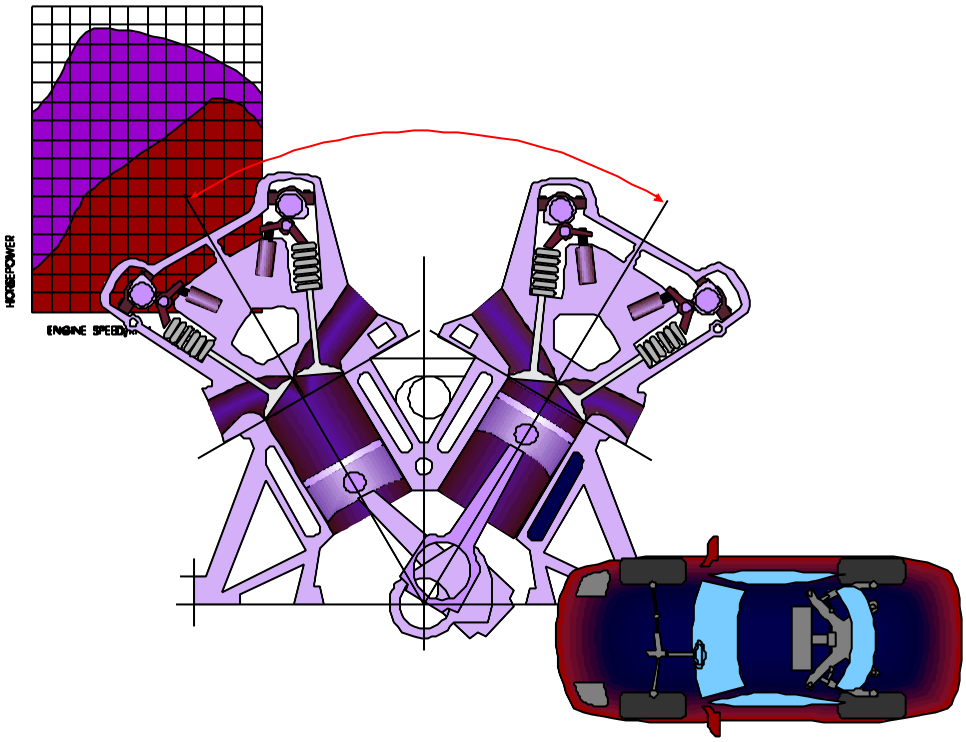
Self Assessment Educational Programme
Mechanical Engineering
1995 – 1999

October 1999

Faculty of Design, Engineering and Production



Self Assessment Educational Programme
Mechanical Engineering
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Delft University of Technology
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1 Introduction

Early in the year 2000 Mechanical Engineering will have a combined education visitation and research assessment.

The Faculty of Design, Engineering and Production regards the education visitation and research assessment as a milestone in the continuous process of quality control in education and research. The results of this assessment will provide important information to direct education and research policy on the basis of past performance and future plans, at faculty level as well as at section level.

The Faculty of Design, Engineering and Production provides three educational programmes, these being:

- Industrial Design Engineering;
- Marine Technology;
- Mechanical Engineering.

In 1997 the faculties of Mechanical Engineering and Marine Technology merged with Industrial Design Engineering to form the Faculty of Design, Engineering and Production. Mechanical Engineering has a number of departments, each comprising a number of sections.

The evaluation of the education programme will be based on the self-assessment report of Mechanical Engineering. Since September 1997 a major renewal of the education programme of Mechanical Engineering has been in progress.

The research assessment will be based on the contents of the research progress reports. The qualitative information was formulated by the programme directors, supervised by the Scientific Advisory Committee.

1.1 Mission of Delft University of Technology

The TU Delft wishes to function as an internationally prominent technological university, both in the field of education and in the field of research. The University is committed to the major social and technical scientific problems and challenges. It contributes to finding solutions for, and wishes to be appealed to in these matters.

1.2 Mission of Faculty of Design, Engineering and Production

The mission of the Faculty of Design, Engineering and Production is to contribute to knowledge, skills, methods and professional attitudes in the fields of Industrial Design Engineering, Marine Technology and Mechanical Engineering. The Faculty aims to achieve this goal through education, research and design to an internationally recognized scientific level, as befits its status as part of Delft University of Technology.

Mechanical Engineering contributes to this mission by the study, innovation and improvement of production, transport, process, energy and biomedical systems and equipment, as well as the related basic sciences.

Industrial Design Engineering contributes to this mission by the study, innovation and improvement of (the development of) durable products for people, on the basis of the integrated interests of users, industry, society and environment.

Marine Technology contributes to this mission by the study, innovation and improvement of ships and floating marine structures designed as for transport, exploitation of the sea and services.

1.3 *Profile of Mechanical Engineering*

1.3.1 Organization

Mechanical Engineering has four departments, which comprise eleven sections. These sections have three major tasks:

- to contribute to the educational programmes;
- to carry out research;
- to contribute to the solution of society-driven problems.

Following on from a traditional study programme involving lectures and practical exercises the faculty has chosen for Thematic Project Education (TPE) which involves a balanced combination of lectures, projects and problem-driven education. The projects are structured around thematic topics (e.g. transport, energy).

The greater part of the research programme is carried out by PhD-students. The objectives of the research programmes are two-fold. Firstly the research aims to generate new scientific knowledge and has to contribute to the technical and economical development of the society. Secondly, the programmes have to support the educational programmes and have to ensure that PhD-students can provide evidence of their ability to carry out research independently. For this reason there are close links between the educational and the research programmes.

1.3.2 Research Programmes

As mentioned above, Mechanical Engineering consists of four Departments in which the eleven sections participate with the research programmes as mentioned in the table below.

Table1-1: Overview of divisions, groups and research programmes

Departments	***Sections***	***Research programmes***
Basic Sciences	Fluid Mechanics; Engineering Mechanics; Micromechanics of Materials; Systems and Control Engineering; Man-Machine Systems. 1)	Fluid Mechanics; Engineering Mechanics; Micromechanics of Materials; Systems and Control Engineering; Man-Machine Systems and Control.
Process and Energy	Refrigeration and Indoor Climate Control; Equipment for the Process Industry; Thermal Power Engineering.	Refrigeration and Indoor Climate Technology; Process Equipment; Thermal Energy Conversion
Transport Technology	Dredging Technology and Bulk Transport; Transport and Logistic Technology. 2)	Dredging Technology and Bulk Transport Dynamics of Vehicle Systems
Design and Production	Production Technology and Organization 1) 3)	Production

1) *The Micro Engineering section ceased to exist in 1998. Part of this section has been integrated in the Man-Machine Systems section. Due to circumstance the work of Micro Engineering has not been submitted for assessment.*
2) *Within the Transport and Logistic Technology section only the programme of Vehicle Technology has been reported on. The workload of the Professor of the Chair of Logistics has been reduced considerably and the programme will be redefined in the near future after the appointment of a new professor.*
3) *It is intended that this section will be merged with the design sections of Industrial Design Engineering to form the new Department "Design and Production".*

The area's of application of the sections and the associated research programmes have been chosen because of their great relevance to society, and because they generate a multitude of challenging scientific questions. As new knowledge very often results from an interdisciplinary approach, the University stimulates research programmes with an interdisciplinary character in which different sections and organizations (within- or outside the faculty) participate. For this reason, projects involving both the application sections and basic sections are encouraged. The research programmes of the basic sections are both fundamental and application orientated.

1.3.3 Participation in research schools and research institutes.

Mechanical Engineering is commissioner of the J.M. Burgerscentrum and the Dutch Institute of Systems and Control research schools, which are approved by the Royal Dutch Academy of Sciences (KNAW), and also participates in seven other research schools. An overview of research schools and of the participating sections is given in the next table.

Table1-2*: Overview of research schools and participating groups*

Research schools	***Participating sections***
J.M. Burgerscentrum	Fluid Mechanics (Secretariat)
Dutch Institute of Systems and Control (DISC)	Systems and Control Engineering (commissioner); Man-Machine Systems
Onderzoekschool Procestechnologie (OSPT) Process Technology Research School	Equipment for the Process Industry
Integrated BioMedical Engineering of Human Function (IBME)	Man-Machine Systems
Polymeer Technologie in Nederland (PTN) Polymer Technology in the Netherlands	Engineering Mechanics; Micromechanics of Materials
Engineering Mechanics	Engineering Mechanics; Micromechanics of Materials
Materiaalkunde Instituut Materials Science institute, Delft, Eindhoven, Groningen (MIDEG)	Micromechanics of Materials
Transport, Infrastructure and Logistics (TRAIL)	Transport and Logistic Technology; Dredging Technology and Bulk Transport
Integrale Produkt Vernieuwing Integral Product Renewal	Production Technology and Organization; Engineering Mechanics
Waterbouw Hydraulic Engineering	Dredging Technology and Bulk Transport

Furthermore Mechanical Engineering participates in the International Research Institute for Simulation, Motion and Navigation (SIMONA), the Koiter Institute Delft, Group for Offshore Technology (WOT), Institute for Wind Energy and the Delft University Clean Technology Institute (INTERDUCT).

1.3.4 Infrastructure

In the present situation the research laboratories are situated at 13 different locations in three different buildings. In 1999 a major housing and renovation operation was started. At the end of this operation, which will take approximately 3 years, Mechanical Engineering will have moved to the southern part of the building, thus making space for Industrial Design Engineering to move to the northern part of the building. The number of laboratory locations will be reduced to four. The laboratory for Basic Research will include the facilities for Fluid and Solid Mechanics, Systems and Control Engineering, Man-Machine Systems and Ship Structures. The second laboratory, for Mechanical Engineering, will comprise facilities for Production Technology, Transport Technology (including Dredging and Bulk Transport), Thermal Power Engineering, Refrigeration and Indoor Climate Control. The laboratories of Equipment for the Process Industry and Ship Hydromechanics (towing tank) will remain at their present locations.

The building for practical education will be situated between the two main laboratories. This building will provide accommodation for design studio's, computer rooms, a manufacturing centre and the student education laboratories for mechatronics and thermodynamics. The design studio's of Marine Technology will be located on the first floor on the right side of the main entrance.

On the ground floor accommodation will be created for 42 project work units as well as eight meeting rooms for student project groups.

Furthermore Mechanical Engineering and Marine Technology will share three workshops: a mechanical engineering workshop, an electronics workshop and an instrument workshop. The Equipment for the Process Industry Section has its mechanical engineering workshop in its present location. For the Ship Hydromechanics laboratory a workshop is provided for the production of models.

1.3.5 Financial flexibility permitting new research and education policy.

In order to stimulate new initiatives in education and research the faculty has created a "renewal fund" (beleidsruimte). The budget (approximately NLG 1,300,000 per year) of this fund is used by the Dean to stimulate new developments and to improve the infrastructure for both education and research. In addition to this "renewal fund" of the faculty the University has two sources of funding for new education and new research.

For education the source is the "Education renewal fund" (Onderwijs stimulerings fonds). For research the University has created the Delft Interfaculty Research Centre's (DIOC's).

During the last three years a major investment has been made in "Thematic Project Education". This has been financed by the faculty "Renewal fund" and the University "Education renewal fund". Approximately NLG 5,000,000 has been invested in the following facilities:

- project work units and PC-computer infrastructure;
- presentation equipment in lecture rooms;
- mechatronics laboratory;
- thermodynamics laboratory;
- PC instruction and examination rooms;
- CAD workstations.

There are plans to renew the manufacturing centre.

The faculty participates actively in a number of DIOC's, which in particular stimulates interdisciplinary research. Mechanical Engineering participates in the following DIOC's:

Table1-3*: Overview of DIOC's and participating groups*

Name of the DIOC-programmes	***Participating sections***
Mastering the molecules	Equipment for the Process Industry Systems and Control Engineering
Minimally Invasive Surgery and Intervention Technology (MISIT)	Man-Machine Systems (commissioner)
Development of improved endoprotheses for the upper extremities (DIPEX)	Man-Machine Systems (commissioner) Engineering Mechanics
Micromechanics for macroscopic lifetime optimization	Micromechanics of Materials
Design and management of infrastructures	Systems and Control Engineering
Freight automation	Transport and Logistic Technology

In addition to the DIOC's the faculty has recently decided to stimulate new research on Thermal Power Engineering (additional budget NLG 1,000,000) and Production Technology (budget to be determined in the near future).

In 1998 the Ministry of Science and Education put NLG 4,000,000 at the disposal of the three Technical Universities to finance a number of Chairs in Mechanical Engineering in order to re-establish these Chairs at an early date and to stimulate new research. The faculty has obtained funds for two chairs: Man-Machine Systems and Transport and Logistic Technology.

To strengthen research in the field of Engineering Mechanics, the University has set up the "Koiter Institute", in which Aerospace Engineering, Civil Engineering and Mechanical Engineering sections are participating. Within the framework of the "Koiter Institute" the Executive Board of the University has donated funds to finance a Chair of "Engineering Dynamics" for a period of five years.

1.3.6 Human Resources Policy

Since 1998, the Chair of each section has to submit a policy plan for the section to the Dean.

This policy plan includes the plans of the section for the development of the education programme, research development, participation in research schools, external fund raising, scientific output, infrastructure (laboratory and computer facilities), personnel and the financing of the section. Each year the realization of the policy plan is evaluated and the results are discussed with the Chair.

With regard to personnel the plan involves proposals for:

- personnel planning in relation to the education and research programme;
- recruitment of new personnel; type and qualifications;
- education, training and the mobility of present personnel.

The Personnel and Organization Section offers professional assistance for this activity. Every year the performance of each employee is assessed. During an annual discussion between the employee and his manager agreements are made about the professional and personnel development of the employee. These agreements are recorded and monitored by the Personnel Department.
The faculty strives for a balanced age distribution of the personnel and tries to take this into account when recruiting new personnel. When recruiting new professors the faculty strives to attract internationally recognised candidates.

The faculty tries to create optimal conditions for the members of the academic and supporting staff to perform to high standards, both in education and research. In order to achieve this goal each year during the discussion of the assessments the possibilities for the further education and training of personnel are examined. This topic is also included in the policy plan of each section.
The "Van Leeuwenhoek" programme, for which the University has made funds available, provides an opportunity to appoint a limited number of employees of proven excellence as professors. Thus the programme tries to prevent "top talent" from leaving the University. The faculty received funds for two Chairs in the fields of Engineering Mechanics and Biomedical Engineering.

New staff members are recommended to follow courses on didactics. Members of Staff are encouraged to carry out a PhD study. A doctorate enhances their prospects of promotion to the rank of associate professor. Usually it is not possible to become an associate professor without proven excellent didactic capabilities and a research achievement comparable with a doctor's degree.

The achievements of PhD students are regularly assessed, especially at the end of the first year, when there is a go-no go point. At the beginning of the PhD study a plan is drawn up containing lectures to fill in gaps in their knowledge. The faculty provides opportunities to follow courses on how to write a thesis, how to present papers at international gatherings and how to apply for a job after the award of the doctorate.

Furthermore, the faculty makes use of the opportunities created by university funds to recruit research fellows and guest professors from abroad, and of the possibilities offered by the KNAW-fellowship programme to contract young researchers, called KNAW-fellows. After a period of four years KNAW-fellows are appointed to tenured positions on the staff of the faculty. These fellows and guest professors play an important role in the renewal of education and research as well as in the development of the staff.

1.3.7 Quality Control

Education

The educational programme of Mechanical Engineering uses different instruments for the quality control of the individual courses and projects and for the curriculum as a whole. On an annual basis Mechanical Engineering reports to the Board of the University through the AKO (Advisory Committee Quality of Education). This reporting has different purposes, long term (5 years) educational strategy, short term (1 year) educational development programmes, quality control and funding of curriculum development. The AKO was founded in 1997 as an advisory committee for the Executive Board of the University.

In 1998 a quality control project was funded by the Dutch government to develop a quality control system for Mechanical Engineering and Marine Technology. This project started in 1999. Various instruments are used for quality control, but the current system is not yet consistent and sufficiently structured to meet the requirements of the AKO.

The most important instruments for quality control currently used by Mechanical Engineering are:

1. The university wide course evaluation system (mainly for courses, after each course)
2. The project evaluation system used for Thematic Project Education (once per project)
3. The course response system used for courses in the BSc phase (every 2 weeks)
4. The yearly curriculum evaluation
5. The "more than consumer guide" (yearly [3])
6. Personal observations and impressions of the education management.
7. Countrywide and university wide inquiries (Hogere Onderwijsgids, Elsevier, NIPO)

The quality control system being developed is intended to make the system used visible and controllable to the students, the teaching staff and the management and to detect and eliminate gaps in the system. It is expected that the system will be developed and partly implemented during the course of 1999/2000 and fully implemented during the course of 2000/2001.

Research

The Scientific Advisory Committee for Mechanical Engineering monitors and evaluates the research programmes of the sections within it. The committee advises the Dean of the Faculty on important issues related to the research, such as the desirable research profile for vacant chairs and strategic policies.

As Mechanical Engineering considered the assessment period of five to six years too long for its policy making process, in 1997 it decided to introduce a peer review system, largely based on the same principles as the Research Protocol of the VSNU. To perform this peer review the research was divided into research programme’s. For each programme, the objectives, the results and a list of publications during the period 1993 to 1996 were drawn up and sent to five peers, mainly abroad. Most of the peers were selected on the recommendations of the programme directors, although several more were added by the faculty management. For this reason one has to interpret the results with caution. The additional comments of several peers, which were passed on to the research sections, were of great value.

The peers were asked to give their opinions on the aspects of scientific quality, scientific productivity, scientific relevance and long term viability on a scale varying from excellent to very poor. About 85 % of the peers responded.

The results of the peer review, which are available for the review committee upon request, were discussed with the sections concerned .

1.3.8 Key data of Mechanical Engineering

1a	University	:	Delft University of Technology		
1b	Faculty	:	Design, Construction and Production		
1c	Subfaculty	:	Mechanical Engineering		
2	Divisions	:	<u>Groups</u>		
	Basic Sciences	:	Engineering mechanics; Micromechanics of materials; Fluid mechanics; Systems and control engineering; Man-Machine systems and Control.		
	Transport Technology	:	Dredging and bulk transport; Transport and logistic technology		
	Process and Energy	:	Refrigeration and indoor climate control; Equipment for the process industry: Thermal power engineering.		
	Design and Production	:	Production technology and organization		
3a	Research institutes (commissioner)	:	Delft University Clean Technology Institute (INTERDUCT)		
3b	Research institutes (participant)	:	SIMONA Koiter Institute Delft; Group for Offshore Technology (WOT); Institute for Wind Energy.		
4a	Research schools (commissioner)	:	J.M. Burgerscentrum; Dutch Institute of Systems and Control (DISC).		
4b	Research schools (participant)	:	Onderzoekschool Procestechnologie (OSPT); Integrated Biomedical Engineering of human function (IBME); Polymeer Technologie in Nederland (PTN); Engineering Mechanics; Materiaalkunde Instituut Delft, Eindhoven, Groningen (MIDEG); Transport, Infrastructure and Logistics (TRAIL); Waterbouw; Integrale Produkt Vernieuwing.		
5	Education programmes	:	Mechanical Engineering		
6a	Income in 1998 (in NLG x 1000)	:	direct funding	:	31.977
			NWO-funding	:	1.850
			contract research	:	8.500
6b	Costs in 1998 (in NLG x 1000)	:	personnel costs	:	31.153
			other costs	:	10.580
7a	Human resources in 1998 (in FTE)	:	academic staff	:	169
			supporting staff	:	123
7b	Students 1998/1999	:			1215

8 Research programmes submitted for evaluation

		input academic staff (fte)
1	Fluid Mechanics	12.1
2	Engineering Mechanics	6.9
3	Micromechanics of Materials	7.6
4	Systems and Control Engineering	8.3
5	Man-Machine Systems and Control	9.5
6	Refrigeration and Indoor Climate Technology	5.3
7	Process Equipment	22.8
8	Thermal Energy Conversion	5.8
9	Dredging Technology and Bulk Transport	3.7
10	Dynamics of Vehicle Systems	3.1
11	Production	5.1
	Total	90.2

2 Programme Philosophy

2.1 Mission of the education of Mechanical Engineering

In relation to social and technological developments in society and in accordance with the strategic vision of Delft University of Technology, the Faculty of Design Engineering and Production formulated the following mission with respect to the education of mechanical engineers:

The education of highly qualified mechanical engineers, with a high level of technical and scientific knowledge and abilities, who can carry the responsibilities for their activities towards society. These Mechanical Engineers have the ability to design and to innovate. They also have the ability to continue their education and to ensure their functioning in the future.

With its educational and research programme, the Mechanical Engineering Division wants to make a substantial national and international contribution to the education of highly qualified Mechanical Engineers. Co-operation with other universities, research institutes and companies, is also encompassed within this objective.

2.2 Qualifications of the Mechanical Engineer.

Mechanical engineering is the technical science that deals with mechanical systems and processes and the associated equipment that enables the social and technological development to proceed.

In addition to the technology, attention is also paid to the logistic, economic and managerial aspects of the field of study.

The academically educated Mechanical Engineer has the ability to apply scientific methods and means to the solution of technological, scientific and social problems related to the field of mechanical engineering. This problem-solving ability is one of the most important aspects.

The academically educated Mechanical Engineer is capable of personally carrying the responsibility of his/her activities.

The academically educated Mechanical Engineer carries out assignments as a scientist, as a designer/developer, as a technical or project manager, as a technical/commercial consultant or as a teacher. During course of the career of the Mechanical Engineer, the content of the work may shift from the technical to the managerial side.

The Delft University Mechanical Engineer should be a scientifically-thinking, problem-solving engineer. The ability to translate theoretical knowledge into solutions to problems is of much greater importance than the area of the problem. The process of problem solving is the main issue.

To gain a thorough command of the problem solving process, it is necessary to have excellent theoretical knowledge and the skills to apply this knowledge.

2.3 The programme philosophy.

Since the learning methods and the capabilities of each student differ, the perfect teaching methodology does not exist. Choices can be made between inductive (bottom up) and deductive (top down) learning and between the means of implementation, like classical lectures and project or problem based education. Depending on the character of the knowledge or skills to be taught and on the capabilities of the student, there may be an optimum teaching method for the student in question.

The Mechanical Engineering Division of Delft University of Technology is convinced that the teaching system should be focussed on the learning abilities of the student and not on the teaching abilities of the scientific staff. The teaching should be student-centred and the teaching staff should adapt itself to this principle.

The Mechanical Engineering Division of Delft University of Technology is also convinced that it is the aim of the education to focus on the knowledge and skills a student possesses at the time of graduation. This implies optimization of the curriculum as a whole and not sub-optimization of individual courses or projects.

This process of optimization also aims to obtain a high efficiency, a short average time between starting the study programme and graduation and high motivation of the students.

Depending on the type of knowledge, inductive or deductive teaching methods or a combination of these has to be used. Theoretical knowledge requires that the student undergoes a process of growth and learns how to acquire profound knowledge. This usually requires the use of inductive methods, while the skills to put the knowledge to practical use can be acquired by following deductive methods. Encyclopaedic technical and non-technical knowledge and skills can best be taught by deductive methods. It is not the aim of the academic engineer to memorise such information, but rather to be able to use his knowledge and experience in the context of tackling scientific, technical or social problems. This is also the case with non-technical knowledge and skills like economics, management, law, ethics, environmental issues and sustainability. These aspects of mechanical engineering knowledge and skills should also be placed in the context of scientific, technical or social problems.

From these points of view, the Mechanical Engineering Division has developed Thematic Project Education (TPE) for the general part of the curriculum.

The width of the field of study of mechanical engineering led the Faculty to decide to split the 5-year MSc study into a general phase of 3 years (Kandidaats or BSc) and a specialization phase of two years (Ingenieurs or MSc).

Thematic Project Education is comprised of approximately 50% lectures and 50% projects. The projects are supported by introductory lectures and briefings and have a project or problem based character. TPE is founded on the philosophy that students have to develop their problem-solving ability to an academic level. In this approach, methodology is just as important as knowledge and skills.

The theoretical (inductive) courses comprise Mathematics, Solid and Fluid Mechanics, Materials Science, Thermodynamics and Control Engineering.

The project and problem based education comprises the non-theoretical, economic, managerial, ethics, environmental issues, sustainability and social subjects and the skills to make the theory operational.

Figure 2-1 shows a scheme of the Mechanical Engineering Education Programme.

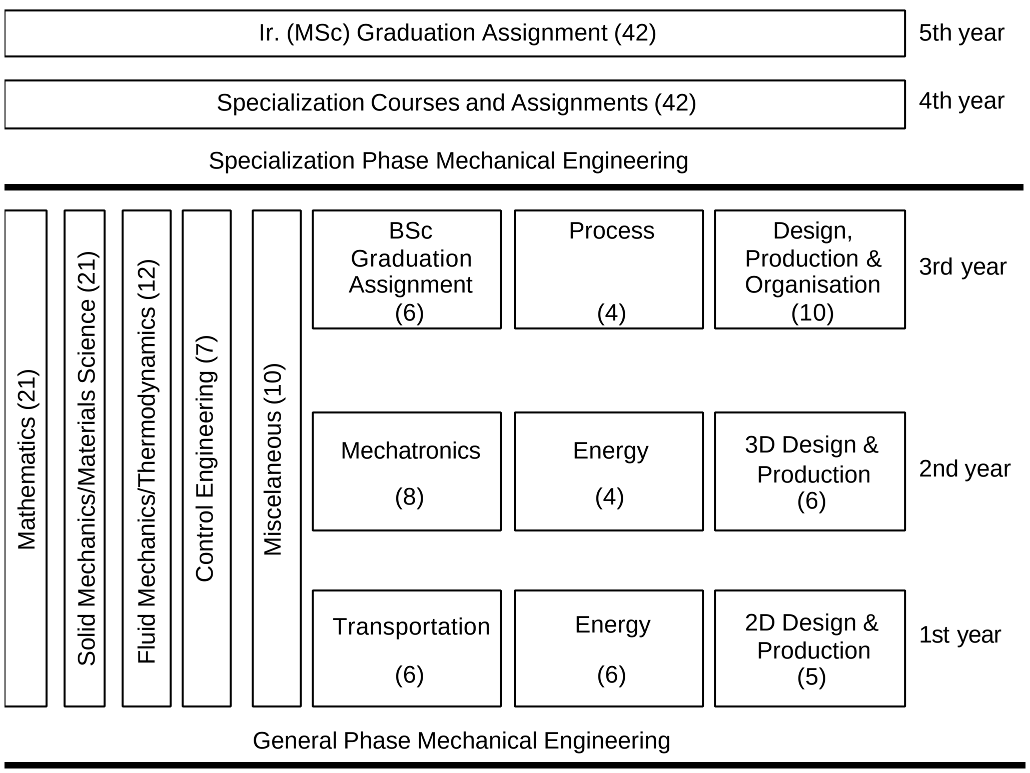

Figure 2-1: The educational programme
(The figures between brackets indicate the number of credit points).

