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The Manufacturing Engineering Programs at the City Polytechnic of Hong Kong

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This paper describes the mechanics and operational philosophy of an integrated manufacturing engineering course, as developed at the City Polytechnic of Hong Kong. Specifically, a suitable program structure is expounded, and an assessment of the extent of desirability of such a repository curriculum is presented and analysed, against the background of a consideration for the requirements of the Hong Kong manufacturing industry, including the potential marketability of the graduates.

INTRODUCTION

MANUFACTURING ENGINEERING, as defined by the Society of Manufacturing Engineers, USA, 'is that specialty of professional engineering which requires such education and experience as is necessary to understand, apply and control engineering procedures in manufacturing processes and methods of production of industrial commodities and products, thus requiring the ability to plan the practices of manufacture, to research and develop the tools, processes, machines and equipment, and to integrate the facilities and systems by which products may be manufactured economically'.

Thus, by virtue of their education and training, manufacturing engineering graduates and professionals should be well equipped to handle a wide range of job functions in the manufacturing (and often service) industries, as implied by the above definition.

A PREAMBLE

It is clear from the above, that manufacturing engineering involves highly interdisciplinary education. To reassert, it requires the application of knowledge and skills in several of the science and engineering-based disciplines, such as mechanical engineering, electrical and electronic engineering, computer science, control engineering, materials engineering, production management, etc. In addition to the above tools, today's professional manufacturing engineers are expected to be technically versed in various scientific and management principles; they must also have a comprehensive view of manufacturing as a total system. Hence, by this view, although it may be argued that manufacturing engineering is a recognised and acknowledged professional discipline, the role of the manufacturing engineer is often not that of a specialist but indeed one of an 'integrationist' [1].

The manufacturing engineering (ME) programs at the City Polytechnic of Hong Kong (CPHK) were officially launched into full operation with the first intake of students in October 1988. The courses are run as full-time (FT) and part-time evening (PTE), dual-mode programs, and have as one of their main features, the ingredients to prepare the graduates for specialist supervisory/managerial positions in manufacturing.

THE PROGRAM AIMS AND OBJECTIVES

It is intended here to first outline the general and specific aims and objectives of the programs [1, 2].

General aims

In general terms, the program aims are as follows:

(a) To provide the education and training necessary for potential professional engineers, in order to:
  (i) independently and/or jointly design, implement and supervise the manufacturing activities in a variety of industries, producing discrete and unique products;
  (ii) provide specialist support in the major functional areas of manufacturing engineering, in a large or complex manufacturing industry.
(b) To provide young people in Hong Kong with an opportunity to obtain further training in modern manufacturing engineering practice.
(c) To provide the facilities and opportunities for developing educational, engineering and interpersonal skills, necessary to cope with the vagaries and challenges of modern manufac-

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turing technological innovation, in terms of new proceses, new materials and new methods of manufacture.

Specific aims and objectives

To enhance the general aims, the programs are designed around the following specific aims and objectives:

(a) To provide adequate knowledge grounding and a sound footing in the sciences and mathematics, as a foundation for the acquisition of basic manufacturing engineering skills.
(b) To provide a broad grasp of the fundamental principles of manufacturing engineering, essential for graduates to competently practise and function (with experience), in a typical manufacturing industry.
(c) To provide a sound knowledge of the common operational techniques and computer applications considered to be an integral part of some identified functional specialisms, such as design, automation and management, within the manufacturing engineering circle.
(d) The program also aims to provide opportunities to facilitate the developing of creativity and practical application skills, through a range of application tasks, with special emphasis on realistic manufacturing systems.
(e) To provide an appreciation of:
    (i) the technological aspects of electronic products manufacture; metals and plastics conversion processes;
    (ii) the social, industrial and legal framework within which the manufacturing engineer must operate in Hong Kong.
(f) To provide training and education aimed towards the acquisition of skills and adequate tools in technical communication and report writing.

PROGRAMS STRUCTURE

In pursuance of the above aims and objectives, the programs are designed around the 'modular' structure (characteristic of all the City Polytechnic programs).

To enhance this modular feature, the programs are structured in such fashion that relevant core courses are systematically programmed/scheduled, so as to enhance the attainment of the stated aims and objectives, as dictated by the manpower needs of the local industry. In the main, the program structure bears the hallmarks of interlocking subject 'blocks', which are integrated into a coherent whole. (For the sake of clarity, a module may be defined as a component subject area within a course, and typically takes 30 hours to complete, spread over one term, usually ten weeks, at CPHK.)

The programs are divided into 'Parts', each of which is composed of a prescribed combination of modules. Considering the Higher Diploma

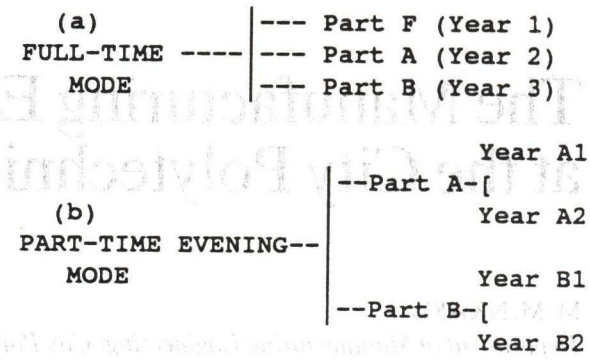

Fig. 1. The HDME programs structure.

(HDME) level, in the FT mode, there are three Parts: F, A and B; each of one year's duration; whereas the PTE mode comprises two Parts: A and B, each extending over two years, to equate with the academic content of their corresponding FT Parts, as illustrated in Fig. 1.

