titles are classified into three categories: 1) Industrial Design (ID) group:

Table 2 Classifications of job titles available in the ID profession

Category	Industrial Design (ID)	Mechanism Design (MD)	Others
Job titles in the ID profession	Industrial design assistant, industrial designer, industrial design engineer, project industrial designer, senior industrial designer (engineer), industrial design director/ manager, (industrial) product designer/engineer, (product 21) styling designer, styling design engineer, 3D designer/ engineer, product appearance styling designer, merchandise appearance design engineer, product development engineer, product creative engineer/director	Mechanism (R&D) engineer, (product) mechanism designer/engineer, senior mechanism designer, structure design engineer, mechanism design (R&D) manager, mechanism project manager	Design researcher, design project manager, concept researcher, project planner, product planner/engineer, concept development researcher/designer, human–machine interface designer, GUI graphics designer, package engineer, package design engineer/ manager, CAD engineer, CAID engineer
265 jobs grouped into 13 job titles	Three levels: 1) industrial designer 2) senior industrial designer 3) design director/manager	Three levels: 1) mechanism designer 2) senior mechanism designer 3) mechanism director/ manager	1) product planner 2) concept researcher 3) design project manager 4) interface designer 5) package engineer 6) package design manager 7) CAID engineer

Table 3 Classifications, amount, and ratio of 13 job titles in the ID profession

Job Category	Industrial Design			Mechanism Design			Others							Total
Subtotal	151			83			31							265
Ratio	57%			31.3%			11.7%							100%
Job title	ID	SID	DD	MD	SMD	MDD	PP	CR	DPM	IFD	PE	PDM	CAIDE	
Amount	135	8	8	65	12	6	9	5	4	2	3	2	6	
Ratio	51%	3%	3%	24.5%	4.5%	2.3%	3.4%	1.9%	1.5%	0.8%	1.1%	0.8%	2.3%	

ID: Industrial Designer, SID: Senior Industrial Designer, DD: Design Director/Manager, MD: Mechanism Designer, SMD: Senior Mechanism Designer, MDD: Mechanism Design Director/Manager, PP: Product Planner, CR: Concept Researcher, DPM: Design Project Manager, IFD: Interface Designer, PE: Package Engineer, PDM: Package Design Manager, CAIDE: Computer Aided Industrial Design Engineer.

including industrial designer, senior industrial designer, and design director/manager. 2) Mechanism Design (MD) group: including mechanism designer, senior mechanism designer, and mechanism director/manager. 3) Others: including planning, management, interface, package and CAID, etc. As shown in Figure 1, among the 265 jobs, 57% of the total are for the ID group, 31.3% for the MD group, and 11.7% for the Others group. A total of 43% of the job openings can be classified into the Mechanism Design and Others groups, indicating that the job market does provide extensive job opportunities for ID graduates.

2.2.2 Recruiting qualifications

As shown in Table 4, recruiting qualifications are classified into basic requirements (educational background, age, gender and past experience preferred) and required competencies (professional and general skills, personality and attitudes). Figure 2 shows the top five competencies for the overall ID profession as follows: 3D graphic software ability, basic communication ability in English, fluency in English, 2D graphic

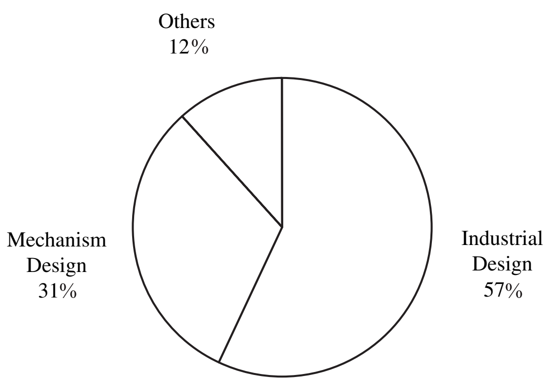

Figure 1 The ratio of job openings in three categories

Table 4 Classifications of recruiting qualifications

Category	Item	Qualification
Basic requirements	Education	Senior high school; college; university; graduate; not mentioned; abroad studies
	Age	Under 30; under 35; under 45; not mentioned
	Gender	Male; female; not mentioned
	Past experience	1–2 years; 3–5 years; 6–9 years; over 10 years; not mentioned
	Other experience	International working experience; managerial experience; can work independently; experience with a particular industry/product; interest to a particular industry/product
Competency requirements	Professional	3D graphic software; 2D graphic software; creativity and imagination; knowledge of molding tools or plastics injection; aesthetic discipline; sketching and ideation; popular messages and trends; new product planning and marketing; (clay) modeling
	General	Basic communication ability in English; fluency in English; can communicate, coordinate, organize; international views

software ability, creativity and imagination. Nearly 55% of the total expect applicants to have 3D graphic software ability and 51% expect communication ability in English. In addition to professional and general competencies, applicants' personality and attitudes, such as

