MNC-Sponsored Multidisciplinary Industrial-Strength Capstone Design Projects in China

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Abstract

With a growing need to reform Chinese higher engineering education, University of Michigan—Shanghai Jiao Tong University Joint Institute (JI) initiated multinational corporation-sponsored industrial-strength Capstone Design Projects (CDP) in 2011. Since 2011, JI has developed 96 corporate-sponsored C DPs since its inception, which include multinational corporation sponsors such as Covidien, Dover, GE, HP, Intel, NI, Philips, and Siemens. Of these projects, healthcare accounts for 27%, energy 24%, internet technology (IT) 22%, electronics 16%, and other industries 11%. This portfolio reflects the trends and needs in the industry, which provides opportunities for engineering students to develop their careers. An accumulated 480 JI students have been teamed up based on their individual backgrounds, specifically electrical engineering, computer engineering, computer science, mechanical engineering, and biomedical engineering. The corporate-sponsored rate grew from 0% in 2010 to 86% in 2014.

Keywords: Multinational corporation (MNC), multidisciplinary, capstone design projects (CDP), electrical engineering, computer engineering, computer science, mechanical engineering, biomedical engineering, healthcare, energy, internet technology (IT), and electronics.

1. Introduction

1.1. International Higher Education Development in China

With the increasing demands of global economy in the 21st century, there has been a trend of foreign university campuses being inaugurated into China, including the University of Nottingham Ningbo China, Xi'an Jiaotong-Liverpool Univeristy, Duke Kunshan Univeristy, and New York University Shanghai. In addition, the growing needs of reforming Chinese higher education spurred the establishment of numerous joint ventures between American prestigious universities and top-tier Chinese universities, including the Joint Institute between University of Michigan (UM) and Shanghai Jiao-Tong University (SJTU), the Joint Engineering Institute between University of Pittsburgh and Sichun University, and the Joint Institute of Engineering between Sun Yat-Sen University and Carnegie Mellon University. Therefore, with the interest of foreign universities, this is a great opportunity for China to learn from these international institutes and eventually reform its own higher education system.

1.2. University of Michigan—Shanghai Jiao-Tong University Joint Institute

The mission of the UM—SJTU Joint Institute (JI) is to establish a leading international research institute which educates innovative future leaders and to construct a model university which emulates a successful UM experience. In March 2014, eight years after JI was founded, it received the Andrew Heiskell Award, the highest honor in international higher education. This was the first time a Chinese university won the award. "An excellent example of a successful, mature, and sustainable partnership," remarked Daniel Obst, Deputy Vice-President of International Partnerships, Institute of International Education (IIE) [1], [2].

1.3. International Engineering Programs

JI offers both undergraduate and graduate educational programs focusing on area of Electrical and Computer Engineering (ECE) and Mechanical Engineering (ME). Collaborating with UM and SJTU allows JI to run numerous programs. JI accepts about 250 students each year. Of them, 150 students (60%) are pursuing the SJTU degree and staying in Shanghai for four years. The other 100 students enrolled into the Dual-Degree Program (DDP) study in Shanghai for the first two years and then the College of Engineering (CoE) or the College of Literature, Science, and the Arts (LSA) at UM for the last two years. Most of the DDP students choose CoE which offers 15 undergraduate engineering programs, such as electrical engineering (EE), computer engineering (CE), computer science (CS), and biomedical engineering (BME) [3].

1.4. Design-Based Capstone Courses in the US and China

The Capstone Design Projects (CDP) is an undergraduate project-based capstone course required for all JI seniors. JI's CDP combines two courses, Major Design Experience (VE450) and Design and Manufacturing III (VM450), into a single one. VE450 is required for ECE students, whereas VM450 is for ME students. The course mission of CDP is to help students to innovate and to apply seemingly fragmented engineering knowledge acquired at JI to the design and/or manufacturing of real-world multidisciplinary engineering systems, including EE, CE, CS, ME, and BME [4]. JI offers a CDP course in the summer semester and another one in the fall. The average class size for each semester is 120 students divided into 24 teams. The students are taught by four CDP faculties.

