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Recent Developments in Manufacturing Engineering Education in Hong Kong

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Society of Manufacturing Engineers

SME Compendium
of International Models
of Manufacturing Education

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1. Introduction

Hong Kong is a territory of six million people packed into an area of less than 350 square miles. It has practically no land for agriculture or any mineral resources. Yet, Hong Kong today ranks among the top ten countries in the world in terms of per capita income, domestic exports and reexports. Hong Kong has achieved this status mainly through its manufacturing and service industries. In particular, domestic manufacturing accounts for nearly a quarter of the gross domestic product and a third of domestic employment. Added to this, over the last seven years, Hong Kong has invested heavily in the Pearl River Delta region of the People's Republic of China and other locations in the Far East. Thus, investment in manufacturing from Hong Kong is providing employment to some four million people in these regions.

During the early stages of its development (over forty years ago), Hong Kong's manufacturing industry largely relied on the production of inexpensive products such as silk flowers and plastic consumable products in addition to textiles. The competitive edge in those days came from inexpensive labour. Manufacturing Technology and industrial know-how was mostly imported.

However, over the years, with rising standards of living, the competitive advantage in terms of labour costs was slowly eroded. Hong Kong entrepreneurs faced this challenge through progressive up-market moves through product diversification into higher value added products, and a quick adoption of new and emerging manufacturing technologies. Thus, today, Hong Kong's product range encompasses textiles, garments, electronic consumer products, plastic products, light engineering products and a limited variety of machinery. Further, labour intensive manufacturing operations are rapidly being moved into southern China whereas domestic manufacturing activities are shifting towards strategic issues, system planning, product design, and industrial automation.

This shift from labour intensive operations to knowledge and technology intensive operations has necessitated a review of the tertiary education sector in Hong Kong. Till recently, only 6% of the relevant age group had access to degree level education within

Hong Kong. However, realising that this scenario was not capable of sustaining the rapid expansion and technological upgrading of Hong Kong's industry, the Hong Kong Government decided in 1988 to double the number of first year first degree places within a span of five years. Thus, Hong Kong is presently in the midst of an unprecedented expansion of its university level education. This paper focuses on some recent initiatives taken in the context of degree level education in manufacturing engineering.

2. Overview of Manufacturing Education in Hong Kong

Figure 1 provides an overview of manufacturing engineering education in Hong Kong. The range of programmes offered extend from the craftsmen level to PhD. Funding for all these programmes is mainly provided by the Hong Kong Government. A small proportion however is derived from the fees paid by the students.

Programmes at the Certificate and Diploma levels in Manufacturing Engineering are offered by the Vocational Training Council through four of its eight Technical Institutes. The entry qualification to these programmes is the Hong Kong Certificate of Education (Ordinary level) which is obtainable after eleven years of schooling. The Council supervises curricular development and the monitoring of academic standards.

Higher Diploma programmes aim to provide the education needed for working as Technician Engineers. Such programmes are being offered by the Hong Kong Polytechnic and by the Vocational Training Council through its two Technical Colleges (the Tsing Yi and Chaiwan colleges). The entry qualification for these programmes is the Hong Kong Certificate of Education ("Ordinary" level). The curricula of these sub-degree programmes emphasise industrial practice rather than engineering science. Traditionally, Hong Kong has largely relied on graduates from such programmes for filling supervisory level jobs.

Table 1 summarises the enrolment statistics into programmes up to the Higher Diploma level.

Programmes from the first degree to PhD levels are offered by the Hong Kong University, the Hong Kong University of Science and Technology, the Hong Kong Polytechnic and the City Polytechnic of Hong Kong (see Table 2). The two polytechnics are expected to become universities sometime in late 1995. All the four institutions have the power to accredit their own programmes and give their own awards. However, macro-level planning, budgeting and monitoring of academic standards is done by the Universities and Polytechnics Grants Commission (UPGC). The Commission has recently decided to conduct periodic Teaching Assessment Exercises for assessing the quality of teaching in all institutions under its custody. The intention is to move progressively towards a funding

mechanism which is linked not only to student numbers but also to performance.

First degree programmes across the territory are of three year duration. Entry to these courses in Manufacturing Engineering is mainly from the "Advanced" level certificate holders in Mathematics and Physical Sciences. The advanced level school qualification is typically obtained after thirteen years of schooling with the final two years of study devoted to advanced studies in Mathematics and Physical Sciences. Thus, unlike the first year curricula in the four year engineering programmes in North America, it has not been found necessary to include foundation topics related to Mathematics, Physics, etc within the three year degree programmes in Hong Kong.

Student contact loads typically range from 16 to 21 hours per week in the first degree programmes. This might appear as too heavy in comparison with North American practice. However, up to 45% hours of the total contact time is devoted to small group tutorial or laboratory activity. Thus, the total academic load on students is comparable to that in North America where one often finds that the total contact load is significantly smaller but most of this load is derived from lectures where new subject material is covered.

Table 3 lists the addresses of the professors administering these degree level programmes in manufacturing engineering. Sections 3 to 6 describe the essential features of the programmes available at each institution. Since the degree programme offered by the City Polytechnic has the largest intake, the programmes at this institution are described last and in greater detail.