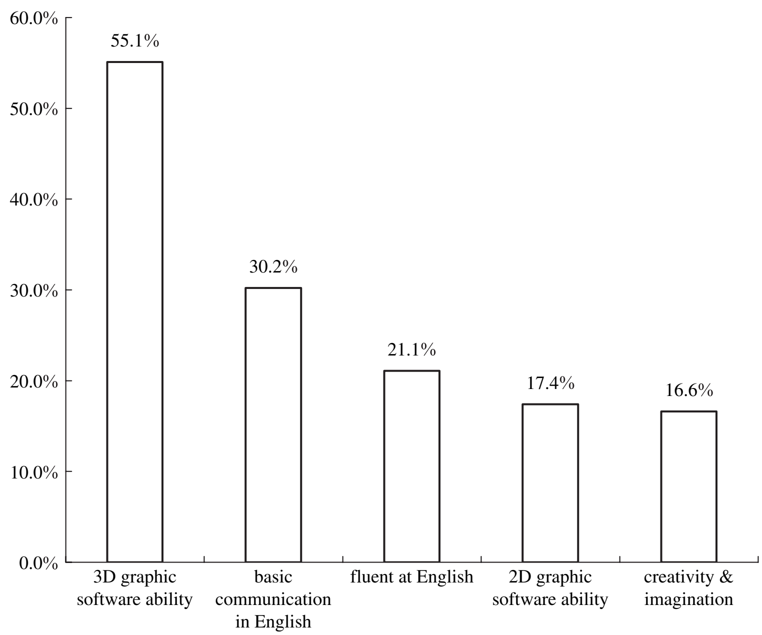

Figure 2 The top five competencies for the overall ID profession

active, aggressive and optimistic (10.6%); able to travel to China or abroad (7.2%); interested in and devoted to design (4.5%); and having team spirit (4.5%), etc. are also mentioned.

Table 5 summarizes recruiting qualifications for the overall ID profession in the right-hand column:

1) Education: except for concept researchers, a college or university degree is generally required.
2) 70.6% of the total have no age preference, 18.1% are limited to individuals under 35 years old. Those who apply for managers are preferred to be under 45 years old.
3) 93.2% prefer no particular gender, but 6% of the total prefer male.
4) Past experience: 1 to 2 years is generally preferred, but senior designers and managers generally require 3 to 5 years experience.
5) Other experience: experience with a particular industry or product is the most important; and the ability to work independently is the second.

2.2.3 *Comparisons of recruiting qualifications among the three job categories and 13 job titles*

The amount and ratio of the requirements for 13 job titles in the ID profession are listed in Appendix A and Appendix B. Table 5 compares the recruiting qualifications among three job categories in the subtotal columns:

1) Education: the groups of ID and Others generally request a college degree, whereas the MD group requests a university degree.
2) Age and gender preferred are not mentioned by any of the three categories.
3) The ID and MD groups request 1 to 2 years work experience, whereas Others request 3 to 5 years.
4) Other experiences: all three categories generally expect applicants to have experience with a particular industry or product.
5) Among the top three competencies requested, there are two professional competencies (3D and 2D graphic software abilities) requested by the ID group, and one general competency (basic communication ability in English). One professional competency (3D graphic software ability) and two general competencies (fluency in English and basic communications ability in English) are requested by the MD group. The Others request two general competencies (ability to communicate, coordinate and organize, as

Table 5 Comparative summary of recruiting qualifications

Item	Category	Industrial Design				Mechanism Design				Others								Total
	Job Title	ID	SID	DD	Subtotal	MD	SMD	MDD	Subtotal	PP	CR	DPM	IFD	PE	PDM	CAIDE	Subtotal	
Education		C	U	U	C	U	C/U	C	U	U	G	C/NM	U/G	C	C	NM	C	C
%		46.7	62.5	50	43.7	49.2	50ea	50	48.2	55.6	60	50ea	50 ea	100	100	33.3	32.3	42.3
Age		NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
%		64.4	87.5	62.5	65.6	69.2	91.7	66.7	72.3	66.7	100	100	100	100	100	100	90.3	70.6
Gender		NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
%		92.6	100	87.5	92.7	90.8	100	83.3	91.6	100	100	100	100	100	100	100	100	93.2
Past experience		1–2 years	3–5 years	1–2 years	1–2 years	1–2 years	3–5 years	3–5 years	1–2 years	3–5 years	NM	3–5 years	NM	1–2 years	1–2 years	3–5 years	3–5 years/NM	1–2 years
%		53.3	100	75	47.7	46.2	83.3	50	38.6	44.4	60	75	100	100	50	50	35.5ea	42.6
Other experience		PIPE		ME	PIPE	PIPE	PIPE	PIPE	PIPE	PIPE		ME	PIPE	PIPE	PIPE		PIPE	PIPE
%		22.2		50	21.2	43.1	75	66.7	49.4	55.6		100	50	33.3	50		25.8	30.6
Top competency		3D (61)	3D (75)	3D (50)	3D (60.9)	3D (55)	3D (75)	3D (33)	3D (56.6)	NP plan (33)	Sharp observe (80)	Coordinate (100)	3D, basic Eng., creativity, aesthetic, coordinate, international	Fluent Eng. (33)		3D (67)	Coordinate (35.5)	3D (55.1)
%		Basic Eng. (33) 2D (27)	2D (63) Basic Eng. (50)	Fluent Eng. (50) Basic Eng. (38)	Basic Eng. (34.4) 2D (29.1)	Basic Eng. (29)	Fluent Eng. (50)	Molding (33)	Fluent Eng (26.5) Basic Eng. (25.3) Fluent Eng. (67)	Fluent Eng. (22) Active (22)	Sketching (60)		Views (50 ea)	Basic Eng. (33)		Basic Eng. (33) Fluent Eng. (33)	Fluent Eng. (25.8)	Basic Eng. (30.) Fluent Eng. (21.1)