In contrast to JI's newly four-year (2011-2014) CDP development, CDP education has been ubiquitous in the US, and increasingly, in major universities around the world. Two reasons: First, Accreditation Board for Engineering and Technology, Inc. (ABET) accreditation requires undergraduate students have such a practical knowledge integration experience. ABET points out "a major design experience based on the knowledge and skills acquired in earlier course work and incorporating appropriate engineering standards and multiple realistic constraints.'[5] Second, a strong sense is present among academic educators/administrators and industry stakeholders that graduates need to be better prepared at school for future industry challenges [6]. In addition, various CDP forums have been well developed throughout academic community around the world, primarily in the US. The Capstone Design Conference was held in the US in 2007, 2010, 2012, and 2014, providing a forum for the extended capstone design community. The purpose of the forum is to allow faculty, administrators, industry representatives, and students to share ideas about improving design-based capstone courses [7].

In recent CDP development in the US, J. Widmann et. al. points out why a current engineering graduate needs to have multiple disciplines knowledge and skills. In addition, he or she is able to work with teammates from a variety of disciplines in an interdisciplinary team fashion [8]. J. Estell et al. describes a 10-year continuous effort to increase the number of students engaged in multidisciplinary capstone design projects at Ohio Northern University [9]. K. Csavina1 et al. describes how Arizona State University Polytechnic campus creates the iProject approach as a mechanism to provide industry generated and funded projects [10]. T. Tayag points out Texas Christian University's capstone design program organizes a large team of 15-20 students function as a small business enterprise in order to incorporate engineering knowledge into the students' design experience [11].

Compared to the relatively innovative and mature CDP model in major universities around the world, the CDP structure in China is more traditional. In most cases, government funding project or faculty's idea is the primary source to sponsor a CDP in Chinese major universities, including top-tier Peking University, Tsinghua University, Shanghai Jiao-Tong University, and Fudan University. The scope of a CDP tends to focus more on in-depth knowledge and skills in one or two disciplines. After CDP's training, Chinese college graduates do not have enough experiences of exposing to what J. Widmann et. al. points out "recognizing the complexities of modern engineered products and systems." [8] Furthermore, it seems a long way to go for Chinese universities when comparing to ABET criteria 3(d) and (h): "an ability to function on multidisciplinary teams" and "the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context."[5]

1.5. The Idea

In 2010 when JI first launched a CDP course, all the projects were sponsored by its faculty. There was no any corporate sponsor at that time. Interestingly, the idea of initiating multinational corporation (MNC)-sponsored industrial-strength CDPs didn't come from the engineering capstone community in the US. It didn't come from the Capstone Design Conference hosted in the US or any other major US universities who are experienced in getting CDP corporate sponsorship either.

As a matter of fact, the idea of initiating MNC-sponsored CDPs was inspired by the concept of International Business Consulting Projects (IBCP) of International Business Education and Research (IBEAR) MBA Program at University of Southern California's (USC) Marshall School of Business and then brought into JI in 2011 [12]. There are two major differences between IBEAR's IBCP and JI's CDP. First, IBCP focuses on market research and business consulting, whereas CDP focuses on engineering design and prototype manufacturing. Second, each IBCP team is required an international travel period of two weeks to conduct in-depth interviews with customers and suppliers, while CDP is limited to domestic travel.

JI leadership realizes directing a MNC-sponsored CDP can be difficult for faculty members due to other teaching and research responsibilities, and often because of the multiple administrative tasks and business skills necessary to effectively initiate and maintain sponsor relationships [13]. In order to pursue external CDP growth initiatives and collaborate with MNCs, JI appointed a CDP faculty lead to serve as Faculty Director of Corporate Relations, who is responsible for making deals and maintaining relationships with MNCs.

2. Making Deals

2.1. Target Corporations in Shanghai

Positioned as the commercial and financial center of mainland China, Shanghai has, by the end of 2012, 1019 MNC headquarters and/or organizations, including 403 MNC headquarters, 265 foreign investment companies, and 351 foreign research and development (R&D) centers [14]. Situated in an advantageous location, Shanghai provides a globally unique environment which allows JI to reach out to world-class MNCs and promote the concept of developing industrial-strength CDPs. With very limited manpower and resources, JI targets at MNC R&D centers located in three industrial parks, including Zhangjiang High-Tech Park, Shanghai Zizhu High-Tech Industrial Park, and Caohejing High-Tech Park.

2.2. Marketing Strategies

There are numerous marketing strategies involved regarding getting a CDP sponsorship from the outside: push, pull, pull and push, and final events. The first marketing strategy is push which involves taking CDP services directly to a target corporation via whatever means. Nevertheless, push alone never works. Second, the next strategy is pull where an interest of collaborating with a university is created within a target corporation who demands a project service from the university. This pull strategy works when the university's brand is strong and the project development is mature. This one doesn't work in its early development stage.