Thematic Project Education is based on four fields of interest (themes) that the Mechanical Engineering Division is focussed on: Transportation Engineering, Process & Energy, Mechatronics and Design and Production & Organization. These four fields of interest form the basis of the themes as implemented in the general part of the study and reflect the width of the Mechanical Engineering Division. A theme can be subdivided into smaller projects; each of a project or problem based character. These small projects, however, are coherently based on a few main teaching objectives and one main subject. This results in a series of projects that have to be carried out sequentially. Over the years, the teaching objectives will stay the same, while the project subjects change e.g. every two years within the scope of the theme, to match the actuality. The integration of theoretical and non-technical issues is called 'Theme Linking & Embedding' (TLE).

To explain TPE a short description of the Transportation & Energy themes followed in the first year will be given. In 97/98 and 98/99, the Transportation theme was based on the container transportation process, where the movements of containers were considered from a ship via a container terminal to their final destination. In 6 small projects the student had to look at the logistics of the terminal, at the design, construction and systems engineering of different types of equipment used and at the non-technical issues like the responsibility for accidents occurring at a terminal. In 99/00 and 00/01 a virtual Paris Dakar race will be considered, again encompassing the logistics, the equipment, the planning and the organization.

The Energy theme for 98/99 and 99/00 is based on natural gas from exploitation to end-user. Some issues that are covered, are the world wide energy issues, environmental issues, a system description and the equipment required.

Projects are carried out by groups of 8 (1st year), 4 (2nd year) or 2 (3rd year) students. Two mentors, a member of the staff and a 3rd or 4th year student guide each group.

The projects are developed by the scientific staff under the guidance of a theme co-ordinator. The scientific staff developing the projects includes a specialist on the subject and members of the staff who give the theoretical courses. This guarantees that the content of the theoretical courses is linked to and embedded in the projects.

The projects are completed by the submission of a report, an Internet or poster presentation or an oral examination. The theoretical courses are followed by the traditional written examinations.

The choice and the implementation of Thematic Project Education guarantees the width and the multidisciplinary character of Mechanical Engineering. The concept satisfies the objective of flexibility and familiarises the student with the fields of interest of mechanical engineering Division in the general phase. Selection takes place by means of the theoretical courses in the propaedeutic phase, although there is no binding advice on the continuation of the study.

Because of the daily contact between staff and students, the concept also guarantees online monitoring of the educational processes.

The chosen educational concept requires that the members of staff develop a new way of working and thinking. The education is no longer teacher-centred, but is now student-centred. The education of the staff still requires a lot of attention, as does the embedding of TPE in the organization of the faculty. This is especially true with respect to the roles of the theme co-ordinators, the staff who develop the project assignments and the staff who supervise the students as they work on their assignments.

When a student has completed the general phase of the Mechanical Engineering curriculum (the Kandidaats or BSc phase), the specialization phase (Ir. or MSc phase) follows. It is the custom and also an objective of the Delft University that every student who satisfactorily completes the BSc phase will also carry out the MSc phase, leading to the award of the Degree of Ingenieur (MSc). The specialization phase of two years comprises specialization courses, a practical training period and a graduation assignment. In the Mechanical Engineering Division there are twelve possible specializations, sometimes with sub-specializations (see Chapter 4).

3 Goals, aims and objectives.

The final goals of the Mechanical Engineering education programme describe the aggregation of knowledge, understanding, skills and attitudes of the graduate Mechanical Engineer, who is prepared for his/her first professional position and who has the capacity for further development during his/her professional career. These goals are made attainable by relating them to specific courses, to projects within themes and to the theses of students following the Mechanical Engineering Education Programme. The high demands of modern technological developments and of society require that the graduate mechanical engineer should possess the following qualities:

1. A solid grasp of the basic engineering sciences including their generic and instrumental functions.
2. A broad knowledge and understanding of the related engineering sciences and their applications in mechanical engineering.
3. A broad and thorough knowledge and understanding of mechanical engineering disciplines and of the skills required in the practice of mechanical engineering
4. Knowledge of and insight into general engineering practice and in particular to mechanical engineering applications.
5. A scientific technical attitude to professional problem solving.
6. Communication skills.
7. Understanding of the context in which mechanical engineering is practised.
8. Understanding of his/her own capacity and interest.

3.1 A solid grasp of the basic engineering sciences including their generic and instrumental functions.

The basic sciences have to be restricted to those subjects that are of interest in the field of mechanical engineering, these are:

1. Mathematics (analysis, differential equations, linear algebra, statistics & probability and numerical analysis)
2. Thermodynamics and fluid mechanics
3. Solid mechanics (statics and dynamics) and materials science
4. Systems and control engineering

The knowledge of the basic sciences is generic and not object-related. It basically concerns the physics and mathematics for engineers. The mechanical engineer requires considerable skills to make use of this knowledge in the typical engineering disciplines. The depth must be sufficient for understanding of the interconnections and coherence between the typical engineering subjects. The in-depth knowledge should be used in physical and mathematical modelling. The teaching method followed for the basic sciences is the provision of inductive theoretical courses. The results of these courses form the main selection criteria in the propaedeutic phase.

3.2 A broad knowledge and understanding of the related engineering sciences and their applications in mechanical engineering.

The related engineering sciences are those engineering subjects that will confront the Mechanical Engineer in high-tech industry and society, these are:

1. Electricity
2. Chemistry
3. Informatics

Usually it is the Mechanical Engineer who has to use the engineering sciences of related fields of interest. The Mechanical Engineer requires enough knowledge and skills in these fields, to be able to communicate about them the other specialists. The Mechanical Engineer has to be able to use his knowledge on these subjects to solve ‘state of the art’ problems and requires the skills to apply his knowledge in new situations by using functional problem analysis and by the selection of the appropriate technology. The Mechanical Engineer requires the skill to follow and absorb new developments in these fields of interest and apply them where appropriate.

The teaching method followed for the general engineering sciences is a combination of deductive TPE and inductive courses.

3.3 A broad and thorough knowledge and understanding of mechanical engineering disciplines and of the skills required in the practice of mechanical engineering.

The mechanical engineer requires a broad and thorough knowledge and understanding of the demands of the design and manufacturing of mechanical engineering systems, equipment and tools, which are:

1. Engineering mechanics, strength of materials and constructions
2. Manufacturing methods
3. Design methods, including 2D and 3D CAD
4. Mechatronics, including instrumental electronics, sensors, actuators and informatics
5. Systems and equipment (including drives, transmissions and construction elements)
6. Production, maintenance, management and organization
7. Operational use

Irrespective of their specialization, in the final phase (Ir./MSc phase), all students have to be familiar with the most important mechanical engineering disciplines . A broad scope in the BSc phase is given priority, rather then a narrow in-depth focus. During the MSc phase, the focus is narrowed to a more restricted field of interest within The Mechanical Engineering Division. In this phase the required depth is prescribed by the final thesis.

The teaching method used for the Mechanical Engineering Division disciplines is mainly deductive TPE with some inductive introductory courses and briefings. Basic engineering sciences and related engineering sciences are implemented by using TLE.

3.4 Knowledge of and insight into general engineering practice and in particular to mechanical engineering applications.

The mechanical engineer requires knowledge and insight into general mechanical engineering applications. The main fields of interest are:

1. Transportation engineering
2. Energy and climate engineering
3. Chemical process engineering equipment
4. Mechatronics
5. Design, production and organization

These fields of interest are implemented as TPE in the general phase (BSc phase) of the curriculum. The projects include the application of theoretical knowledge to practical mechanical systems and equipment, the demonstration of hardware and training in the skills needed for various applications and training in independent and group-wise problem solving. These applications give the student opportunities for orientation in the fields of interest of The Mechanical Engineering Division (transportation engineering, energy and design and production during the propaedeutic phase).

3.5 A scientific technical attitude to professional problem solving.

The Mechanical Engineer has to be able to recognize, formulate and to analyze engineering problems independently and to offer one or more acceptable solutions. In general, a typical technical problem is not restricted to a single discipline. General mechanical engineering problems are multidisciplinary and also contain non-technical components (e.g. ethical, environmental, managerial, economics and social components). Preferably physical and mathematical modelling and the use of mathematical and numerical methods will be part of the work. The development of problem solving capabilities is a process that extends over many years, even beyond the graduation of the student.

At The Mechanical Engineering Division Delft, this approach is incorporated in TPE and starts in the first year. In the third year it is tested as part of the BSc assignment. The fifth year is occupied by the MSc assignment during which the capabilities developed will be tested at an academic level.

The problem-solving methodology of a typical engineering problem consists of:

1. Defining the context of the problem
2. Defining the problem
3. Making a project planning
4. Problem analysis, including a literature survey and consultation of experts
5. Identifying the ‘blanks spots’, the unknown issues
6. Filling in the blanks
7. Make a survey of known solutions
8. Generating new solutions
9. Choosing the optimal solution based on arguments, simulation and testing
10. Designing, constructing and implementing the chosen solution
11. Reporting and transfer of conclusions and solutions

Of course these steps will not necessarily be sequential, many times it is an iterative process.

3.6 Communication skills.

The Mechanical Engineer has to be able to communicate with colleagues from different disciplines as well as with people with a non-technical background. After graduating he/she will probably work in a team of specialists and/or manage people with different levels of education and backgrounds. The student has to become familiar with the different aspects of communication, including oral and written communication, discussion techniques and various types of presentation. Communication via e-mail and the Internet also plays an important role in TPE. Every student is given an e-mail and Internet account and if required also a telephone or direct cable account for home use, free of charge. Most student apartments are, or soon will be, equipped with a direct cable connection. Communication is one of the strongest aspects of TPE. From the first moment a student starts the education course in mechanical engineering he/she studies in groups/teams of students and has to present the work carried out both orally and in written form, either individually or with the group. The final BSc and MSc theses will be completed by an individual oral presentation.

3.7 Understanding of the context in which mechanical engineering is practised.

The mechanical engineer requires knowledge and understanding of the most important actors in the mechanical engineering industry (national as well as international) and institutes and of their mutual relations. A basic understanding of the context in which engineering is practised is required, including:

- Economics
- Organization and management
- Law
- Ethics and environment
- Customer and social needs
- History

The Mechanical Engineer requires insight into the portfolio of the mechanical engineering branch including:

- Types of industry, customers, research institutes, government institutes, education and their mutual relations
- Sub-divisions of companies and organizations and their mutual relations
- Relations between the mechanical Engineering branch and society

Economics is not restricted to cost awareness and whether or not a product is cost-effective.

These subjects are focussed on the first entry-level to professional positions.

These subjects are implemented in the TPE during the first phase (BSc phase), in 4th year specialization courses and in the MSc assignment.

3.8 Understanding of his/her own capacity and interests.

In view of his/her forthcoming professional career, the mechanical engineer has to obtain insight into his/her own capabilities and interests. This insight will be mainly attained during the final phase of the study. The width of the general part of the study gives the students a chance to become oriented on the specific fields of interest. The final phase of the study increases this insight by means of the specialization programme and the graduation thesis for the MSc degree. Usually during the final phase the student has a possibility to carry out practical work and visit industry. In many fields of interest this can be carried out abroad.

3.9 Summary and conclusions.

The mechanical engineer must be prepared for a broad range of engineering duties in various mechanical engineering or related fields of interest. The final objectives 1-8 have to ensure that the graduated mechanical engineers possess the following attainments:

- A broad technical education, including a good understanding of design and manufacturing processes
- Accessibility to a broad range of employment positions
- Sufficient flexibility in the professional career
- Ability to think critically and creatively
- Understanding of the context in which engineering is practised
- Good communication skills
- Ability to function in a team
- Curiosity and a desire for life-long learning
- Good problem solving capabilities

These qualities should ensure that they have access to a broad range of career openings.

As prevously stated in this chapter, the acquisition of good problem-solving abilities encompasses the other attainments that have been mentioned even if the types of problem are not restricted to engineering problems. It is the understanding of and the attitude behind the methodology applied to problem solving and not merely the knowledge, on which the reputation of the graduate of Delft (Mechanical Engineering) is based. The academic knowledge has to be considered as one of the tools necessary to develop the problem- solving capabilities to an academic level.

4 Educational programme.

4.1 Introduction.

During the last decade there have been a number of extensive changes in the curriculum. Until 1982 there was a 5-year curriculum with a 3-year general phase and a 2-year specialization phase. There was a propaedeutic examination after 1 year, a Bachelor's degree level (kandidaats) examination after 3 years and a Master's degree level (ingenieurs) examination after 5 years. According to this system the graduate engineer had an opportunity to follow on with a 4-year PhD research project

In 1983 this programme was changed to a 4-year curriculum with a 2-year general phase and a 2-year specialization phase. The propaedeutic examination came after 1 year, a D1 examination after 2 years (without diploma) and a Master's degree level (ingenieurs) examination after 4 years. According to this system the graduate engineer had an opportunity to continue by following a 2-year design programme or to start a 4-year PhD research project. Although the number of PhD students has greatly increased, there has never been much interest in the 2 years design programme, probably because it does not lead to an academic degree.

Five-year curriculum

In 1994 the government decided to allow the curriculum for technical academic studies to be extended to 5 years again, with the proviso that the general phase of the curriculum should not be extended, except for non-technical and social aspects and work placement during the general phase. Once again this programme has a general phase of 2.5 years and a specialization phase of 2.5 years, consisting of a propaedeutic examination after 1 year, a D1 examination after 2.5 years and a Master's degree (ingenieurs) examination after 5 years.

According to this system the graduate engineer has an opportunity to continue by following a 2-year design programme or undertaking a 4-year PhD research project.

Owing to the many changes in the structure of the curriculum, the coherence and the sequence of the curriculum did not remain undamaged. The previous review committee concluded that the educational level and the quality of the engineers who had recently graduated was good, but that the educational process leading to the award of the MSc degree had many shortcomings, including teaching methods and facilities. Chapter 12.2 gives an overview of the conclusions and recommendations of the 95/96 review committee.

In 1996 an Educational Director was appointed, the assignment given by the Dean being to make use of modern teaching methods to restore structure, coherence and the sequence of the curriculum. Thematic Project Education approach is the result of this assignment which includes the restoration of the Bachelor's degree examination.

Thematic Project Education

This system again has a 3-year general phase and a 2-year specialization phase, with a propaedeutic examination after 1 year, a Bachelor's degree (kandidaats) examination after 3 years and a Master's degree (ingenieurs) examination after 5 years. In this system the graduate engineer still has the opportunity to continue with a 2-year design course or a 4-year PhD research project.

TPE was introduced to the 1st year student in 1997, to the second year students in 1998 and to the 3rd year students in 1999. The first new Bachelor's degrees will be presented in August 2000.

A result of these changes is that there are students in the specialization phase who still have to complete the 1993 4-year curriculum and there are many students in the 2nd and 3rd years who have to complete the 1994 5-year curriculum. Since TPE was introduced in 1997, the 1st and the 2nd years of the new curriculum have been in operation and have been evaluated. The 3rd year is being implemented in the 1999/2000 course year, but because of the many students still following the 1994 5-year curriculum, parts of this previous curriculum will still be available to the students. The specialization phase of the TPE will start in September 2000, so in the 1999/2000 course year, students who start their specialization phase will still be following the 1994 curriculum with a 2.5-year specialization phase. Beginning in September 2000, students who have completed the TPE Bachelor's degree examination will have a specialization phase of 2 years. The specialisation phases of the 1994 and 1997 curriculums will run parallel with the new one for a number of years to allow students to complete their studies by following the curriculum they started with. Students who want to switch from the old 5-year curriculum to the TPE curriculum during their general phase (Bachelor's) phase are allowed to do so. An adapted educational TPE programme will be provided on an individual basis.

A review of the new curriculum in terms of the four courses and the themes is given in Table 4-1, which includes the number of credit points associated with each subject. The numbers of credit points for the old situation are given in parentheses, showing the major changes in the curriculum.

Table 4-1: Credit points for courses and projects for the new curriculum (the credit points of the old curriculum are mentioned between brackets).

General Phase Mechanical Engineering				
Courses	**1st year**	**2nd year**	**3rd year**	**Total cp.**
Mathematics & Informatics	10 (10)	5 (8)	6 (3)	21 (21)
Solid Mechanics & Materials Science	9 (9)	8 (8)	4 (2)	21 (18)
Fluid Mechanics & Thermodynamics	3 (2)	4 (5)	5 (2)	12 (9)
Systems & Control Engineering	1 (0)	3 (6)	3 (0)	7 (6)
Miscellaneous	2 (13)	0 (4)	4 (7)	6 (21)
Credit points courses	25 (34)	20 (31)	22 (14)	67 (75)
Projects	**1st year**	**2nd year**	**3rd year**	**Total cp.**
Transport	6 (0)			6 (0.0)
Energy & Process	6 (0)	4 (0)	4 (0.0)	14 (0.0)
Design & Production	5 (4)	6 (7)	10 (4.5)	21 (15.5)
Mechatronics		8 (1)	0 (2.5)	8 (3.5)
Bachelors Assignment			6 (0.0)	6 (0.0)
Miscellaneous		0 (3)		(3.0)
Practical Work	0 (4)	4 (0)		4 (4.0)
Credit points Projects	17 (8)	22 (11)	20 (7.0)	59 (26.0)
Credit points Total	42 (42)	42 (42)	42 (21.0)	126(103)

4.2 The general phase Mechanical Engineering (see fig. 2.1).

In this section the new TPE curriculum is described. The TPE curriculum comprises the first 3 years of the study, leading to a Bachelor's (kandidaats) degree. On average, 55% of the curriculum consists of inductive theoretical courses and 45% of TPE projects. For the theoretical courses, 4 continuous courses are included in the 3-year BSc curriculum.

These courses are:

1. Mathematics
2. Solid mechanics and materials science
3. Fluid mechanics and thermodynamics
4. Systems and control engineering

In the first year there are three TPE themes: Transport, Energy and the Integral Design Project 1. In the second year the themes are Mechatronics and Energy and the Integral Design Project 2, while in the third year the themes are Process Technology and the Industrial Production Project. In the thematic project the student gains knowledge in the field of applied mechanical engineering, puts this knowledge and that of the theoretical subjects into practice, and broadens his view by considering a number of non-technical subjects like economics, organisation, sustainability, control of the environment and safety. He also acquires a number of skills including those needed for communication, reporting, using computers and the Internet.

4.2.1 First year

In the first year the foundations of the four disciplines mentioned above are laid by means of a ‘classical‘ course programme, comprising the subjects of Materials Science, Statics, Strength of Materials, Dynamics, Thermodynamics, Fluid dynamics, Systems and Control Engineering, Analysis and Linear Algebra (together 25 credit points). At the same time, knowledge gained from these courses is used in projects on the Transport and Energy themes and the Integral Design Project 1. Furthermore, the student learns and exercises a number of non-technical skills, like communication, reporting, planning and teamwork. The projects are awarded 17 credit points.

The Integral Design Project 1 concentrates on 2D design. The students learn and practice drafting, drawing and using CAD to design a mechanism. Furthermore, they learn to operate machine tools, test construction parts under load and construct the mechanism that they have designed. Twelve design studios and a workshop will be installed in the new education building.

An overview of the first year curriculum is presented in Table 4-2.

Table 4-2 First year TPE curriculum Mechanical Engineering

1st year Mechanical Engineering		
Courses		
Course code	**Course name**	**Credits**
mk1A	**Materials science 1**	**2**
wb1106	**Statics**	**2**
wb1107	**Strength of materials**	**3**
wb1108	**Dynamics 1**	**2**
wb1123	**Thermodynamics and fluid mechanics 1**	**3**
wb2103	**System- and control engineering 1**	**1**
wb5103	**Manufacturing engineering**	**2**
wi104wb	**Analysis B**	**6**
wi135wb	**Linear algebra**	**4**
Credit points courses		***25***
Projects		
Project code	**Project name**	**Credits**
wbtp01	**Thematic projects 1 Transport**	**3**
Wbtp01 d1	Project 0: introduction transport	0.75
Wbtp01 d2	Project 1: computer systems and networks	0.75
Wbtp01 d3	Project 2: systems approach container crane	0.75
Wbtp01 d4	Project 3: fixed connections container crane	0.75
wbtp02	**Thematic projects 2 Transport**	**3**
Wbtp02 d1	Project 4: systems approach AGV	1
Wbtp02 d2	Project 5: rotary connections stack crane	1
Wbtp02 d3	Project 6: social aspects transport	1
wbtp03	**Thematic projects 3 Energy**	**3**
Wbtp03 d1	Project 7: introduction energy	1
Wbtp03 d2	Project 8: scale rules energy consumption	1
Wbtp03 d3	Project 9: pump design CH-installation	1
wbtp04	**Thematic projects 4 Energy**	**3**
Wbtp04 d1	Project 10: modelling power drive	1
Wbtp05 d2	Project 11: pre-stressed constructions	1
Wbtp05 d3	Project 12: system contemplation	1
wbp516	**Integral design project 1**	**5**
Wbp516 d1	Int. design project: basics	2.5
Wbp516 d2	Int. design project: design	2.5
Credit points projects		***17***
Total credit points		***42***

4.2.2 Second year

In the second year several of the subjects of the theoretical courses are elaborated further: Materials Science, Mechanics of Materials, Dynamics, Fluid Mechanics, Thermodynamics, Systems and Control Engineering and Analyses, supplemented with Differential Equations, together yielding 24 credit points.

Through the projects on the Mechatronics theme the student is introduced to the subjects of electrical and electronic engineering, signal processing, sensors and actuators, learns and practices programming in Visual Basic, determining the accuracy of measurements and calculations and applies his knowledge of System and Control Engineering.

Through the projects on the Energy theme the student acquires knowledge of heat transfer and thermodynamic cycles and processes and applies this knowledge in experiments and in designing a cogeneration plant or a heat pump system. Furthermore, he learns to select suitable sensors for measuring temperature, pressure and flow and gets acquainted with data processing by means of computers. Decisions have to be made on investments, taking into account both environmental control and energy consumption. Data has to be found in databases, reference books and from other sources, by using libraries and the Internet.

In the second year the student has to spend a practical training period of at least four weeks. The student has to apply for a position with a company of his choice. A database is available at the Faculty. A report has to be submitted. Instructional objectives include the development of communication skills in an industrial environment, insight into mechanical engineering, social and organisational aspects of a company and reporting.

In the Integral Design Project 2, the design activities are expanded to include 3D and comprise the complete design process for a mechanical construction. The objective of this project is to design of a mechanical device. A design problem will be translated into technical specifications. Main and subsidiary functions will be discerned and the possibilities to materialise these functions will be indicated. The result of the design-process is a design-file, with essays, calculations, sketches and drawings. When possible, a prototype will be made and tested. The student will defend his design orally and in writing.

The projects together represent a work load equivalent to 18 credit points.

An overview of the second year curriculum is presented in Table 4-3.

Table 4-3 Second year TPE curriculum Mechanical Engineering

2nd year Mechanical Engineering		
Courses		
Course code	**Course name**	**Credits**
mk5	**Materials science 2**	**2**
wb1204	**Mechanics of materials 2**	**4**
Wb1204 d1	Mechanics of materials 2 part 1	1
Wb1204 d2	Mechanics of materials 2 part 2	1
Wb1204 d3	Mechanics of materials 2 part 3	1
Wn1204P	Ansys-exercises	1
wb1205	**Dynamics 2**	**2**
wb1220	**Fluid mechanics 1**	**2**
wb1224	**Thermodynamics 2**	**2**
wb2206	**System- and control engineering 2**	**3**
wi204wb	**Analysis B continuation**	**2**
wi232wbn	**Differential equations**	**3**
Credit points courses		**20**
Projects		
Project code	**Project name**	**Credits**
wbtp201	**Thematic Projects Mechatronics**	**8**
Wbtp201 d1	Part 1	2
Wbtp201 d2	Part 2	2
Wbtp201 d3	Part 3	2
Wbtp201 d4	Part 4	2
wbtp202	**Thematic Projects Energy**	**4**
Wbtp202 d1	Part 1 Heat exchangers and gas geysers	1.5
Wbtp202 d2	Part 2a Heat pump boilers	2.5
	Part 2b Diesel engines	
wbp524	**Integral Design Project 2**	**6**
Wbp524 d1	Part 1	1
Wbp524 d2	Part 2	3
Wbp524 d3	Part 3	2
Wbprw51	**Practical Training**	**4**
Credit points projects		***22***
Total credit points		***42***

4.2.3 Third year

During the third year the courses on theoretical subjects are continued with compulsory subjects: Dynamics, Strength of Materials, Fluid Mechanics, System and Control Engineering, Thermodynamics, Numerical Analysis and Probability Theory and Statistics, together yielding 18 credit points. Additional subjects have to be selected to obtain at least 4 credit points (see the list of subjects in Table 4-4). The programme also comprises two projects: the Integral Production Project and a project on the theme of Process Technology, which together yield 14 credit points, and a Bachelor’s assignment (kandidaats opdracht) yielding 6 credit points.

Table 4-4 Third year TPE curriculum Mechanical Engineering

3rd year Mechanical Engineering (new programme)		
Courses		
Course code	Course name	Credits
Wb1308	Dynamics 3	2
Wb1309	Strength of materials 3	2
Wb1321	Fluid mechanics 3	2
Wb2310	System- and control engineering 3	3
Wb4304	Thermodynamics 3	3
Wi212	Numerical Analysis C1	3
Wi380	Probability theory and statistics	3
at least 4 credit points to select of the following optional courses:		
Wb1310	Multi-body dynamics	2
Wb1415	Materials selection in design	2
Wb1422A	Advanced fluid dynamics A	2
Wb2306	Cybernetic ergonomics	2
Wb2311	Modelling	2
Wb3301	Introduction transport	2
Wb3302	Power drives	2
Wb3303	Mechanisms	2
Wb3407A	Introduction to logistic systems	2.5
Wb4300A	Equipment for heat and mass transfer	2
Wb5413	Development of production organisations	2
Credit points courses		22
Projects		
Project code	Project name	Credits
Wbtp301	Project Industrial Production	10
Wbtp302	Thematic project Process Technology	4
Wbtp303	Bachelors thesis	6
Credit points projects		20
Total credit points		*42*

In the Integral Production Project, the students learn to design an integral production system together with the corresponding organisation, taking into account the assembly and production processes, sustainability and the environment, business administration and economy, life-cycle, marketing and sales.

In the Process Technology theme, the student is acquainted with the design and operation of process installations. The subject of Physical Transport Phenomena has to be studied; a suitable separating process has to be selected and dimensioned, using a model. The separating processes to be considered are distillation, crystallisation, stripping and membrane technology. The interactions between equipment and process are studied in an experimental set-up. Furthermore, the aspects of safety and environmental control are introduced.

The Bachelor’s assignment at the end of the general phase, which gives 6 credit points, is carried out by two students working together. The students have to investigate a given problem, design a research scenario, formulate hypotheses, design tests, perform measurements and analyse and interpret data. The results are presented in a written report in the format of a congress paper and in an oral presentation at an internal Faculty Congress. The project may be carried out in a DUT laboratory or in an industrial setting.

Because a number of students who started studying by following the old curriculum have not yet finished the general phase of the study, the old third-year curriculum is also available. Table 4-5 gives a review of it.

Table 4-5: Third year programme of the old curriculum (until the 98/99 course).