Summarizing, for the HDME program, there are altogether 73 modules in the entire programs. Entrants to the Part F take a total of 59 modules to complete the program, whereas those from Part A have 39 modules to grapple with, as summarized in Table 1.

FINAL-YEAR PROGRAMS STREAMING

Introduction

As shown in Table 1, in the Foundation Year (Part F), the programs offer 18 modules (lectures + laboratories), which are geared to provide a solid foundation in the mathematical sciences, manufacturing processes, engineering drawing, engineering mechanics, engineering materials, electrical and electronic principles and communication skill. In addition to the 18 modules, students are provided actual hands-on practical training, at the Industrial Centre, for three-and-a-half days per week in the second term; also for six weeks in the summer term, at the end of the academic year.

Part A comprises 16 lecture modules and five laboratory modules, covering the basic knowledge and skills required in the supervision of small and simple manufacturing industries; it also provides effective support to the further modules to be taken in the Part B. The major subject areas covered involve the design and analysis, and include: manufacturing systems, manufacturing planning, business functions, manufacturing technology, electrical products manufacturing, automation, electronics and microprocessors, engineering mathematics, and the Kong Kong environment.

Part B (the Final Year), aims to develop the knowledge and skills required to assume specialist positions in production management, or design for manufacture, or industrial automation, in large and/or complex manufacturing industries. Pursuant to this aim, and in recognition of the need to

Table 1. Distribution of the HDME modules by the parts and scheme

MODULES / PARTS	Lecture Modules	Laboratory Modules	Practical Training	Project Modules
F	16	2	2	-
A	16	5	-	-
B	12	3	-	3

meet the challenges of modern manufacturing industry, the students are streamed into three appropriate options, towards the end of Part A. The streaming is such that all students in Part B, irrespective of the stream to which they belong, take 12 lecture modules, three laboratory modules, and three project modules. Each of the streams are examined and discussed below.

The production management (PM) stream

Part B modules for the PM Stream aim to develop the knowledge and skills required in the design, analysis and implementation of production, materials and quality management techniques. Among the major subject areas covered are production control, quality control/management, work design, materials requirements planning, manufacturing resources planning, managing employees, etc. In addition, students are provided a broad appreciation of computer-aided manufacture and flexible automation systems, in order to enhance their potential capability to cope with the vagaries of emerging computerized manufacturing and other automation technologies.

The design for manufacture (DFM) stream

Part B modules for the DFM Stream are designed to inculcate the knowledge and skills required for the development and implementation of process plants and production tooling, in the manufacture of discrete and unique products. Among the subject areas covered are computer-aided design/manufacture, quality control, design techniques/methodology, manufacturing databases and networks, process engineering, tool design, etc.

The industrial automation (IA) Stream

The main aim of the Part B modules for the IA Stream is to develop the ability to provide specialist technical support in the implementation of modern automation systems in the manufacturing industry. Towards this goal, the main subjectareas covered are computer-aided design and manufacture, manufacturing systems design techniques, automation methodologies, manufacturing databases and networks, control engineering, mechanization, flexible automation techniques, etc.

General

To further enhance the attainment of the stated programs objectives, the department is currently actively developing two substantial computer-integrated manufacturing laboratory-support facilities—System level Applications and Integration Laboratories (SAIL)—Types I and II. SAIL I is for mould/die making, and SAIL II is for assembly processes. To reiterate the intended gearing of the course towards practical industrial orientation, the students are actively involved in the design, construction and implementation of these systems. Such involvement currently takes the form of projects and other laboratory-based exercises, which are referred to as 'student centred activities' (SCAs). In the main, the products and the specific technical features of these systems are expected to be used extensively as course-material throughout the programs, as well as for staff and students' research activities [5].

Figures 2 and 3 illustrate the distribution of the modules by the streams, parts and terms, for the FT and PTE modes, respectively. A flowchart showing the integration of the various modules identified in Figs 2 and 3, is presented in Fig. 4. The corresponding flowcharts for the modules in Parts F and A, as well as those for each of the final year streams are presented in Figs 5–8.

PROGRAMS ADMINISTRATION

To enhance the smooth operation and effective communication between the staff and students, the course is technically administered by a Course Coordinator (CC), who is responsible to the Department Head, see Fig. 9. To assist the CC, there are appointed Part Tutors for each of the Parts; furthermore, each student is also assigned a Personal Tutor. Thus, to provide adequate channels of communication between the staff and students of the programs, the department serves the following six guidelines on the various avenues available [1]:

(a) Students having academic difficulties with a specific module are encouraged to directly contact the module lecturer concerned.