ID: Industrial Designer, SID: Senior Industrial Designer, DD: Design Director/Manager, MD: Mechanism Designer, SMD: Senior Mechanism Designer, MDD: Mechanism Design Director/Manager, PP: Product Planner, CR: Concept Researcher, DPM: Design Project Manager, IFD: Interface Designer, PE: Package Engineer, PDM: Package Design Manager, CAIDE: Computer Aided Industrial Design Engineer, C: college, U: university, G: graduate, NM: not mentioned, PIPE: particular industry /product experience, ME: managerial experience.

well as fluency in English). This shows that communication ability in English is a general competency commonly requested by all three categories, whereas 3D graphic software ability is a professional competency requested by both ID and MD groups.

The various qualifications generally requested by each of the 13 job titles are described in Appendix C. Table 5 compares the recruiting qualifications for the 13 job titles. Among the qualifications for the 13 job titles, the requirements for age and gender are similar, but education, past experience and other experience are slightly different. Referring to the top three competencies required by the various titles, industrial designers (ID), senior industrial designers (SID), design directors/managers (DD), mechanism designers (MD), senior mechanism designers (SMD), interface designers (IFD) and CAID engineers (CAIDE) all require 3D graphic software ability as the top competency. Similarly, 3D graphic software ability and basic communication ability in English are both required by ID, SID and DD. In addition, ID and SID request 2D graphic software ability, whereas DD requires more fluency in English to communicate with international clients. MD, SMD and MDD request 3D graphic software ability. The particular competency requested by the Others group depends on different job titles. For example, CAID engineers request 3D graphic software ability, concept researchers require skills of sketching and ideation, and product planners request skills for new product planning and marketing.

2.2.4 Comparisons of overall qualifications between in-house design departments and design houses

Figure 3 shows that job openings in the ID profession in Taiwan are largely from IHDs (82%), which is different from the situation in the

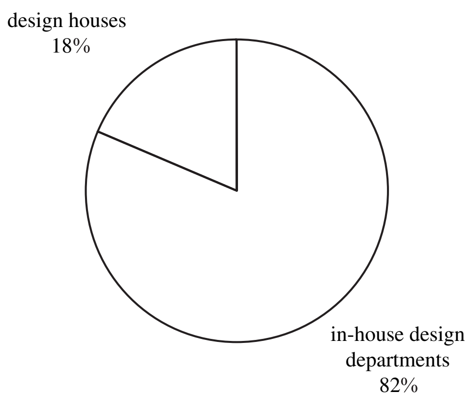

Figure 3 The ratio of job openings for IHDs and DHs

Table 6 Comparisons of recruiting qualifications between in-house design departments and design houses

Item	Industry	In-house Design Departments				Design Houses				Total
	Job Category	ID	MD	Others	Subtotal	Feminity ID	MD	Others	Subtotal	
		118 44.5%	74 27.9%	24 9.1%	216 81.5%	33 12.5%	9 3.4%	7 2.6%	49 18.5%	265 100%
Education		C	U	C	C/U	C	NM	NM	C	C
%		42.4	50	33.3	41.7/41.2	48.5	66.7	57.1	44.9	42.3
Age		NM	NM	NM	NM	NM	NM	NM	NM	NM
%		61.9	70.3	87.5	67.6	78.8	88.9	100	83.7	70.6
Gender		NM	NM	NM	NM	NM	NM	NM	NM	NM
%		90.7	90.5	100	91.7	100	100	100	100	93.2
Past experience		1–2 years	1–2 years	NM	1–2 years	NM	NM	3–5 years	NM	1–2 years
%		52.5	40.5	37.5	46.3	36.4	44.4	57.1	36.7	42.6
Other experience		PIPE	PIPE	PIPE	PIPE	PIPE	WI	ME	WI 12.2	PIPE
%		22	55.4	33.3	34.7	18.2	22.2	42.9	PIPE 12.2	30.6
Top 3 competency		3D (57.6)	3D (54.1)	Basic Eng. (25)	3D (50.9)	3D (72.7)	3D (77.8)	3D (71.4)	3D (73.5)	3D (55.1)
%		Basic Eng. (34.7)	Fluent Eng. (28.4)	Fluent Eng. (25)	Basic Eng. (31)	2D (51.5)	Molding (44.4)	Coordinate (57.1)	2D (38.8)	Basic Eng. (30.2)
		2D (22.9)	Basic Eng. (27)	Coordinate (20.8) NP plan (20.8)	Fluent Eng. (23.1)	Creativity (36.4)	Active (33.3)	Active (28.6)	Creativity (32.7)	Fluent Eng. (21.1)

C: college; U: university; G: graduate; NM: not mentioned; PIPE: particular industry/product experience; ME: managerial experience; WI: work independently.