3rd year Mechanical Engineering (1994 curriculum)		
Courses		
Course code	Course name	Credits
Aa22	Introduction law	2
Wb1303	Dynamics 3A	1
wb1304	Strength of materials 3A	1
wb2204	Introduction control engineering	3
wb4200/5	Applied Thermodynamics	2
Wb5201	Drive Systems	2
Wb5307	Industrial production	2
wi380	Probability theory and statistics	3
Credit points courses		16
Projects		
Project code	Project name	Credits
Wbp020	Mechanical Engineering Project	2
Wbp530	Economical and managerial project	4.5
Credit points projects		6.5
Total credit points		*22.5*

4.3 Specialisation phase Mechanical Engineering.

At the end of the general phase the student chooses one of the fields of specialization for the specialization phase. Mechanical Engineering offers the following choices:

- Dredging Technology and Bulk Transport
- Engineering Mechanics
- Micromechanics of Materials
- Equipment for Process Industry
- Fluid Mechanics
- Man-Machine-Systems
- Marine Engineering
- Production Technology and Organization
- Refrigeration and Indoor Climate Control
- Systems & Control Engineering
- Thermal Power Engineering
- Transport and Logistic Technology

During the specialization phase the student is supervised by one of the teachers of the relevant section (see Chapter 9) who also provides him his Masters assignment.

The requirements of the specialization phase will be changed starting September 2000. For a coherent view of the complete curriculum, not only the requirements for the new curriculum are given below, but also those for the 1994 curriculum.

The new TPE curriculum

In the new curriculum, to be effective from September 2000, the specialisation phase will take 2 years (see Fig. 2.1), with a study load of 84 credit points.

The TPE curriculum in the fourth year comprises 42 credit points courses and projects. The courses should at least include:

- 4 credit points social subjects
- 6 credit points basic sciences

The TPE curriculum in the fifth year comprises the the final assignment and optionally additional projects as follows:

- the masters thesis assignment of at least 26 credit points with a maximum of 42 credit points
- other assignments with a minimum per assignment of 8 credit points

A practical training period of 10 credit points should be included in the 4th or the 5th year and may be part of the masters thesis assignment.

Present situation

In the present curriculum the specialisation phase takes 2½ years, with a corresponding study load of 2½ x 42 = 105 credit points.

The specialisation phase consists of:

- a set of courses for at least 42 credit points
- one or more assignments, for at least 30 credit points
- a practical training period for at least 10 credit points.

The set of courses should consist of the following clusters:

- Mathematics and informatics for at least 6 credit points
- Fundamental mechanical engineering, for at least 6 credit points
- Social subjects, for at least 6 credit points
- Applied subjects in the field of the specialisation, for at least 6 credit points.

The professor who is responsible for the cluster determines the number of credit points for each cluster.

The study programmes for the various specialisations are described in Appendix 1.

4.4 Special programmes

4.4.1 Programme for graduates from Higher Professional Education (HBO)

The Faculty offers a special Master's course to graduates in mechanical engineering from HBO.

The course consists of two parts:

- a general programme of 23 credit points, which is identical for all HBO-students and includes mathematics, mechanics, fluid mechanics and thermodynamics, see Table 4-7.
  This part of the programme is intended to bring the HBO graduate up to the level in the fundamental engineering sciences reached by the DUT students, after the general phase (2½ years and 3-years respectively).
- an individual specialisation programme, arranged in consultation with the professor of the chosen specialization and comprising a number of subjects relevant to the field of specialisation, and a final assignment, together giving 72 credit points.

Students who passed the HBO with good or very good results will be able to finish the programme in 2.5 years.

Table 4-6 The general programme for HBO students

Code	Courses	Credits
wb1104	**Strength and Stiffness for TH**	**5**
wb1105	**Dynamics for TH**	**4**
wb1220	**Fluid Mechanics and Heat Transfer 1**	**2**
wb1224	**Thermodynamics 2**	**2**
wi104th	**Analysis for TH**	**6**
wi104tho	**Analysis for TH optional**	**(1) ***
wi130hwb	**Linear Algebra for TH**	**4**
wi131hwb	**Linear algebra for TH optional**	**(1) ***
	Total	***23***

*) depending on the specialisation chosen

4.4.2 Programme for KIM students

The Royal Netherlands Naval College (KIM) educates officers during a five-year programme. The programme for Officers Technical Service comprises a propaedeutics part of 1 year, and a final examination phase, consisting of a general part of 2 years, a practical training of 0.5 years and a specialisation phase of 1.5 years. The level at the point of entry to the specialisation phase is roughly equal to that of DUT students who have finished the Basic Phase.

The Faculty offers two programmes to KIM Technical Service students:

– a combined study at KIM and DUT

– a DUT programme for KIM graduates.

In both cases the student receives the title of Ir. after graduating.

Combined programme

In consultation with the KIM and the DUT professor, a specialisation programme is agreed upon, consisting of two phases:

Phase 1: A number of subjects plus an assignment or part of an assignment yields 62 credit points. On this basis, the student graduates at KIM. Because design does not play any role in the curriculum of Officers Technical Service at KIM, design is an important item in this programme.

Phase 2: The remaining subjects, plus part of the assignment or a second assignment yield 23 credit points. After passing phases 1 and 2 the student graduates from DUT.

Programme for KIM graduates

In contrast to the combined programme, the set of subjects studied may deviate to a greater or lesser extent from that of DUT students, depending on the specialisation at KIM. At KIM the students already complete an assignment yielding 17.5 credit points, so the final assignment at DUT only gives 25 credit points. In addition 11 credit points remain to be gained by following courses. The programme for these is individually tailored.

4.4.3 MSc programme

The DUT two-year Master of Science (MSc) International Programme [1] is intended for talented foreign students who already hold a relevant Bachelor of Science (B.Sc.) or equivalent degree, in a technical or engineering discipline. The International MSc Programme provides academic training with excellent prospects for an international career. The working language of the programme throughout each course is English. The programme started in 1997 and has attracted participants from Asia, Africa, America and Europe although not yet for Mechanical Engineering.

Depending on the specific course, the first year comprises theoretical study, assignments and laboratory work. The second year is largely devoted to the final thesis work, which involves participation in the University's research projects or development work during an internship in industry. Each course has a total study load of 84 credits (42 credits per year). One credit nominally equals one week of study.

Course structure

The first year of the MSc course in Mechanical Engineering consists of compulsory and optional modules, a design project and a literature study. The optional modules are placed in the second semester and are selected on the basis of the field of specialisation. The choice of modules can be tailored to individual needs to cover any gaps in the knowledge required for the final thesis. Together with the humanities modules, the thesis defines the programme of the second year.

After completing the MSc studies the Mechanical Engineer is capable of applying scientific methods and insights to the solution of technical problems within the field of mechanical engineering. Analysis, synthesis and evaluation are important factors when solving these problems. The Mechanical Engineer is also capable of taking personal responsibility when developing, applying and passing on technical knowledge, especially during the research, conception, design and construction, but also in higher and pre-university education.

The following MSc specialisation courses in Mechanical Engineering are offered since September 1999:

- Control Engineering
- Production Engineering and Organization
- Transportation Engineering

Below the courses are described in short.

Control Engineering

The areas of activity are the development of theoretical tools for system modelling and control, the application of these to mechanical systems and processes and the implementation of control designs. Research is carried out in two subject areas, these being system identification and robust multivariable control design. The applications are focussed on three fields that are relevant for industry: advanced process control and the electro-mechanical and servo-hydraulic motion control systems. The MSc-students get a firm basis in modelling techniques, analysis and synthesis for the wide range of applications such as process plants, power systems, robotics and mechatronic devices. During the thesis work the theoretical knowledge is applied in one of the research projects.

Table 4-7 MSc programme Control Engineering

Code	Courses	Credits	
		NL	ECTS
wb2302/5	Control theory	5	7.5
wb2305	Digital control	2	3
wb2307	Signal analysis	3	4.5
wb2401/5	Multivariable control systems	5	7.5
wb2403/5	System identification	5	7.5
wb2405/5	Modelling process dynamic systems	3	4.5
wb2406/5	Modelling of dynamic systems	3	4.5
wb2417	Projects	2	3
wbp200	Design exercise	4	6
wb2303	Measurement theory and praxis	2	3
wi404T4	Complex analysis	3	4.5
Bb…..	Organisation & Ethical Issues	3	4.5
vk….	Safety & Environmental Issues	3	4.5
	Literature survey	10	15
	Thesis work	32	48
	Total	*85*	*127,5*

Production Engineering and Organisation

The Production Engineering and Organisation specialisation concentrates on the entire manufacturing process, from product design to after-sales. This involves the manufacturing processes as well as the machines and tools for the manufacture of discrete products. In addition to technical knowledge of production processes, understanding of the use of means of production in an industrial environment, i.e. technical management, is of great importance. Central issues in this field are the design, management and control of processes used in manufacturing industries.

Table 4-8 MSc programme Production Engineering and Organisation

Code	Courses	Credits	
		NL	ECTS
io24	Design methodology	2	3
wb5100	Applied systems theory	1	1.5
wb5301	Machine tool design	1	1.5
wb5307	Industrial production	2	3
wb5413	Development of production organisations	2	3
wb5414	Design of machines and mechanisms	3	4.5
wb5415	Maintenance management	1.5	2.75
wb5416	Numerical control and production systems	4	6
wb5417	Innovations in manufacturing	2	3
wb5418	Integral product- and production design	1	1.5
wbp500	Design assignment	3.5	5.25
wm0501	Introduction business economics	2	3
wm0504	Industrial organisation A	2	3
wm0505	Industrial organisation B	2	3
	Literature assignment	4	6
	Laboratory assignment	6	9
	Total of first year modules	**42**	**63**
bb…..	Organisation & ethical issues	3	4.5
vk….	Safety & environmental issues	3	4.5
	Thesis work	36	54
	Total of second year modules	**42**	**63**
	Total	**84**	**126**

Transportation Engineering

Transportation Engineering covers the design, construction and operation of systems and equipment for the controlled handling and transportation of freight, bulk materials, soils and people. It also includes the systems and equipment used for the creation of the infrastructure.

Transportation Engineering is the process of planning, implementing and controlling the efficient, cost-effective flow and storage of raw materials, in-process goods, finished products and the related information from point-of-origin to point-of-consumption in order to conform to customers requirements. This comprises both physical and managerial components. The physical component relates to the physical-logistic aspects of goods, supply and demand processes, separate means of transport and those aspects integrated in a logistic configuration. The managerial component relates to policy, co-ordination and control of goods flows and logistic machinery.

Transportation Engineering involves designing infrastructure, the construction of infrastructure and the use of infrastructure. All three aspects are part of the MSc course. Because of the multi-disciplinary character of Transportation Engineering, the course consists of some components of the following: Mechanical Engineering, Civil Engineering, Marine Technology, Electrical Engineering and Mathematics/Informatics. This is reflected in the curriculum of the course. The graduation project can be focussed on the design of a logistic system, the design of transportation equipment, the design of dredging and tunnel drilling equipment or the design of road and railway vehicles. Graduation projects also include organisational and economics aspects.

Table 4-9 MSc programme Transportation Engineering

First year modules MSc specialisation Transportation Engineering Academic year 1999/2000			
Code	**Description**	**Credits NL**	**Credits ECTS**
et13-71	Electrical Drives	2,5	3,75
mp3780	Soil Mechanics 1	2	3
wb1413	Multi Body Dynamics	2	3
wb3400	Automobile Technology	2	3
wb3402A	Train Technology	2	3
wb3406A	Transport Technology A	2,5	3,75
wb3407A	Introduction Logistics	2,5	3,75
wb3408B	Dredging Design	2	3
wb3410	Large Scale Transport Systems	2	3
wb3412	Bulk Materials Handling	2,5	3,75
wb3414	Dredging Processes 2	2,5	3,75
A choice of (7,5 NL credits):			
mp3790	Soil Mechanics 2	2	3
Wbxxxx	Fluid Mechanics 3	2	3
wb2402	Hydraulic Drives	2	3
wb3406B	Transport Technology B	2,5	3,75
wb3407B	Logistics: Design & Software Engineering	2,5	3,75
wb3407C	Logistics: Modelling & Simulation	2,5	3,75
wb3411	Tunnel Boring Machines	1	1,5
wb3413	Dredging Processes 1	2,5	3,75
wb4301B	Introduction Combustion Engines	1	1,5
wi472	Introduction Operations Research	3	4,5
x2MT1	Offshore Hydromechanics	2	3
	Literature / Research Assignment	10	15
	Total of first year modules	**42**	**63**
Second year modules MSc course Transportation Engineering Academic year 2000/2001			
bb…..	Organisation & Ethical Issues	3	4,5
vk….	Safety & Environmental Issues	3	4,5
	Problem Analysis Assignment	18	27
	Conceptual Design Assignment	18	27
	Total of second year modules	**42**	**63**
	Total	**84**	**126**

5 Student intake

5.1 Quantity of intakes

5.1.1 Trends in first-year student intake

Unless stated otherwise, all student-related statistical numbers in this report have been retrieved from the 'Statistisch Jaarboek 1998/1999' **[2]**. In Chapter 7.5 this choice will be motivated and a comparison between the DUT data and the data provided by VSNU will be presented.

In Table 5-1 and Figure 5.1 the intake of first-year students of the Mechanical Engineering (ME) study programme, divided into male and female students, is presented for the period 1994 - 1998. The relative share of the Delft ME students in the total Dutch ME student population (Delft University of Technology, Twente University and Eindhoven University of Technology) is presented under the heading rel- Σ_3ME. In addition to this, intake numbers have been presented, taking the peak year 1991 as the reference year: the year in which the number of first-year students of all national universities reached its maximum value (KUO 1998). These percentages are given for respectively the ME study programme at DUT, all university ME study programmes in the Netherlands (Σ_3ME), DUT as a whole, and all national universities.

Table 5-1 Intake number of first-year students.
In addition to the absolute Mechanical Engineering (ME) student numbers as a function of the year of intake, relative numbers have been given with respect to the three national ME studies (Σ_3ME) and with respect to the year of intake 1991 (the relevant 'totals'). For further explanation see text.

year	ME at DUT					Σ_3ME	DUT	all universities
	male	female	total	rel-Σ_3ME	total (1991=100%)	total (1991=100%)	total (1991=100%)	total (1991=100%)
1994	259	13	272	42%	68%	76%	79%	88%
1995	196	11	207	35%	52%	66%	72%	80%
1996	211	7	218	40%	55%	61%	70%	78%
1997	202	6	208	39%	52%	59%	76%	81%
1998	189	15	204	39%	51%	58%	79%	85%

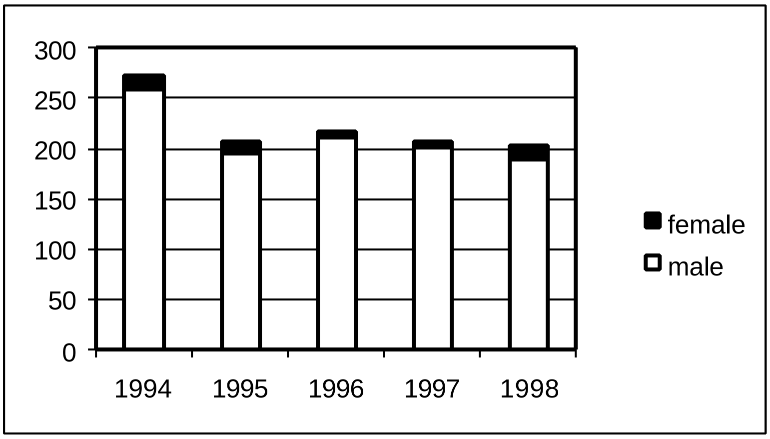

Figure 5-1 Intake number of first-year students

Figure 5.1 shows that the intake numbers were more or less stable during the last four years. However, Table 5-1 shows that since 1991 the intake has been halved in comparison to that of 1991. This trend can also be observed, although less dramatically, for all ME study programmes, for DUT as a whole and for all national universities. It should be noted, however, that the increase in intake during the last two years of both DUT and other universities did not occur in the ME study programmes.

Parallel to this, it should be noticed that the number of first-year ME students in the reference year 1991 has been overestimated by roughly 10% in Table 5.1. This overestimation is due to students who deliberately registered temporarily at Mechanical Engineering in the period of 1989-1992 (see Chapter 6.5). This means that the ‘relative-to-1991’ decrease in the ME students at DUT is also overestimated by roughly 10% of its value.

The decrease in intake during the last five years as compared to the foregoing five-year period has not yet influenced the output of graduates. Since the labour market prospects for Mechanical Engineers for the period 1997-2002 are good (Chapter 8.4.1) the expected decrease in output is undesirable.

To change things for the better, an extra member of staff has recently been appointed to the promotional team of the faculty (Chapter 5.4). Targets for the next five-year period are:

- An intake of at least 250 students
- A relative share in the total Dutch ME student population of between 40 and 50%

Another factor that contributes to the decreasing intake is the bad press DUT-ME has had in recent years. In a weekly magazine ('Elsevier') and an annually published booklet ('Higher Education Guide'), the results of surveys of students were unfavourable for the DUT ME study. To counteract this bad image, educational reform has been introduced by using Thematic Project Education: in the Propaedeutic Phase in 1997 and in the post-Propaedeutic Phase in 1998.

5.1.2 Female students

The relative intake of female students is roughly 5%, and no significant trends have been observed. Experience shows that female students do not appreciate being treated differently from male students, therefore they are not approached as a specific target group. The relative number of female students is considered too low: the aim is to raise this number to 10% within the next five-year period. They will undoubtedly make excellent mechanical engineers. However, too few choose a ME study, owing to their wrong impression of both the study and the profession. In promotional activities for VWO students (Chapter 5.4) special attention is given to this aspect, e.g. by placing less focus on heavy industry, and more on subjects like medical technology, and the commercial and managerial aspects of engineering.

5.1.3 Trends in intake of the Graduate Phase

In Table 5-2 the final Propaedeutic yield numbers are taken as an approximation for the intake numbers of the Graduate Phase.

Since 94/95, the curriculum has been composed of a P (Propaedeutic or first-year), a D1 (Doctoral 1, nominally 1.5 years), and a Graduate Phase (2.5 years). Since the start of the Thematic Project Education in September 1997 both the D1- and the Graduate Programme comprise 2 years. The Final yield is approximately 90% of the final Propaedeutic yield (Chapter 7.3). The final Propaedeutic yield will therefore be used as a ‘best guess’ for the intake number of Graduate students.

Table 5-2 Intake numbers of Graduate students ME related to Propaedeutic yield.
For an explanation see text. Figures in brackets are not yet final and may change.

first year	first-year intake	final Propaedeutic yield / Graduate intake		not-passed but still registered
		rate	number	
1986	405	57%	230	0%
1987	435	57%	248	0%
1988	425	53%	227	0%
1989	474	50%	239	0%
1990	384	50%	192	0%
1991	400	(51%)	(204)	(1%)
1992	348	(53%)	(184)	(5%)
1993	285	(58%)	(164)	(4%)
1994	272	(53%)	(143)	(11%)
1995	207	(55%)	(114)	(18%)
1996	218	(39%)	(85)	(41%)
1997	208	(25%)	(52)	(57%)

The dip in the yields between 1989 and 1992 has been attributed mainly to the temporary intake of ‘spurious’ students (Chapter 6.5). The last column in Table 5-2 refers to the percentage of students who were registered at ME but have not yet passed the Propaedeutic examination. Assuming that 50% of them will pass the examinations, the final Propaedeutic yield will be more or less stable: 55 - 60% of the first-year intake will become Graduate intake. So the intake level of Graduate students follows the same trend as the intake number of first-year students. This means that the final Graduate-Phase intake number of the 1995-1997 cohorts will be halved as compared to the 1991 cohort (Table 5-1): a decrease from roughly 200 to 100 Graduate-Phase students!

The intake number of the Graduate Phase, or in other words the Propaedeutic yield is considered too low. The Faculty has set itself the target to raise this output number from the estimated present value between 55 - 60% up to 67% (Chapter 7.4), within the next five-year period. Educational reform by using Thematic Project Education is the main remedy to improve Propaedeutic yield as well as the motivation of the students. It has to be noted however that increasing the output rate has been proven a real challenge!

5.2 Quality of intakes

5.2.1 Trends in first-year student intake

In Table 5-3 the previous education for ME as well as DUT students have been divided into three categories: VWO, HBO and ‘others’.

Table 5-3 Previous education first-year students

year	VWO		HBO		other	
	ME	DUT	ME	DUT	ME	DUT
1994	69%	79%	17%	9%	14%	11%
1995	72%	80%	17%	9%	12%	11%
1996	74%	83%	14%	6%	11%	11%
1997	77%	80%	12%	9%	11%	11%
1998	80%	78%	14%	9%	7%	13%

Table 5-3 shows that almost all first-year students come straight from the VWO. The relative contribution of HBO and ‘others’ decreased during this 5-year period from 30 to 20%. These trends are not representative for the entire DUT: total enrolments are more or less stable. Although the ME

HBO-intake is decreasing, it is still above the average DUT level. The decrease in the number of HBO-students is strongly influenced by the labour market and the study finance system. The higher number for ME compared to DUT is probably due to the special HBO programme.

Combining of Table 5-3 with Table 5-1 shows that in the last four years the absolute number of VWO students gradually increased from 149 to 163. The numbers of HBO and ‘others’ however, are decreasing: from 35 to 29 and from 25 to 14 respectively.

In Table 5-4 the quality is related to its main source: VWO students. The distribution of the number of first-year students has been presented as a function of the VWO-examination marks in mathematics (B) and physics.

Table 5-4 Quality distribution of first-year student intake, based on VWO examination marks (1998 cohort).
Estimated averages have been calculated by taking the arithmetic averages of the corresponding mathematics and physics values.

VWO marks	distribution of first-year student intake					
	mathematics (B)		physics		estimated averages	
	ME	DUT	ME	DUT	ME	DUT
=8	36%	34%	32%	32%	34%	33%
7	36%	30%	44%	35%	40%	32%
=6	28%	36%	24%	33%	26%	35%
totals	100%	100%	100%	100%	100%	100%

Table 5-4 shows that in comparison with DUT, for ME the distribution of VWO marks has shifted to higher values for both mathematics and physics. In addition to this it should be noted that the average VWO marks for the entire DUT are already 0.5 above the national averages. This means that most of the ME intake belongs to the group with good and excellent marks for their VWO science and maths.

5.2.2 Trends in intake of the Graduate Phase

In Table 5-5, the estimated values of the Graduate-Phase intake distribution are presented as a function of average VWO marks. Comparing these figures with the first-year student intake distribution (Table 5-4) shows the 'filter function' of the Propaedeutic Phase: the distribution function shifts clearly towards the higher VWO marks. The 74% of the first-year intake with VWO marks =7 shifts to 86% for the Graduate population. For the population of DUT as a whole, this shift is less: from 65% to 72%.

So, whereas, relative to the DUT population, many students with high VWO ratings start the ME study, this contribution increases even more strongly in the Graduate Phase.

Table 5-5 Quality distribution of Graduate intake (1998 cohort).
The VWO marks are based on average values for physics and mathematics (B). The two final columns present the distribution of the VWO marks of the Graduate intake. This distribution has been estimated by applying the final Propaedeutic yields to the first-year intake figures (Table 5-4).

VWO Marks	final Propaedeutic yield (Graduate intake)		Propaedeutic yield distribution (Graduate intake)	
	ME	DUT	ME	DUT
=8	79%	89%	45%	40%
7	61%	74%	41%	32%
=6	32%	58%	14%	28%
Totals			100%	100%

From these figures it has been concluded that towards lower VWO marks the chances of becoming a Graduate-Phase student are decreasing. However one out of three with marks =6 succeeds: well-motivated students with lower VWO marks can pass the ME Propaedeutic examination.

5.3 Target groups

Special programmes in the mechanical engineering have been developed for HBO students and for foreign BSc students. The HBO programme has been described in Chapter 4.4.1 and the MSc programme for foreign students in Chapter 4.4.3. Apart from the HBO programme for Graduates, there is the so-called 'FlexPro' (Flexible Propaedeutics). This is an exchange programme between three ME studies at neighbouring HBO schools and the ME faculty. Within FlexPro during the first six months of their study students can switch from HBO to DUT or vice versa. Each year up to 10 students take advantage of the FlexPro.

5.4 Information and promotion

Looking at the market, the total number of first-year university students in the Netherlands as well as at DUT appears to have decreased by circa 25%, from a maximum value in 1991 to a minimum value in 1996 (Table 5-1). Up to 1998 inclusive, the intake numbers were increasing by circa 8%. The latter trend at DUT, however, cannot be observed for Mechanical Engineering throughout the Netherlands as well as at DUT. The number of first-year students has stabilized at roughly its 1995 value (with the exception of the University of Twente where the numbers are still decreasing). From this point of view it is clear that Mechanical Engineering is in strong competition for students. One way to do this is to promote the study at DUT for VWO students. The other way is to use a promotion campaign for a wider public, including parents and primary school pupils. This latter is not the task of ME, but should be carried out at DUT or national level. The primary aim of all the initiatives is to promote the ME programme based on realistic information.

Promotional initiatives for VWO students are carried out on two levels: the central DUT level and the faculty level.

On the central level the following activities are co-ordinated by the Communication and Marketing Group, and supported by the Promotional Team of the Faculty:

- Participation in the DUT Information Days for VWO students, organized each year in autumn and spring. In 1998/1999 circa 300 students visited the faculty with their parents.
- Participation in a DUT stand at the Educational Markets in Groningen (2 days) and in Utrecht (3 days), organized annually in September and in October.
- Information given directly at the VWO schools. At these presentations (10-15 times a year) the faculty runs its own stand, which is manned by senior students.
- In co-operation with the University of Amsterdam, in 1998 DUT started a project for VWO students in the region of Amsterdam: 'Orientation towards Study and Profession'. The aim is to inform students during a two-day faculty workshop on the acquisition and application of

knowledge: ‘the set up of a production line, followed by product evaluation’. In 1998/1999 Mechanical Engineering organized one workshop for 30 VWO students.

- In co-operation with the Erasmus University of Rotterdam, in 1998 DUT started a similar ‘Orientation towards Study and Profession’ project. In 1998/1999 one group of 4 VWO students successfully completed this workshop.

On the faculty level, two staff members (1.0 and 0.8 FTE) from the Promotional Team, supported by 10-15 senior students, take care of the following activities:

- At the request of VWO schools, directly or by their former students, senior students provide information for a group of interested final-year VWO students. The information is presented classically to a number of schools in a region, using the standard information kit (overhead sheets, brochures and video). In 1998/1999 circa 10 presentations have been given.
- As an information follow-up VWO students can participate in a ‘day-in-a-student’s-life’. In the academic year 1998/1999 circa 100 VWO students participated in groups of 2 students, per senior student.
- During the Dutch Science and Technology Week young persons can individually follow 2-hour lab work. In 1998/1999 circa 150 VWO students participated.
- During the Dutch Science and Technology Weekend once every five-year, Mechanical Engineering presents itself to a broad public. The last time this was done, in 1996, 1500 people visited the faculty, where a number of sections presented themselves.
- As part of a Delft initiative, the ‘TopTest’, an intelligence contest for highly talented primary-school pupils, a group of ten finalists carries out a practical task to introduce them to mechanical engineering.
- In 1998/1999 also, VWO schools were invited to participate by entering a group of 4 students in the Design Contest: a contest for Mechanical Engineering students to design and construct a machine that would appeal to them and the public (like the creation of a darts machine, in addition to which the winning machine competed against the world champion).