PART	TERM	PM	DFM	IA
B	3	PROJECT III ME8322	PROJECT III ME8322	PROJECT III ME8322
		LAB III-C (QEII + MRPII) ME8122	LAB III-C (PEIII) ME8122	LAB III-C (MRPII + CTII + FATII) ME8122
		MANAGING EMPLOYEES IN MFG BM0231	PROCESS ENGG III ME2222	CONTROL TECHNOLOGY II ME3221
		QUALITY ENGG II ME1222	TOOL DESIGN (METALS) II ME2325	FLEXIBLE AUTOMATION TECHNIQUES II ME3422
		MFG RESOURCES PLNG ME1722	TOOL DESIGN (PLASTICS) II ME2323	MFG RESOURCES PLNG ME1722
		MFG DATABASES & NETWORKS ME3420	MFG DATABASES & NETWORKS ME3420	MFG DATABASES & NETWORKS ME3420
	2	PROJECT II ME8321	PROJECT II ME8321	PROJECT II ME8321
		LAB III-B (CAM + MRP) ME8121	LAB III-B (CAM + PEII) ME8121	LAB III-B (CAM + CTI + FATI) ME8121
		MATERIAL REQUIREMENTS PLNG ME1721	PROCESS ENGG II ME2221	CONTROL TECHNOLOGY I ME3220
		QUALITY ENGG I ME1221	TOOL DESIGN (METALS) I ME2324	FLEXIBLE AUTOMATION TECHNIQUES I ME3421
		FLEXIBLE AUTOMATION SYSTEMS ME3320	TOOL DESIGN (PLASTICS) I ME2322	FLEXIBLE AUTOMATION SYSTEMS ME3320
		CAM ME2420	CAM ME2420	CAM ME2420
	1	PROJECT I ME8320	PROJECT I ME8320	PROJECT I ME8320
		LAB III-A (QET + WDT) ME8120	LAB III-A (QET + PEI) ME8120	LAB III-A (QET + MECH) ME8120
		PRODUCTION CONTROL ME1720	PROCESS ENGG I ME2220	MECHANISATION ME3120
		WORK DESIGN TECHNIQUES B ME1321	CAD ME2321	CAD ME2321
		WORK DESIGN TECHNIQUES A ME1320	DESIGN FOR MANUFACTURE ME2320	DESIGN FOR MANUFACTURE ME2320
		QUALITY ENGG TECHNIQUES ME1220	QUALITY ENGG TECHNIQUES ME1220	QUALITY ENGG TECHNIQUES ME1220
	S			
A	3	MFG SYSTEMS III ME1112	LAB II-E MFG SYS II/III ME8113 / LAB II-B MFG PROC TECH I/II ME8111	MFG PROCESS TECHNOLOGY II ME2212 / AUTOMATION II ME3311 / LAB II-D AUTOM I/II ME8112 / LAB II-C ELEC µP I/II EE7109 / ELECTRONICS & µP II EE3192 / HONG KONG ENVIRONMENT AP0501
	2	MFG SYSTEMS II ME1111		MFG PROCESS TECHNOLOGY I ME2211 / AUTOMATION I ME3310 / ELECTRONICS & µP I EE3191 / NUMERICAL MATHS AM0109
	1	MFG SYSTEMS I ME1110	BUSINESS FUNCTIONS BM0407	ELECTRONIC PRODUCTS MANUFACTURE ME2210 / LAB II-A (METRO/ ELE PR MFT) ME8110 / METROLOGY ME2213 / INTRO TO PROGRAMMING CS0300 / DIFF EQNS & TRAN ANALYSIS AM0108
	S	Practical Training II in summer (at least 6 weeks in IC)		TI DIPLOMATES
F	3	TECHNICAL COMMUNICATION II EN0142	ENGG MECHANICS II ME2402 / BASIC ENGG MATERIALS AP0402 / LAB I-B (ENGG MECH/ MAT) ME8100 / TECHNICAL DRAWING II CL0105 / BASIC ELECTRONICS EE2090 / LAB I-A (ELE PRI/ BASIC ELEC) EE7090	
	2	TECHNICAL COMMUNICATION I EN0141	ENGG MECHANICS I ME2401 / PRACTICAL TRAINING I IN IC ME5000 (3 1/2 DAYS/WK) / ELECTRICAL PRINCIPLES II EE1092 / BASIC MTDS OF ALGEBRA & CALCULUS II AM0105	
	1	EXPT TECH & REPORT WRITING CL0101	BASIC MECHANICS ME2400 / MFG PROCESSES A ME2200 / MFG PROCESSES B ME2201 / TECHNICAL DRAWING I CL0104 / ELECTRICAL PRINCIPLES I EE1091 / BASIC MTDS OF ALGEBRA & CALCULUS I AM0104	
				HKCEE 'O' LEVELS

Fig. 2. Consolidated course structure—HDME (FT).

(b) Students wishing to discuss any aspect of the overall organization of the programs, are directed to the Course Coordinator.

(c) Students enquiring on any issues related to any particular Part of the programs, would normally contact the Part Tutor concerned.

(c) Students having any general academic and/or personal problems which might interfere with their studies, are encouraged to seek the advice of their Personal Tutors.

(e) A formal consultative process between the students and staff also exists in the form of a Joint Staff/Students Consultative Committee, whose membership includes all the Part Tutors, as well as two students from each year of the FT and PTE modes.

(f) Each Part of the FT and PTE modes of the program is represented by one student each, in another decision-making body, the Course Committee.

PART	TERM	PM	DFM	IA
B2	3	LAB III-C (MRP + MRPII) ME8122		LAB III-C (MRPII + FAT) ME8122
		MANAGING EMPLOYEES IN MFG BM0231	TOOL DESIGN (METALS) II ME2325	FLEXIBLE AUTOM TECH II ME3422
		MFG RESOURCES PLANNING ME1722	TOOL DESIGN (PLASTICS) II ME2323	MFG RESOURCES PLANNING ME1722
	2	PROJECT III ME8322	PROJECT III ME8322	PROJECT III ME8322
		MATERIAL REQ PLANNING ME1721	TOOL DESIGN (METALS) I ME2324	FLEXIBLE AUTOM TECH I ME3421
	1	PROJECT II ME8321	PROJECT II ME8321	PROJECT II ME8321
		FLEXIBLE AUTOM SYSTEMS ME3320	TOOL DESIGN (PLASTICS) I ME2322	FLEXIBLE AUTOM SYSTEMS ME3320
	S	MFG DATABASES & NETWORKS ME3420	MFG DATABASES & NETWORKS ME3420	MFG DATABASES & NETWORKS ME3420
		PRODUCTION CONTROL ME1720	DESIGN FOR MANUFACTURE ME2320	DESIGN FOR MANUFACTURE ME2320
B1	3	PROJECT I ME8320	PROJECT I ME8320	PROJECT I ME8320
			LAB III-C (PEIII) ME8122	
		QUALITY ENGINEERING II ME1222	PROCESS ENGINEERING III ME2222	CONTROL TECHNOLOGY II ME3221
	2	LAB III-B (CAM + QEII) ME8121	LAB III-B (CAM + PEII) ME8121	LAB III-B (CAM + CT) ME8121
		CAM ME2420	CAM ME2420	CAM ME2420
		QUALITY ENGINEERING I ME1221	PROCESS ENGINEERING II ME2221	CONTROL TECHNOLOGY I ME3220
	1	LAB III-A (QET + WDT) ME8120	LAB III-A (QET + PEI) ME8120	LAB III-A (QET + MECH) ME8120
		WORK DESIGN TECH B ME1321	PROCESS ENGINEERING I ME2220	MECHANISATION ME3120
		QUALITY ENGINEERING TECH ME1220	QUALITY ENGINEERING TECH ME1220	QUALITY ENGINEERING TECH ME1220
	S	WORK DESIGN TECH A ME1320	CAD ME2321	CAD ME2321