European and U.S. design industry. Table 6 compares the overall qualifications between IHDs and DHs as follows:

1) Basic requirements:
   a) Education: IHDs generally request a college/university degree, and 8.8% of the IHD jobs even request a graduate degree, whereas DHs generally require a college degree or do not mention it. Thus, it seems that IHDs place more emphasis on level of education.
   b) Age: age is not indicated by two thirds of IHD and DH jobs.
   c) Gender: gender preferred is not mentioned by over 90% of IHD and DH jobs.
   d) Past experience: IHDs generally request 1 to 2 years, whereas it is generally not mentioned by DHs.
   e) IHDs generally prefer experience with the particular industry or product, whereas DHs generally request the same experiences as above, plus the ability to work independently.
2) Required Competencies: the top three rankings for DHs are all professional competencies, such as 3D and 2D graphic software abilities, creativity and imagination; whereas for IHDs, in addition to 3D graphic software ability, the verbal skills of basic communication ability in English and fluency in English rank second and third, respectively. It seems that IHDs also emphasize more on applicants' general competencies.

2.2.5 Comparisons of qualifications for each job category between in-house design departments and design houses

The amount and ratio of competency requirements for each job category between in-house design departments and design houses are listed in Appendix D. Table 6 shows the comparisons of qualifications for each job category between in-house design departments and design houses:

1) ID group: both IHDs and DHs request a college degree; age and gender are generally not mentioned by either; IHDs request 1 to 2 years work experience, whereas it is generally not mentioned by DHs; both request experience with the particular industry or product. Among the top three competencies requested, in addition to 3D and 2D graphic software abilities—which are required by both IHDs and DHs, IHDs request basic communication ability in English, whereas DHs request creativity and imagination.

2) MD group: IHDs request a university degree, whereas it is generally not mentioned by DHs; age and gender are not generally mentioned by either; IHDs request 1 to 2 years experience, whereas it is generally not mentioned by DHs; IHDs request experience with the particular industry or product, whereas DHs request the ability to work independently. Among the top three competencies requested, in addition to 3D graphic software ability, which is requested by both IHDs and DHs; IHDs request fluency in English and basic communication ability in English, whereas DHs request knowledge of molding tools or plastics injection, as well as active, aggressive and optimistic personality.
3) Others group: IHDs request a college degree, whereas it is generally not mentioned by DHs; age and gender are generally not mentioned by either; DHs request 3 to 5 years work experience, whereas this is generally not mentioned by IHDs; IHDs request experience with the particular industry or product, whereas DHs prefer managerial experience. Among the top three competencies requested, in addition to ability to communicate, coordinate and organize, which is requested by both IHDs and DHs; IHDs request fluency in English, basic communication ability in English, and knowledge of new product planning and marketing, whereas DHs request 3D graphic software ability, as well as active, aggressive and optimistic personality.

Based on the above comparisons, it is found that the qualifications for each job category differ between IHDs and DHs. The former seems to place more emphasis on applicants' general competency, whereas the latter values their professional competency more.

3 Discussion

3.1 Implication for industrial design practice

For the technological and vocational trends, does the development of ID practice tend towards integration or specialization? Sethia (2001) claims that a higher level of design roles, Generative Design, is emerging because the nature of design profession tends to integration, which enables it to play a critical and active role in the product development. However, according to the discoveries of this study, some large companies have divided the ID function into specialization based on different design tasks in the product development process. For example, the BenQ group has set up a Center for Digital Fashion Design to recruit ID talent, including the titles of design researcher, design project manager, ID leader, CAID designer, industrial designer, mechanism designer, package designer, 3D/2D animation/computer graphic designer, human factor researcher, user interface specialist, etc. The Acer group has established the Value Lab, dividing the ID function into concept development, product design, mechanism design and tooling management to recruit the titles of concept researcher, industrial designer, mechanism design engineer, design project manager, etc.

Therefore, the ID practice has developed toward both integration and specialization, and one of the influential factors is the scale of corporations. Due to their limited resources of manpower and cost, small companies tend to integrate and expect designers being fully responsible for the concept design at the beginning, as well as for the detailed design at the final stage. However, on the other hand, large companies, particularly the high tech industry, consider the increasingly complex technology and demanding awareness of consumers, and realize that there are needs to be devoted to design research in order to understand user needs. In other words, large companies utilize the specializations of concept research, mechanism design, interface design, interaction design, CAID, etc. to introduce more user-friendly products or systems. In addition, Press and Cooper (2003) propose that a new designer in the 21st century will need to fulfill the roles of intelligent maker, knowledge worker, sustainable entrepreneur, and active citizen concerned with issues of environment, society, commerce, network communication, etc. The expected roles that designers will play in the 21st century need to be incorporated into design education.