6 Do-ability of the programme

6.1 Introduction

The term do-ability of the study programme is used here to define the way in which a well-motivated mechanical-engineering student is able to complete the programme within the nominal time. In this chapter factors which contribute to this do-ability are discussed, for instance: the set-up of the programme, student counselling and guidance and the way in which feedback from students is acquired. In addition to this, how doable the programme is will be illustrated by discussing the actual duration in ‘feasibility of succeeding within the nominal time’ and by treating the study effort. Finally, specific study-delay factors will be considered.

6.2 Set-up of the programme

In 1994 the four-year programme was changed to the five-year programme, comprising a P (Propaedeutic or first-year), a D1 (Doctoral 1, nominally 1.5 years) and a Graduate Phase (2.5 years).

In the new five-year thematic programme, introduced in September 1997, the P Phase lasts one year and both the D1 and the Graduate Phase last nominally two years (Chapter 4). The load of the curriculum is 42 credit points, i.e. 1680 study hours, on a year basis.

In 1997 the Thematic Project Education was introduced in the Propaedeutic Phase and in 1998 it was started in the D1 Phase. Thematic Project Education contributes 40% to the total yearly load. For a detailed description of the education programme see Chapter 4.

Naturally the study load and the examinations have been evenly distributed over the year to avoid temporarily overburdening the students.

6.3 Student counselling and guidance

A major task of the student guidance staff is to acquire fast feedback for students, with respect to their learning results and their learning behaviour, as observed in the Thematic Project groups. During the first half of the first year each group of eight students has a Student Mentor: a senior student who acts as a general guide and advisor. Apart from this the Thematic Project groups are supervised during the first year by a Teacher Mentor who coaches the students with emphasis on study processes (how to learn) and on group processes. Both Student Mentor and Teacher Mentor are trained by an instructor from the Educational Development Unit of the Faculty of Technology, Policy and Management.

Two members of the staff have been appointed as Student Advisors for both Mechanical Engineering and Marine Technology. The Student Advisors work according the Professional Code of the CSD (Delft College of Student Advisors). They are the first in line for the student to consult with on matters like choice of study, planning of study, and personal, medical and psychological problems that interfere with their study. Sometimes the Student Advisors refer the students to other professionals. The Student Advisor should be seen as an independent trustworthy person whose services are easily accessible: they can be consulted every day during one hour at noon and, in addition to this, during one full afternoon a week. It is also possible to make an appointment. Prospective students and foreign students in particular, use email to communicate with the Student Advisors. The counselling task of the Student Advisor includes mediation on an individual basis, e.g. if there are differences of opinion between a student and an instructor about the evaluation of course work.

The study progress is monitored centrally at DUT. During the academic year all students, with the exception of the first-year students, receive three reviews of their progress (marks and credit points) in October, in March, and in July.

The first-year students receive one overview at the end of the year in July. Together with this July report, they receive a non-binding study advice, based on the ratio between the number of credit points gained and the nominal number of credit points, the so-called cp-ratio. Four different categories of study advices are distinguished: ‘positive’ ($^{2}/_{3}$ < cp-ratio), ‘moderately positive’ ($^{1}/_{2}$ < cp-ratio = $^{2}/_{3}$), ‘doubtful’ ($^{1}/_{10}$ < cp-ratio = $^{1}/_{2}$), and ‘negative’ (cp-ratio = $^{1}/_{10}$). If a study advice is ‘not positive’, i.e. the cp-ratio is less than or equal to $^{1}/_{2}$, the student is invited for a personal talk. Next year (1999/2000) there will be a request rather than an invitation for those who are still registered in September. The target is to see 99% out of these students. The main purpose of these talks is to gain insight into the reasons for the delay and to agree upon a realistic study plan.

Table 6-1 presents the distribution of study advices given during the last 7 years. During that period the number of positive advices has redoubled amply. Now more than half the number of students receives a positive advice, whereas roughly 10% receive a negative advice.

Table 6-1 Distribution of non-binding study advices, for an explanation see text.

first year	number of advices	relative number of study advices			
		positive ($^{2}/_{3}$<cp-ratio)	moderately positive ($^{1}/_{2}$<cp-ratio =$^{2}/_{3}$)	doubtful ($^{1}/_{10}$<cp-ratio=$^{1}/_{2}$)	negative (cp-ratio= $^{1}/_{10}$)
1992	301	23%	18%	40%	19%
1993	323	20%	15%	43%	22%
1994	217	37%	9%	27%	27%
1995	160	48%	19%	19%	14%
1996	165	54%	11%	27%	8%
1997	164	52%	18%	25%	5%
1998	167	50%	22%	17%	11%

In 1999/2000 a new student monitoring system (VOLG++) will be implemented. VOLG++ provides an opportunity to trace well-defined groups. One of the first aims is to invite older students who are making little or no progress with their studies for a personal talk.

6.4 Feed-back from students

The optimal way to reveal study-delay factors is to listen to student wishes and complaints. There are a number of ways in which students can communicate about these matters; e.g. through:

- The Director of Education or via the Student Advisor;
- The Educational Committee, consisting of four elected students and a number of staff members (the Director of Education is invited to attend, the Student Advisor participates as an advisor). The committee has a counselling and signalling function with regard to the Dean;
- The Students' Council: the elected DUT-broad student organization, with an advisory function to the Board of the University. At faculty level there is a similar students’ council;
- The Course Evaluation: a survey among those students who have taken an examination or completed a project. The Course Evaluation questionnaire is drawn up by the Faculty of Technology, Policy and Management (Educational Development Unit) and is meant to assist in the permanent improvement of the curriculum;
- The ME Students’ Association ‘Leeghwater’, which organizes groups of about three students (‘Course Response Groups’) to follow and assess courses. With regard to wishes and complaints these groups can address the teacher directly, or via the education officer of the Students’ Association. If this does not give the appropriate result they can apply to the Director of Education or to the Student Advisor. In addition to this, Course Response Groups contribute to a yearly student consumers' guide (Méér dan Konsumentengids) in which all the courses of each faculty are assessed 'by students for students'.

All wishes or complaints will be considered. Wishes will be realized and complaints will be dealt with whenever they are realistic and appropriate action is possible.

An example of a recently-removed study-delay factor is the more frequent scheduling of re-examinations. When there are 4 terms a year they follow each succeeding term. If there are 5 terms a year they follow every other succeeding term.

6.5 Feasibility of succeeding within the nominal time

Table 6-2 presents the percentage of first-year students that succeeded in their Propaedeutic Phase and in their Graduate Phase. The figures show that only a small minority of students was able to finish their Propaedeutic Phase (on average 20%) and their Graduate Phase (on average 13%) within the nominal times of 1 and 4 years respectively. The effect of the change in the length of the curriculum from 4 to 5 years in the year 1994 is not yet visible in the Final yields presented.

Table 6-2 Pass-rates of the ME study.
Figures in brackets are not yet final and may change.

first year	intake number	Propaedeutic Phase					Graduate Phase						
		passed within … years (Propaedeutic yield)				not passed still registered	passed within … years (Final yield)						not passed still registered
		1	2	3	= 4		4	5	6	7	8	= 9	
1986	405	12%	52%	56%	57%	0%	3%	7%	17%	40%	47%	(51%)	(1%)
1987	435	14%	47%	54%	57%	0%	2%	6%	19%	36%	43%	(49%)	(2%)
1988	425	12%	47%	52%	53%	0%	2%	8%	23%	40%	43%	(46%)	(2%)
1989	474	13%	42%	48%	50%	0%	2%	6%	20%	32%	39%	(42%)	(6%)
1990	384	16%	42%	48%	50%	0%	5%	10%	20%	33%	39%		(7%)
1991	400	9%	41%	49%	(51%)	(1%)	4%	7%	15%	30%			(17%)
1992	348	15%	37%	47%	(53%)	(5%)	5%	9%	21%				(34%)
1993	285	16%	37%	50%	(58%)	(4%)	7%	12%					(47%)
1994	272	22%	40%	50%	(53%)	(11%)	9%						(51%)
1995	207	20%	40%	55%		(18%)							
1996	218	20%	39%			(41%)							
1997	208	25%				(57%)							

In September 1994 a government regulation, which prohibited students from being registered for more than two years at a faculty unless they had passed the Propaedeutic examinations was rescinded. In the period prior to 1994 this regulation was circumvented by a number of students temporarily enrolled in another faculty in order to obtain their Propaedeutic qualifications before returning to their original study. These students appear in the statistics of the 'temporary' faculty only in the first-year intake numbers. For ME this results in the intake numbers presented for the period 1989-1992 being artificially high (in the range of an excess of 5-15%). This means that in these years the yields are artificially reduced (for both Propaedeutic and Graduate Phase students). This is assumed to be the main reason for the dip in the first and the fourth year yields around 1991. Exclusion of these spurious ME students would probably result in a more gradual increase in the first and fourth year yields from 1986 to 1993.

This trend towards an increase will be supported by a change in the rules for the government scholarships in 1993. This change relates to the way in which the scholarship is related to the number of credit points gained each year. It implied that above a threshold of 25% of the nominal number of credit points the financial conditions become more favourable. In 1995 this threshold value was raised to 50%.

The increase of the number of students who succeed within the nominal time is also enhanced by improvements in the study programme and by the introduction of Thematic Project Education in 1997 (see also Chapter 4).

The yield targets set by DUT are supported by ME:

- At least 50% of those who pass their Propaedeutic examination pass it within one year.
  Although statistics relating to final Propaedeutic yields are not yet available for the most recent years, the trend of an increasing pass-rate within one year shows that this aim is realistic: an estimated final Propaedeutic yield of 6o%, corresponds to a Propaedeutic pass-rate of 30% within one year; 5 % higher than the last available pass-rate of 25%.
  However, the target set by the Faculty is a final Propaedeutic yield of 67% (Chapter 7.4). This ME target results in a Propaedeutic pass-rate of 33% within one year.
- At least 80% of those who pass their Propaedeutic examinations within 2 years graduate within the remaining nominal time plus one year.
  Furthermore ME has set a target for those who pass their Propaedeutic examinations within 1 year: 80% of them have to graduate within the remaining nominal time plus one year.
  In Chapter 7.3 it will be shown that both 80% targets were not achieved in the past: for the 4-years curriculum 70% of those who pass their Propaedeutic examination within 1 year graduate within 5 years, whereas only 47 % of those who pass within 2 years graduate within 6 years! Moreover it should be noted that the actual yields have been affected positively by the inclusion of the HBO intake.
- A median course duration of 5.5 year.
  Although no course duration numbers are yet available for the 5-year programme (started in 1994), the previous median duration of 6.6 years for the 4-year programme, shows that this really is a challenge.

6.6 Study effort

The terms nominal study load and study effort will be used to distinguish between the study time scheduled in agreement with the nominal duration of study, and the average study time actually spent, respectively. A nominal study load of one week (40 hours) corresponds to 1 credit point.

Although in the past the study effort has been evaluated, no hard figures are available for the present study programme. The previous evaluations showed that the annual study effort was less than the nominal annual study load. However, for the entire study programme the cumulative study effort appeared to be equal to the total nominal study load. Naturally an annual study effort lower than the nominal study load scheduled for each course year results in a course duration longer than the nominal one. In addition to this, the assignment of study loads to some parts of the study programme was not realistic. For instance the number of credit points assigned to a number of courses in the specialization phase was too low. On the change in 1994 from the four- to the five-year curriculum these values were adapted on the basis of more up-to-date information provided by the course co-ordinators.

Recent information is available from the Course Evaluation, the Course Response Groups, (Chapter 6.4) and the Thematic Projects (via the Student and Teacher Mentor, Chapter 6.3). This information shows the effects of a number of measures taken recently:

- Introduction of Thematic Project Education raises the annual study effort, and is expected to reduce the actual course duration.
- Integral monitoring of the courses by the Director of Education, based on data supplied by the students instead of using the load specified by the course co-ordinators. This renders a more realistic load rating and provides better insight into the distribution of the study-effort over the year.

The final assignment still remains a point of particular attention: generally the related study effort exceeds the nominal load. This has been attributed to a strong involvement and motivation into the assignment of both the student and the supervisor. To cope with this extension a set of ‘boundary conditions’ for the final assignment will be defined and introduced in 1999/2000.

6.7 Study-delay factors

The following points are considered to be bottlenecks:

- Availability of marks.
  Generally, the time it takes to retrieve marks after an examination or the handing in of a project report is considered to too long. In a number of cases this will have a negative affect on individual study schedules. Owing to a lack of up-to-the-minute information it has not yet been possible, for example, to invite those first years who lag behind for a personal talk with one of the Student Advisors before the end of their first half year (Chapter 6.3). For those who want to continue their

study, contact with the Student Advisor may contribute to an improved attitude towards the study and a realistic study schedule. For those who want to change their course or quit, it is preferable that this is done before the end of the first-half year, since this has no major financial consequences for students with a government scholarship.
Since the beginning of the academic year 1999/2000, the 'mark-retrieval' period has been officially reduced from 6 to 3 weeks (Opleidings Specifieke Deel Studentenstatuut (OSDS) Werktuigbouwkunde).

- Imbalance in the relation between study effort and assigned study load.
  As was discussed in Chapter 6.6 the study load of the courses and the projects is controlled permanently by the Director of Education. This renders a more optimal matching of subjects and a more balanced distribution of the study effort.
  The average duration of the final assignment is long, in comparison with the nominal time assigned to it. In the academic year 1999/2000 a general set of boundary conditions for the final assignment will be introduced, to reduce its average actual duration.
- Poor logistical organization of a number of projects and laboratory courses.
  This bottleneck will be removed largely by the introduction of Thematic Project Education, TPE: both staff and laboratory facilities have been tailored to enable the students to perform the study within the nominal time. This results in a maximum throughput capacity for the second year of 4 groups of 48 students. After introducing TPE into the first and the second year, in 1997 and 1998 respectively, TPE will be introduced in 1999 into the third year of the study programme.
  Obviously a large-scale renewal of the study programme by means of introducing TPE in three study years within a three-year period, without some hitches is hardly possible. It will take some time to run TPE smoothly and to cope with starting problems like the availability of adequate staffing, optimal staff attitudes to TPE and optimization of the description of the project assignments.
  To cope with the imminent shortage of laboratory facilities during the renovation operation in 1999/2000 (Chapter 1.3.4), the programming of the laboratory courses has been adapted and extra temporary facilities have been created for the year 1998/1999 to enable delayed students of the '1994 5-year curriculum' to perform their practical courses prior to the renovation activities.
- Lack of motivation in some members of the staff.
  The large reorganization process (Chapter 12.2.2) finalized in 1998, caused unrest, and with this frustration and de-motivation among some of the staff. In addition to this the current renovation will be an extra load for several staff members. It is to be expected that both the renewal of the programme and the new housing of the education facilities will provide an improved environment for the provision of better support to the students.
- Unattractive parts and shortage of realistic examples in the study programme.
  These deficiencies will be tackled for the greater part by the introduction of TPE and by the TPE-oriented training for the staff.
- Inadequate communication about programme-related matters.
  The communication of programme related matters, including changes in the education programme and the timetables has been greatly improved by the extensive use of Internet, Visual Display Units and notice boards.
- The poor motivation of some students.
  For a number of students the choice of the ME study was a negative one. In other words, ME remained after all other alternatives had been discarded. It is considered part of the task of all faculty members who contribute to the education programme, especially for the Student Advisors and the Student and Teacher Mentors, to try to optimize the motivation of these students at an early stage. This includes also assisting in the choice for an appropriate study, even if this does not result in electing to study mechanical engineering.

7 Student numbers and yields

7.1 Propaedeutic yields

Table 7-1 presents the Propaedeutic yields as a function of the duration of the study. In addition to this, numbers of students who quit the ME study have been presented as 'percentage of loss'. The loss numbers are available only for the first 7 years, which means that the actual final-loss percentages can be larger than the ones presented under the heading 'percentage of loss within =3 years'. It should be noted that the loss percentages are not restricted to the Propaedeutic Phase: they also include those students who quit the ME study after passing their Propaedeutic examinations. As will be shown in Chapter 7.2 about 10 % of those who pass their Propaedeutics quit the ME study. This means that for a Propaedeutic success rate of 60%, the presented loss percentages include about 6% of students who quit after passing their Propaedeutics.

Table 7-1 Propaedeutic Phase.
Student numbers and yields in % of the first year of intake. Figures in parentheses are not yet final and may change.

first year	intake number	Propaedeutic examination					percentage of loss within … years		
		passed within … years				not-passed, still registered			
		1	2	3	=4		1	2	=3
1986	405	12%	52%	56%	57%	0%	29%	44%	46%
1987	435	14%	47%	54%	57%	0%	30%	46%	48%
1988	425	12%	47%	52%	53%	0%	32%	50%	52%
1989	474	13%	42%	48%	50%	0%	34%	53%	53%
1990	384	16%	42%	48%	50%	0%	32%	56%	60%
1991	400	9%	41%	49%	(51%)	(1%)	34%	45%	(55%)
1992	348	15%	37%	47%	(53%)	(5%)	30%	39%	(46%)
1993	285	16%	37%	50%	(58%)	(4%)	19%	31%	(42%)
1994	272	22%	40%	50%	(53%)	(11%)	25%	32%	(41%)
1995	207	20%	40%	55%		(18%)	15%	24%	(36%)
1996	218	20%	39%			(41%)	13%	21%	
1997	208	25%				(57%)	18%		

As has been discussed in Chapter 6.5, the yields in the 1989-1992 period were negatively affected by the temporary intake of 'spurious' students. This affect has been assumed to be the main reason for the dip around 1991 in the yield numbers.

Table 7-1 clearly shows the trend of increasing yields for those who pass their examination within the nominal time of 1 year. Although these percentages are still low, the increase is greater than the overall DUT values. For ME, the first-year percentages increase from the three-year average in the 1986-1988 period of 13% to the average value of 22% in the 1995-1997 period. This is a relative increase of 71%. The overall DUT values are 19 and 29% respectively, corresponding to a relative increase of 57%. As has been discussed in 'Feasibility of succeeding within the nominal time' (Chapter 6.5), this trend is attributed to:

- A change in rules for government scholarships: in 1993 a 25% threshold value for required credit points was introduced. In 1996, this level was raised to 50%.
- Reform of the programme: permanent improvements in the programme and the introduction of Thematic Project Education in 1997.

Apart from this, the available cumulative Propaedeutic yield numbers (after 2, 3 and =4 years) have not changed significantly. This means that the selective function of the Propaedeutic Phase has not changed and has shifted encouragingly towards the beginning of the study.

Whereas the yield within the first year increases, the corresponding loss percentage decreases. If the final yield numbers were to remain stable, this would mean unchanged final loss numbers and an undesirable loss-percentage shift towards older students.

ME’s Propaedeutic-yield targets for the next five-year period are:

- To raise the final Propaedeutic yield from the estimated present value of between 55 and 60% to a value of 67% (Chapter 7.4).
- To ensure that at least 50% of the final Propaedeutic output will succeed within one year (Chapter 6.5). This results in a desired Propaedeutic pass-rate of at least 33% within one year.

7.2 Post-Propaedeutic yields

Table 7-2 presents the post-Propaedeutic yields as a function of the duration of the study. Except for 1994, all numbers relate to the former four-year curriculum. It should be noted that here also the relative dip in the graduate numbers around 1991 has been attributed mainly to the temporary intakes of ‘spurious’ students (Chapter 6.5).

Table 7-2 shows the strongly selective function of the Propaedeutic Phase. The estimated present final Propaedeutic yield of about 60% is related to a high estimated final post-Propaedeutic yield of about 90%.

The Faculty’s post-Propaedeutic yield target for the next five-year period is a stabilized or slightly higher final yield of 90%, despite the desired rise in the Propaedeutic yield from between 55 and 60% to 67% (Chapter 7.1).

Table 7-2 Post-Propaedeutic Phase.
Student numbers and yields in % of post-Propaedeutic intake. Figures in parentheses are not final.

first year	post-Propaedeutic intake number	graduated within … years						not passed, still registered
		4	5	6	7	8	=9	
1986	230	6%	12%	29%	70%	82%	(90%)	(2%)
1987	248	3%	11%	33%	64%	75%	(85%)	(4%)
1988	227	4%	14%	42%	75%	81%	(86%)	(4%)
1989	239	3%	11%	41%	64%	77%	(84%)	(11%)
1990	192	11%	21%	41%	67%	78%		(14%)
1991	204	7%	13%	29%	59%			(31%)
1992	184	9%	17%	39%				(54%)
1993	164	13%	20%					(75%)
1994	143	17%						(78%)

7.3 Final yield and actual duration of the study programme

Table 7-3 presents the Final yields and the median duration as a function of the duration of the study. The two notes given with Table 7-2 also apply here. Firstly, all numbers relate to the former four-year curriculum except those of the 1994 intake. Secondly, the relative dip in the yield numbers around 1991 has been mainly attributed to the temporary intakes of ‘spurious’ students (Chapter 6.5).

The estimated Final yield numbers have been based on the assumption that yield numbers from the past can be applied to the data available at present:

- A final Propaedeutic yield of 57.5% (Chapter 7.1) to estimate the anticipated intake for the Graduate Phase: those students considered in Table 7-3 who had not yet passed their Propaedeutics (Table 7-1, period 1991-1994);
- A final post-Propaedeutic yield of 90% (Chapter 7.2).

The most recent estimated Final yield numbers are in agreement with the average value to be expected: the post-Propaedeutic yield times the Propaedeutic yield, which equals 52%.

The 80% targets, relating the Propaedeutic yield within respectively 1 and 2 years to the Final yield within the remaining nominal time plus 1 year (Chapter 6.5) will be evaluated to show to what extent they were achieved in the past. For this purpose, the last available three-year averages will be considered. No corrections will be applied for the above-mentioned ‘1991 dip’, since this effect will affect the yields from corresponding intake periods in the Propaedeutic and the Graduate Phase in a similar way. The average Final yields within 5 and 6 years are respectively 9.3 and 18.7 % (Table 7-3). The corresponding Propaedeutic yields (Table 7-1) within 1 and 2 years are respectively 13.3% (1991-1993) and 40.0% (1990-1992). So the 80% targets were not achieved in the past: 70% of those who pass their Propaedeutic examination within 1 year graduate within 5 years, whereas only 47 % of those who pass within 2 years graduate within 6 years.

The ‘80% targets’ result in the following yields for the ‘1994 5-year curriculum’. Considering the most recently available 3 years for the Propaedeutic yields: an average pass-rate within 1 year of 22% and a pass-rate within 2 years of 40% (Table 7-1) results in pursued Final yield numbers within 6 years of 18% and within 7 years of 32%.

For the desired Propaedeutics pass-rate of 33% within 1 year and of 50% within 2 years (Chapter 6.5), the corresponding Final yield targets within 6 and 7 years are respectively 27% and 40%.

Table 7-3 Final yields and median duration of the study, relative to first-year intake numbers. Numbers in parenthesis are not yet final. For an explanation of the estimated Final yield values see text.

first year	first- year intake number	graduated within … years							estimated Final yield	median duration of study [years]
		4	5	6	7	8	=9	not, still registered		
1986	405	3%	7%	17%	40%	47%	(51%)	(1%)	52%	6.5
1987	435	2%	6%	19%	36%	43%	(49%)	(2%)	51%	6.7
1988	425	2%	8%	23%	40%	43%	(46%)	(2%)	48%	6.4
1989	474	2%	6%	20%	32%	39%	(42%)	(6%)	47%	6.6
1990	384	5%	10%	20%	33%	39%		(7%)	45%	6.5
1991	400	4%	7%	15%	30%			(17%)	45%	6.9
1992	348	5%	9%	21%				(34%)	50%	
1993	285	7%	12%					(47%)	53%	
1994	272	9%						(51%)	51%	

From Table 7-3 the following conclusions, including the related targets, have been drawn:

- The Final yield in the period considered is stable and on average about 52%; ME's target is to raise this Final yield to 60%.
- The actual median duration of the programme is more or less stable, with an average value of 6.6 years for the 4-years programme. As was mentioned in Chapter 6.5, the DUT target is a duration of 5.5 years for the 5-years programme. Naturally, ME will make an effort to achieve this target. It should be noted however, that students will take optimal advantage of the government scholarship, which lasts up to 6 years. This means that the 'better' students in particular will broaden and/or deepen their study by including extra courses. Another option frequently used is the extension of the final practical training period, since the allowance received eliminates the financial necessity to graduate.

Previous education

The effects of the previous education on the Final yield numbers have been presented in Table 7-4.

Table 7-4 clearly shows the influence of the group of students who follow the HBO study programme (Chapter 4.4.1). Most of those HBO students who finally succeed, i.e. about 65%, graduate within the 'general nominal time' of four years. Therefore the group of HBO students, which makes a 12%-contribution to the statistical results, significantly affects the median duration that is presented. Their median duration of 4.4 years is 2.4 years less than the duration of the largest group considered: the VWO students. Still this is much more than the 'nominal HBO time', which was 2 years for the period considered. This long actual duration has been attributed to the large gap between the higher education they had received previously and the university education. To bridge this difference the HBO students have to follow a large number of fundamental courses, which are generally experienced as being both theoretical and difficult. No Final yield figures are available from the present HBO study programme, which started in 1997/1998 and which nominally lasts 2¼ years.

With respect to the Final yield the HBO students are most successful: their Final yield is more than 10% higher than the Final yield of both VWO and 'other' students.
In addition to this very few of the VWO and 'other' students succeeded within the nominal time of the four-year programme. Less than 1% of the total of 7% who succeed within the nominal time are drawn from the major group, the VWO students. Most of the VWO students graduate in their seventh year of study: they comprise 16% of the intake, which corresponds to about 33% of those who finally succeed.

Table 7-4 Intake, Final yield and duration for students with different previous education.
All numbers are averages over the parenthesized first-year periods as presented in the headings. Numbers in parentheses are not definitive yet.
Note: the numbers largely refer to the former four-year programme.

previous education	relative intake	graduated within … years						not passed, still registered	median duration of study [years]
		4	5	6	7	8	=9		
	(91-94)	(92-94)	(91-93)	(90-92)	(89-91)	(88-90)	(86-88)	(86-88)	(86-88)
all	100%	7%	9%	18%	32%	40%	(49%)	(3%)	6.5
VWO	79%	1%	5%	15%	31%	41%	(49%)	n/a	6.8
HBO	12%	40%	52%	51%	55%	56%	(60%)	n/a	4.4
other	9%	11%	13%	24%	42%	42%	(47%)	n/a	6.4

7.4 Policy pursued

The ME policy pursued with respect to 'student numbers and yields' can be summarized as follows:

- To raise the Final yield, related to the first-year intake number, from the estimated present value of 52% to 60% (Chapter 7.3).
- To attain a stabilized or slightly higher final post-Propaedeutic yield of 90% (Chapter 7.2).