A2	3	MFG PROCESS TECHNOLOGY II ME2212	LAB II-B MFG PROC TECH I & II ME8111	LAB II-D AUTOMATION ME8112	AUTOMATION II ME3311
	2	MFG PROCESS TECHNOLOGY I ME2211			AUTOMATION I ME3310
	1	NUMERICAL MATHEMATICS AM0109	LAB II-A (METRO/ELEC PROD MANUF) ME8110		ELECTRONIC PRODUCTS MANUF ME2210
	S	DIFF EQNS & TRANS ANALYSIS AM0108	METROLOGY ME2213		HONG KONG ENVIRONMENT AP0501
A1	3	MANUFACTURING SYSTEMS III ME1112	LAB II-E MFG SYSTEMS II & III ME8113	LAB II-C ELECTRONICS & μP EE7190	ELECTRONICS & μP II EE3192
	2	MANUFACTURING SYSTEMS II ME1111			ELECTRONICS & μP I EE3191
	1	MANUFACTURING SYSTEMS I ME1110	BUSINESS FUNCTIONS BM0407		INTRODUCTION TO PROGRAMMING CS0300

Fig. 3. Consolidated course structure—HDME (PTE).

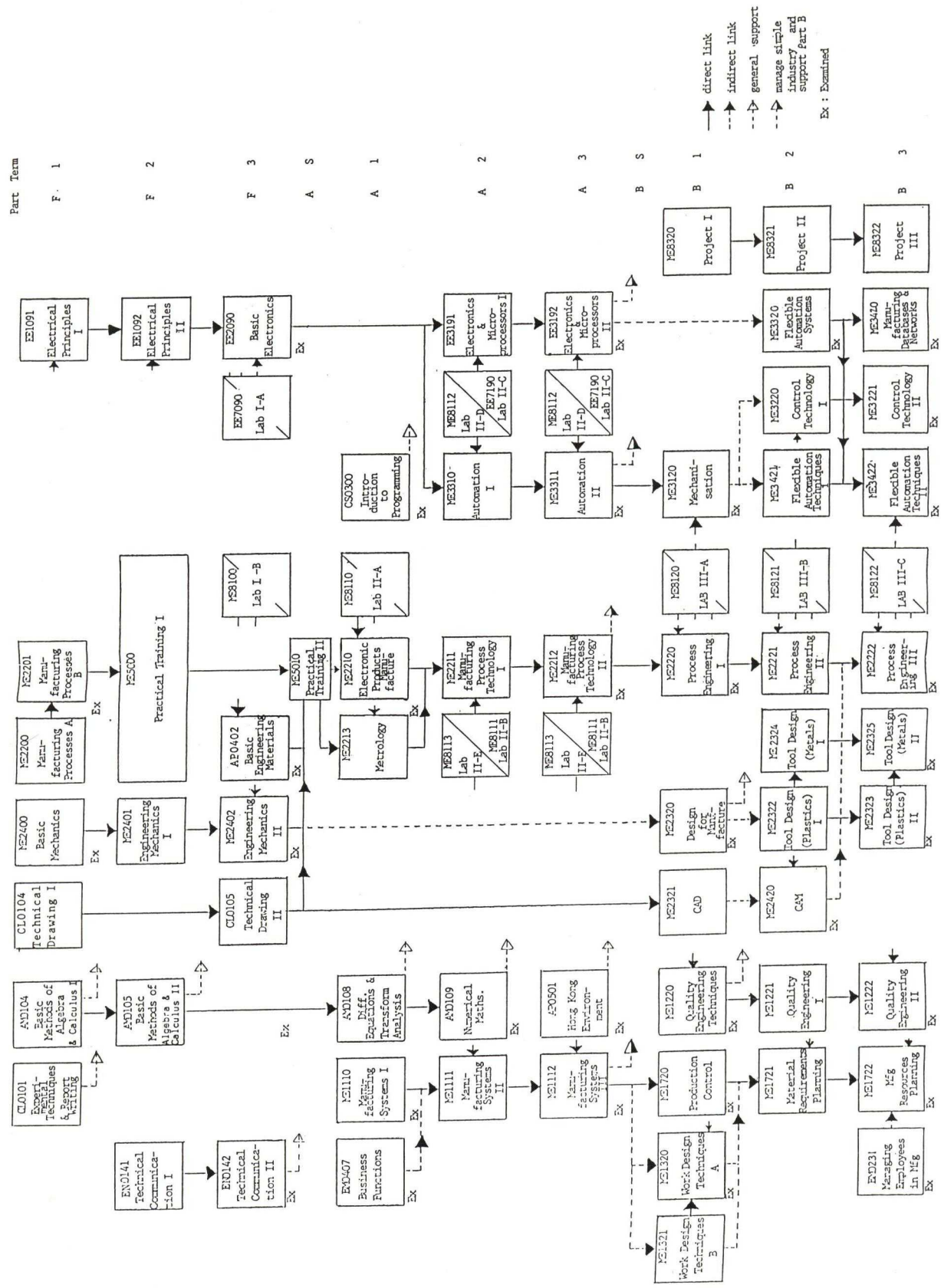

Fig. 4. Flowchart of the entire HDME modules.