Third, the pull and push strategy is one of the most effective strategies for securing a CDP sponsorship. That is, a corporate proactively approaches a university and shows an interest of collaboration. Then the CDP faculty lead follows up, promotes CDP, and communicates with the corporate decision maker. The majority of the successful JI CDP corporate deals was associated with the pull and push strategy, including Covidien, Dover, GE, HP, Logic Solutions, National Instruments, and Philips.

Last, hosting a final event is a powerful strategy for promoting CDP sponsorship. There are two types of final events at the end of each semester: Design Expo and Final Delivery. The Design Expo is held on campus, while Final Delivery is held within the sponsor corporate. The reason why JI made a deal with Intel and Siemens was because they visited Design Expo and witnessed students' performance. Final Delivery is where students demonstrate direct results. After the Final Delivery at Siemens in July 2013, Yucheng Tang, the R&D lead of Siemens Gas Turbine Engineering, China, commented, "We had a great journey enjoying the fruitful results from the CDP. Again, the results exceeded our expectations and pushed us to envision a higher level for the next phase. We witnessed innovation, dedication, and collaboration from both sides involving CDPs to confront real industrial challenges." This explains why Siemens have sponsored JI's CDP education for a consecutive three years.

2.3. Win/Win Mentality

When it comes to making deals with MNCs and creating a sustainable partnership, there is one thing above marketing strategies—having a win/win mentality. When entering a new business partnership, most people want to make sure they win first. Such thinking may work at once or twice, but it will not sustain the partnership. A win-win thinker, on the contrary, goes into a relationship and makes sure his or her business partner wins first. With this in mind, the two parties can win together many times [15], [16]. Win/win is the most important mentality university stakeholders should have, if they want to see a growing and sustainable CDP sponsorship.

2.4. Project Summary

Since 2011, JI has developed 96 corporate-sponsored CDPs since its inception. The project fields are diverse, including healthcare, energy, power & water, open-source software, mobile internet, wireless, electronics,

Table 1. Summary of 96 MNC-sponsored industrial-strength CDPs developed at JI (2011-2014)