3. The Hong Kong University (HKU)

The programme leading to Bachelor of Engineering (Industrial and Manufacturing Systems Engineering) offered by the Department of Industrial and Manufacturing Systems Engineering at HKU is the oldest amongst the four. This programme is directed towards the design and management of manufacturing as well as service systems which involve the basic resources of people, equipment, materials and money. The objective is to ensure that these resources are optimally coordinated to produce the highest efficiency. Thus, this programme provides a broad based education of relevance both to manufacturing and servicing industries. The curriculum covers a wide range of subjects : computer-aided design and manufacturing (CAD/CAM), manufacturing processes, quality assurance, production planning and control, design of plant facilities, ergonomics (human factors engineering), environmental engineering, industrial organization and management, as well as management accounting and finance. For those who wish to follow a career in the service industries, there is an optional course on operations management

for service industries. Apart from lectures, tutorials and laboratory work, students also undertake workshop training, training in industry and a project in the final year.

The Department of Industrial and Manufacturing Systems Engineering at HKU also offers a Master of Science Degree programme in Industrial and Manufacturing Systems Engineering. The programme is intended for engineering and science graduates who are holding managerial or supervisory positions in Hong Kong's industrial or service organizations. Students select eight modules from the following: comparative management and economic systems, organization theory and behavioral science, quality management, costing and finance, operational research techniques, computer applications, industrial statistics, facilities design, ergonomics - man/machine systems, ergonomics - working environment, reliability and maintenance, CAD/CAM, and plastics processing technology. Total contact hours are around 300. In addition, the students work on a dissertation. The programme duration is 2 to 3 years in the part-time mode.

MPhil/PHD programmes related to Manufacturing Engineering are on offer by the departments of Industrial and Manufacturing Engineering as well as Mechanical Engineering at HKU. These programmes have been particularly successful in research related to operations research, geometric modelling, CAD/CAM and robotics.

4. The Hong Kong Polytechnic (HKP)

The Department of Manufacturing Engineering at HKP was formerly called the Department of Production and Industrial Engineering. The term "Production Engineering" signified mainly the study of activities at the shop floor level: manufacturing process technologies, tool design, machine tools, etc. Subsequently, with Hong Kong entering the era of computer applications in manufacturing, topics such as CNC machine tools, control, instrumentation and flexible manufacturing systems were added to the subject portfolio of the department. The term "Industrial Engineering" largely encompassed aspects related to production management, off-line activities devoted to productivity and quality improvement and assurance, and enterprise level issues. However, in the mid eighties, it was observed that this schizophrenic coexistence of two perceived distinct disciplines was not in harmony with the growing realisation, around the world, of the need to develop a systems view of manufacturing. Consequently, the department was retitled as the Department of Manufacturing Engineering with the term "Manufacturing" signifying the synergy between of Production Engineering and Industrial Engineering. It is of interest to note that a similar transformation of terminology occurred around the same time in the Engineering Council of the UK where the Institution of Production Engineers was retitled as the Institution of Manufacturing

Engineers (more recently, the latter has been amalgamated into the Institution of Electrical Engineers).

Reflecting the historical development of the department, the Bachelor of Engineering (Honours) in Manufacturing Engineering, offered by the department pays significant attention to the technological as well as managerial aspects of manufacturing. The foundation subjects covered in the curriculum include introduction to manufacturing engineering, communications, mathematics, electronic engineering, electrical and mechanical technology, instrumentation and measurement, computing studies, and materials technology. The core manufacturing engineering curriculum is divided into five themes: control and automation, quality and reliability, manufacturing management, design (for manufacture), and manufacturing technology. Further, students are expected to take two of the following five optional subjects in the final year: manufacturing processes in electronic assembly, machining and treating die and mould materials, industrial experimentation for quality engineering, simulation of manufacturing systems, and quality system implementation and auditing. In addition, the students undertake fourteen weeks of basic industrial training in the Industrial Centre of the Polytechnic, and work on a substantial project in the final year. Interestingly, the objective of the basic industrial training is said to be "to enable the student to acquire knowledge through his hands and the pores of his skin while stood on his feet as opposed to acquiring it through his eyes and ears while seated". A limited number of students may opt for the four year sandwich version of the programme where industrial training of one year duration is provided in the pre-final year.

The Faculty of Engineering at HKP is offering a modular MSc programme within which students could choose the specialisation of their interest. Two specialisations, Industrial Automation and Precision Engineering, are of interest in the context of Manufacturing Engineering. The former programme is hosted by the Department of Manufacturing Engineering whereas the latter is run by the Departments of Mechanical Engineering and Manufacturing Engineering. Both programmes admit degree holders in electronic, electrical, mechanical or manufacturing engineering. Industrial Automation students take ten core modules spanning subject areas such as automated assembly, CIM, concurrent engineering, microprocessor control, lasers in Manufacturing, and robotics. In addition, the students are required to take some non-core modules. The set of non-core modules includes subjects such as advanced manufacturing technology, artificial intelligence, industrial marketing, management of technology and innovation, total quality management, and project Management.

The Department of Manufacturing Engineering is also active in research through its MPhil/PhD programmes and funded research projects. The major research areas include cutting theory, laser

machining and welding, diamond turning, composite materials, assembly, decision support systems, computer-aided-management, and productivity enhancement.

5. The Hong Kong University of Science and Technology (HKUST)

The undergraduate programmes offered by HKUST are founded on a credit-based system, and all programmes lead to honours degrees. The university believes in total education and its credit based structure aims to strike a compromise between the sharp focus prevalent in Chinese and British universities and the broad based characteristic of American universities. To ensure breadth of education, undergraduates take just over one-third of their credits outside their major department with at least 12 credits in the School of Humanities and Social Science.