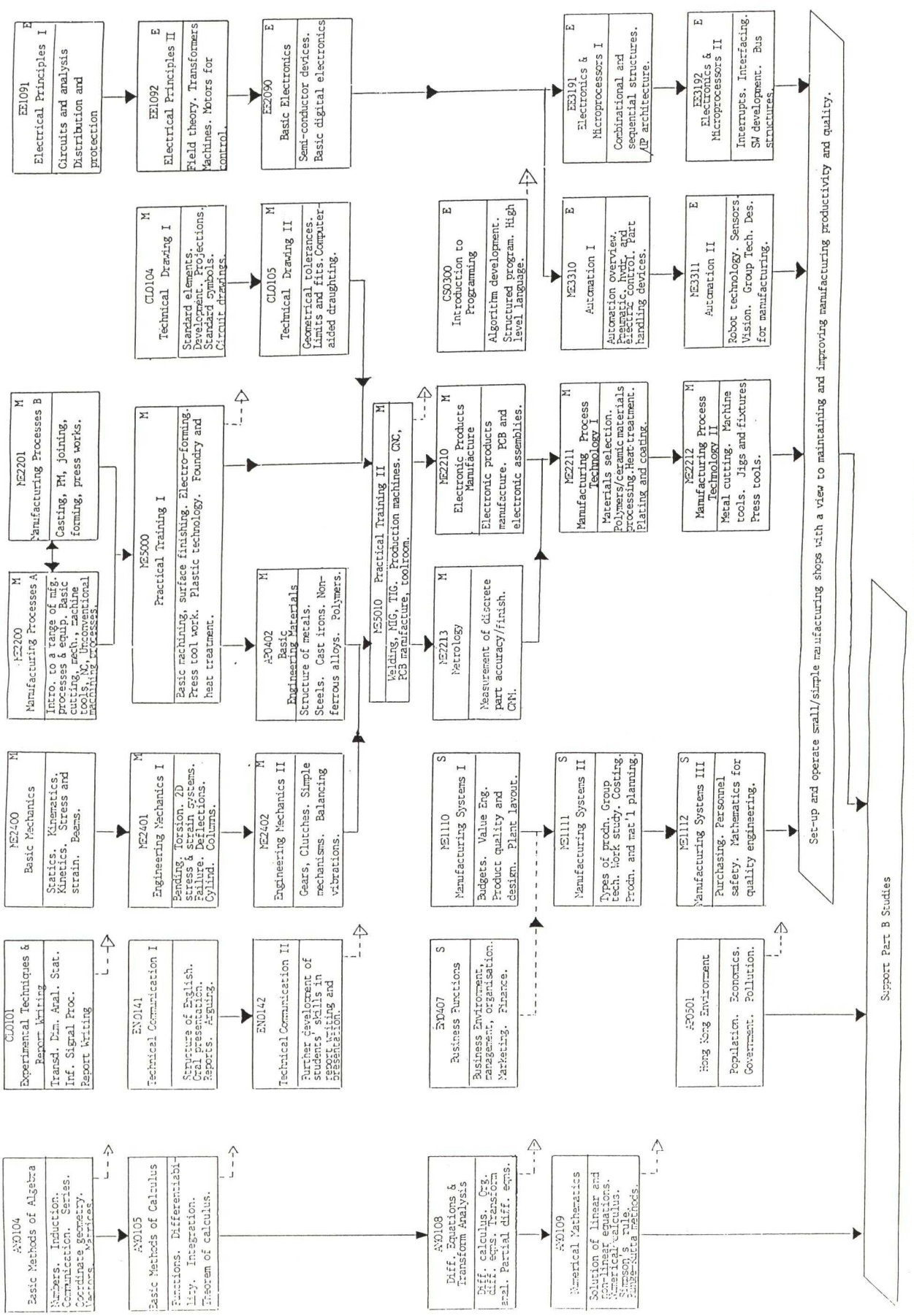

Fig. 5. Flowchart of the Parts F and A modules.