Code	Year	Semester	Capstone Design Project Title	Corporate	Industry
A1	2011	Summer	Motion Quantification of Surgical Tools in Minimally Invasive Surgery	Covidien	Healthcare
A2	2011	Summer	Design and Synthesis of an Onmi-Directional Mobile Platform	Covidien	Healthcare
A3	2011	Summer	Realization of a 3D Display without Eyewear	Covidien	Healthcare
A4	2011	Summer	Design a Hand Rehabilitation Device for Ball-Grasp Training	Philips	Healthcare
A5	2011	Summer	Influence of Resonance Behavior on Mucus Clearance	Philips	Healthcare
A6	2011	Summer	A LabVIEW Based Smart Energy Management System	National Instruments	Energy
A7	2011	Summer	Monitoring and Controlling System of Air-conditioner	National Instruments	Energy
A8	2011	Summer	Development and Application of Wi-Fi Based Proximity Sensor Classmate PC	Intel	IT
A9	2011	Summer	Development of Wi-Fi Based Proximity Detection Demo System	Intel	IT
B1	2011	Fall	A Mockup Surgical Intervention System under Visual Guidance	Covidien	Healthcare
B2	2011	Fall	Design of Reusable Radio Frequency Ablation (RFA) Catheter for Chronic Venous Insufficiency	Covidien	Healthcare
B3	2011	Fall	Multiuse Fiber of Endovenous Laser Treatment for Chronic Venous Insufficiency	Covidien	Healthcare
B4	2011	Fall	Edutainment Community Development Based on Proximity Detection System	Intel	IT
B5	2011	Fall	Position Technology of Wi-Fi Based Proximity Detection Demo System	Intel	IT
C1	2012	Summer	Design of Multi-Use Fiber of Endovenous Laser Treatment for Chronic Venous Insufficiency	Covidien	Healthcare
C2	2012	Summer	Imaging Guided Laser Tissue Soldering for Minimally Invasive Surgery	Covidien	Healthcare
C3	2012	Summer	Design of One-Step Punctuating Device for Internal Jugular Vein	Covidien	Healthcare
C4	2012	Summer	GUI Test Automation by Image Recognition	Intel	IT
C5	2012	Summer	Video Codec Auto Testing	Intel	IT
C6	2012	Summer	Intelligence Control/Display Panel for Electric Vehicles	RIM/QNX	Auto
D1	2012	Fall	3D Reconstruction of Artificial Tissues Using Real-Time Ultrasound Images	Covidien	Healthcare
D2	2012	Fall	Stereo Display of 3D Object Reconstruction Using Ultrasound Images	Covidien	Healthcare
D3	2012	Fall	Ex-Vivo Experimental Verification of Designed Reusable Fiber for Endovenous Laser Treatment	Covidien	Healthcare
D4	2012	Fall	Mechanical Design of an Innovative Actuation System for Gas Turbines	Siemens	Energy
D5	2012	Fall	A Simulation System for Laser Hole Drilling Process	Siemens	Energy
D6	2012	Fall	Design of Knowledge Capture and Retrieval System Based on Social Network	Siemens	Energy
D7	2012	Fall	Equipment Recipe Network Integration	Dover	Electronics
D8	2012	Fall	Redesign of Transport Rail for SMT Print Machine	Dover	Electronics
D9	2012	Fall	Camera-Based GUI Test Automation by Image Recognition	Intel	IT
D10	2012	Fall	GUI Test Automation by Image Recognition (Phase 2)	Intel	IT
D11	2012	Fall	Video Codec Auto Testing (Phase 2)	Intel	IT
E1	2013	Summer	Design of Ablation Electrode to Enclosure Perforator	Covidien	Healthcare
E2	2013	Summer	Distal Dexterity Enhancement of Laparoscopic Electrosurgical Tools	Covidien	Healthcare
E3	2013	Summer	Study of Laser Tissue Ablation Mechanism Using a Nanosecond Pulsed Green Laser and a 980 nm Continuous Wave Laser	Covidien	Healthcare
E4	2013	Summer	Drawing and BOM (Bill of Material) Management Process for PSG (Pump Solutions Group) Shanghai	Dover	Industrial Eng.
E5	2013	Summer	Design of Hydro China Production Line for Sprite Series	Dover	Industrial Eng.
E6	2013	Summer	Air Cooling Media Design Optimization	GE	Energy