The Bachelor of Engineering (Industrial Engineering) offered by the Department of Industrial Engineering is the newest amongst the manufacturing engineering related programmes on offer in Hong Kong. The curriculum is designed to provide the student with a broad and balanced knowledge in the areas of mathematics, humanities, social science, basic engineering, computer applications, and business management. In order that theory and practice can be combined, workshop and industrial training are required. Students are also required to take a number of courses from other engineering departments in addition to the departmental requirements, such as quality control and production and manufacturing systems.

The programme emphasises computer and analytical skills. The concept of concurrent engineering receives prominent treatment. After the first two years of common curriculum, a student may elect to specialise in computer-integrated manufacturing (CIM), facility and environment engineering, systems engineering, operations research, or manufacturing strategy. All students are encouraged to take some courses offered by the School of Business and Management.

The Department of Industrial Engineering also runs an MSc in Industrial Engineering of one and half year duration in the full-time mode. Each student is required to complete 30 approved course credits. Six of these credits should be from an MSc project under the supervision of a qualified supervisor. For industrially-based projects a supervisor may be co-opted from the industry.

The Departments of Industrial Engineering and Mechanical Engineering at HKUST are also offering MPhil/PHD programmes related to Manufacturing Engineering. Amongst the research areas under investigation are CAD/CAM, process planning, manufacturing system control, material handling, applications of queuing theory, inventory control modelling, reliability, and quality control.

Another notable research area aims to develop an integrated approach to design for manufacturability, inspection, maintenance, and repair. Further, robotics and control research is in progress with emphasis on designing automated work cells to manufacture families of products within the existing factory environment.

6. The City Polytechnic of Hong Kong (CPHK)

CPHK launched its Department of Manufacturing Engineering in 1987. Today the department has grown to be the largest manufacturing engineering department in Hong Kong. The department is presently offering Bachelor of Engineering (Honours) programmes in Manufacturing Engineering and Mechatronic Engineering.

The development of the Manufacturing Engineering degree programme at CPHK took place in a period when Hong Kong industry had started widely adopting computer applications in manufacturing (Computer-aided Design and Computer-aided Manufacture, etc) and the developed world had widely articulated the conviction that manufacturing must be viewed as a system. These factors had a significant influence on the programme at the City Polytechnic. In particular, the views of SME (the manufacturing wheel, etc.), and the debates on manufacturing education (inspired by Dr. Eugene Merchant) at CIRP (International Institution for Production Research) provided the ideological framework underpinning the curriculum.

The programme is offered in both the full-time and part-time evening modes. Graduates of Hong Kong Advanced Level Examinations, taken after 13 years schooling, are admitted to the full-time mode whereas working technician-engineers with a Higher Diploma in mechanical or manufacturing engineering are admitted to the part-time evening mode. The latter are however exempted from the curriculum corresponding to the first year in the full-time version of the degree programme. These admission criteria are common across the four institutions offering manufacturing programmes in Hong Kong. The full-time mode of the course is three years in duration. Part-time evening students are exempt from the first year curriculum in the full-time mode. However, part-time evening students take four years to study the rest of the curriculum.

The aim of the programme at CPHK is to provide the education and training needed by manufacturing engineers who are able to

i. develop and manage system level procedures governing the productivity and quality maintenance/improvement activities in any engineering related industry;
ii. develop and manage "process engineering" and "design for manufacture" activities in discrete product manufacturing industries; and
iii. contribute significantly towards the modernisation and computerisation of manufacturing facilities and systems.

Figure 2 illustrates the broad structure of the programme whereas Table 4 summarises the sequencing of subjects as offered in the full-time mode of the programme.

The Systems Theme (S-theme) aims to develop the basic knowledge required in the organisation and manipulation of information concerning the interactions between diverse manufacturing resources (people, money, materials and machines) with a view to meeting specified manufacturing system objectives such as improved productivity, quality, and competitiveness.

The aim of the Mechanical Theme (M-theme) is to provide the basic knowledge required in the conceptualisation, analysis, selection and application of the mechanical entities (products, production equipment and tooling) and manufacturing processes involved in the manufacture of discrete products.

The Electronics/Computer Theme (E-theme) aims to provide the basic knowledge required in planning the utilisation of electrical/electronic devices, computer hardware and software, and communication and control systems towards the flexible control and automation of manufacturing facilities.

Together, the S, M and E themes, cover the technical and strategic aspects of manufacturing engineering. Within each theme, the subject content progresses from scientific fundamentals to applicational skills and on to a consideration of system level issues.

The supporting modules group aims to provide a foundation in Mathematics and English communication skills.

The programme contains 600 hours of industrial training divided into Basic Training and a Manufacturing Project. Basic Training provides hands-on experiences of a broad range of manufacturing processes and machines. Manufacturing Project aims to develop the skills necessary in integrating diverse manufacturing processes towards the one-off manufacture of a specified product.

The aim of the individual student project undertaken in the final year is to refine the creativity, problem solving and applicational skills of the students. The total number of projects undertaken in the department are roughly divided equally amongst those inspired by the industry, by SAILs (discussed later) and the research projects being undertaken by the faculty members.

The students are divided into three streams in the final year (Manufacturing Management, Manufacturing Technology and Manufacturing Systems) in order to enable a degree of specialisation amongst the students and a diversified graduate

output to meet a variety of industrial needs.

A significant feature of the programme is the emphasis placed on the development of applicational and integrative skills amongst the students. This can only be achieved by focusing on "learning" by students rather than on "teaching" by faculty. The next section describes the concept of Student Centred Activities (SCAs) as implemented in this programme.