3.2 Implication for design education

Inevitably, the continuous transformations of new technology and the product development process have stimulated the development for design practice, so design education needs to be reviewed and updated periodically. For example, this study found that 55.1% of job openings request applicants with ability in 3D graphic software; so schools may decrease the ID students' training in drawing renderings and making sophisticated models since they are being replaced by computers (Yen, 2002). In addition to professional knowledge and skills, employers also value applicants' general competencies, such as abilities to communicate, coordinate and organize, the ability to communicate in English, with experience of studying or living abroad, having international views, etc. in order to respond to globalization. Moreover, personality and attitudes such as being active, aggressive and optimistic; enthusiastic with a sense of responsibility; interested in and devoted to design; and the ability to travel abroad are additional expectations for job applicants. In addition to emphasis on the training of knowledge and skills, developing the personalities of caring and daring in students could motivate them to solve real problems for human beings in innovative ways (Ratner, 1998).

Design educators are not able to predict the possibilities of technology. Therefore, it is necessary to emphasize the design process based on the inquiry approach and continuous learning of new knowledge and skills for design students in order for them to adapt to these changes. In particular, there should be greater emphasis on the process and regarding products as media instead of a final purpose. The role of industrial design in the product development process has changed and extended. Therefore, ID education today should not simply emphasize form giving, drawing and model making, and should place more value on the design process of inquiry based and conscious problem solving (Friedman, 2000). On one hand, due to the rapid development of technology, 50% of what we teach today will be out-of-date in five years (Schön, 1988). The skills that students are learning in schools today will be out-of-date when they are employed (Kumar, 2003). As Swanson (2000) claims, 'the design students of today will be the inventors of the design field of tomorrow.' On the other hand, approximately 70% of the competencies of industrial designers are acquired through the on-the-job experience (Lin, 1995). Shaw (Kumar, 2003) expects the industry to adapt so that the graduates have general competencies and would learn most professional skills once they are employed. Above all, the goal of educating design students in universities is to cultivate their abilities in problem solving, lifelong learning (Kumar, 2003) and reflective thinking (Schön, 1988), so they will be better able to adapt to future changes and challenges.

The debate whether designers should be educated as generalists or specialists still goes on without a conclusion. Two design programs demonstrate different educational approaches. The School of Design at Carnegie Mellon University in the U.S. (http://www.cmu.edu/cfa/design/) is one example of the generalist-oriented programs, whereas the ID department at Technische Universiteit Eindhoven (TU/e) in the Netherlands (http://www.industrialdesign.tue.nl/) is a prototype for the specialist-oriented model. By multiple general curricula and the interdisciplinary collaboration with the departments of engineering, management, and social science on campus (Buchanan, 2000), the former may educate design students to have a higher level of design expertise, Generative Design. The latter is based on the educational goals of 'competency-based learning' and 'student as a junior employee'. It enables students to learn within a simulated professional environment by executing specific design projects and intensive contacts with the industry, such as co-op programs, internship and inviting professional designers to teach on campus (Vinke, 2002). No matter which educational model is chosen, it is necessary to provide sufficient information and guidance to students for their career planning and decision-making.

3.3 Implication for student career guidance

The results show that the job market does provide extensive job opportunities for ID graduates. For example, 43% of the job openings can be classified as Mechanism Design and Others groups (planning, project management, interface design, package engineering, CAID, etc.). Additionally, students from both general and vocational high schools with various backgrounds might have different learning approaches, personalities, interests, aptitudes, and capabilities. After entering an ID program to take multiple courses and to understand different design tasks in the product development process, students' career paths might vary considerably. The standard criteria to assess the students' abilities in creativity, form giving and model making for the ID students in traditional design studios should be reconsidered. Branham (1999) stated, 'student-centered learning will become the dominant pedagogy in design education in the first quarter of the 21st century.' Encouraging students to self-direct their own learning and choose their desired design role as a career would be a better approach to design education.

Design educators need to take more responsibility to update their knowledge about the professional world in order to help students to prepare for the transition from school to work (Ball, 2002). This includes helping students to explore their own aptitudes, talents and interests and to understand the job titles for the ID practice in order to better prepare for future employment. Information about design job openings in the employment market, such as the recruiting qualifications of the 13 job titles in the ID profession shown in Appendix C, can help students to understand the qualifications for the various design tasks, to plan their own design careers as early as possible, and to plan ahead for courses in order to develop competencies needed for future employment. Furthermore, design graduates need to note that, in addition to the term 'industrial designer,' the job titles for the ID practice include the words of 'product/merchandise,' 'development,' 'form,' 'three dimensional,' 'appearance,' 'creative,' etc., positioning as designers or engineers. ID students come from diverse backgrounds with various aptitudes and there are extensive employment opportunities for the ID profession; so guiding students to plan their career is essential. Providing students with sufficient information about curricula and career development before they enter universities is also essential. Then, guiding them to better understand their own abilities, the job opportunities and the matches between them after they enter universities is also necessary. Encouraging students to find potential opportunities within the extensive ID practice, and further reach the goal of 'putting eligible talents with suitable aptitudes in the right jobs' is an ultimate ideal.