- Combine the two previous targets, this results in a Propaedeutic yield of 67%. This is an increase of 10% with respect to the estimated present value between 55 and 60% (Chapter 7.1).
- To ensure that at least 50% of the final Propaedeutic yield will succeed within one year (Chapter 6.5). With the above-mentioned target for the Propaedeutic yield of 67%, this results in a rise in the Propaedeutic pass-rate within one year from the present 25% to 33%.
- To raise the Propaedeutic pass-rate-within-two-years from the present 40% to 50% (Chapter 6.5).
- To attain a final yield-within-6-years of 27% and a final yield-within-7-years of 40% (for the present 5-year curriculum, Chapter 7.3).
- To reduce the median duration of study, from the present 6.6 years for the former 4-year curriculum to 5.5 years for the present 5 year curriculum (Chapter 7.3).

7.5 VSNU data

In this report the DUT data from the 'Statistisch Jaarboek 1998/1999' **[2]** has been used as the main source of statistical information. In addition to this VSNU has provided similar information [4]. VSNU has used data provided by the Dutch universities, which are identically processed by CBS. This means that equal education programmes of different universities can be evaluated directly if the universities treat their data similarly.

Nevertheless ME has still used the DUT information, because

- The DUT data contains much more information. Like information on the quality of the intake as presented in Chapter 5.2 and information on ‘not-passed, still registered’ or ‘loss percentages within the study programme’ as has been used in this chapter and the foregoing chapters.
- Consistency within the report is guaranteed by using the same information set.
- Consistency within the faculty and within DUT is maintained by using the common data set.
- For a large number of quantities the two data sets deviate strongly, for which no satisfactory explanation has yet been found.

The differences between the two sets will be illustrated by presenting those quantities in which the DUT and the VSNU data differ significantly: the Propaedeutic (Table 7-5), the post-Propaedeutic (Table 7-6) and the Final yield (Table 7-7).

Part but certainly not all of the differences can be attributed to the difference in the composition of a cohort. The following definitions have been used:

VSNU: All new intakes within an academic year and for the study programme considered, which are registered between September 1st and August 31st. Students who register for more than one programme within this year are not counted. New intakes for the Propaedeutic Phase are distinguished from new intakes for the Graduate Phase.

DUT: All new intakes within an academic year and for the study programme considered, which are registered on December 1st. In case a student registers for more than one programme he/she has to specify which one has to be considered as the main programme and that is the one that counts. All new intakes are considered as being first-year students.

**Table 7-5 Propaedeutic yields.
Cf Table 7-1, 6-2 and 5-1.**

first year	first-year intake number		Propaedeutic examination passed within … years					
			1		2		3	
	DUT	VSNU	DUT	VSNU	DUT	VSNU	DUT	VSNU
1988	425	395	12%	11%	47%	46%	52%	50%
1989	474	443	13%	10%	42%	40%	48%	46%
1990	384	356	16%	12%	42%	38%	48%	46%
1991	400	353	9%	6%	41%	40%	49%	48%
1992	348	306	15%	13%	37%	36%	47%	47%
1993	285	274	16%	11%	37%	30%	50%	43%
1994	272	265	22%	15%	40%	33%	50%	42%
1995	207	200	20%	16%	40%	37%	55%	50%
1996	218	214	20%	16%	39%	35%		
1997	208	204	25%	25%				

Table 7-5 includes the Propaedeutic yield as presented by both DUT and VSNU. All previous educations have been included into the first-year intake numbers. Table 7-5 shows a systematic higher DUT intake number, with a maximum difference of 14% reached in 1992. This difference can probably be attributed in part by the temporary ‘spurious intakes’ around 1991, as discussed in Chapter 6.5. Also the yield numbers of DUT are systematically higher, with maximum differences of 7% for the yields within 1 and 2 years and of 8% for the yields within 3 years.

Since DUT is convinced of the correctness of their Propaedeutic yield numbers, DUT can hardly understood that the differences are only due to a difference in definition of cohort composition. For instance in 1994, a year in which the phenomenon of ‘spurious students’ does not exist anymore, DUT counts within the first year, 18 successful students more than VSNU does!

**Table 7-6 Post-Propaedeutic yields.
Cf Table 7-2.**

first year	post-Propaedeutic intake number		graduated within … years									
			4		5		6		7		8	
	DUT	VSNU	DUT	VSNU	DUT	VSNU	DUT	VSNU	DUT	VSNU	DUT	VSNU
1988	227	203	4%	3%	14%	13%	42%	41%	75%	74%	81%	81%
1989	239	214	3%	2%	11%	8%	41%	39%	64%	64%	77%	79%
1990	192	169	11%	8%	21%	17%	41%	36%	67%	66%	78%	77%
1991	204	179	7%	5%	13%	11%	29%	27%	59%	58%		
1992	184	161	9%	6%	17%	11%	39%	34%				
1993	164	137	13%	4%	20%	12%						
1994	143	114	17%	3%								

Table 7-6 presents the comparison on basis of post-Propaedeutic yield numbers. In line with Table 7-5 the DUT post-Propaedeutic intake numbers are systematically higher than the VSNU numbers. Also the yield numbers of DUT are systematically higher although the differences for yields within 7 and 8 years are no longer significant. Remarkable is the difference in yields within 4 years for 1994: 14%!

Obviously the discrepancies between the DUT and VSNU yields have even become larger. In line with the remark made for Table 7-6 it will be clear that DUT has no explanation for this.

**Table 7-7 Final yields, relative to first-year intake numbers.
Cf Table 7-3 and Table 6-2.**

first year	first- year intake number		graduated within … years									
			4		5		6		7		8	
	DUT	VSNU	DUT	VSNU	DUT	VSNU	DUT	VSNU	DUT	VSNU	DUT	VSNU
1988	425	395	2%	2%	8%	7%	23%	22%	40%	39%	43%	43%
1989	474	443	2%	2%	6%	5%	20%	19%	32%	32%	39%	39%
1990	384	356	5%	6%	10%	10%	20%	19%	33%	33%	39%	38%
1991	400	353	4%	4%	7%	7%	15%	16%	30%	31%		
1992	348	306	5%	5%	9%	10%	21%	22%				
1993	285	274	7%	7%	12%	12%						
1994	272	265	9%	8%								

Finally Table 7-7 presents the comparison for the Final yields. All differences between the DUT and the VSNU Final yields are less than or equal to 1% and considered as not being significant. This is remarkable since the post-Propaedeutic yields did show large differences for yield numbers within 4, 5 and 6 years. Closer examination of the numbers in Table 7-6 and 7-7 shows that this can not be attributed to a difference in intake numbers between the DUT and the VSNU sets, but only to the internal inconsistency of the VSNU data.

8 The graduates

8.1 *Specialization*

Mechanical Engineering offers a wide range of specializations after the basic study. In Table 8-1 an overview of the number of graduates per specialization is given.

Table 8-1 Numbers of graduates per specialization for the period 1993 - 1998

Specialization	93-94	94-95	95-96	96-97	97-98	totals	
Engineering Mechanics	10	7	5	7	7	36	4.0%
Micromechanics of Materials	1	1		1		1	0.3%
Fluid Mechanics	2	0	3	2	2	9	1.0%
Systems & Control Engineering	26	27	24	19	26	122	13.1%
Man-Machine Systems and Micro Engineering **)	10	11	20	18	24	83	9.0%
Dredging Technology and Bulk Transport	13	8	3	13	7	44	4.7%
Transport and Logistic Technology	47	51	33	33	45	209	22.5%
Equipment for Process Industry	19	26	20	21	10	96	10.3%
Thermal Power Engineering	22	16	19	20	19	96	10.3%
Refrigeration and Indoor Climate Control	7	6	11	4	3	31	3.3%
Production Technology and Organization	35	38	33	33	35	174	18.7%
Marine Engineering	5	9	7	3	4	28	3.0%
Totals	196	199	178	173	184	930	100.0%

*) for the specialization Micro Engineering no more students have been admitted since August 1996

8.2 *Theses*

The quality of a student's final reports is judged by a an examination committee, consisting of the professor of the specialization concerned, one or more of his colleagues from within the Faculty, the student's tutor and, in most cases, an outside expert in the field concerned. The composition of the committee is designed to obtain a high degree of objectivity. The examination marks are considered a good indication of the quality of the students' final work.

The average mark for the final examination of 930 students during the period 1993 - 1998 was 7.68, with a standard deviation of 0.73, the highest marks being 9, the lowest 6. 40% of the students obtained a mark between 7 and 7.9, 44% a mark between 8 and 8.9. A mark between 6 and 6.9 was given to 5%, a mark of 9 or higher to 11% of the students.

The average mark, obtained by students for examinations during the general phase is 6.78 (P examination) and 6.83 (D1 examination), for courses in the specialization phase 6.72. So, the marks for the masters theses are on average a full point higher. This may be caused by the following factors:

- mechanical engineers are better at applying knowledge than at memorising and exactly reproducing it
- working on their final assignments, students are pushed by their coaches to deliver a product of high quality
- students are aware they show what they are really worth in their masters thesis
- examiners tend to give relatively high marks for the masters thesis, because these act as a business card, not only for the student, but also for the section.

Apparently the students' motivation for obtaining high marks for examinations does not increase during the course of the study. Obtaining the number of credit points, required to keep their grants, suffices. Students are more motivated for solving problems in the field of their own interest and producing useful results. Their interest in solving problems appears already when working on projects in the TPE programme, where assignments are kept as open as possible. Most students pay much time and energy to the thematic projects and work on them with enthusiasm.

A short investigation was carried out among a number of examination committee members from outside (26 respondents), to get an impression of the way people in industry assess the quality of the theses of graduates from Delft and the way they function in practice. The average ranking of the *scientific level* of the theses was 'sufficient' to 'good' and their *importance to industry* was generally ranked as 'good', while their *relevance to society* was on average 'sufficient'. A trend of improvement was observed in the 'importance to industry'. Details are presented in Table 8-2. In view of the small number of respondents, the figures should be interpreted with care.

The way mechanical engineers from Delft function in practice was ranked 'good' by 74% of the respondents, 'excellent' by 5%, 'sufficient' by 16% and 'fair' by 5%. This picture is supported by the results of a second investigation, carried out among a number of alumni (12 respondents).

Table 8-2 Quality of theses, judged by external experts

Aspects	poor	fair	sufficient	good	excellent
Scientific level	0%	0%	50%	38%	4%
Importance to industry	0%	8%	8%	63%	13%
Relevance to society	0%	25%	29%	33%	8%

8.3 Practical training

Practical experience is an important part of the education of the modern engineers. Work experience is required for some 15 – 20 % of the position open to graduate engineers (WO-Scanner 1996 **[9]** and 1997 **[10]**). The present education in mechanical engineering comprises two periods of practical training: one in the second year yielding 4 credit points and one in the specialization study yielding 10 credit points.

The first period is meant to provide on-the-job training in the industry, mainly on 'shop floor' level; a first acquaintance within an industrial environment and a confrontation with the social, organizational and engineering aspects of industry. At the same time students get some experience in applying for a job. The student should select a company from the Faculty's database and apply for a practical assignment. A report has to be written.

The second period of practical training is in the field of specialization, preferably in an industrial environment. The purpose is to acquaint the student with work on a professional engineer's level. The knowledge and skills already acquired should be applied to solve a new problem. In the present 5-year programme, the second period of practical training is mandatory. In the previous 4-year programme such a training period was not compulsory, but nevertheless frequently incorporated into the programme of specialization.

The practical training period is organised by the different groups offering the specialization study. Students are encouraged to spend their practical training period abroad. During the practical training period the student is expected to perform a task on a level comparable to that of a graduate engineer. A report about the training period must be submitted.

8.4 Labour-market position

Data on the labour-market position of recently graduate mechanical engineers were obtained from a number of sources:

- De arbeidsmarkt naar opleiding en beroep tot 2002. Researchcentrum voor Onderwijs en Arbeidsmarkt, Maastricht, oktober 1997 **[8]**
- De arbeidsmarkt naar opleiding en beroep tot 2002; Statistische Bijlage; Actualisering 1998. Researchcentrum voor Onderwijs en Arbeidsmarkt, Maastricht, oktober 1998 **[8]**
- the WO-Scanner 1996 and 1997, yearly interviews with graduates from Delft University of Technology, Universiteit van Maastricht and the Faculties of Economics of the Erasmus

University Rotterdam, Katholieke Universiteit Brabant, Universiteit van Amsterdam, Vrije Universiteit Amsterdam, carried out by the Research Centre for Education and the Labour Market (ROA) and DESAN Market Research BV **[9]**, **[10]**

- the WO-monitor 1998, yearly interviews with graduates from all Dutch universities, carried out by the Research Centre for Education and the Labour Market (ROA) and DESAN Market Research BV **[11]**
- an interview with experts in the different fields of specialization and alumni, carried out by the Faculty of Design, Engineering and Production

8.4.1 Prospects

General

Due to a number of factors, the labour market in the Netherlands is becoming restricted. The most important factor is the economic growth in recent years but demographic developments also play an important role. The number of young people is continuously decreasing, causing a decreasing inflow of school-leavers into the labour market. At the same time the outflow increases due to the increasing proportion of people over 50 years. A third factor is the increasing level of qualification: on one hand there is a shift in employment from lower occupational groups to higher occupations, on the other hand, for many occupational groups, the requirements with respect to education are increasing. As a consequence the restriction of the labour market is most distinct for higher professional and scientific types of education.

For the period 1997-2002 ROA expects an average annual growth in employment of 1.7%. In the previous period (1992-1996) this was 1.4%. At the same time an increase in outflow of working people of 3.3% is expected, against 3.0% in the period 1992-1996.

Economic sectors

Due to an unfavourable age distribution, there is great need for replacement in *industry* and *education*. In the *services sector* however, recruitment problems are also being caused by the great need for new employees, in order to realise expansion. In absolute numbers the growth in employment is largest in services industry, some 45,000 persons in 1997. Other important growth areas : *trade*: 2.2% (against 1.9% in the period 1992-1996); *metals and electrical industry*: 1.8% (-0.7%); *chemicals*: 1.7% (-1.7%); *transport and communication*: 1.5% (1.0%).

Mechanical Engineering

The labour-market perspectives for Mechanical Engineers with scientific education are characterised by ROA as ‘good’ for the period 1997-2002. Furthermore, mechanical engineers are very versatile, which is expressed by the large number of different occupations and the relatively high percentage of mechanical engineers, replacing people with other types of education.

The respondents of the interviews carried out by the Faculty also generally estimate that the labour-market prospects for mechanical engineers are good.

According to the estimates of the respondents of both reviews by the Faculty, the first positions mechanical engineers most frequently hold, are in engineering, R&D and design, mainly at a practical level. They also occupy management positions in production, production-planning and operations/maintenance.

8.4.2 Actual situation

General

From the WO-Scanners and the WO-Monitor it appears that the labour-market position of mechanical engineers from Delft has improved during the past three years (Table 8-3). At the moment of interrogation 92% of the students graduating from Delft during the period September 1994 and August 1995 had a paid job by the end of 1996. For the next generations this was 95% in 1997 and 96% in 1998. Among the students graduating between October 1996 and September 1997 64% started looking for a job before graduation. The relative number of graduates who were unemployed at the moment of investigation has decreased during the past three years, while that of graduates with a permanent appointment increased. Of the generation 1996-1997, 6% already had a job when studying. 69% had a permanent appointment with probation, and 31% a temporary job. Only 5% of them had a temporary appointment, without prospects. On average, one was actively searching a job for 4 months. In 1.2% of the cases it took more than 6 months to obtain a job, in 1996 this 6% and in 1995 9%.

Table 8-3 Employment situation of mechanical engineers from Delft University
Source: WO-Scanner 1996 and 1997 **[9]**, **[10]**; WO-Monitor 1998 **[11]**

	1996	1997	1998
Paid job	92%	95%	96%
Student	2%	3%	1%
Unemployed	6%	3%	2%
Permanent appointment	58%	61%	69%
Searching > 6 months	9%	6%	1%

Positions held

According to the data presented in the WO-monitor, a relatively large number of graduates are working as design engineers: 38%, of whom about 3/4 work on a scientific level. More than 12% hold a job as a scientific researcher. Nearly 4% are working as planning engineers. Compared to graduates from other universities, a considerable number of mechanical engineers from Delft (11%) are working as automation consultants; the percentage of designers, industrial organization experts and technologists from Delft is smaller, the relative number of scientific researchers larger. Further details of the most important positions appear in Table 8-4.

Table 8-4 Positions held most frequently by young graduates (in %)
Source: WO-monitor 1998 **[11]**.

Position	Delft		Other universities	
designer / design engineer	38.1		46.4	
designer		5.0		8.9
id., scientific level		29.4		34.5
design engineer		3.7		3.0
position in ICT	11.0		7.2	
information analyst		0.0		3.6
system analyst / designer		0.0		1.2
system programmer		0.0		0.6
automation consultant		11.0		1.8
planning engineer	3.7		0.6	
scientific researcher	12.3		10.8	
industrial organisation expert	3.7		7.3	
technologist	1.6		4.2	
chemical / food technologist		0.0		2.4
product technologist		0.4		0.6
process technologist		1.2		1.2
other	30.9		27.1	

Branch

Mechanical engineers find their way in many different branches, mainly in a technical environment. This is reflected by the relatively large percentage “other”, in Table 8-5 below. Technical consultancy is the most frequent single branch. The most important “non-technical” branch is that of automation. The percentage of graduates from other universities, working in the machine construction industry, is noticeably larger than that from Delft. The same observation can be made for positions in R&D and scientific education. The majority of mechanical engineers from Delft, who occupy a position as a scientific researcher, are working in industry and R&D-institutes (60%), the majority of those from other universities in scientific education (70%).

Table 8-5 Main branches in which graduates are employed (in %)
Source: WO-monitor 1998 **[11]**.

Branche	TU Delft	Other Universities
technical consultancy	21.0	18.0
automation companies etc	7.3	9.8
hydraulics engineering	5.5	2.0
machine construction	4.9	11.5
automotive / transport equipment	4.9	4.7
electrical / electronic equipment	4.9	4.4
Metals industry	4.9	3.4
scientific education	4.9	8.5
shipbuilding	4.9	0.0
R&D	3.7	7.5
organisation consultancy	3.7	2.4
transport	3.6	0.0
oil and gas production	1.2	2.4
utilities	1.2	1.4

Type of employment

The majority of graduate mechanical engineers start working as employees: 89% of the graduates from Delft, 83% of those from other universities (WO-Monitor 1998). About 70% of the graduates from Delft have a permanent appointment and have 25% a temporary appointment. For the latter group the mean duration of the appointment is 16 months, this being somewhat lower than for graduates from other universities. Some 5% of graduates are working as an AiO (trainee research assistant) or are PhD students holding a grant. For other universities this percentage is slightly higher (7.5%).

The average number of working hours per week is nearly 40, for graduates from all universities. None of the graduates from Delft and only 1.2 % of those from other universities are working part-time involuntarily.

Job requirements

Between 65% and 70 % of the young mechanical engineers from Delft hold positions for which a scientific education is required, the average for all types of education at Delft University being about 60%. For 80% to 85% the graduate’s own education or a related type of education is required, which is about the average figure for all types of education at Delft University.

There is a significant difference between graduates from Delft and those from other universities in the employers’ requirements for the positions they hold. For 73% of the positions held by Delft graduates a scientific education was required, for 26% a higher professional education. For graduates from other universities these numbers are 59% and 37% respectively (WO-Monitor 1998 **[11]**).

Salaries

Compared to young graduates with different type of education, mechanical engineers have relatively good salaries: an average of NLG 4,400 a month (gross) in 1997, against an average salary of NLG 4,170 for all types of higher education. Only graduates in Electrical Engineering and Information Technology had higher salaries at the end of 1997. From the WO-Monitor 1998 it appears that the average salary of mechanical engineers from Delft in 1998 was slightly higher than that of graduates from other universities: about NLG 4,600 against just above NLG 4,400.

Conclusions

From the data available, the following conclusions can be drawn:

- Mechanical engineers generally have good prospects in the labour market.
- Unemployment among mechanical engineers is low.
- Salaries are relatively high.
- The relative number of graduates in Mechanical Engineering from Delft University who are overqualified for their jobs is relatively small.

9 Organization and staff

9.1 Organization

9.1.1 Delft University of Technology

Figure 9-1 depicts the organization of Delft University of Technology. It consists of the following bodies:

Executive Board

The Executive Board is the highest governing body of the TU Delft. It is responsible for governing and managing the university in its entirety and consists of three members. The members of the Executive Board are appointed by the Supervisory Board. To this end, the Supervisory Board consults the Works Council and the Student Council (at the institute level) confidentially.

The Executive Board consists of three members: President, Rector Magnificus (Vice-president) and Vice-president Research.

Supervisory Board

The Executive Board is accountable to the Supervisory Board, which is appointed by the Minister. The Supervisory Board has a number of other specific tasks that are stated by law, such as approving the governing and management regulations, Institutional Plan, the choice of the system of participation, the budget, and the annual report.

Operational Committee

The Operational Committee consists of the members of the Executive Board and the Deans. In the Operational Committee, the Executive Board consults with the Deans about matters of general importance that affect the university in its entirety. The consultations relate partly to the specific interests of the faculties and thereby aim to improve the unity and evolution of the university as an institution of scientific education and research.

Board of Professors

The Board of Professors advises the Executive Board about the quality control in relation to its academic staff. This encompasses the policy for maintaining/improving the quality of academic staff, the nominations for the appointment of professors, the development of criteria and procedures for promoting and appointing or re-appointing academic staff, the development of a high-quality career policy for academic staff, the guarantees for optimum functioning and rights, and the duties and terms of employment of academic staff.

Furthermore, the Board of Professors advises the Executive Board on the selection of candidates for the position of Rector Magnificus. It functions as a sounding board for the Executive Board in matters of institutional import. The Board of Professors also reviews the selection of visiting lecturers and research fellows, and examines proposals for royal honours granted to professors and senior lecturers.

Advisory Board for Technological Policy of the TU Delft (ARTD)

The ARTD advises the Executive Board in relation to the technological policy to be pursued by the university.

Set Committee for Guidance in the Application of the Allocation Model (BTA)

The Committee reports to the Executive Board concerning the execution of the allocation model (financing system for the faculties) and advises on possible improvements therein. It also supervises the quality control of the output data supplied by the various faculties to the Executive Board.

Board of Doctorates

The tasks of the Board of Doctorates are as follows: it must determine the promotion code; it appoints supervisors of PhD students and composes promotion committees; it confers PhDs; it confers the doctorate Honoris Causa; and it advises on the establishment of special chairs.

Advisory Committee Quality Care for Education (AKO)

The Committee advises the Executive Board on the quality assurance in relation to the university's education.

Works Council

The Works Council derives its authority from the Dutch Act concerning Works Councils (WOR). Its field of operation involves, among other things, the right to advise on economic and organizational matters and the right of approval regarding matters of a social nature. The Works Council has twenty-one members and sits for a term of two years.

Student Council

The Student Council's authority can be derived from the MUB (University Government Act). The Executive Board may add further powers to the Rules and Regulations of the Student Council. The Student Council has ten members and sits for a term of one year.

Staff Executive Board

Two categories of tasks are subsumed under the Staff Executive Board. In the first place, this body must support the Executive Board in the execution of its tasks, and secondly, it must provide functional management for the decentralised departments of Personnel and Organization, Finance, Marketing, and Information Management.

Service Departments

The service departments of the TU Delft are as follows:

- Communication and Marketing Group (C&MG)
- Student Service Centre (SSC)
- Business Service Centre (BSC)
- University Service Centre (UDC)
- TU Delft Estate Management (VGB)
- Technical Support Service (DTO)
- Library of the TU Delft (BTUD)
- General and Technical Services (FD)

Faculties

The TU Delft comprises seven faculties:

- Architecture
- Civil Engineering and Geosciences
- Information Technology and Systems
- Aerospace Engineering
- Design, Engineering and Production
- Applied Sciences
- Technology, Policy and Management

DIOCs

The TU Delft has selected ten interdisciplinary technology themes that are the spearheads of research. These themes are at the basis of the Delft Interfaculty Research Centres, the DIOCs.

Research Schools

The TU Delft, together with other universities in the Netherlands, participates in twenty-four research schools. The TU Delft is the secretary of ten of these schools.

Institutes

Under the law, the TU Delft has two research institutes, IRI and OTB. The IRCTR is a legal research institute of the ITS faculty.

Four top institutes, recognised by the Ministry of Education, Culture and Science, are Nutrition, Metals, Telematics, and Polymers. The TU Delft participates in the three last-named. The scientific management of the top institute Metals (NIMR) is located in Delft.

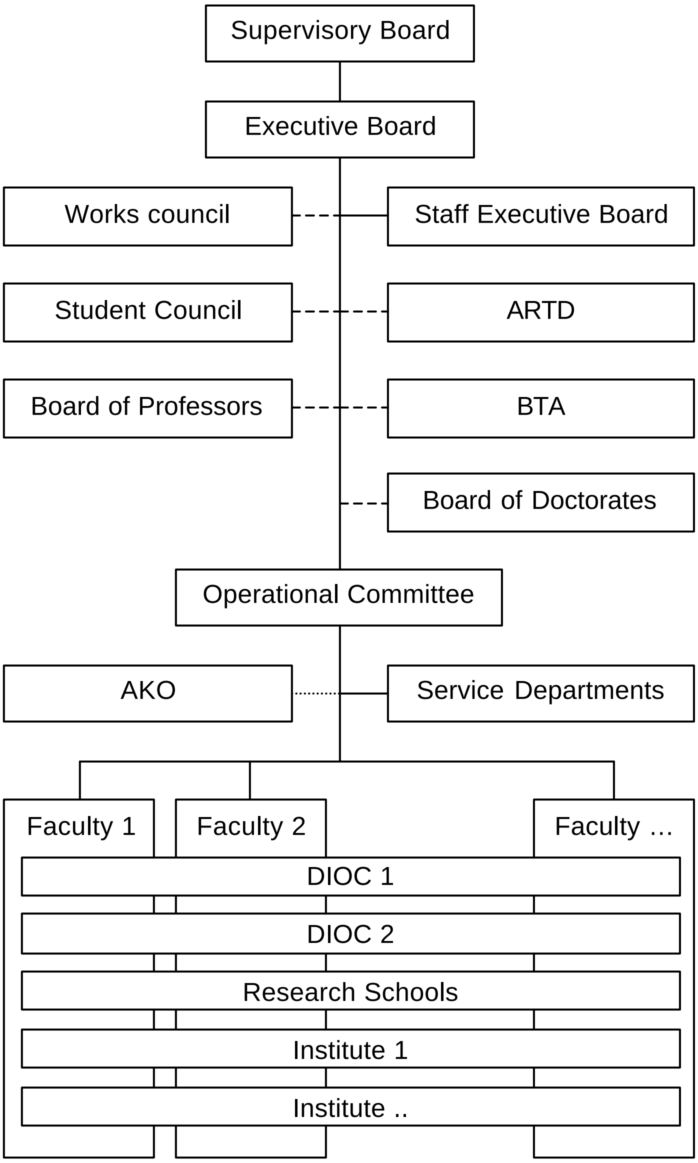

Figure 9-1 Organization chart Delft University of Technology

9.1.2 Faculty of Design, Engineering and Production

The Faculty of Design, Engineering and Production provides three education programmes:

- Industrial Design Engineering
- Marine Technology
- Mechanical Engineering.