The Department of Manufacturing Engineering is also running an MSc programme in Industrial Automation of two and half year duration in the part-time evening mode. The programme aims to provide the education needed for engineers charged with the responsibility for initiating, justifying and implementing automation projects in a manufacturing industry. Degree holders in mechanical, manufacturing, electrical, electronic or textile engineering with at least two years of relevant industrial experience are admitted. In view of the diversity of the educational backgrounds of the students, an attempt is made to "equalise" their basic competencies in control engineering, CAD, and flexible automation techniques early in the programme through assigning an individualised array of self-study tasks. The programme focuses on the development of flexible and integrated automation systems rather than on the mechanisation of individual work stations. Amongst the major subject areas included in the curriculum are control engineering, CAD, design for automation, factory communications, flexible automation techniques, and automation systems integration. While the subjects are taught in a generic fashion applicable to a wide variety of industrial contexts, each student is required to write term papers which aim to apply the concepts in one or more applicational contexts of specific interest to their industry. Hands-on understanding of automation systems is obtained through the study of SAILs (described later) in the "Automation Workshop" module. In addition, the students are required to undertake dissertation work where they make an in-depth study of an automation problem drawn from their respective companies.

The department is active in research through its MPhil/PhD programmes and an array of funded research projects. Amongst the major research topics are: modelling of machining operations; design for assembly; geometric feature recognition; process planning for machining, sheet metal work, extrusion, injection moulding and printed circuit board industries; elasto-hydrodynamic lubrication; vision systems; fibre optics; flexible conveying systems; automated guided vehicles; robotics; machine condition monitoring; modelling of flexible manufacturing systems; project management; decision support systems; risk analysis; ergonomics; and production planning and control.

7. Student Centred Activities (SCAs) at CPHK

The traditional pattern of classroom activity may be said to be Teacher Centred Activity (TCA). Consider for instance how TCA usually manifests itself in a "laboratory" class devoted to Metrology. Typically, here, the teacher plans a series of structured "experiments" such as "measure the roundness of the given part using a Talyrond". Each student is given a structured hand-out concerning the theoretical principles underlying the instrument and the procedure to use it. The student performs the "experiment" (which actually is not an experiment at all in a scientific sense) and submits a report. With this process, the student may understand how to use a Talyrond but does not necessarily get an idea "why" he needs to use it and "when" he should select the particular instrument. In short, he does not understand the system purpose of the task. Further, the teacher, who has planned the experiments, is in full control of the activity in the sense that he knows who would be doing what during any given laboratory session.

Consider how the same activity might be reorganised in order to provide a "system purpose" to the tasks. At CPHK, this is achieved firstly by redefining the laboratory not as "a place where experiments are conducted" but as "a place where the facilities for performing a specified class of tasks are made available". Secondly, the role of the teacher is redefined as "posing a holistic challenge to the students and providing them with the necessary consultancy services". Finally, the classroom activity is organised on a "student centred" basis (SCA).

An SCA could take the following form in a Metrology laboratory class. Each student group is assigned the holistic task of producing an inspection report on a fairly complex and realistic machined part. Given the engineering drawings and specifications of the part, the students are required to decide on the measurement tasks *themselves*, perform them in the order *they* consider to be most effective and, finally, produce *their* inspection report. *They* decide on the measuring equipment that needs to be used and learn to use them on a need to know basis. In this scenario, it is not the teachers but *the students themselves* who decide what is to be done and when.

The programme at CPHK has a number of mandatory SCAs stipulated in its curriculum (see the subjects marked with an asterisk in Table 4).

8. The System-Level Application and Integration Laboratories (SAILS) at CPHK

Amongst the objectives of the BEng programme at CPHK are the development of a systems view of manufacturing and the ability to

manage modern and computerized manufacturing systems. The traditional approach towards meeting such objectives has been through the provision of work experience to students in an appropriate manufacturing industry. Such a strategy has been used with varied success in the many "sandwich" programmes being offered in the UK and the "co-op" programmes offered in the USA. Unfortunately, Hong Kong does not have sufficient a number of industries with computerized systems to support the large number of students requiring such a work experience. Hence, it has become necessary to develop in-house facilities called System-Level Application and Integration Laboratories (SAILs). There are two SAILs in development and use at the Department of Manufacturing Engineering, CPHK.

SAIL 1 is a flexible machining shop designed as a mould and die shop (see Figure 3). CAD/CAM work is performed in a CAD Centre equipped with Hewlett Packard and Sun work stations utilising Mcdonnell Douglas Unigraphics II and Moldflow software. The designs and NC programs are downloaded into a set of DEC (Digital Equipment Corporation) workstations providing supervisory control through an Ethernet. The supervisory computers communicate with the CNC machines through a variety of shop floor networks. An automated guided vehicle (AGV) is being developed to provide material handling.

SAIL 2 is a flexible assembly system equipped with a variety of industrial robots, sensors and vision systems, and a multi-station, multi-pallet programmable conveying system (see Figure 4). Two SunSparc work stations provide support for real-time simulation.

The SAILs are being developed by multi-disciplinary faculty teams. The teams aim to progressively make the SAILs more intelligent, flexible, and autonomous. The faculty members in the development teams decide each year the developmental goals for the following year, specify them in sufficient detail, and divide the overall task into convenient sub-tasks such that each sub-task is manageable by a single student. The sub-tasks are "sub-contracted" to students as final year projects. Further, final year students are usually asked to reset and tool-up one of the SAILs to manufacture/assemble a given product family. These approaches clearly provide a system-level view to the students in addition to conserving the results from their efforts in terms of an improved system.