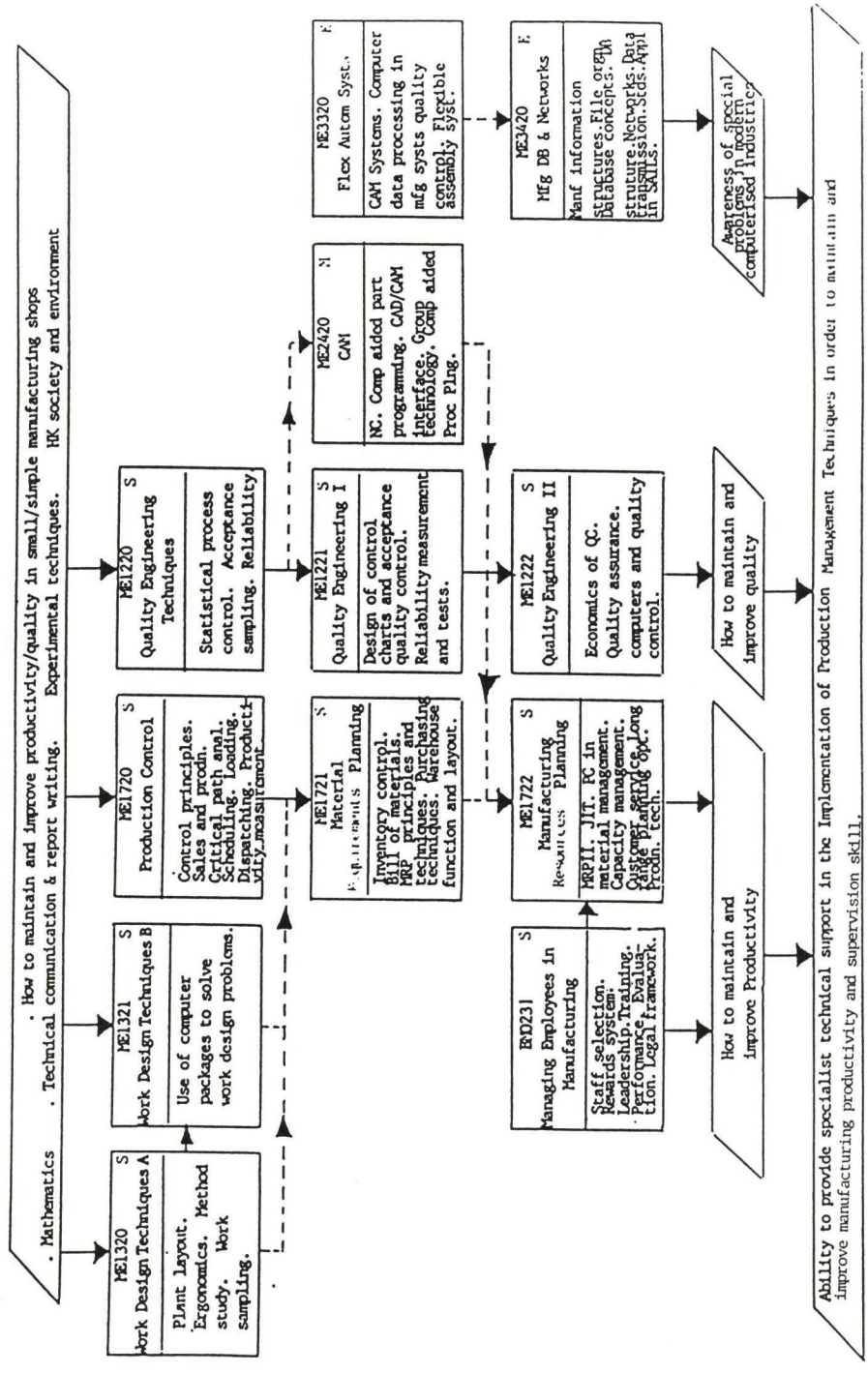

Fig. 6. Flowchart of Part B modules (production management stream).