The organization scheme of the Faculty is given in Fig. 9-2.

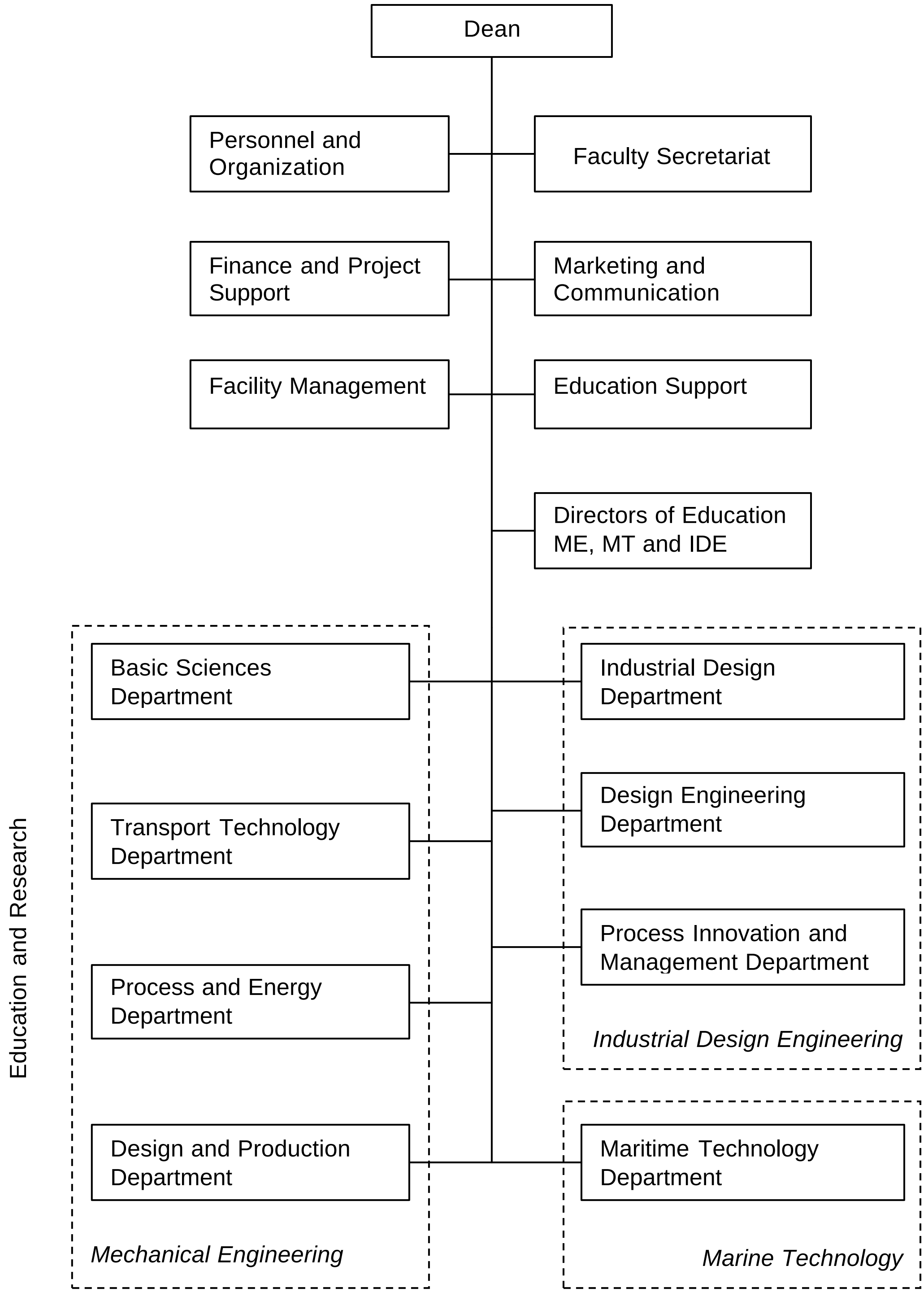

Figure 9-2 Organization diagram Faculty of Design, Engineering and Production

Dean

The Dean is the head of the Faculty and is responsible for the administration of the Faculty and the organization of the education and the study of science within the faculty. The Dean decides on the Education and Examination Regulations, general directives for the study of science, the yearly research programmes of the Faculty, supervises the execution of the Education and Examination Regulation, the research programme and the reporting on these matters to the Executive Board of the University. The Dean is appointed by the Executive Board of the University.

Director of Education

The Director of Education is responsible for the organization of the Education Programme, policy preparation and development and facilitates the development of the Education Programme in all its aspects. The Director of Education decides on the participation of the Departments in the Education Programme and consults the Chairmen of the Departments. The Director of Education is appointed by the Dean.

Bureau

The Faculty Bureau supports the Faculty management and the sections in a number of tasks and takes care of the infrastructure.

The Bureau comprises the following offices:

- Education Support
- Personnel and Organization
- Marketing and communication
- Finance and Project Support
- Facility Management
- Faculty Secretariat
- Advisor Working Conditions, Safety and Environment

Education Support Office

The *Education Support Office* comprises Student Advisers, a Co-ordinator of Practical Training and the Students Administration Office. The Education Support Office is managed by the Director of Education. The Education Support Office compiles and issues the schedules for courses, projects and examinations, issues the Student Statute, descriptions of the curriculum and the individual courses on paper and on the Intranet, and provides information on changes in schedules on VDUs in the entrance hall and on the Internet. The Student Administration Office keeps the records of the students' progress. Students who have questions or problems e.g. concerning the choice of the study, the progress of their study, planning their study, regulations, the assessment of their work by a teacher, can seek advice from a Student Adviser. The Student Advisers are exempt from education duties and sit on several committees.

The Education Support Office carries out the following tasks:

Continuous

Recording the results of preliminary examinations, projects and examinations
Giving advice in relation to study and personal problems
Planning the allocation of meeting rooms and lecture halls
The organization of the mentor system
Service to students in relation to study results and reviews
Service to lecturers in relation to study results and reviews
Service to the management in relation to throughput, performance and other quantitative information
Internet support and up-dating of education information on the Internet
Advising about international exchanges

Frequent

The organization and preparation of examinations (P, D1 and Final)
The organization en planning of preliminary examinations, projects etc. (each term)
Making overviews of results of the students for the students, the professors and the management
The organization of the examination committees and the provision of secretarial support
The organization of the education committees and the provision of secretarial support
The organization the presentation of diplomas

Annual

The editing of 'W-Patroon' and 'Kompas'
The formulation of student's statutes
The formulation and editing of Education and Examination Regulations
The formulation of lecture, project and examination schedules
The organization information sessions on specialization subjects
The organization information sessions for prospective students
The monitoring of study progress
The organization of teachers meetings

Occasional

The formulation of self-assessment reports
The organization of education assessments
The organization and editing relating to accreditation

Marketing and Communication Office

The *Marketing and Communication Office* provides the extramural communication and organises campaigns to attract new students. The Marketing and Communication Office reports directly to the Dean.

Personnel and Organization Office

The *Personnel and Organization Office* is staffed by P&O officers who look after the Personnel Administration Office.

Finance and Project Support Office

The *Finance and Project Support Office* consists of Financial Administration Officers, two Project Analysts and a Research Officer. The Research Officer reports directly to the Dean.

Facility Management

Facility Management comprises the technical Service Department and the Information and Automation Department.

Technical Service Department

The Technical Service Department takes care of buildings and infrastructure and includes the Reader Shop, Repro Department and Audio-Visual Media Service.

Information and Automation Department

The Information and Automation Department is responsible for the computer infrastructure, including the Windows NT network, runs the computer service desk and supports the sections with respect to CAI.

Working Conditions, Safety and Environment

The *Advisor on Working Conditions, Safety and Environment* reports directly to the Dean.

Education Committee

An Education Committee has been set up for each education programme. The duties of the Education Committee are laid down by law:

- to advise the Dean on the Education and Examination Regulation
- to yearly review the execution of the Education and Examination Regulation
- to advise the Dean on all matters relating to education provided in the Education Programme concerned.

Examination Committee

For each Education Programme, an Examination Committee is appointed by the Dean. The Examination Committee is responsible for the organization and co-ordination of the examinations and interim examinations and appoints examiners. The Examination Committee decides on procedures for the examinations. The Examination Committee consists of members of staff charged with providing education in the Education Programme concerned.

The Examination Committee appoints separate committees to assess the results for the P- and D1-examinations. For each Ir-examination an individual ad hoc examination committee is formed.

Science Committee

The Science Committee advises the Dean on the research programme.

Unit Committee

The Unit Committee is a committee of the Works Council and is authorised to consult with the Dean of the Faculty. The Unit Committee takes over the rights and powers of the Works council, for matters regarding the Faculty.

Student Council

The Faculty Student Council represents the students of the faculty and looks after their interests. The council has nine members: 3 students of Industrial Design, 3 Mechanical Engineering students and 3 Maritime Technology students. The Faculty Student Council has the right of endorsement in relation to the Faculty Regulations, the Education and Examination Regulations, the educational part of the Students Statute and Faculty rules on safety, health and welfare, as far as students are concerned. The Faculty Student Council has the right to advise about the budget plan, matters concerning the smooth running of Faculty matters, major changes in provisions for students and education, the Education Policy, the Annual Report of Education and the appointment of the Director of Education. The Dean supplies all information the Faculty Student Council reasonably requires to fulfil its duties and informs the council at least once a year in writing on the policy pursued during the past year and the intended policy for the next year regarding finance, organization en education. The faculty Student council is elected by and from amongst students of the Education Programmes concerned.

Departments

Scientific research is carried out in the Departments, which also take care of the education in the subjects concerned. Mechanical Engineering comprises eleven Sections, clustered in four Departments, see Table 9-1. Each Section comprises a number of Chairs, including one Core Chair. The Core Chair is a full-time chair, the other chairs are mainly part-time chairs. The Core Professor is the chairman of the section.

Table 9-1 Departments, Sections and Chairs of Mechanical Engineering

Departments	***Sections***	***Chairs***	
Basic Sciences	Fluid Mechanics	**Fluid Mechanics**	1)
		Fluid Mechanics (0.5)	2)
		Rheology (0.2)	
		Multiphase Flow (0,2)	
	Engineering Mechanics	**Engineering Mechanics**	
		Engineering Dynamics (1.0)	4) 7)
		Structural Optimazation (1.0)	3)
		Computational Mechanics (0.2)	4)
		Fibre Reinforced Plastics (0.2)	
	Micromechanics of Materials	**Micromechanics of Materials**	
	Systems and Control Engineering	**Systems and Control Engineering**	
		Mechatronics (0.3)	7)
	Man-Machine Systems	**Man-Machine Systems**	
		Medical Measuring Technology (0.2)	
		Biomechanics and Control (1.0)	3)
Process and Energy	Refrigeration and Indoor Climate Control	**Refrigeration and Indoor Climate Control**	
		Indoor Climate control (0.3)	7)
	Equipment for the Process Industry	**Equipment for the Process Industry**	
		Project Engineering (0.3)	
	Thermal Power Engineering	**Thermal Power Engineering**	7)
		Combustion (0.2)	
		Large-scale Energy conversion (0.2)	
		Gas Turbines (0.2)	
Transport Technology	Dredging and Bulk Transport	**Dredging and Bulk Transport**	
	Transport and Logistic Technology	**Transport and Logistic Technology**	7)
		Vehicle Dynamics (0.2)	
		Guided Vehicle Systems (0.3)	7)
		Large-scale Transport systems (0.4)	
Design and Production	Production Technology and Organization 5)	**Production Technology and Organization**	7)
		Production Engineering (0.3)	
		Maintenance Management (0.0)	
		Mechanical Engineering Design (1.0)	6)
		Mechanization of Production (0.2)	

1) Chairs in **bold** printing denote Core Chairs (full-time)
2) Chairs in normal Roman printing denote ordinary chairs (mainly part-time)
Numbers in parentheses denote Full-Time Equivalents (FTE)
3) Chairs in *italics* denote Anthony van Leeuwenhoek Chairs (personal appointments)
4) Donated by the Koiter Institute
5) It is the intention to merge this section with the design sections of Industrial Design Engineering into the department "Design and Production".
6) Chair will not be continued after retirement of present Professor.
7) Vacant on October 1st.

9.1.3 Organization of the education programme Mechanical Engineering

The Dean decides on the Education Programme, which is proposed by the Director of Education.

The Director of Education determines the educational objectives and buys the education modules required from the departments/sections of the Faculty and from other supplying Faculties. The teacher (a member of the scientific staff) is responsible for the quality of the content and for the realization of the education module. The module is established by mutual agreement between the teacher and the professor of the field of interest. Education and Research Supporting Personnel take part in providing experimental programmes and laboratory training courses in projects, design courses and production exercises under the direction of scientific staff members.

Classical courses

In the programme of classical courses, lectures are given by professors, associate professors and assistant professors. The head of the relevant section is responsible for the content and quality of the lectures.

Thematic projects

Each theme is co-ordinated by a Theme Co-ordinator who is responsible for the coherence of the various projects within the theme and the coverage of the instructional objectives set, for the integration of the activities into the timetable and for the evaluation and feed back. The Theme Co-ordinator determines the final marks for the examination subject.

Teacher Supervisors are responsible for the contents of the projects within the theme and formulate the assignments. The Teacher Supervisors acts as a commissioner towards the students.

In the first year the Teacher Supervisors assess the content of the students' work for each project and determine the group marks for the content of the group's product (design, report, and presentation). A Teacher Mentor assesses their behaviour in the group and their share in the activities. The Thematic Project groups are supervised by a Teacher Mentor who coaches the students with emphasis on learning processes (and group processes). Each group of eight students is coached by a Student Mentor with respect to the planning of its studying activities. The Teacher Mentors assess the individual share of each student in the realization of the product, and the students functioning as a panel chairman, a reporter etc.

In the thematic projects of the second and third years, emphasis is put on theoretical and experimental work. Students are guided by the Teacher Supervisor with respect to the main subject of the project and one or more teachers for the non-technical issues. The teachers can be consulted by the students on subjects in their field of expertise. The teachers determine the marks for the different parts of the project. Experimental work is supervised by an instructor.

9.1.4 Evaluation

In the present organization of the Faculty, the Dean is responsible for education and research, personnel and organization, finance and facilities, whereas in the past the Faculty Board was responsible for the education and research programmes and the Faculty Controller was responsible for personnel and organization, finance and facilities. Together with the institution of the function of Director of Education, this brought considerable improvement. Both communication channels and responsibilities are much clearer and now there is an integral view of education and the education programme is no longer a collection of separate components. The coherence between education and research on one hand, and supporting services on the other hand, is improved considerably.

The present organizational structure based on departments was introduced recently and is not yet fully supported by the scientific staff. Staff members identify themselves primarily with their sections. In consequence, in many instances one still operates from the sections as organizational units. On the other hand, the sections still play a role in the new organization model. The introduction of the sections some years ago improved the approachability and the sense of responsibility of the staff.

9.2 Human resources policy

Since 1998, the Chair of each group has had to submit a policy plan of the group to the Dean. Amongst other thins, this plan contains the plans of the group for the development of the education programme, research development, and participation in research schools, external fund raising, scientific output, infrastructure (laboratory and computer facilities), personnel and the financing of the group. Each year the realization of the policy plan is evaluated and the results are discussed with the chair.

With regard to personnel, the plan involves proposals for:

- personnel planning in relation to the education and research programme;
- recruitment of new personnel; type and qualifications;
- education, training and mobility of present personnel.

In this activity, the section for Personnel and Organization offers professional assistance. Every year the performance of each employee is assessed. In a yearly discussion between the employee and his manager, agreements are made about the professional and personal development of the employee. These agreements are recorded and monitored by the personnel department. The Director of Education has an advisory function in the assessment of teaching personnel.
The Faculty strives for a balanced age structure/distribution of its personnel and tries to consider this fact when recruiting new personnel. When recruiting new professors the faculty strives to attract internationally recognised candidates.

The faculty tries to create optimal conditions for the members of the academic and supporting staff to perform to high standards, both in education and research. In order to achieve this goal, each year during the discussion of the assessments, the possibilities for further education and training of personnel are investigated. This topic also forms a part in the policy plan of each section.
The “Van Leeuwenhoek” programme, for which the university has made funds available, provides an opportunity to appoint a limited number of employees of proven excellence as professors. Thus, the programme tries to prevent top talent from leaving the university. The faculty has received funds for two professorships in the field of Engineering Mechanics and Biomedical Engineering in 1999.

New staff members are recommended to follow courses/lectures on didactics. Staff members are encouraged to carry out a PhD study. A PhD degree enhances their chances of promotion to the rank of associate professor. In general, it is not possible to become an associate professor without proven excellent didactic capabilities and a research achievement comparable with a PhD.

The achievements of PhD students are regularly assessed, especially at the end of the first year, when there is a go/no- go point. At the beginning of their study, a plan is drawn up containing lectures to fill in gaps in their knowledge. The faculty offers them an opportunity to follow courses on how to write a thesis, how to present papers internationally and how to apply for a job after their graduation.

Furthermore, the faculty makes use of the opportunities created by university funds to recruit research fellows and guest professors from abroad, and the possibilities offered by the KNAW-fellowship programme to contract young researchers, called KNAW-fellows. After a four-year period of employment, KNAW-fellows obtain a tenured post in the faculty. These fellows and guest professors play an important role in the renewal of education and research as well as in the development of the staff.

9.3 Academic Staff

9.3.1 General information

Table 9-2 presents information on the Academic Staff. For this purpose two main categories will be distinguished: the senior staff, which covers the categories of full professors, associate professors and assistant professors, and the junior staff comprising the faculty research assistants, PhD students and student assistants.

Table 9-2 Academic Staff info on: sex, PhD level and appointment. Reference date August 1st, 1999.
Note: In contrast with Table 9-1 only DUT appointments have been considered, i.e. staff members not on the ME payroll are excluded

category	sex		total	PhD level	appointment		
	male	female			full-time	part-time	[FTE]
full professor	21	0	21	67%	9	12	14.8
associate professor	24	0	24	71%	20	4	21.5
assistant professor	27	3	30	10%	25	5	27.5
subtotal senior staff	*72*	*3*	*75*	*48%*	*54*	*21*	*63.8*
faculty research assistant	28	0	28	36%	24	4	25.9
PhD student	48	5	53	0%	52	1	52.8
student assistant	12	2	14	0%	0	14	4.6
subtotal junior staff	*88*	*7*	*95*	*11%*	*76*	*19*	*83.3*
total	160	10	170	27%	130	40	147.1

The amount of female members within the senior staff is just 3 out of 72, which is considered as being low. It is even less than the present 5% intake of female students, which is also considered as being low (Chapter 5.1.2).

The PhD level within the senior staff is 48%, with a maximum of 71% for the category of associate professors. In addition to this, 36% of the faculty research assistants has a PhD.

Roughly 20% of those appointed via DUT are part-timers, taking into account that full professors and especially student assistants are the main contributors with respectively 57 and 100%.

9.3.2 Education load

In Table 9-3 all the members of the Academic Staff with a research and/or education task are included. This in contrast with Table 9-2 where staff members not on the ME payroll are excluded. Therefore the number of appointment-FTE's of the PhD-students in Table 9-2 deviates strongly from the corresponding number in Table 9-3. Other differences between appointment-FTE's and total-FTE's are attributed to the difference in reference date: August 1st, 1999 for Table 9-2 and December 31st, 1998 for Table 9-3.

Table 9-3 Academic Staff: education and research load, calendar year 1998.
Research contributions are related to the reference calendar year 1998 (Research Report Mechanical Engineering 1993-1998 [5]); total-FTE's to the reference date December 31st, 1998. In general the heading 'other' refers to managerial tasks; with respect to PhD students it includes also the 'study aspect'. In contrast with Table 9-2 all members of the Academic Staff with an education and / or research task have been included. For further explanation see text.

category	education		research		other		total	
	[FTE]	[%]	[FTE]	[%]	[FTE]	[%]	[FTE]	[%]
full professor	6.6	50%	4.0	30%	2.6	20%	13.2	100%
associate professor	13.6	50%	9.4	35%	4.1	15%	27.0	100%
assistant professor	17.6	66%	6.3	24%	2.7	10%	26.5	100%
subtotal senior staff	*37.7*	*56%*	*19.7*	*30%*	*9.3*	*14%*	*66.7*	*100%*
faculty research assistant	9.2	36%	13.8	54%	2.6	10%	25.6	100%
PhD student	2.5	4%	54.7	86%	6.4	10%	63.6	100%
student assistant	6.8	100%	0.0	0%	0.0	0%	6.8	100%
subtotal junior staff	*18.5*	*19%*	*68.5*	*71%*	*8.9*	*9%*	*96.0*	*100%*
total	56.2	35%	88.2	54%	18.3	11%	162.7	100%

The education load in Table 9-2 has been estimated by taking the research load from the Research Report Mechanical Engineering 1993-1998 as a starting point. On two items the derived research load differs from the one of the Research Report. Firstly the contribution of the Faculty of Chemical Engineering within the Section of Equipment for the Process Industry has been excluded: 7.2 FTE's. Secondly the research contribution of the Chair of Logistics within the Transport and Logistic Technology Section has been included: 5.8 FTE's. The net result of -1.4 FTE's is the difference between the total research load presented in Table 9-3: 88.2 FTE's and the total research load of the Research Report (89.6 FTE's, Chapter 1.3.8). The magnitude of the activities under the heading 'other' has been estimated per category. The remaining FTE's are assumed to be spent on the education task. The resulting education contributions of the senior staff are considered as realistic. The education contribution of the faculty research assistants, however, is probably overestimated: their primary research task does not correspond to their relatively large estimated education task of 36%.

The resulting education load of the complete Academic Staff equals 56.2 FTE's. This includes the relatively high effort required to realize separate programmes, like KIM and HBO. The 56.2 FTE's correspond reasonably to the teaching load calculations based on all courses and projects given by ME staff members. These calculations encompass also educational services provided within other education programmes. The latter are well-balanced by educational services received from other faculties.

To derive the student-to-staff and the graduate-to-staff ratio the education load has been corrected for the effort required to develop the TPE Programme. During the past 3 years (1997-1999) this non-structural education load is on average 8 FTE's (including 4 student-assistant FTE's) on year basis. A 3 FTE-effort of temporary project members on the development of TPE is left out of consideration. The resulting 48.2 FTE's education load for the academic year 1998/1999 is presented in Table 9-4. A total number of 1215 registered ME students yields a student-to-staff ratio of 25.2 [FTE^{1}]; 173 graduates yield a graduate-staff ratio of 3.6 [FTE^{1}].

Table 9-4 Education load of the academic staff related to the number of registered students and to the number of graduates, academic year 1998/1999.

Academic Staff [education-FTE]	number of students	number of graduates	ratio: student / staff [education-FTE^{-1}]	ratio: graduate / staff [education-FTE^{-1}]
48.2	1215	173	25.2	3.6

9.3.3 Age structure

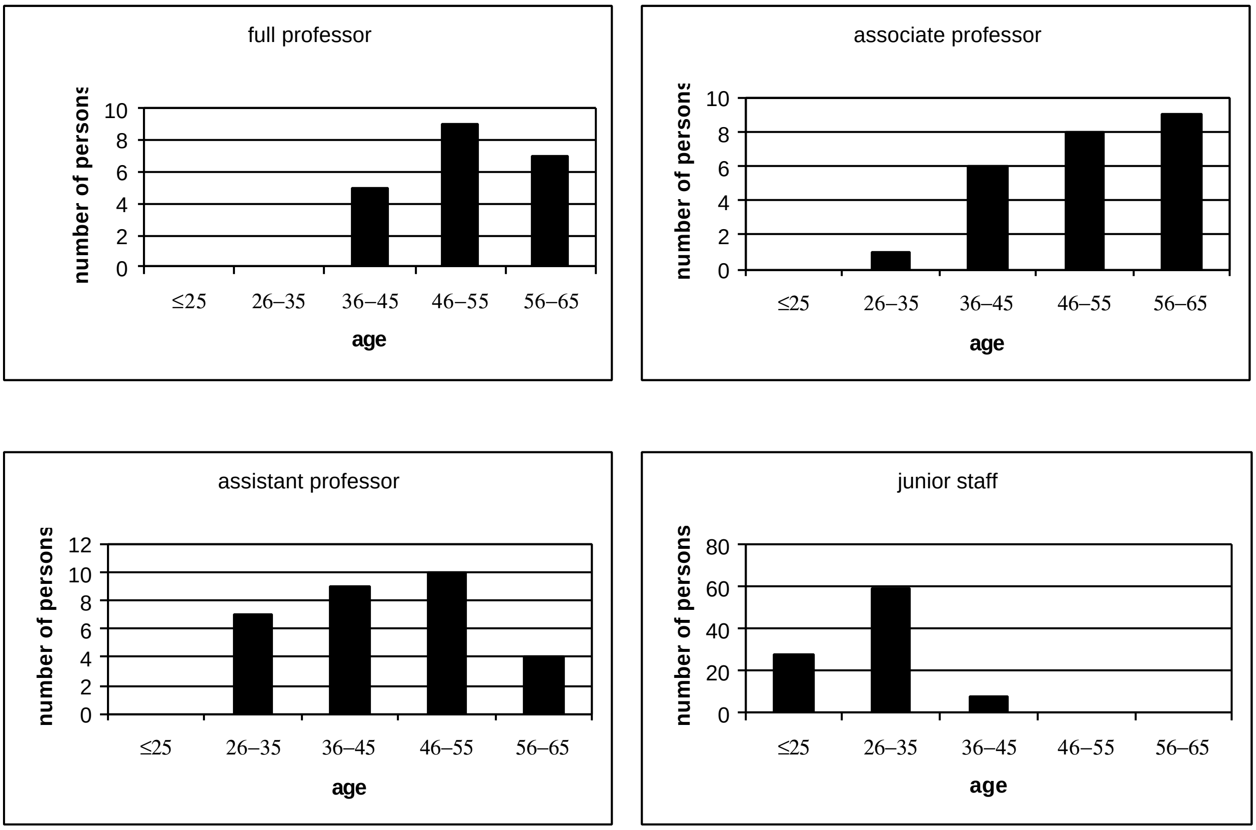

Figure 9-3 Age distribution of the Academic Staff.
Reference date August 1st, 1999. Data from the same source as used for Table 9-2.

The age distributions of the three categories representing the senior staff and the age distribution of the junior staff as a whole are depicted in Figure 9-3. The average age of the associate professors is considered as high.