4 Conclusions

This study collected 265 job opportunities for analysis. Further studies may be conducted over a longer period of time and a wider spectrum of media to collect more data. Notably, it is advisable to increase the amount of samples from design houses or other job categories, such as design promotion or design education, in order to assure the data validity. Even so, the results not only enable the design professional to better understand the employment opportunities and the required competencies for various design jobs in the product development process, but also helps design educators to consider whether or not curricula can match the developmental trend for industry and satisfy individual students' needs. On the other hand, the findings can encourage students to prepare better for their future during the school period, such as planning their career in advance and equipping their skills via course selection. Some useful findings are summarized as follows:

1) The employable job titles for the ID practice include not only the term 'industrial designer,' but also the words of 'product/merchandise,' 'development,' 'form,' 'three dimensional,' 'appearance,' 'creative' designers or engineers. A total of 265 job opportunities in the industrial design profession grouped into 13 job titles are classified into three categories: a) 57% are for the Industrial Design (ID) group: including industrial designer, senior industrial designer, and design director/manager. b) 31.3% are for the Mechanism Design (MD) group: including mechanism designer, senior mechanism designer, and mechanism director/manager. c) 11.7% are for Others: including planning, management, interface, package and CAID, etc. In other words, 43% of the job openings can be classified into the Mechanism Design and Others groups, indicating that the

job market does provide extensive job opportunities for ID graduates.

2) The recruiting qualifications are classified into basic requirements (educational background, age, gender and past experience preferred) and required competencies (professional and general skills, personality and attitudes). The top five competencies for the overall ID profession as follows: 3D graphic software ability, basic communication ability in English, fluency in English, 2D graphic software ability, creativity and imagination. Communication ability in English is a general competency commonly requested by all three categories, whereas 3D graphic software ability is a professional competency requested by both ID and MD groups.
3) Job openings in the ID practice in Taiwan are largely from the in-house design departments (82%), which differs from the situation in the European and U.S. design industry. The in-house design departments place more emphasis on level of education and require less professional competencies. Design houses value applicants' professional competency more and expect them able to work independently.
4) The qualifications for each job category vary depending on the design roles at each stage of the product development process and the different levels of design manpower, such as junior designers, senior designers and design managers. Large companies, particularly the high tech industry, have divided the ID function into the specializations of concept research, mechanism design, interface design, interaction design, CAID, etc. in order to design more user-friendly products.
5) The job market does provide extensive employment opportunities, so the career choices for ID students are diverse. Helping students to understand their own aptitudes, interests and specialties, as well as the available jobs in the ID profession is essential. No matter whether design students are educated as generalists or specialists, they should become lifelong learners and reflective practitioners in order to adapt to the changes and challenges in the future.

Acknowledgements

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Appendix A. The amount and ratio of basic requirements for 13 job titles in the ID profession

Item	Job Title	ID 135 51%	SID 8 3%	DD 8 3%	MD 65 24.5%	SMD 12 4.5%	MDD 6 2.3%	PP 9 3.4%	CR 5 1.9%	DPM 4 1.5%	IFD 2 0.8%	PE 3 1.1%	PDM 2 0.8%	CAIDE 6 2.3%	Total 265 100%
Education															
Senior high school		8	0	0	0	0	0	0	0	0	0	0	0	0	8 3.0%
College		63	1	2	27	6	3	1	0	2	0	3	2	2	112 42.3%
University		40	5	4	29	6	2	5	2	0	1	0	0	0	94 35.5%
Graduate		10	1	2	3	0	1	0	3	0	1	0	0	0	21 7.9%
Not mentioned		14	1	0	6	0	0	3	0	2	0	0	0	4	30 11.3%
Abroad studies		7	1	0	0	0	1	2	1	3	0	1	0	0	16 6.0%
Age															
Under 30		8	0	0	2	0	0	0	0	0	0	0	0	0	10 3.8%
Under 35		30	0	0	14	1	0	3	0	0	0	0	0	0	48 18.1%
Under 45		10	1	3	4	0	2	0	0	0	0	0	0	0	20 7.5%
Not mentioned		87	7	5	45	11	4	6	5	4	2	3	2	6	187 70.6%
Gender															
Male		8	0	1	6	0	1	0	0	0	0	0	0	0	16 6.0%
Female		2	0	0	0	0	0	0	0	0	0	0	0	0	2 0.8%
Not mentioned		125	8	7	59	12	5	9	5	4	2	3	2	6	247 93.2%

(*continued*)

Appendix A (*continued*)

Item	Job Title	ID 135 51%	SID 8 3%	DD 8 3%	MD 65 24.5%	SMD 12 4.5%	MDD 6 2.3%	PP 9 3.4%	CR 5 1.9%	DPM 4 1.5%	IFD 2 0.8%	PE 3 1.1%	PDM 2 0.8%	CAIDE 6 2.3%	Total 265 100%
Past experience															
1–2 years		72	0	0	30	1	1	3	1	0	0	3	1	1	113 42.6%
3–5 years		22	8	6	17	10	3	4	1	3	0	0	0	3	77 29.0%
6–9 years		0	0	1	0	0	1	0	0	0	0	0	0	0	2 0.8%
Over 10 years		0	0	1	0	0	1	0	0	0	0	0	0	0	2 0.8%
Not mentioned		41	0	0	18	1	0	2	3	1	2	0	1	2	71 26.8%
Other experience															
International working experience		1	0	1	0	1	1	0	0	0	0	0	0	0	4 1.5%
Managerial experience		0	0	4	0	1	3	0	0	4	0	0	0	0	12 4.5%
Can work independently		5	0	0	6	4	0	2	0	2	0	0	0	0	19 7.2%
Experience to particular industry/product		30	0	2	28	9	4	5	0	0	1	1	1	0	81 30.6%
Interest to particular industry/product		8	0	0	6	0	0	0	0	0	0	0	0	0	14 5.3%