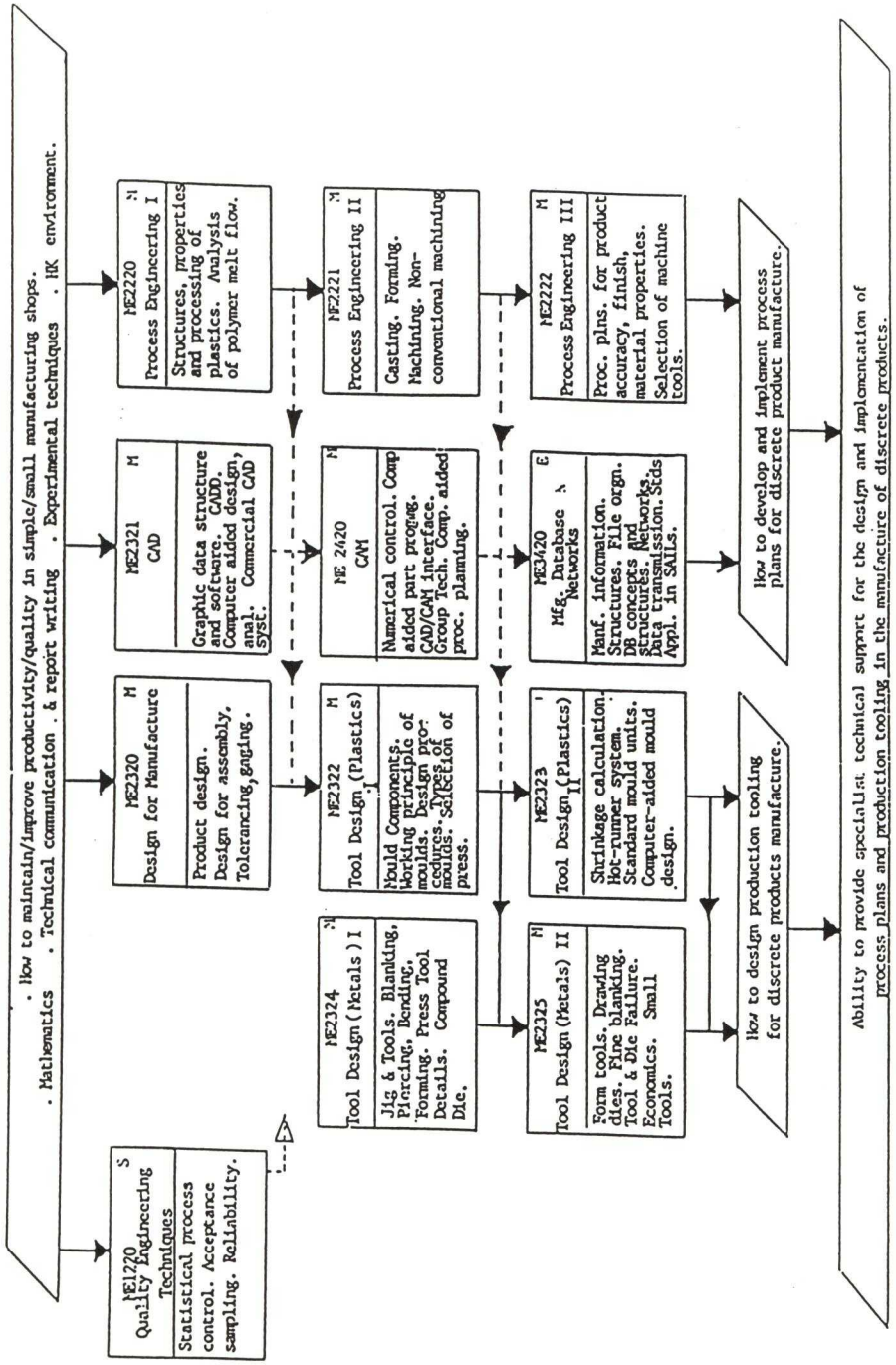

Fig. 7. Flowchart of the Part B modules (design for manufacture stream)

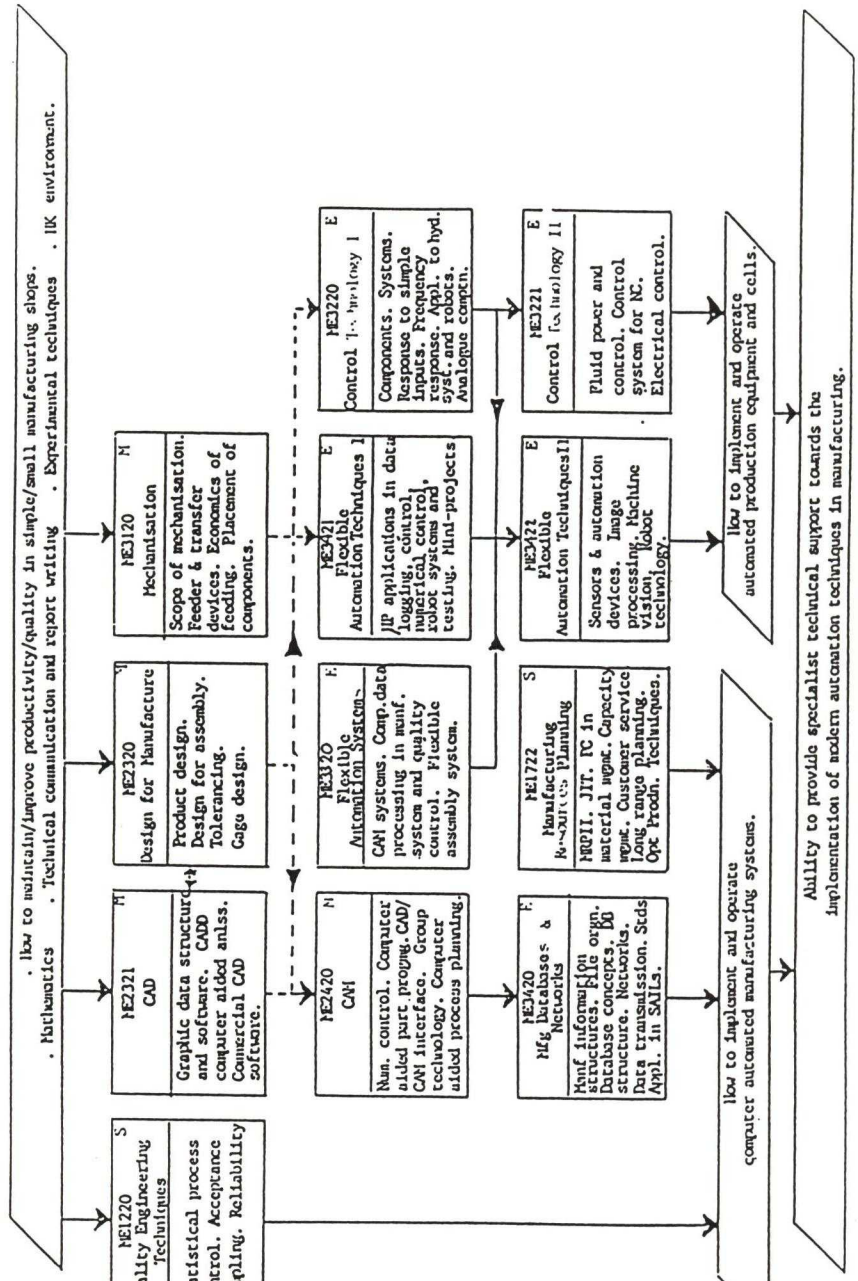

Fig. 8. Flowchart of the Part B modules (industrial automation stream).