10 Facilities

10.1 Introduction.

10.1.1 Renovation of facilities and buildings.

In January 1999 a major renovation of buildings and facilities of the faculty has started. It is planned that the renovation, which will be spread over three phases, will be completed in September 2001. With regard to Mechanical Engineering the renovation and rearrangement of almost all facilities (lecture halls, practical education facilities, study places, project working units, laboratories and workshops) will be done in phase 2. This phase covers the period November 1999 – September 2000. This means that, during the visitation, most of the facilities are provisional and are situated on temporary locations or on their old location. The renovation gives the opportunity to adapt the facilities to the new Thematic Project education in an optimal way.

The following paragraphs describe the situation after the renovation. The temporary situation during the visitation is described as well. Fig. 10-1 gives an overview of the building for Mechanical Engineering and Marine Technology.

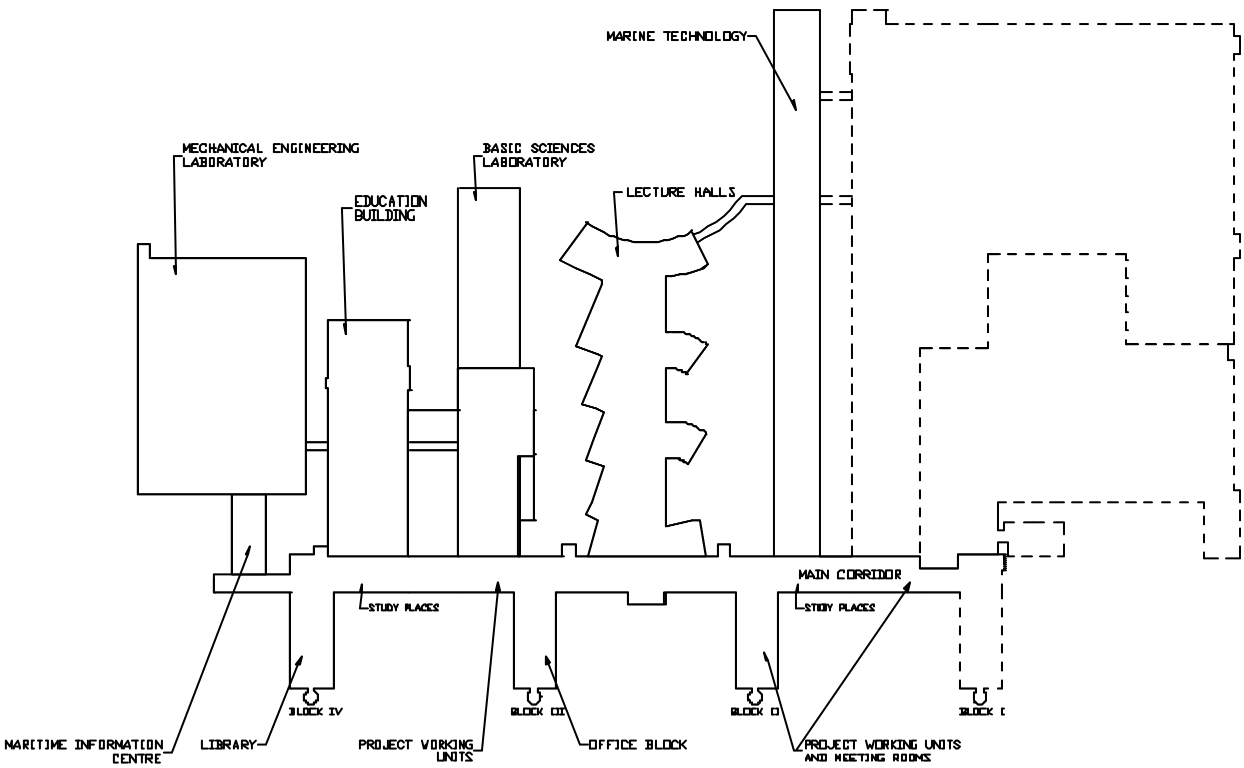

Figure 10-1 Building for Mechanical Engioneering and Marine Technology

10.1.2 Opening times

The faculty and facilities, as described in the following paragraphs, are open for students and staff from Monday till Thursday between 07.00 and 22.00 hours and on Friday between 07.00 and 18.00 hours. The faculty library is open on working days from 08.30 till 17.30 hours. The university library is open every day.

10.2 Lecture halls, colloquium rooms.

The faculty has 6 lecture halls for Mechanical Engineering and Maritime Technology. The largest hall has 315 seats and the smallest 83. The halls are provided with blackboards, overhead projectors and slide projectors. The (4) larger halls are also provided with a PC, connected to the network and a video projector. The facilities enable the showing of films, video and computer presentations and simulations. They also enable teachers to prepare their presentations and simulations in their offices and to demonstrate these by logging in, in the lecture hall.

In addition to the lecture halls 4 colloquium rooms will be available for lectures and instructions to smaller groups of students (20 – 50). These rooms will be equipped with modern presentation facilities as well. For the smaller lecture halls and colloquium rooms two portable systems with PC and video projector are available.

The lecture halls as described are available; the colloquium rooms are not yet on their final location, but are situated on old locations.

10.3 Study and working places for students.

For students the following study places are available:

- approximately 90 individual study places in the main corridors connecting the office blocks of the faculty main building (Mekelweg 2)
- 60 study places in the faculty library. Some of these study places will be provided with PC's connected to the network (see figure 10-2)
- 1000 study places in the central university library. These study places are intended for the use of all students of DUT and are provided with PC's. The university library is situated opposite to the faculty building at a distance of approximately 200 m

The study places in the faculty and university libraries are already available, while the study places in the main corridors will be ready in September 2000.

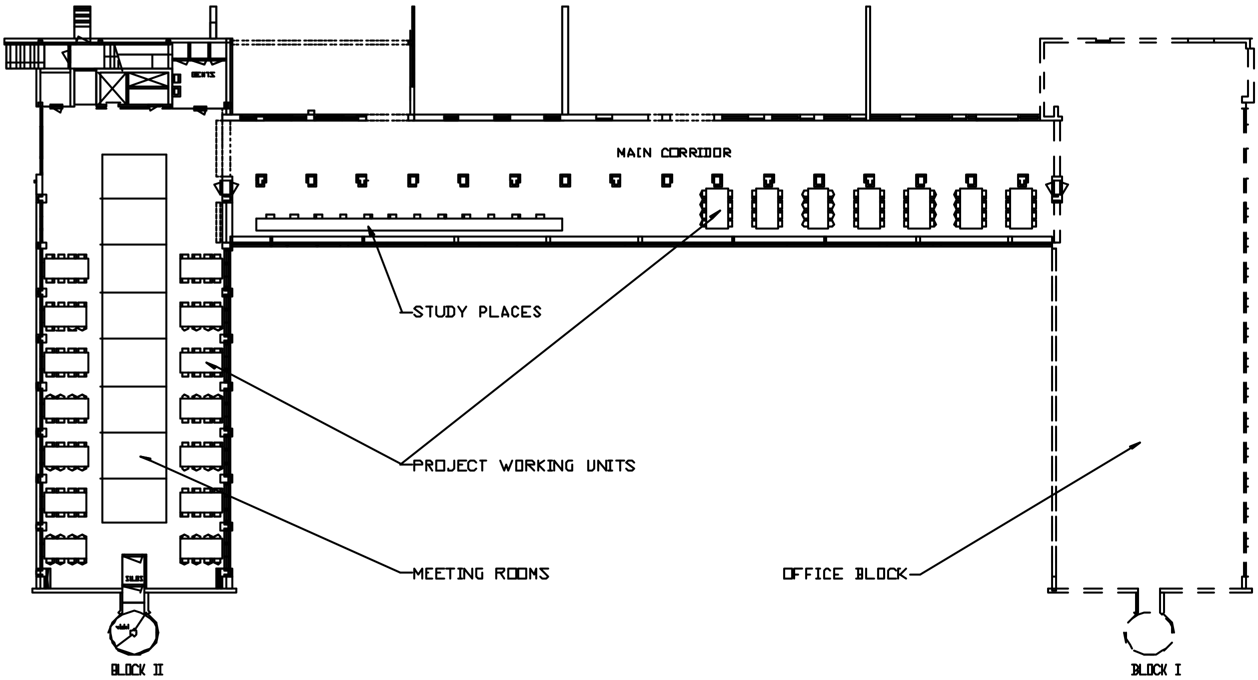

Figure 10-2 Block II and main corridor, ground floor

For the thematic project education 42 project working units are available. These working units are provided with a large table, 8 – 10 seats, a PC connected to the faculty network, facilities to connect portable PC's to the network and a whiteboard. The project working units will be located in the main corridors, in the hall adjacent to the lecture halls and on the ground floor of block II.

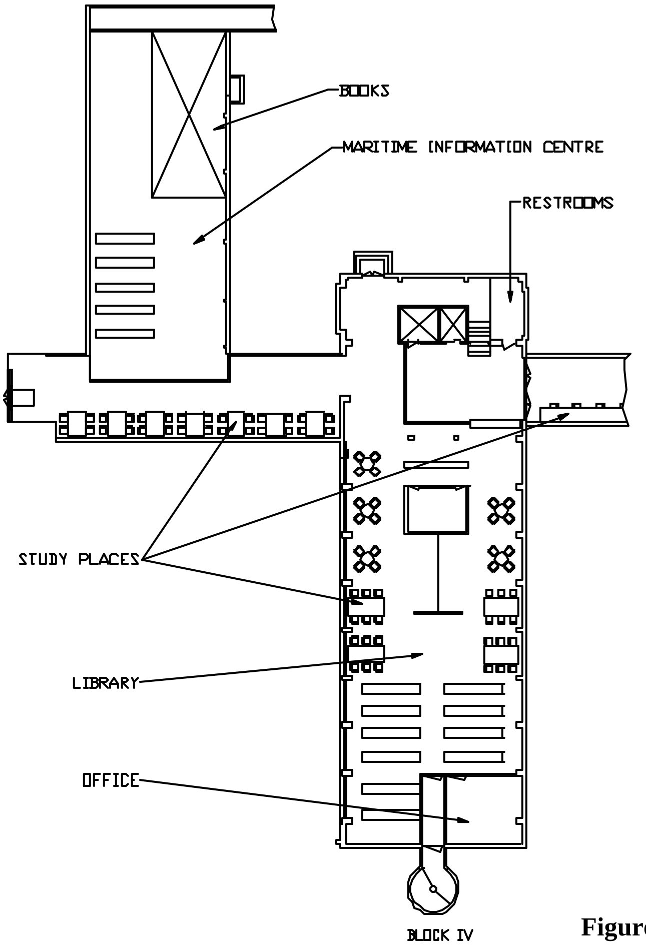

Figure 10-3 Library and Maritime Information Centre, ground floor.

In addition to the project working units, 8 meeting rooms will be provided on the ground floor of block II, to be used for project group meetings with and without the mentors.

For the students approximately 600 lockers will be available for storage of their belongings.

The project meeting rooms will be available in September 2001. The project working units are available now, but not on their final locations.

10.4 Building for practical education.

After the renovation Mechanical Engineering will have a building wing (onderwijsgebouw) in which all facilities for practical education in the general phase of the study (study years 1, 2 and 3) will be concentrated. These facilities include:

10.4.1 Design studios

Twelve design studios will be provided, for use by groups of 2 or 4 students (see figure 10-4). Each studio will be equipped with desks, a worktable, chairs, whiteboard, storage facilities and 2 high end PC’s, suitable for 3D-CAD, calculations, simulations and office automation. The PCs will be connected to the faculty network. The design studios are intended to be used for the IOP (integral design and production) projects in the second year.

The design studios will be available in September 2000.

At present, a CAD-hall is used for the second year IOP project. In this CAD-hall 20 UNIX workstations are provided.

Both PCs and workstations are currently used by students. It is intended that after September 2000 only PCs will be used in the general phase of the study.

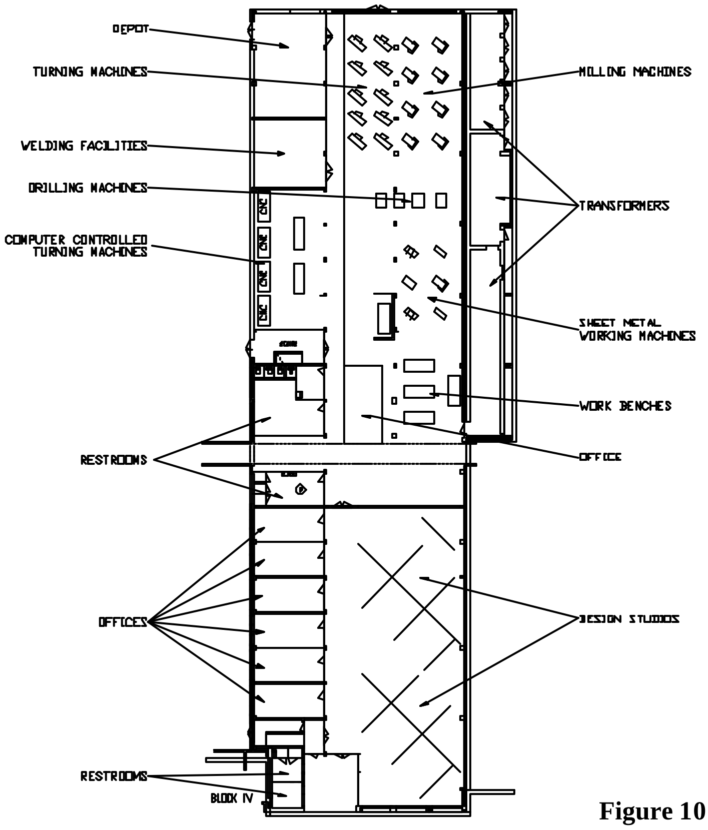

Figure 10-4 Education building, ground floor

10.4.2 PC rooms.

Three PC rooms will be available. Each PC room will be equipped with 6 clusters of 4 PCs. So in total 3*6*4 = 72 PC's will be installed in these rooms.

The PC's will be used for:

- instructions and training, amongst others in the use of CAD, finite element and simulation software
- computer examinations and tests
- individual use by students for CAD, calculations, simulations, internet, e-mail and reporting

At present 4 PC rooms, with in total 100 PCs, are available, but not yet on their final location.

10.4.3 Manufacturing centre.

A manufacturing centre will be provided. The centre is used for:

- instructions to students in the use of production equipment
- production and assembly of equipment designed and produced by students in the IOP projects
- production and assembly of equipment designed and produced by students for the annual design contest

The centre will be equipped with state of the art manufacturing equipment and tools:

10 lathes, 8 milling machines, 8 drilling machines, plate-shaping equipment, welding shop, assembly workbenches and a CNC room.

At present a manufacturing centre is available at another location with the same, however rather old, equipment.

10.4.4 Mechatronics laboratory.

A mechatronics is provided for projects in the second study year a mechatronics laboratory. In this laboratory twelve units, each for two students, are installed (see figure 10-5). Each unit is equipped with "Fischer Technik" mechanical equipment and professional electrical equipment, sensors, actuators, motors, robots and PC's. The units are supplied with an 88 channel AD/DA/DI/DO system, including signal pre-processing and power amplifiers. The students design a mechatronic system, develop the necessary control software and assemble and test the system in the laboratory.

At present the mechatronics laboratory is at a temporary location.

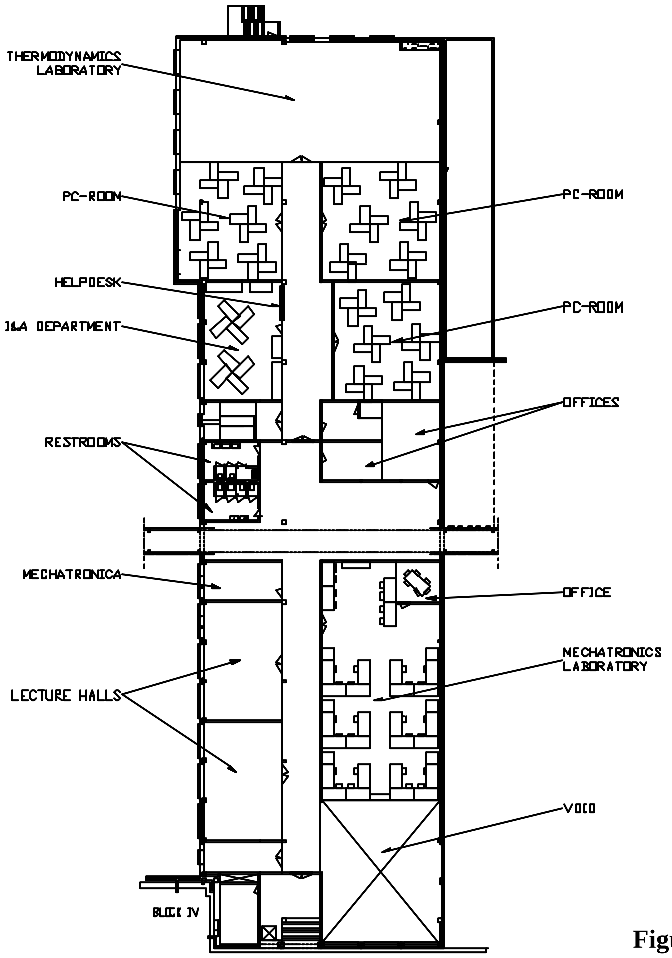

Figure 10-5 Education building: first floor

10.4.5 Thermodynamics laboratory.

A thermodynamics laboratory will be provided, to be used in connection with the thematic projects on energy and process technology (see figure 10-5).

In the practical education building will be provided:

- 12 natural gas-heated water heaters for domestic use
- 4 heat pump systems

These facilities are presently located in the research laboratories for control engineering and refrigeration.

Student facilities will also be provided in the new laboratory for mechanical engineering:

- a diesel engine testbed
- a gas turbine testbed

and in the laboratory for process equipment:

- separation equipment: destillation, crystallization and CO_2 stripping.

10.5 Libraries.

A combined faculty library for Mechanical Engineering and Marine Technology, is already available. It contains a collection of books and periodicals, primarily intended for use by students during their study. A library committee advises about the collection. The number of books in the faculty library is approximately 8000. The number of periodicals is about 200 and includes general and scientific journals in the fields of mechanical engineering and marine technology and a number of journals of general interest. The collection also involves CD-ROMs and videos. The faculty library is part of and managed by the university library. The computerised catalogues of the faculty libraries and university central library are integrated.

The faculty also houses the Maritime Information Centre (MIC), which is also part of the university library. This is a service centre for the maritime industry and in its field probably the most extensive facility in the world. It contains more than 10000 books, subscribes to 400 (maritime) periodicals and has 1700 conference proceedings. In addition there is a database with 18000 ship descriptions. The MIC is accessible for students.

The university library is the largest technical scientific library in the Netherlands and is located at a short distance from the faculty.

The faculty library and MIC will move to their combined new location (see figure 10-3) in September 2000.

10.6 Computer infrastructure.

The faculty is standardised on two types of computer systems: PC's and UNIX workstations.

As the capabilities of PC's are ever increasing, it is the intention to use after September 2000 only PC's in the general phase of the study.

The I&A (information and automation) department maintains for PC's a Windows NT network. I&A operates all PC's in use for education (PC rooms, design studios, project working units etc.) and for the service departments of the faculty (P&O, finance, secretariat etc.). It supports the use of the university wide standardised office automation suite (Microsoft: Word, Excel, Outlook, Power Point etc.), the specific software for the service departments and the scientific/technical software on which the faculty has standardised (PC Matlab, Simulink, Ansys, Adams, Autocad etc.)

Every student is given an account, which permits the use of the standardised software and gives entrance to the www and e-mail. Next to that students (and staff members) can get a remote phone-in account, which enables to work from home. Student houses in Delft have a direct connection to the university network.

As well as the PC network the faculty also has a network in which a large number of UNIX workstations. UNIX workstations are currently used for CAD and by the scientific departments and sections for research. Some sections, which need high performance computing, are connected to external computer centres.

In the laboratories non-standard computer systems may be used depending on the facilities needed for research.

10.7 Research laboratories.

After the renovation Mechanical Engineering will have 3 laboratories for research:

- laboratory for basic sciences, in which facilities are provided for fluid and solid mechanics, control engineering and man- machine systems
- mechanical engineering laboratory with research facilities for production technology, transport technology including dredging and energy and refrigeration systems
- laboratory for process equipment. This laboratory is a joint venture with the faculty of applied sciences.

The research facilities of the different groups are now spread over the faculty buildings. In September 2000 the new laboratories for basic sciences and mechanical engineering will be ready (see figure 10-

1). The laboratory for process equipment will remain on its present location, Leeghwaterstraat, at a distance of approximately 500 m from the main faculty building (Mekelweg 2).

Students in their specialization phase may make use of the facilities in the research laboratories for their graduation project (masters thesis). The facilities may be used also investigations connected to the BSc- project (kandidaats opdracht).

10.8 Financial constraints

Due to the fact that the renovation of the faculty coincides with the implementation of TPE, it has been possible to adapt the facilities to the requirements set by the forms of education. Through contributions of the university education renewal fund and giving education a high priority in the faculty, it has been possible to achieve a more or less optimal infrastructure. For renewal of these facilities in the future the faculty will make deprecations.

11 Internationalization and external contacts

11.1 Internationalization policy

For Delft University of Technology, internationalization is of strategic importance for the following reasons **[12]**:

- Delft University of Technology wants to function as one of the leading technical universities in Europe, in the fields of research as well as that of education. This implies that the TU Delft has to operate on a world-wide scale.
- The quality of the education can be improved by exchanging students and teachers with universities abroad.
- Research is an international matter. Therefore research at DUT will benefit from a continuous exchange of researchers.
- In order to maintain the present level of research it may be necessary to recruit PhD students from abroad.
- Because of the growth of the international labour market DUT has to prepare its students for an international career.

Choices

To this end the University has formulated a number of strategic choices, of which the most important are:

- Existing contacts with a limited number of partner-institutions abroad will be intensified with respect to co-operation in the areas of education and research by developing common policy regarding quality control, course development and the recruitment of foreign students. For a start this kind of co-operation will be set up with ETH Zürich and Imperial College London.
- Central budgets and support will be aimed especially at exchanging students, researchers and teachers with these selected universities.
- Exchange students from partner-institutions who comply with the entrance criteria will be given an opportunity to participate in the Master of Science programme given in English, free of charge. Funds will be created in co-operation with trade and industry for the accommodation of foreign students.

MSc Programme

As a result of the internationalization strategy, MSc Courses in a number of disciplines are offered in English by most of the Faculties of the University.
The faculty has set up a MSc Programme in Mechanical Engineering. MSc courses can be followed in the following fields of specialization:

- Control Engineering
- Production Engineering and Organization
- Transportation Engineering

Details of the MSc programme are given in Chapter 4.3.3.

Funds

To stimulate students to take part in one of the international exchange programmes or to do practical training abroad, the University has a number of mobility funds to its disposal **[13]**:

- Stimuleringsfonds Internationale Universitaire Samenwerkingsrelaties (STIR)
  This fund is intended to stimulate student mobility in the direction of foreign universities.
  Delft University or the Faculty of the student must have a formal co-operation agreement with the foreign university.
- Fonds Internationale Stages
  This fund is intended to stimulate the development of students' international experience and professional knowledge by means of a practical training period at a foreign company, institution or organization.
  The receiving body must express its appreciation of the student's stay by various means including the reimbursement of expenses and providing free lodging. After finishing the training period the student must submit a certificate from the Faculty's practical training co-ordinator or an

examination proof, stating that the student has fulfilled his obligations and showing the credit points obtained.

- Leonardo Beurzenfonds
  LONARDO is a programme of the European Union, intended to promote the exchange of knowledge between universities and industry in Europe. The programme offers scholarships to students who will spend practical training period at a company or an international research institute abroad in one of the member countries or in Cyprus, Hungary, Liechtenstein, Norway, Rumania or Iceland.
  The duration of the practical training period must be at least 3 and at most 12 months.
- Erasmus Beurzenfonds
  The SOCRATES-ERASMUS programme is a programme of the EU, intended to stimulate member states to exchange students with each other, by offering scholarships.
  Delft University participates in a large number of ERASMUS exchange programmes.
  The student must submit a report before July 1 of the academic year in which the exchange takes place.
- CvB funds
  The Executive Board (CvB) administers a number of funds from which individual students can receive financial support for following courses at foreign universities with which TU Delft has no structural co-operation agreement. Journeys abroad, organised by student societies can be sponsored. A report must be submitted.

In general, the following requirements must be met:

- the student remains registered at Delft University
- the course or practical training followed abroad must be an integral part of the course programme of Delft University and must be equivalent to at least 8 credit points
- in the case of practical training, the receiving company or institute must express its appreciation of the student’s stay by various means including the reimbursement of expenses and the provisions of free lodging.
- for a stay abroad the student receives financial support from one fund only.

To assist foreign students, who intend to follow courses at the Faculty, all course descriptions are available in English and can be accessed on the Faculty's web. The student’s workload is indicated by means of ECTS credit points.

11.2 Institutional contacts with the international scientific community

Delft University of Technology has co-operation agreements with the following institutions **[13]**, **[14]**:

- The European Louvain Network, besides TU Delft consisting of:
  Rheinish-Wetsfälische Technische Hochschule, Aachen (RWTH)
  Katholieke Universiteit Leuven (KUL)
  Imperial College of Science and Technology London (ICL)
  Université Catholoque de Louvain, Louvain-laNeuve (UCL)
  Groupemant des Grandes Ecoles, Paris
  Norges Tekniske Hogskole, Trondheim (NTH)
- Royal Institute of Technology, Stockholm, Sweden
- Eidgenössische Technische Hochschule, Zürich, Switzerland
- Ecole Polytechnique Fédérale de Lausanne, Switzerland
- Technical University Prague, Czech Republic
- Technical University Warsaw, Poland
- Tsinghua University, Beijing, China
- Institute of Technology Bandung, Indonesia
- National University of Singapore
- Kyoto University, Kyoto, Japan
- University of Tokyo, Japan
- University of Osaka, Japan
- University of Texas, Austin, USA
- University of Michigan, Ann Arbor, USA.

In most cases exchange programmes are included in the agreements.

11.3 Studies and practical training abroad and exchange programmes

Exchange programmes

Within the frame of the SOCRATES-ERASMUS programme, Delft University has student exchange programmes with a large number of universities in Austria, Belgium, the Czech Republic, Denmark, Germany, Finland, France, Greece, Great Britain, Hungary, Ire, Italy, Norway, Poland, Portugal, Rumania, Slovenia, Spain and Sweden.

Furthermore there are exchange programmes with universities outside the EU, for instance with:
- Ecole Polytechnique Fédérale de Lausanne (EPFL), Switzerland
- Eidgenössische Technische Hochschule (ETH), Zürich, Switzerland
- University of Texas, Austin, USA
- University of Michigan, Ann Arbor, USA.
- National University of Singapore
- Kyoto University, Kyoto, Japan
- University of Waterloo, Ontario, Canada.