The SAILs include sufficiently varied equipment and facilities to provide laboratory support for a number of focused learning tasks related to control, instrumentation, automation, work design, product design, tool design, robotics, NC programming, factory communications, production scheduling, etc. While these tasks could be performed in traditional laboratories, performing them in the SAILs is more meaningful from a systems point of view.

The SAILs have helped significantly in developing a culture of team research. Many of the research projects listed in section 6 were inspired by the involvement of the staff concerned in the development of SAILs. SAIL 1 in particular has succeeded in promoting collaborative research ventures with the Tsinghua University and the Nanjing University of Science and Technology in China.

9. R&D in Manufacturing Engineering

The private sector in Hong Kong has traditionally been apathetic towards investing in R&D activities. This apathy may be partially explained by the "Flying Geese" analogy proposed by Prof. Edward Chen of the Hong Kong University: the giant Japanese goose is at the head of the formation charting new technological territories, the Taiwanese and Korean geese flank and chase the Japanese giant, the Hong Kong and Singaporean geese are flying in the wake of Taiwan and Korea living off the markets left behind by the geese in front of them, and at the tail end of the formation are countries like Thailand and Malaysia. As a consequence of Hong Kong's reliance on product sectors previously developed but left behind by more industrialised countries, there has been little incentive for either Hong Kong industry or Hong Kong Government to invest heavily in R&D.

However, this picture is rapidly changing as a result of rising labour costs, the growing industrial activity in China by Hong Kong industrial houses, and the need to maintain and improve upon Hong Kong's international competitiveness. As a result, the Hong Kong Government has recently initiated several ventures to help Hong Kong industry move up market through more R&D and product development. The most important of these initiatives is the rapid expansion of tertiary education. Secondly, the Universities and Polytechnics Grants Commission is providing significantly more funds to support research projects. The research funds are granted through a peer review process organised by the Research Grants Council. Research standards are monitored by conducting periodic Research Assessment Exercises where each academic department is rated through an expert peer review process. Thirdly, the Hong Kong Government is establishing a Technology Centre (fashioned after the well known concept of Science Parks) where new "hi-tech" industries could incubate prior to maturing into path breaking commercial establishments. In addition, technology transfer is being promoted through the establishment of smaller centres established in the tertiary academic institutions. An example of such a venture is the Rapid Prototyping Centre which is being organised by the Hong Kong Productivity Council and the City Polytechnic of Hong Kong.

9. Future Trends

It should be apparent from the previous sections that the degree programmes in manufacturing engineering in Hong Kong have experienced substantial transformation in both quantitative and qualitative terms in the recent years. In particular, several innovative approaches have been incorporated with regard to curricula and pedagogic strategies. However, the rapid expansion in terms of student intakes has resulted in the admission of students with a much wider spectrum of abilities. In consequence, students with more limited academic abilities are finding the broadly based manufacturing engineering programmes difficult to cope with. Consequently, manufacturing engineering departments in Hong Kong are presently reviewing their curricular strategies. Amongst the solutions being explored are moving from three-year degree programmes to four year degree programmes and the development of more narrowly based programmes.

One can assume that many structural adjustments will take place in the tertiary education sector in Hong Kong after the sovereignty over Hong Kong reverts to China in 1997. In the context of manufacturing engineering, there would be a need to progressively reconcile the industrial and educational traditions in the two regions. This is the major challenge to be faced by manufacturing education in Hong Kong in the next decade.

Industry in China has been primarily financed and closely controlled by the state whereas Hong Kong industry has thrived in a *laissez faire* society. China has a highly diversified industry. Its products range from heavy engineering and military products to light consumer products. It also has a significant components manufacturing industry. Hong Kong has traditionally relied on the assembly of light consumer products designed elsewhere and using imported components. Chinese industries so far have been preoccupied with improving their 'productivity' and are just waking up to the eras of 'quality' and 'innovation'. Hong Kong industry is already well versed in managing 'productivity' and is responding strongly to the demands of the 'quality' era. However, Hong Kong has just entered the awareness phase with regard to using innovation as a competitive weapon.

Manufacturing engineering education in China has largely been process oriented and science based. Scientific expertise with regard to manufacturing processes, tooling and equipment is much more extensive and deep in China than in Hong Kong. However, owing to its allegiance to the communist ideology, the human, financial and management aspects of the discipline of manufacturing engineering are not well developed in China. In contrast manufacturing engineering in Hong Kong has long been viewed as the study of how to develop, implement and manage complex systems made up of not only materials and machines but also men and money with

a view to satisfying the needs of customers. Thus, Hong Kong has been taking a much broader view of the discipline of manufacturing engineering. It is therefore apparent that while the educational ethos in either region has its own strengths and weaknesses, each complements the other. Herein lies the opportunity for both regions. One hopes that the post-1997 period in Hong Kong would be sufficiently stable and prosperous to enable the two regions to interact strongly with a view to deriving the full benefit from the complementary nature of the two systems. Whatever the eventual solutions, it is clear that Hong Kong is turning out to be an exciting and rewarding place for educators in manufacturing engineering.