E7	2013	Summer	Design of Low-Scaling Home Reverse Osmosis System	GE	Water
E8	2013	Summer	Programmable Test Automation Solution for HP Laserjet	HP	Electronics
E9	2013	Summer	OpenCL Accelerated Face Detection	Intel	IT
E10	2013	Summer	FFT Implementation on OpenMAX DL	Intel	IT
E11	2013	Summer	In-Process CAM System Development for Laser Repairing of Gas Turbine Components	Siemens	Energy
E12	2013	Summer	An Innovative Actuator System for Gas Turbines (Phase 2)	Siemens	Energy
F1	2013	Fall	3D Reconstruction and Display of Artificial Tissues Using Real-Time Ultrasound Images	Covidien	Healthcare
F2	2013	Fall	Magnetically Anchored Stereo Vision Unit for Single Incision Laparoscopic Surgery (SILS)	Covidien	Healthcare
F3	2013	Fall	Photoacoustic Ultrasound (PAUS) for Co-Registered Imaging of Bone Structure and Vasculature	Covidien	Healthcare
F4	2013	Fall	Improvement of Design Workflow, Drawing Standards, Drawing and BOM Management	Giti Tire/Seyan	Industrial Eng.
F5	2013	Fall	Lubrication and Sealing System for High Speed Taper Roller Bearing (TRB) Pair on Gearbox	GE	Energy
F6	2013	Fall	Pre-Feasibility Analysis Software for GE 6FA CCHP (Combined Cooling Heating and Power)	GE	Energy
F7	2013	Fall	Plasma Drilling System	GE	Energy
F8	2013	Fall	Design of Low-Scaling Home Reverse Osmosis System (Phase 2)	GE	Water
F9	2013	Fall	Programmable Test Automation Solution for HP Laserjet (Phase 2)	HP	Electronics
F10	2013	Fall	Calibration Tool Improvement with Gamma Correction for HP LaserJet	HP	Electronics
F11	2013	Fall	Chinese Character Printing Quality Performance Evaluation for HP LaserJet	HP	Electronics
F12	2013	Fall	OpenCL Accelerated Face Detection (Phase 2)	Intel	IT
F13	2013	Fall	Guide Vanes Angle Detection & Control Method for Gas Turbine (Phase 3)	Siemens	Energy
F14	2013	Fall	UG (Unigraphics) PLM (Product Lifecycle Management) Application Study in Actuation Ring of Gas Turbine	Siemens	Energy
F15	2013	Fall	Development of an Optical Prototype System for Laser Drilling Breakthrough Detection with Illumination	Siemens	Energy
G1	2014	Summer	Rechargeable and Detachable Coil Delivery System	Covidien	Healthcare
G2	2014	Summer	Photoacoustic Ultrasound (PAUS) for Co-Registered Imaging of Bone Structure and Vasculature (Phase 2)	Covidien	Healthcare
G3	2014	Summer	Design Upgrade of Consumable Cartridge Filling Device	Dover	Electronics
G4	2014	Summer	Smart Monitoring for Obstructive Sleep Apnea	GE	Healthcare
G5	2014	Summer	Integrative Android/Hardware Design for Wireless Blood Pressure Meter	GE	Healthcare
G6	2014	Summer	Automatic Cooking Machine App Design Based on Android	GE	Electronics
G7	2014	Summer	Automatic Cooking Machine Structure Design	GE	Electronics
G8	2014	Summer	Portable Reverse Osmosis Machine	GE	Water
G9	2014	Summer	One-Page Mode Scan Solution for HP AiO LaserJet ADF (Auto-Document-Feeder)	HP	Electronics
G10	2014	Summer	Scanning Noise Recognition and Filter Solution for HP AiO (All-in-One) LaserJet	HP	Electronics
G11	2014	Summer	Scan Tilt Auto-Correction Solution for HP AiO LaserJet	HP	Electronics
G12	2014	Summer	Enablement and Revision of Portable Path in Android Compilers	Intel	IT
G13	2014	Summer	OpenCL Based Face Detection and Recognition Algorithm Tuning (Phase 3)	Intel	IT
G14	2014	Summer	Adaptive Video Encoding Based on OpenCL Face Recognition (Phase 3)	Intel	IT
G15	2014	Summer	Showcase Sales Mobile Contact Management Module	Logic Solutions	IT
G16	2014	Summer	Multi-Specimen Creep Test Rig Design for Siemens Gas Turbine	Siemens	Energy
G17	2014	Summer	Laser Engraving of Micro-Nano Structure to Enhance Coating	Siemens	Energy

			Interface Strength for Gas Turbine Component		
G18	2014	Summer	Inlet Guide Vane (IGV) Actuation Control System Integration (Phase 4)	Siemens	Energy
G19	2014	Summer	Compressor IGV Sealing Test Design	Siemens	Energy
G20	2014	Summer	Innovative Clutch Solution for Electronic Seat Belt	YFKSS	Auto
H1	2014	Fall	Automatic Video Object Tracking	AVD	IT
H2	2014	Fall	Bioprinter for Heterogeneous Biomedical Scaffold Fabrication	Covidien	Healthcare
H3	2014	Fall	Wireless Stethoscope	GE	Healthcare
H4	2014	Fall	Portable Reverse Osmosis Machine (Phase 2)	GE	Water
H5	2014	Fall	Simulation of Taper Roller Bearing Pumping Effect (Phase 2)	GE	Energy
H6	2014	Fall	Slipring Driving System on Vibration Test Rig	GE	Energy
H7	2014	Fall	Vector Information Pick Up from Tire Pattern Images	Giti Tire	Auto
H8	2014	Fall	Optical Character Recognition (OCR) for HP AiO LaserJet	HP	Electronics
H9	2014	Fall	Identity Recognition Based on HP Fingerprint Printer	HP	Electronics
H10	2014	Fall	Visualization of Scanning Process for HP AiO LaserJet	HP	Electronics
H11	2014	Fall	OpenCL GPU Accelerated Camera Smart Autofocusing on Intel Platform	Intel	IT
H12	2014	Fall	OpenCL GPU Accelerated Video Abstraction on Intel Platform	Intel	IT
H13	2014	Fall	Car Recognition with GPU Acceleration	Intel	IT
H14	2014	Fall	Automatic Processing Handling System for Valve Crosshead Manufacturing	Liming	Auto
H15	2014	Fall	Showcase Mobile Contact Management (Phase 2)	Logic Solutions	IT
H16	2014	Fall	An Off-Line Breakthrough Detection Approach of Laser Cooling Hole Drilling Process of Gas Turbine Blades	Siemens	Energy
H17	2014	Fall	An On-Line Thermal Imaging Approach for Thermal Coating Process of Gas Turbine Blades	Siemens	Energy
H18	2014	Fall	Miniature Model Design of Gas Turbine IGV Actuation System (Phase 5)	Siemens	Energy

appliance & lighting, 3D printing, and sales force management, etc. Table 1 shows a project summary of the 96 corporate-sponsored industrial-strength CDPs developed at JI during the period of 2011 to 2014.