Appendix B. The amount and ratio of competency requirements for 13 job titles in the ID profession

Item	Job Title	ID 135	SID 8	DD 8	MD 65	SMD 12	MDD 6	PP 9	CR 5	DPM 4	IFD 2	PE 3	PDM 2	CAIDE 6	Total 265 100%
3D graphic software		82	6	4	36	9	2	0	1	1	1	0	0	4	146 55.1%
Basic communication ability in English		45	4	3	19	2	0	1	1	1	1	1	0	2	80 30.2%
Fluent at English		20	2	4	12	6	4	2	2	1	0	1	0	2	56 21.1%
2D graphic software		37	5	2	2	0	0	0	0	0	0	0	0	0	46 17.4%
Creativity and imagination		30	3	1	4	1	1	1	1	1	1	0	0	0	44 16.6%
Can communicate, coordinate, organize		17	2	2	3	4	0	1	2	4	1	0	0	1	37 14%
Active, aggressive, optimistic		16	0	0	3	4	1	2	0	1	0	0	0	1	28 10.6%
Knowledge of molding tool or plastics injection		7	0	0	12	4	2	0	0	0	0	0	0	1	26 9.8%
Aesthetic discipline		14	3	0	1	0	0	0	1	1	1	0	0	0	21 7.9%
Can travel to China or abroad		12	0	2	2	1	1	0	0	0	0	0	0	1	19 7.2%
Sketching and ideation		13	1	0	0	0	0	0	3	0	0	0	0	0	17 6.4%
Interested in and devoted to design		11	0	0	1	0	0	0	0	0	0	0	0	0	12 4.5%
Team spirit		7	2	0	1	0	0	1	1	0	0	0	0	0	12 4.5%
Enthusiastic with sense of responsibility		8	0	0	1	0	0	1	0	1	0	0	0	0	11 4.2%

(*continued*)

Appendix B (*continued*)

Item	Job Title	ID 135	SID 8	DD 8	MD 65	SMD 12	MDD 6	PP 9	CR 5	DPM 4	IFD 2	PE 3	PDM 2	CAIDE 6	Total 265 100%
Willing to learn and be diligent		9	0	0	0	0	0	0	0	0	0	0	0	1	10 3.8%
International views		5	2	0	0	0	0	0	1	1	1	0	0	0	10 3.8%
Popular massages and trends		6	1	0	0	0	0	1	0	1	0	0	0	0	9 3.4%
High EQ with sharp observation		4	0	0	0	0	0	0	4	0	0	0	0	0	8 3.0%
New product planning and marketing		3	0	0	0	0	0	3	2	0	0	0	0	0	8 3.0%
(Clay) modeling		6	0	0	0	0	0	0	0	0	0	0	0	0	6 2.3%

Appendix C. The various qualifications generally requested by each of the 13 job titles

1) Industrial Designer (ID): college degree; 1 to 2 years work experience; experience with the particular industry or product preferred. The top three competencies generally requested are 3D graphic software ability, basic communication ability in English, and 2D graphic software ability.
2) Senior Industrial Designer (SID): university degree; 3 to 5 years experience. The top three competencies generally requested are familiarity with 3D graphic software and 2D graphic software, and basic communication ability in English.
3) Design Director/Manager (DD): university degree; 3 to 5 years experience; managerial experience is preferred. The top three competencies generally requested are 3D graphic software ability, fluency in English, and basic communication ability in English.
4) Mechanism Designer (MD): university degree; 1 to 2 years experience; experience with the particular industry or product is preferred. The top competencies generally requested are 3D graphic software ability, basic communication ability in English, knowledge of molding tools or plastics injection, and fluency in English.
5) Senior Mechanism Designer (SMD): college/university degree (50% each); 3 to 5 years work experience; experience with the particular industry or product is preferred. The top competencies generally requested are 3D graphic software ability, fluency in English; knowledge of molding tools or plastics injection; active, aggressive and optimistic personality; ability to communicate, coordinate and organize.
6) Mechanism Design Director/Manager (MDD): college degree; 3 to 5 years work experience; experience with the particular industry or product is preferred. The top three competencies generally requested are fluency in English, 3D graphic software ability, and knowledge of molding tools or plastics injection.
7) Product Planner (PP): university degree; 3 to 5 years experience; experience with the particular industry or product is preferred. The top three competencies generally requested are new product planning and marketing; fluency in English; active, aggressive and optimistic personality.
8) Concept Researcher (CR): graduate degree. The top competencies requested are high EQ with sharp observation; sketching and ideation abilities; new product planning and marketing abilities;

fluency in English; and the ability to communicate, coordinate and organize.