Acknowledgement

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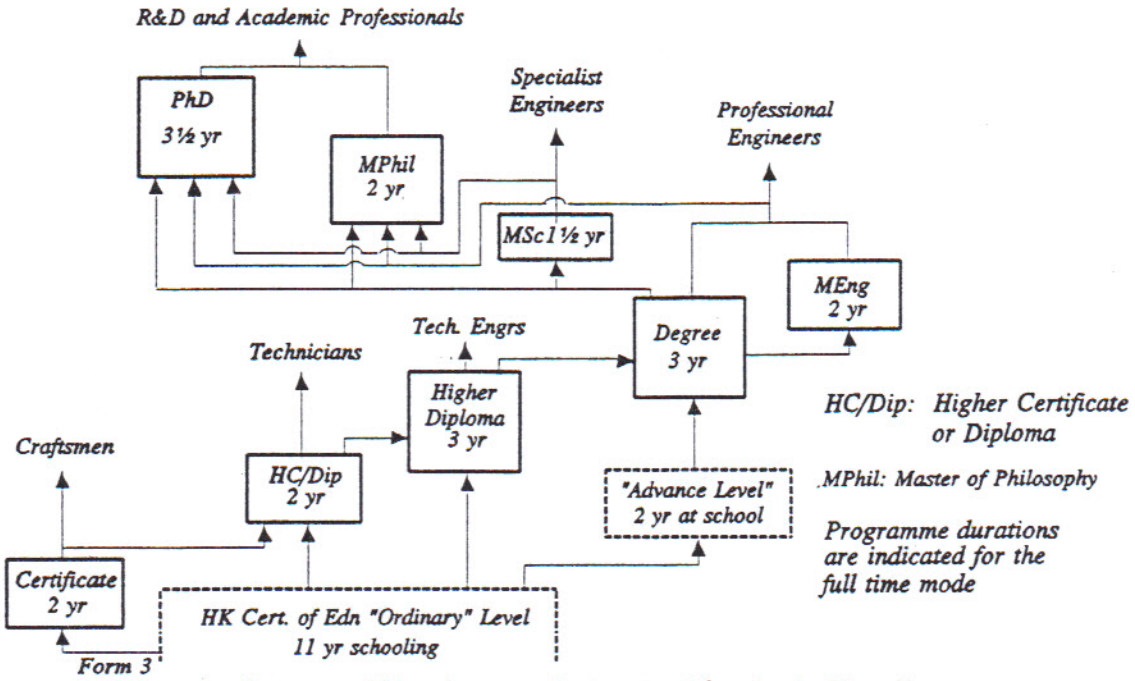
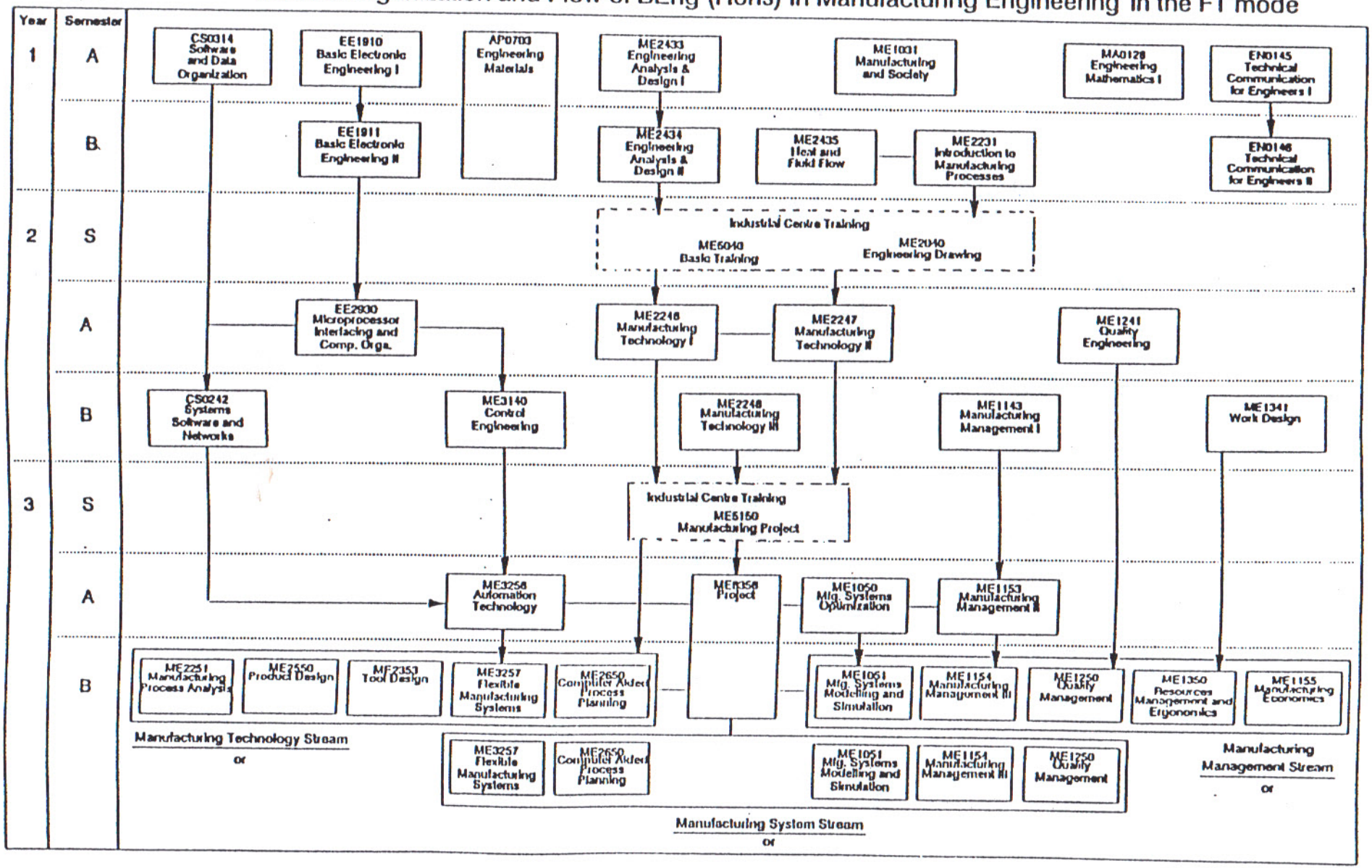