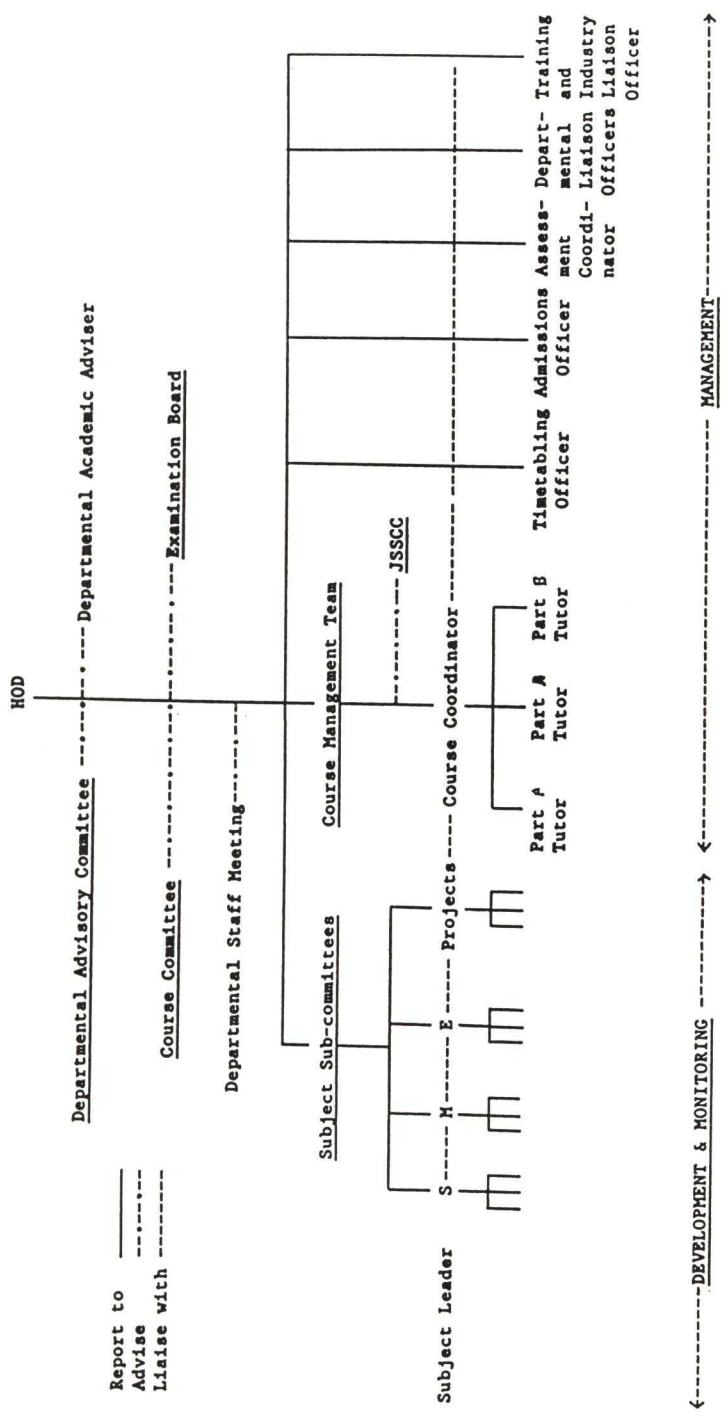

Fig. 9. Organization chart of the course management, development and monitoring.

MARKETABILITY OF GRADUATES

It would seem readily apparent both from the comments so far received from the External Accreditation Assessors of the course, as well as from some leading local industrialists, that the programs are well on course to achieving their desired objectives.

Indications from the various industrial sectors in which the graduates have gained either industry-based final-year projects, or actual professional employment are that, so far, the direction of the programs are, in general keeping in unison with the current prevailing trends in the Hong Kong employment market.

The operators of the programs are therefore confident that on completion of the program, an attainment of the prescribed qualification would signal the introduction of a new breed of knowledgeable, pragmatically skilled, and technically balanced graduates, able to effectively face the demands and challenges of a modern manufacturing industry.

GENERAL DISCUSSION

It is acknowledged that the programs are still at their pioneering stages, and therefore, that the operators are anxious not to sing their praises in pre-emption of reasonable feedback from employers, both actual and potential, of the graduates. Nevertheless, it is felt that the progress currently being made in the implementation and operation of such an innovative program, is a source of joy and pride, not only to the (parent) Department of Manufacturing Engineering, in particular, but also to the entire City Polytechnic of Hong Kong.

It should be borne in mind however, that whilst the operators do constantly strive to improve the innovative aspects of the course, it is nevertheless not claimed that the measures so far introduced are exhaustive, sacrosanct and/or error-proof. In this regard, the operators are always willing to consider (and if thought reasonable), to incorporate any constructive comments and/or criticisms, from anyone, anywhere, anytime.

CONCLUSIONS

An attempt has been made in this paper to present an overview of the mechanics and operational philosophy of a coherent and integrated manufacturing engineering education, in the context of the requirements of the Hong Kong manufacturing industry.

Specifically, it has demonstrated that the programs under discussion prepare the graduates for supervisory and specialist positions for modern manufacturing industries.

The system of streaming students in the final year of the programs into Production Management, Design for Manufacture, and Industrial Automation, offers reasonable scope toward meeting the needs and aspirations of the local industries.

The programs under discussion have been lauded by credible, reputable and prestigious professional bodies, the most notable among which is the Institution of Manufacturing Engineers (UK), for its innovative and ingenious design and operational framework [4].

Indications of the employability of the graduates point to encouraging signs of their potential effectiveness in production management, manufacturing design and industrial automation.

In case of scepticism regarding the immense depth, breadth and calibre of the programs' structure and operatives, it is acknowledged that 'the proof of the pudding is in the eating'. However, the message being sounded here is for such sceptics to 'be patient, time will tell'. So keep the faith babe!!!

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REFERENCES

1. Definitive course document: Higher Diploma in Manufacturing Engineering, Department of Manufacturing Engineering, City Polytechnic of Hong Kong (1988).
2. Definitive Course Document: Bachelor of Engineering (Honours) Degree in Manufacturing Engineering, Department of Manufacturing Engineering, City Polytechnic, Hong Kong (1988).
3. K. V. Patri, Head of Department, Department of Manufacturing Engineering, City Polytechnic of Hong Kong, personal communication.
4. The Institution of Manufacturing Engineers, UK, Communication document, 'B.Eng. (Hons) and H.D. in Manufacturing Engineering' (1990).
5. K. V. Patri, School's In, *Manufacturing Engineer*, July/August, 54 (1990).