9) Design Project Manager (DPM): college degree/not mentioned (50% each); 3 to 5 years experience; managerial experience is preferred. The top competency generally requested is the ability to communicate, coordinate and organize.
10) Interface Designer (IFD): university/graduate degree (50% each); experience with the particular industry or product is preferred. The top competencies generally requested are 3D graphic software ability; creativity and imagination; aesthetic discipline; basic communication ability in English; ability to communicate, coordinate and organize; and international views.
11) Package Engineer (PE): college degree; 1 to 2 years experience; experience with the particular industry or product is preferred. The top two competencies generally requested are fluency in English and basic communication ability in English.
12) Package Design Manager (PDM): college degree; 1 to 2 years work experience; experience with the particular industry or product is preferred. No competency requested is mentioned.
13) CAID Engineer (CAIDE): 3 to 5 years work experience is preferred. The top three competencies generally requested are 3D graphic software ability, fluency in English, and basic communication ability in English.

Appendix D. The amount and ratio of competency requirements for three job categories between in-house design departments and design houses

Item	Organization	In-house Design Department				Design House			
	Job Category	ID	MD	Others	Subtotal	ID	MD	Others	Subtotal
	Amount	118	74	24	216	33	9	7	49
	Ratio	44.5%	27.9%	9.1%	81.5%	12.5%	3.4%	2.6%	18.5%
Professional competencies									
3D graphic software		68	40	2	110	24	7	5	36
		57.6%	54.1%	8.3%	50.9%	72.7%	77.8%	71.4%	73.5%
2D graphic software		27	0	0	27	17	2	0	19
		22.9%	0%	0%	12.5%	51.5%	22.2%	0%	38.8%
Creativity and imagination		22	3	3	28	12	3	1	16
		18.6%	4.1%	12.5%	13.0%	36.4%	33.3%	14.3%	32.7%
Knowledge of molding tool or plastics injection		6	14	0	20	1	4	1	6
		5.1%	18.9%	0%	9.3%	3%	44.4%	14.3%	12.2%
Aesthetic discipline		9	0	2	11	8	1	1	6
		7.6%	0%	8.3%	5.1%	24.2%	11.1%	14.3%	20.4%
Sketching and ideation		9	0	3	12	5	0	0	5
		7.6%	0%	12.5%	5.6%	15.2%	0%	0%	10.2%
Popular messages and trends		6	0	1	7	1	0	1	2
		0%	4.2%	3.2%	3%	0%	14.3%	4.1%	
New product planning and marketing		2	0	5	7	1	0	0	1
		1.7%	0%	20.8%	3.2%	3%	0%	0%	2%
(Clay) modeling		2	0	0	2	4	0	0	4
		1.7%	0%	0%	0.9%	12.1%	0%	0%	8.2%
General competencies									
Basic communication in English		41	20	6	67	11	1	1	13
		34.7%	27.0%	25%	31%	33.3%	11.1%	14.3%	26.5%
Fluent at English		23	21	6	50	3	1	2	6
		19.5%	28.4%	25.0%	23.1%	9.1%	11.1%	28.6%	12.2%
Can communicate, coordinate, organize		13	5	5	23	8	2	4	14
		11%	6.8%	20.8%	10.6%	24.2%	22.2%	57.1%	28.5%
International views		6	0	3	9	1	0	0	1
		5.1%	0%	12.5%	4.2%	3.0%	0%	0%	2%

(*continued*)

Appendix D (*continued*)

Item	Organization	In-house Design Department				Design House			
	Job Category	ID	MD	Others	Subtotal	ID	MD	Others	Subtotal
	Amount	118	74	24	216	33	9	7	49
	Ratio	44.5%	27.9%	9.1%	81.5%	12.5%	3.4%	2.6%	18.5%
Personality and attitudes									
Active, aggressive, and optimistic		8	5	2	15	8	3	2	13
		6.8%	6.8%	8.3%	6.9%	24.2%	33.3%	28.6%	26.5%
Can travel to China or abroad		9	4	0	13	5	0	1	6
		7.6%	5.4%	0%	6%	15.2%	0%	14.3%	12.2%
Interested in and devoted to design		6	0	0	6	5	1	0	6
		5.1%	0%	0%	2.8%	15.2%	11.1%	0%	12.2%
Team spirit		6	1	2	9	3	0	0	3
		5.1%	1.4%	8.3%	4.2%	9.1%	0%	0%	6.1%
Enthusiastic with sense of responsibility		2	0	1	3	6	1	1	8
		1.7%	0%	4.2%	1.4%	18.2%	11.1%	14.3%	16.3%
Willing to learn and be diligent		7	0	0	7	2	0	1	3
		5.9%	0%	0%	3.2%	6.1%	0%	14.3%	6.1%
High EQ with sharp observation		3	0	4	7	1	0	0	1
		2.5%	0%	16.7%	3.2%	3%	0%	0%	2%

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