Figure 1 Overview of Manufacturing Engineering Education in Hong Kong

Figure 2 Module Organization and Flow of BEng (Hons) in Manufacturing Engineering in the FT mode



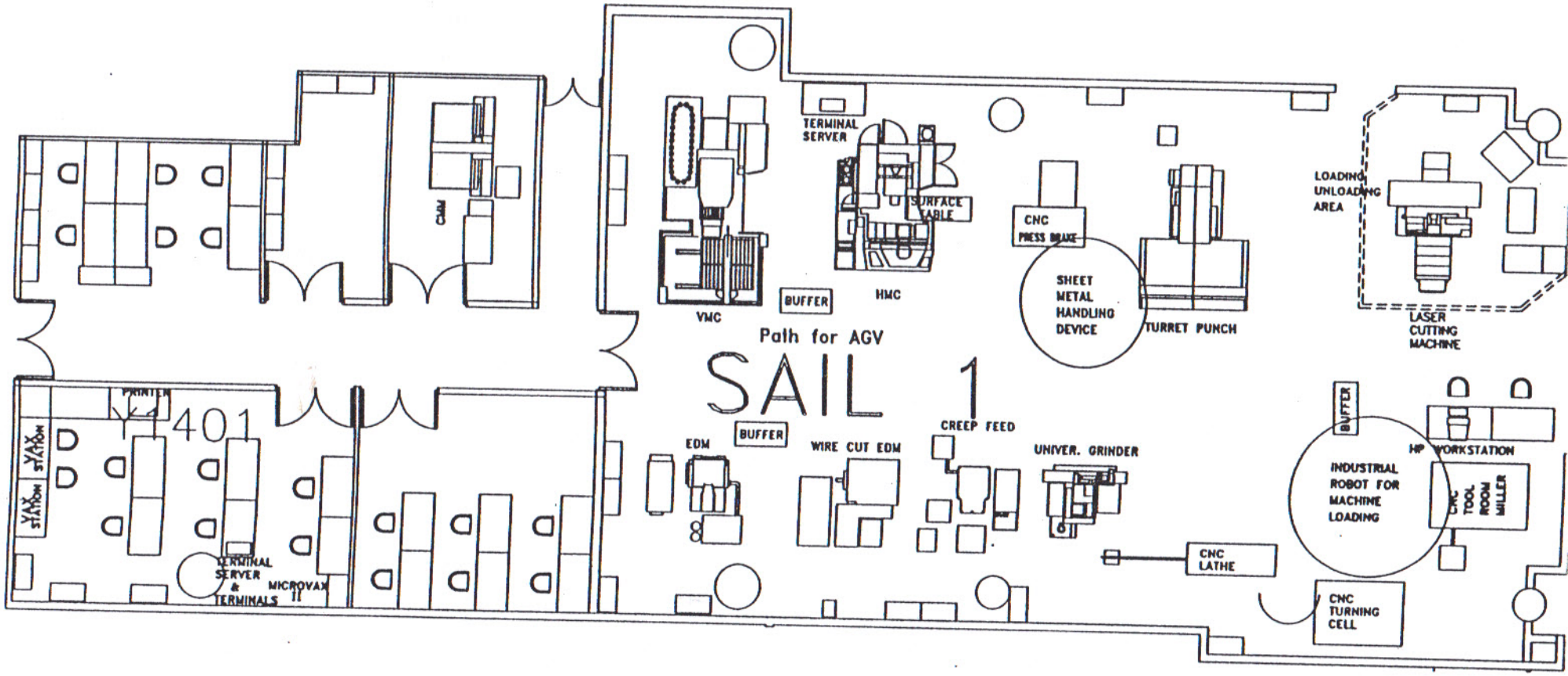


FIGURE 3 SAIL 1 : FLEXIBLE MACHINING SYSTEM

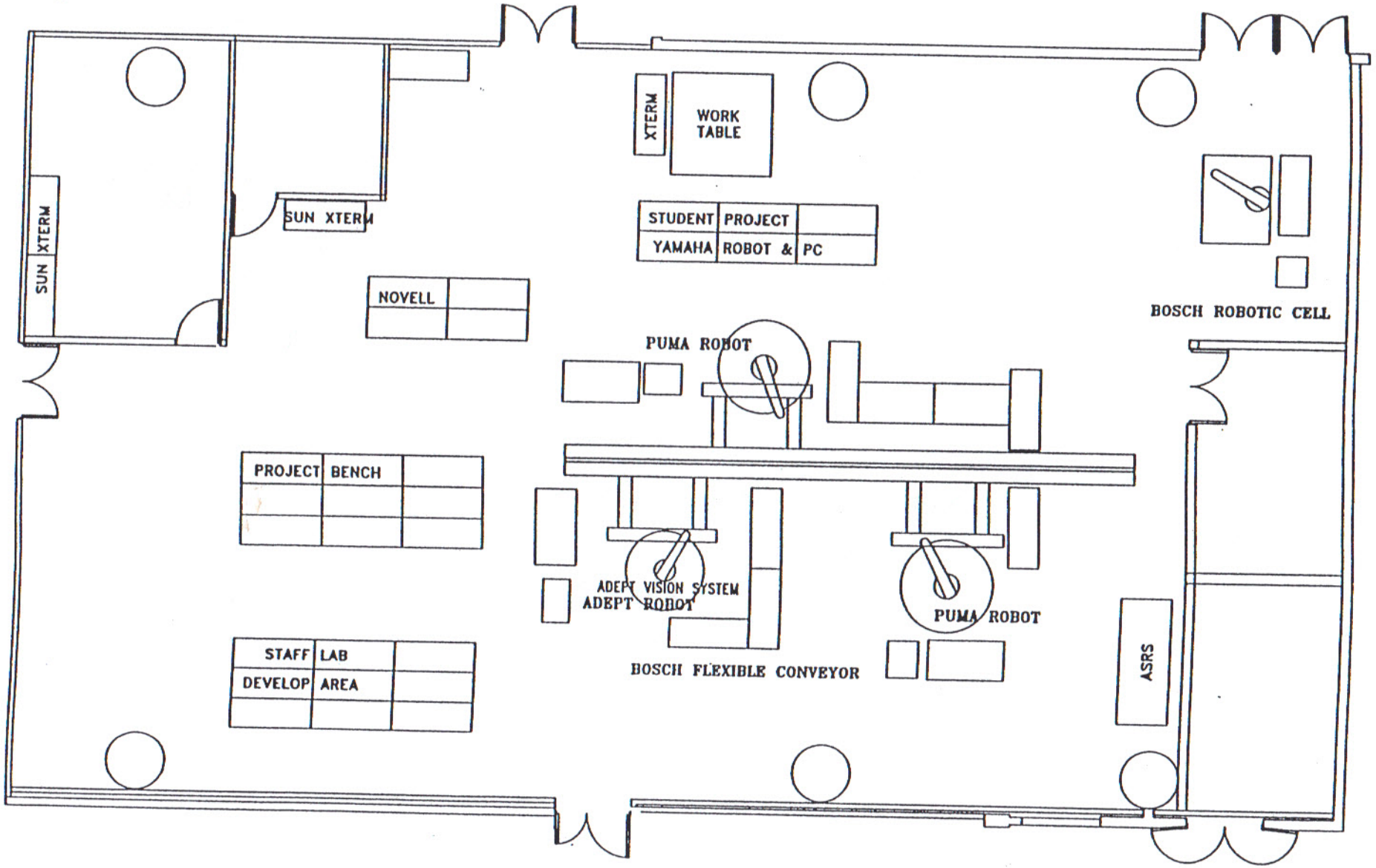


FIGURE 4 SAIL 2 : FLEXIBLE ASSEMBLY SYSTEM

Table 1

Student Enrolments into Manufacturing Engineering Programmes upto the Higher Diploma Level in Hong Kong (as in 1993/94)

Institution / Programme	Hong Kong Polytechnic	VTC Institutions			Total
		Technical Colleges		Technical Institutes	
		Tsing Yi	Chai Wan	(Kwai Chung, Lee Wai Lee, Tuen Mun and Shatin)	
Certificate	---	---	---	694	694
Diploma	---	---	---	525	525
Higher Certificate	206	240	281	---	727
Higher Diploma	371	120	123	---	614

Table 2 : Overview of Manufacturing Engineering First Degree Programmes in Hong Kong

Institution	Department Offering	Title of Programme	Annual Intake		Duration in Full-time (Years)
			Full-time	Part-time	
Hong Kong University	Industrial and Manufacturing Systems Engineering	BEng Industrial and Manufacturing Systems Eng.	63	-	3 years
Hong Kong Polytechnic	Manufacturing Engineering	BEng (Hons) Manufacturing Engineering	80	-	3 years (regular) 4 years (sandwich)
City Polytechnic of Hong Kong	Manufacturing Engineering	BEng (Hons) Manufacturing Engineering	120	40	3 years (full-time) 4 years (part-time)