2.5. Industry Portfolio

Fig. 1 demonstrates the industry portfolio of the 96 corporate-sponsored CDPs developed at JI during the 4-year period. Of these projects, healthcare accounts for 27%, energy 24%, internet technology (IT) 22%, electronics 16%, and other industries 11%. This portfolio reflects the trends and needs in the industry, which provides opportunities for engineering students to develop their careers. Over the past four years, an accumulated 480 JI students have been teamed up based on their individual backgrounds, specifically EE, CE, CS, ME, and BME. For example, a team of five for a healthcare project could comprise of students of different majors from BME, EE, and ME. Another team for an energy project could incorporate ECE and ME students. Depending on the project nature, a team for an electronics project may demand three or four ECE students with a couple ME students. Different from the three industries mentioned, an IT project prefers CS and ECE students who have quick learning abilities, Linux developing experiences, and strong programming skills, such as C/C++ and Java.

2.6. Growth Analysis

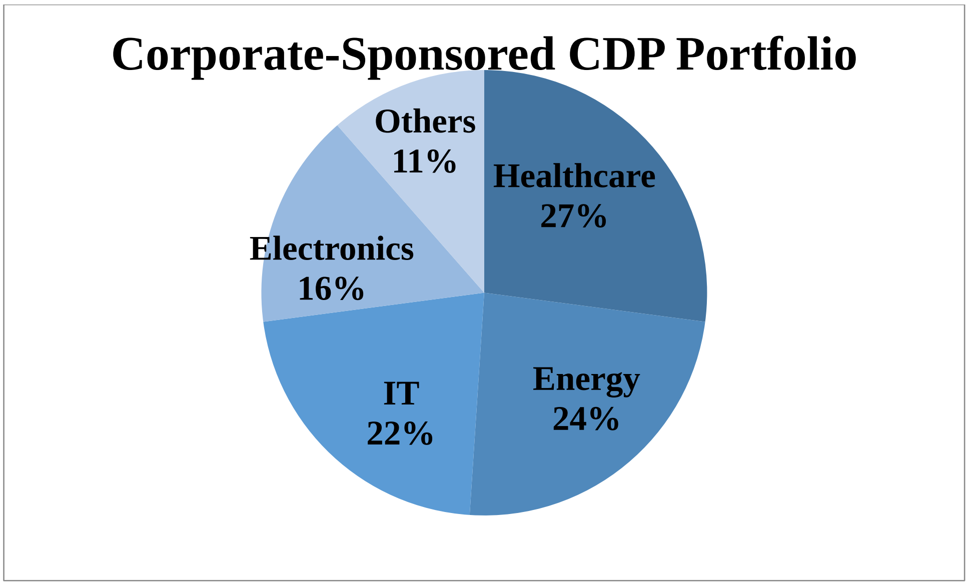

Fig. 1. Industry portfolio of the 96 corporate-sponsored CDPs developed at JI during the 4-year period.

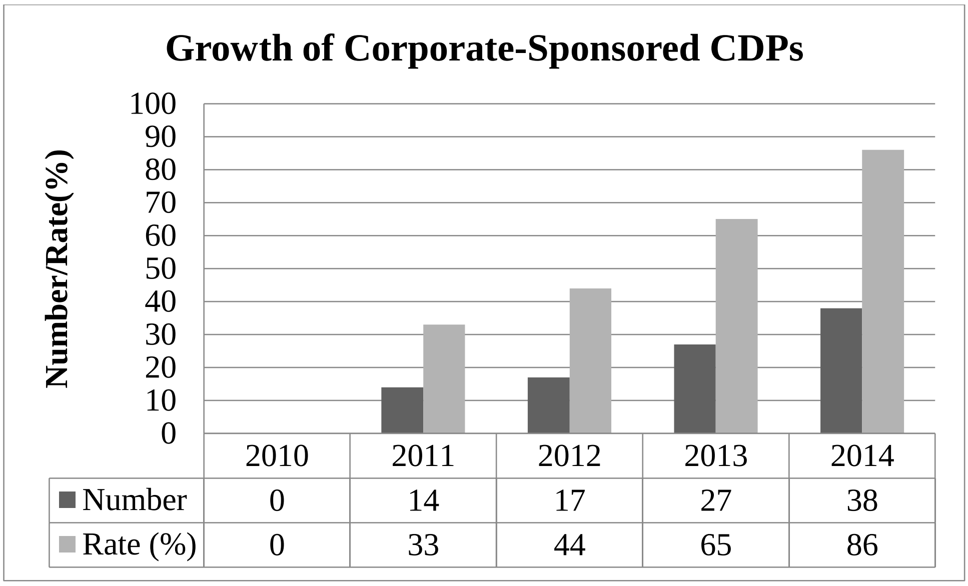

Fig. 2. Growth analysis of multidisciplinary industrial-strength CDPs developed at JI during the 4-year period.

Fig. 2 shows the growth analysis of the multidisciplinary industrial-strength CDPs developed at JI during the 4-year period, including the number of corporate-sponsored projects per year and corporate-sponsored rate, respectively. JI's CDP reached an average annual growth rate of 20% in corporate sponsorship, starting from 0% in 2010, increasing to 33% in 2011 and steadily reaching 86% in 2014.

3. Dual-Track Process

To reap the benefits from MNC-sponsored CDPs, a university needs to develop a dual-track process, as

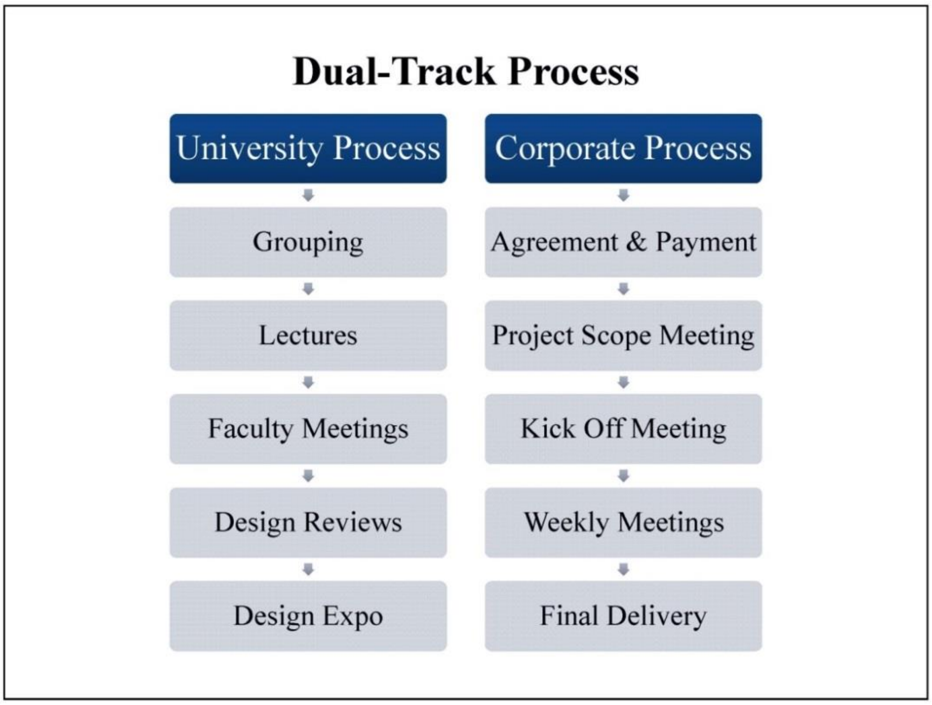

Fig. 3. The dual-track process of developing MNC-sponsored CDPs.

shown in Fig. 3. The dual-track process is more complicated than that from running a traditional campus course.