Hong Kong University of Science & Technology	Industrial Engineering	BEng (Hons) Industrial Engineering	55		

Table 3

Contact Addresses for Manufacturing Degree Programmes in Hong Kong

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Table 4
BEng(Hons) Manufacturing Engineering (Full-time mode) Curriculum at the City Polytechnic of Hong Kong

Year	Systems-Theme		Mechanical Theme		Electronic/ Computers Theme		Supporting Theme/ Project	
	Subject	Hr	Subject	Hr	Subject	Hr	Subject	Hr
I			Eng. Materials Eng. Anal. & Des.* Heat & Fluid Flow Intro. to Mfg Eng.	90 135 30 45	Software & Data Orgn Basic Electronic Eng.	30 120	Science, Technology and Society Tech. Communication Eng. Maths	30 60 60
Summer	60 hours of Engineering Drawing + 10 weeks of Basic Training							
II	Quality Eng.* Mfg Mgmt I Work Design*	75 45 75	Mfg Tech.* I, II, III	225	Micro Processors & Computers Control Eng.* System Software & Networks	60 75 30		
Summer	6 weeks of Manufacturing Project							
	Mfg Mgmt II Mfg Sys. Optmsn	60 45			Automation Tech.*	105	Project	150

Mfg Technology Stream		Mfg Systems Stream		Mfg Management Stream	
Subject	Hr	Subject	Hr	Subject	Hr
Mfg Process Anal. Product Design Tool Design Flex. Mfg Systems* CAPP	30 30 45 75 30	Mfg Sys. Modelling Qual. Mgmt III Mfg Mgmt III Flex. Mfg systems* CAPP	30 30 45 75 30	Mfg Sys. Modelling Qual. Mgmt III Mfg Mgmt III Resources Mgmt & Ergonomics* Mfg Economics	30 30 45 90 30

* This module includes a Student Centred Activity (SCA)