3.1. University Process

There are five processes involved on the university side, grouping, lectures, faculty meetings, Design Reviews, and Design Expo. First, the average CDP class size at JI for each semester is 120 students divided into 24 teams. With the growth of the MNC-sponsored CDPs, the competition among students has increased, which makes the grouping tasks more challenging for the CDP faculty. With this in mind, JI introduced a grouping policy, which prioritizes in the following order: the institution's interest, sponsor/faculty recommendation, and students' preferences. Second, JI's CDP offers selective lectures. A four-unit undergraduate course usually requires 60 class-hours per semester. In 2010 when the CDP course was first launched, 50% of the class hours was dedicated for lectures, and the other 50% was for break-out discussions with sponsors/instructors. Considering a growing diversity of the MNC-sponsored CDP and demanding meetings with corporate sponsors, JI has reduced lecture hours. The lectures focus on several common core subjects, such as literature survey, design process, customer requirements vs. engineering specifications, quality-function deployment (QFD), concept selections, art of presentation, and improving your technical communication. Third, it's faculty meetings. Each CDP project team is required to meet weekly with their section instructor and faculty advisor. The section instructor is responsible for monitoring team progress and the contribution from each member, while the faculty advisor is voluntary to provide technical guidance.

Fourth, it is Design Review (DR). JI's CDP requires every project team to go through four milestones, including three DRs and Design Expo. During each DR, a team needs to conduct an oral presentation and write a report. The first Design Review, DR#1, involves problem and need statement, literature survey, customer requirements, engineering specifications, QFD, and benchmarking. DR#2 involves systematic generation and selection of various design concepts. After DR#2, the team starts a final detailed design, including modeling, circuit diagrams, dimensions, data structures, and algorithm parameters, etc. For those teams that require experiments, prototyping in a machine shop usually begins shortly after DR#2. DR#3 encompasses modeling, analysis and validation of the final design, in which the team presents the prototype progress through animations and video clips [4]. Finally, it's what JI calls Design Expo, which is a one-day campus event consisting of two parts, Oral Defense and Prototype Demo. Oral Defense is held in the morning, whereas Prototype Demo is in the afternoon, followed by Design Expo Competition and Award Ceremony.

3.2. Corporate Process

There are five processes involved on the corporate side, agreement and payment, Project Scope Meeting, Kick off Meeting, weekly meetings, and Final Delivery. First, it is agreement and payment. Once a corporate decides to sponsor a CDP, it is the priority for the university and corporate to sign an agreement. Once the agreement is signed, the next task is for the university to issue an invoice and follow up on the payment. A CDP lasts three to four months. Therefore, it is very important to start this process early since it involves the legal and finance departments of both sides. Second, JI's CDP team creates so-called Project Scope Meeting. The purpose of this meeting is to define a proper scope for the project in terms time length and difficulty level. The best time to set up this meeting is about one month before a project kicks off.

Third, Kick off Meeting. The purpose of this meeting is to make sure everyone on the team understands the problems and needs of their project. During this meeting, a team needs to prepare a team profile which includes background, strengths, special skills, and the role of each team member. Furthermore, a project team needs to be prepared to ask the right questions during the Kick off Meeting. Fourth, it is weekly meeting. The JI CDP course require students to regularly, weekly or biweekly, go to the companies and meet with mentors. The purpose of these meetings is to report to the mentor and seek advices. The last step on the corporate side is Final Delivery. Most of the MNC sponsors do not require a final delivery within their companies. The Final Delivery is an effort beyond JI's curriculum's requirements in order to exceed corporate's expectation, which has a tremendous impact on business relationships, marketing, and promotion.

4. Conclusion

Inspired by the concept of IBCP of IBEAR MBA Program at USC's Marshall School of Business, JI initiated innovative MNC-sponsored industrial-strength CDPs in 2011. The purpose of this initiative is to set an example for innovative engineering education, influence and reform Chinese higher engineering education, and better integrate Chinese higher education to global communities. With the financial, training, and mentoring support from MNCs, such as Covidien, Dover, General Electric, Hewlett Packard, Intel, National Instruments, Philips, and Siemens, JI has developed 96 corporate-sponsored CDPs since its inception

Of these projects, healthcare accounts for 27%, energy 24%, IT 22%, electronics 16%, and other industries 11%. This portfolio reflects the trends and needs in the industry, which provides opportunities for engineering students to develop their careers. Over the past four years, an accumulated 480 JI students have been teamed up based on their individual backgrounds, specifically EE, CE, CS, ME, and BME. JI's CDP reached an average annual growth rate of 20% in corporate sponsorship, starting from 0% in 2010, increasing to 33% in 2011 and steadily reaching 86% in 2014. This four-year review also covers making deals with corporates, marketing strategies, having a win/win mentality, and dual-track process.

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