The Sub-Faculty Mechanical Engineering and Marine Technology has a network of sister Faculties and takes part in ECTS/Socrates-CDI, the Louvain Network, the Big10 Network. Students have been exchanged with universities in: Austria, Belgium, Denmark, England, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Norway, Portugal, Spain, Sweden, Switzerland, Canada and the USA.

Individual contacts

In the majority of cases the exchange of teachers and PhD students takes place on the basis of individual contacts.

The section *Transport Technology and Logistic Engineering* has been partner in the Global Logistic Research Initiative (GLORI) (finished April 1999), the mobility projects TEMPUS 1,2 and 3 (1993 - 1996), exchanging staff and PhD students with East-European countries. Arising from these projects, agreements were made on the exchange of students between the participating partners. Contacts are maintained with Lufthansa German Airlines, University of Köln, Johan Wolfgang Goethe-Universität, Universität Stuttgart (Germany), National University of Singapore, Chalmers University of Technology (Sweden), University of Warwick, Brunel University (England), The University of North Carolina (USA), Politechnika Warszawa, Politechnika Wroclawska (Poland). Students from the section have done their thesis work at Port of Houston (USA), Autonome Roboter G.m.b.H. (Germany), Port of Singapore, Scaldis Reefer Chartering (Belgium).

Students *Vehicle Engineering* have done their thesis work at major automotive companies in Germany, France, Italy, and Sweden.

In the field of specialization *Dredging Technology*, contacts are maintained with University Hohai Changzhou (China), Texas A&M University (USA), and the companies Skanska (Sweden), Great Lakes and Mobile Pulley (USA).

The section *Man-Machine-Systems* maintains contacts with the University of Kassel (Germany), Technical University of Denmark, Université de Valenciennes et du Hainaut Cambresei (France), University of Surrey (England), Massachusetts Institute of Technology (USA).

In the field of *Refrigeration & Indoor Climate Control* staff and students are exchanged with Trondheim University / SINTEF (Norway), University of Texas (USA), ITB Bandung (Indonesia) and University of Bucharest (Rumania) and educational materials are exchanged with KTH Stockholm (Sweden), International Institute of Refrigeration (France), Universität Hannover / FKW (Germany), Katholieke Universiteit Leuven (Belgium).

The section *Production Technology and Organization* participates in INTEND, an international consortium of universities and industrial partners, which aims to improve the performance of geographically distributed teams of engineers. Delft students can follow lectures by Michigan State University teachers via Internet. Furthermore students are exchanged with Ecole des Mines de Douai (France), University of Michigan (USA) and UNICAMP Campinas Brazil (Brasil). Students have carried out their Masters assignments and practical training periods with a major aircraft manufacturer in the US, well-known energy and electronics companies in Germany and France and European food and beverage companies. Contacts are maintained with Ecole de Commerce Grenoble (Grenoble School of Business) and University of Cambridge Department of Manufacturing Engineering.

The section *Engineering Mechanics* exchanges staff and PhD students with the Universities of Bradford and Swansea (UK), University of Florida (USA).

The section *Thermal Power Engineering* exchanges teachers and students with Polytechnic University of Bucharest (Romania), Inter University Research Center for Engineering Science / Institut Teknologi Bandung (Indonesia), Technical University of Denmark. Students are placed for their final assignments at companies in the USA and UK.

The *Fluid Mechanics* section has regular contacts with the University of Illinois at Urbana Champaign, USA, Stanford University, USA, Ecole Polytechnique Fédérale de Lausanne, Switzerland (exchange of staff) and Tsinghua University, Beijing, China (exchange of staff and students). Students had their practical training period or Masters assignment at Ecole Centrale, Lyon, France, University of Rome I ‘La Sapienza’, Italy , University of Thessaloniki, Greece and industrial firms in Switserland and France.

In the field of *Marine Engineering* exchange of students takes place with University of Newcastle upon Tyne (UK), National Technical University of Athens (Greece), Universidad Politecnica de Madrid (Spain) and University of Trondheim (Norway).

Contacts are maintained with individual Professors, Heads of Department, Directors, etc.

Participation

A review of the grants provided to TU Delft students (Overzicht van verstrekte subsidies uit de mobiliteitsfondsen van de TU Delft voor 1997 – 1998 **[15]**) shows an increase during the period 1990 - 1995. In the period 1995 - 1998 the number of grants fluctuated, with a peak in the academic year 1996-1997. There is a decrease in participation in the ERASMUS fund during the period 1993 - 1998 by nearly all faculties, including Mechanical Engineering.

However, in the period 1997-1998 the average stay abroad increased to 6.3 months, which is 1 month longer than in previous periods. This seems to comply with the desire expressed by a number of companies that practical training periods should be extended.

Thirty students from Mechanical Engineering and Marine Technology received grants from one or other of the mobility funds during 1996-1997, compared to 20 students during 1997-1998.

Quality

The quality of the credit points obtained at universities within the European Union is assured by means of the European Credit Transfer System **[16]**. Students participating in ECTS receive full credits for all academic work successfully completed at any of the ECTS partner institutions. These academic credits may be transferred if there has been prior agreement between the institutions on the student workload and the academic level of the subjects concerned. Ten ECTS credit points are equivalent to 7 NL credit points. Furthermore, a certified summary of subjects is supplied, which can simply be transferred. Prior to the exchange the student receives an information package and the student, the home university and the host-institution enter into a study agreement, to which the three parties commit themselves. The ECTS credit points are allowed only if the student has met all the host-university's requirements for the particular subject.

11.4 Foreign students

Delft University of Technology discerns three categories of students from abroad:

- *Regular students*:
  Students who want to obtain the diploma of the Delft University of Technology in the normal way and attend the lectures relating to the regular courses. The language of instruction is Dutch
- *Regular students with at least a BSc degree in engineering*:
  Students who possess at least a BSc degree in engineering and want to obtain the diploma of the Delft University of Technology in the Master of Science International Programme; language of instruction: English.
- *Exchange students*:
  Students from a foreign university who study at Delft University of Technology for a limited period under a specific scheme (i.e. SOCRATES, TEMPUS, ECTS).

11.4.1 Admission

Regular students*; main language of instruction: Dutch*

The main requirement for admission as a regular student at Delft University of Technology is a diploma, which, in principle, qualifies a person for entry to a university of technology in the country of origin. The diploma must be recognized by the government in that country. Depending on the type of diploma, applicants usually have to pass an entrance examination in the Dutch language, mathematics, physics and sometimes in chemistry before enrolment as a regular student is allowed. Preparatory courses in the Dutch language, mathematics and physics are offered by the university. The objective is to eliminate the effects of possible differences in entrance levels of foreign students and their Dutch contemporaries.

Regular students with at least a BSc degree in engineering; *language of instruction: English*

Applicants for the MSc International Programme are selected by a selection committee, on the basis of the documents submitted and, if applicable, of additional testing and/or a personal interview. Applicants must have at least:

- a BSc degree (or equivalent) of acceptable quality and level
- a grade point average of at least 75% of the scale maximum
- fluency in English: for students with mother tongue other than English a score on the Test of English as a Foreign Language (TOEFL) of at least 550
- a result on the Graduate Record Examination (GRE) test of at least 550.

Furthermore applicants must write an essay, describing their motivation and interests giving three examples of thesis topics that would be of interest to them and a short summary of the thesis work or final assignment of the BSc study.

Exchange students

Delft University of Technology offers foreign students the opportunity to attend a course, to carry out a project or write a thesis. They have to be accepted by the faculty concerned and they need the approval of their home university.

Exchange students participating in a SOCRATES-ERASMUS programme and students from universities that have a bilateral co-operation agreement with DUT, are exempted from tuition fees. Exchange students who do not belong to this category are called free-mover students. They have to pay the full tuition fee. However, students from EU/EEA countries are entitled to an allowance to cover tuition fees. They receive this allowance as a grant. Eligible students are those:

- who are nationals from EU/EEA countries (Austria, Belgium, Denmark, Finland, France, Germany, Great Britain, Greece, Iceland, Ireland, Italy, Liechtenstein, Luxembourg, Norway, Portugal, Spain and Sweden) and
- who are following a course of study in the Netherlands for which a grant is available and who are resident in the Netherlands and
- who are between 18 and 27 and
- who are not eligible for the full student grant due to nationality regulations.

12 Quality assurance

12.1 *Internal quality control system*

Quality is considered to be the measure the extent to which goals, aims and objectives have been reached. The goals, aims and objectives with respect to the curriculum are mentioned in Chapter 3. Mechanical Engineering has also formulated a number of additional objectives:

- an over-all yield of 60%
- a Propaedeutic yield of 67%
- a Propaedeutic yield after one year of 33%
- a post-Propaedeutic yield of 90%
- an average total study time of 5.5 years
- the curriculum should be motivating for the students
- the Propaedeutic phase should have an orienting and selective function
- the capacity of the Propaedeutic year is about 250 students/year, matching the desired inflow.
- the educational infrastructure and logistics should guarantee a throughput of 192 students/year (VWO aansluiters: students who just finished their pre-university education) in the second and third year of the general phase of the study.
- the cost of the implementation of the curriculum should fit within known financial constraints.

Quality assurance can be considered the complementary process to quality improvement and quality consolidation, with the aim making the quality of the educational processes visible and controllable. The educational process can be considered as the coherent whole of the curriculum, the organization, the infrastructure and the scientific staff involved in the process. The combined action of these four aspects determines the quality of the educational process.

12.1.1 Parties involved

Two main groups of customers can be distinguished, the students and the employers of the graduates.

Two main products can also be distinguished, the curriculum offered to the students and the graduates as they start their career at their first employer.

Both groups of customers should be satisfied with the quality of the product offered to them by Mechanical Engineering Delft

Based on this starting point, Mechanical Engineering started developing a quality assurance system in 1996 as an integral part of Thematic Project Education. The system distinguishes between curriculum development and quality control, as indicated in Figure 12.1.

In 1998 the Dutch Government funded a quality control project designed to develop a quality control system for Mechanical Engineering and Marine Technology. This project started in 1999 in cooperation with Technical Informatics. Although many different instruments are used for quality control, the current system is not yet consistent and sufficiently structured to meet the requirements of the AKO.

The following bodies play a role in curriculum development and quality control, see Figure 12.1.

Board of University/AKO

The Executive Board of the Delft University appointed an Advisory Committee Quality of Education (AKO) in 1997. Mechanical Engineering reports to the Board through the AKO. The reports have different purposes, long-term (5 years) educational strategy, short-term (1 year) educational development programmes, quality control and the funding of new educational projects. The contact frequency between the Director of Education of Mechanical Engineering, the AKO and the staff of the Executive Board of the Delft University is at least monthly.

Dean/Director of Education

The Dean of the Faculty of Design Engineering and Production is responsible for all aspects of the education in Mechanical Engineering, Marine Technology and Industrial Design. For each education programme an Director of Education has been appointed. The Director of Education of Mechanical Engineering is responsible, on behalf of the Dean, for the all aspects of the education in Mechanical Engineering..

The responsibilities of the Director of Education are:

- long term strategy/policy development
- short term implementation
- the financing of the education, including fund raising
- the Office for Educational and Student Affairs
- the organization of the curriculum
- the educational infrastructure
- the quality control.

Educational Committee

For each education programme an Education Committee has been set up. The duties of the Education Committee are laid down by law. These are:

- to advise the Dean on the Education and Examination Regulations
- to yearly review the execution of the Education and Examination Regulations
- to advise the Dean on all matters relating education in the Education Programme concerned.

The educational committee consists of 4 students and 4 members of the staff.

The Director of Education is always present at the meetings of this committee as a guest, but is not a member of the committee.

Student Council

See Chapter 9.1.2

Mechanical Engineering & External Chairs

The Mechanical Engineering and External Chairs develop and carry out the different courses and projects. They also participate in the educational committee, in the examination committee and the different workgroups concerned with curriculum development.

Leeghwater

The student association of Mechanical Engineering Leeghwater has an important contribution to the quality control and feedback process. Leeghwater organises every year that for each course and project, two participating students are appointed that give a two-weekly response on the course/project they are appointed for. Leeghwater collects all the responses for courses and projects in the general phase of the study and discusses these responses with the Director of Education. The Director of Education takes action if appropriate.

Leeghwater also organises excursions and events (for example the design contest) and thus plays a very important role within Mechanical Engineering.

Students

The students are represented in the Management Team of Mechanical Engineering, in the Student Council, in the Educational Committee, in Leeghwater, usually in workgroups and ad-hoc.

Through these representations the students participate in the curriculum development as well as in the process of quality control. On an ad-hoc basis students, either individually or representing groups, give feedback to the student advisors and the Director of Education. In the Propaedeutic year the students are part of two-weekly evaluation meetings.

Society

The role of the society on the quality of the education of Mechanical Engineering is twofold, on one hand the well structured and systematic reviews and on the other hand the feedback of society on the image of Mechanical Engineering Delft.

The structured and systematic reviews are:

- The 5 year review organised by the VSNU
- The yearly review by the Elsevier
- The yearly review by “De Hogere Onderwijsgids” (the high education guide)

Other reviews may occur in the future.

The image of Mechanical Engineering Delft towards society is partly determined by the results of the reviews that are public, but also by many unknown factors. This image however is considered to be of influence on the inflow of students. Mechanical Engineering is trying to improve the image by, on one hand improving the quality of the education and thus offering a good product, and on the other hand performing good public relations (the design contest in June 99 is a good example of this).

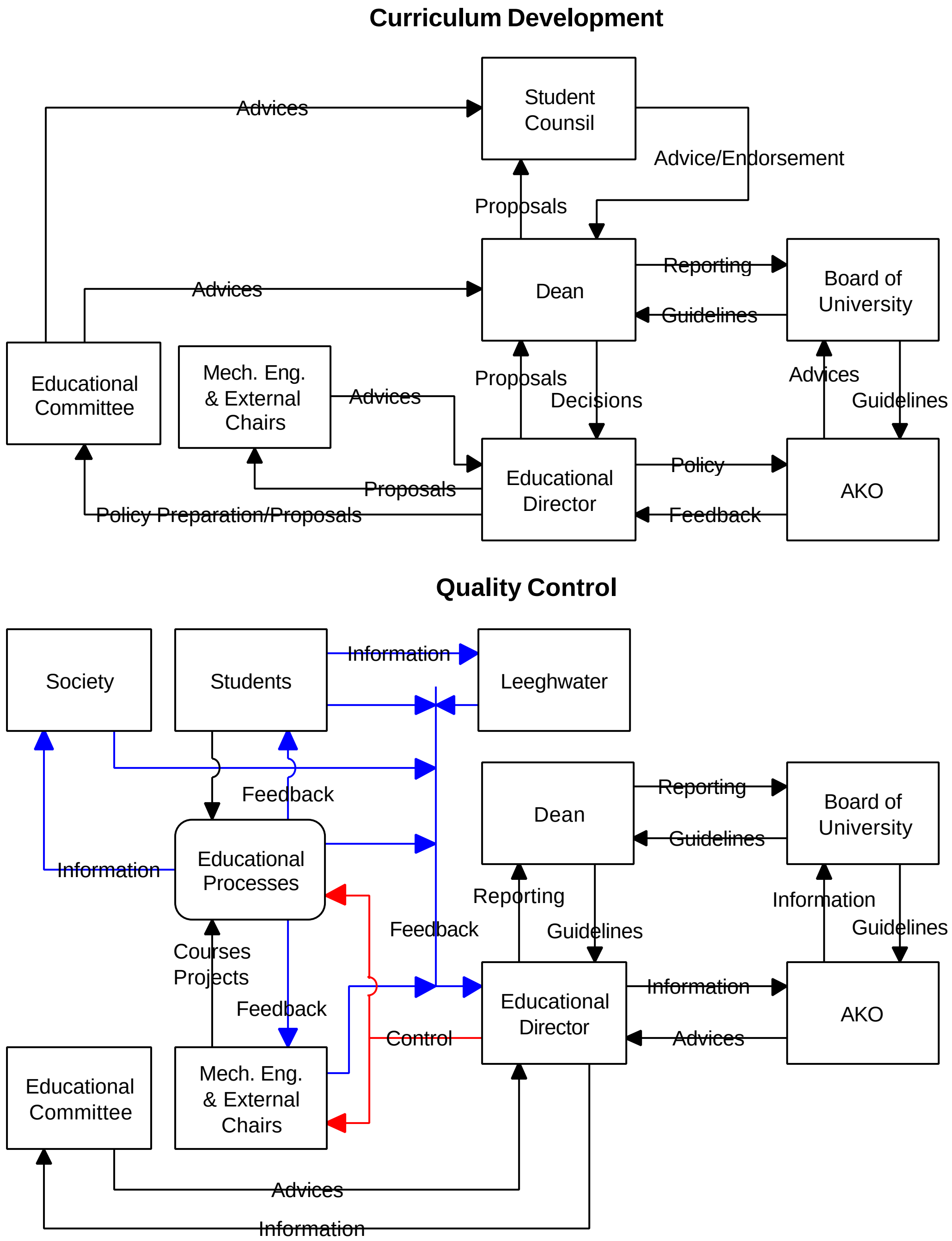

Figure 12-1: Curriculum development and quality control

12.1.2 Current quality feedback and control system

The current quality control system can be sub-divided into a number of categories, depending on the time scale on which feedback and control take place.

Daily

On a daily basis, there is direct feedback between the students and staff members on one side, and the student advisors and the Director of Education on the other. Usually this feedback concerns ad-hoc problems that have to be solved immediately.

Weekly/Two-weekly

On a weekly basis, there is a meeting of the project group TPE, concerning the curriculum development and evaluating the courses and projects running.

On a two-weekly basis, there is feedback between the students and Leeghwater about the courses and projects that are running. Leeghwater collects the information and discusses the information with the Director of Education. Appropriate action is taken.

On a weekly basis, there are a number of meetings between the first year project groups and their Teacher Mentors and Student Mentors.

On a two-weekly basis, there is an evaluation meeting with the first year students concerning the courses and projects running, but especially the projects. One of the Student Advisors and the Director of Education are present at these meetings.

On a two-weekly basis, there is a meeting of the mentors, a Student Advisor and the Director of Education concerning the project running in the first year and the project to follow it. The mentors are briefed about the following project.

On a two-weekly basis, there is a meeting between the student-mentors and a student advisor concerning the first year project groups.

Monthly

On a monthly basis, there is a meeting of the Educational Committee concerning curriculum development and evaluating the courses and projects running.

On a monthly basis, there is a meeting of the Dean, the Director of Education and a student representative concerning the developments of the education, evaluation, investments, etc.

On a monthly basis, there is a meeting between the Dean, the Director of Education and the full professors of the Mechanical Engineering Chairs concerning policy and developments.

Per period

Per period, a course evaluation is carried out, organised by the university. This course evaluation gives feedback on the courses carried out in the period in question.

Per project

On a project basis, an evaluation of the second and third year projects is carried out.

3 monthly

On a 3-monthly basis, there is a meeting of the student council with the dean and the Director of Education concerning policy/strategy.

Yearly

On a yearly basis, there is feedback through the “Elsevier”, the “NIPO” review of the university, the “Hogere Onderwijsgids” and the “Meer dan consumentengids”.

On a yearly basis, the education gives feedback to the AKO. By means of a policy/strategy and investment proposal.

5 yearly

On a 5-yearly basis, the education of Mechanical Engineering is reviewed by the VSNU.

Conclusions quality control system

Although the above shows many ways of feedback from the educational processes to the organization and also the means to control the processes, the faculty is of the opinion that the system is still not structured enough, while there is hardly any system for students in their pre-Graduate Phase.

Because of this Mechanical Engineering, Marine Technology and Technical Informatics started a joint project on quality feedback and control in 1999. This is financed by the Dutch government.

12.2 Actions taken after previous review

12.2.1 Introduction

In 1995, the educational programmes Mechanical Engineering and Marine Technology were assessed, as well as those of two other Dutch and three Belgian Educational programmes for mechanical engineers. The report of the Assessment Committee was published in 1996.

This evaluation describes the situation of educational programme as this was established in 95/96 and the action that the Sub-Faculty of Mechanical Engineering and Maritime Engineering has taken since then.

In 1996 a Director of Educational was appointed by the Faculty to take responsibility for the both policy making and the execution of the educational programme.

The changes in the curriculum in the last decade arose out of the necessity to improve productivity, in part as a result of various advice from various sources. The end product, the graduate mechanical engineer, was judged good, but despite a drastic reduction of the study load, especially in the first year, the study schedule was assessed as being not doable. The production process was considered amenable to improvement. It seemed as if there was always an attempt to tackle symptoms that resulted in the problems being pushed to a different area or a later stage in the course. To deal with the conclusions and recommendations of the assessment report it was deemed necessary to develop an integral view of the education. For this, a distinction must be made between the general phase and the later final years of specialization. The overview in question must especially concern the early years of education, while the individual professors must have a perception of the later specialization phase. From the overview of education a doable study programme must be developed, that satisfies defined final objectives. The internal quality control should ensure the quality of the education.

In addition to direct actions, which are stated (in Italics) below the conclusions and recommendations, ME has developed an integral view of the education programme. This includes an educational philosophy, objectives, execution, management concept, quality assurance, training of teaching staff, infrastructure and educational aids. It has resulted in an education policy plan and a plan to change methods of education. Both were completed in 1998 and are amended annually.
In 1997, Mechanical Engineering introduced Thematic Project Education in the Propaedeutic year. This was implemented in the second and third years in 1998 and 1999 respectively. These developments are based on an integral view of the education, in particular the basic study.

Some actual overlapping actions:

- The development of the integral view of ME
- The development of a Quality Management Plan
- The structuring of contacts with lecturers
- The development of a career planning policy for the teaching staff
- The introduction of Thematic Project Education in ME

The conclusions and recommendations of the Assessment Committee of 1996 with regard to the education programmes in ME and MT are given below. They are followed by actions taken by the Faculty in relation to the education in mechanical engineering (in Italics).

12.2.2 Conclusions concerning both Mechanical Engineering and Marine Technology

1 The content of the four-year educational courses in mechanical engineering and marine technology can be characterised as providing good scientific education to academic level, but they are not doable. The graduates can rightly consider themselves mechanical engineers and naval architects.

re 1: The educational programme now lasts 5 years.

In ME Thematic Education was introduced on 1-9-97. In ME the P-yield after one year has increased to 25%. As a result of the structural reforms, it is anticipated that the P-yield will also rise.

Educational philosophy

2 The objectives are clear and in accordance with the frame of reference that the Committee employs for an academic study in the disciplines in question. However, the objectives are not entirely characteristic of a university education. The way the objectives are fitted into the programmes is good.

3 The Committee observes that the students are often not aware of the objectives of the educational programmes.

4 The programmes provide the students with good opportunities to develop their problem-solving capacity, as well as to think independently and critically. The programme does not adequately promote independent study and working and the relation between the programmes is not entirely satisfactory. The relationship between the education and the later professional activity is clear.

5 The Committee notes that professors feel little personal involvement in the renewal of the programme but fortunately it does see positive trends.

re 2: The objectives have been reformulated in the Thematic Education. The aim is to make a clear distinction between University and the Higher Professional Education Programmes, HBO (the 'why' rather than the 'how').

re 3: The objectives are clearly stated in the W-Patroon/studentenstatuut and in the education policy plans. Every year a copy of the W-Patroon/studentenstatuut is sent to all enrolled students.

re 4: Various projects have been added that will promote independent study. Within thematic Project Education, the coherence has been made integral to the entire basic study. Moreover, the themes mirror the specialization subjects.

re 5: During the monthly discussions of the core professors, educational renewal has a permanent place on the agenda. Moreover, the professors are expressly represented in all the workgroups that are involved in educational renewal.

Programme

6 The programme includes the required basic subjects, which are of a good level. The Committee observes that the students are not sufficiently encouraged to pay attention to the ethical and legal aspects of professional practice during the Propaedeutic phase.

7 The selective function of the Propaedeutic phase is not entirely satisfactory.

8 The Committee considers that the general level of the courses is good to excellent, as are the specialization and the optional subjects. The scientific content of the courses is demonstrated in both the Propaedeutic and the subsequent phases. In some specializations, the managerial character is further developed than one would expect in a technical study.

9 Both educational programmes have a good balance between education and research.

10 The relations between the ways of working and between the timing and succession of the courses are not entirely satisfactory. There is too little progress in the independent study of the students, there are too few stimuli for weaker students and the guidance is not active enough. The Committee values the approach to design teaching, but this does not live up to its promise. Good use is made of the educational potential of the computer.

11 The examinations provide a good reflection of the content of the programmes. The level of the examinations is good, as is their frequency and succession. The procedures for examinations are not entirely satisfactory. The Committee is concerned about the new way of running examinations on computers.

12 The attention paid to the skills of the students (written, oral, computer, and laboratory skills) is good.

R e6: All non-technical aspects are now integrated in the Thematic Project Education, so these are treated on the basis of cases.

Re 7: The orientating and selection functions of the Propaedeutics work excellently within the Thematic Education (see also point 33).
re 8: Managerial and logistic aspects are considered important. The technical component must always remain expressly present in the Chairs concerned.

Re 9: -

re 10: Within the Thematic Education Programme, hard work is in progress to obtain a good balance. The students work in groups and the services of both Teacher Mentors and Student Mentors are available to them.

re 11: In a memorandum on Computer Assisted Instruction the Sub-faculty stated that it is for giving information and communicating via the computer and against further development of examination systems that test knowledge in a too fragmentary fashion.
re 12: In Thematic Project Education these skills are integrated in the projects and are being extended still further.

Theses, final thesis assignment and practical training periods

13 The level of the final thesis assignment is generally considered good to excellent by the Committee. However, it observes a very wide variation in the levels. The Committee detects some problems in relation to the requirements that are set.

14 The rules and guidance for practical training periods are good, especially those carried out abroad.

re 13: There is a big spread between levels attained by the individual students. Work on a quality management plan that will deal with this point is in progress. ME hopes to reduce this variation by the formulation of measurable and testable final attainment levels.

re 14: -

Student numbers and pass-rates

15 The percentage of female students (circa 6% in 1994) is approximately equal to the national average for mechanical engineering education in the Netherlands.

16 The average pass-rates for the Propaedeuse phase after three years (ME and MT, 53% and 48% respectively) are the lowest in the educational programmes under consideration. It is noticeable that a very low percentage of students pass the Propaedeutic examinations in one year.

The average percentage of students from the intake who eventually graduate (41% and. 39% for ME and MT) are the lowest in the educational programmes involved.

The average percentage on the basis of the intake to the specialization phase in ME is good (88%); in MT this percentage (72%), is lower than the national average

17 The average duration of the study (6.3 years for both ME and MT) is the longest of all the educational programmes involved and far too long in relation to a course length of four years. The Committee expects that after the introduction of the new five-year programme the schedules and the duration of the study will be more in line with each other.

re 15: By using different methods of education and improved PR, the Sub-Faculty hopes to attract more female students.

re 16: Actions: Introduction of TPE, better guidance of students, etc.

re 17: The five-year programme in combination with Thematic Education should reveal whether this has improved. At present, the de P-yields have improved but not yet sufficiently. The Thematic Education Programme makes the students work harder and hopefully this will result in a shorter *duration of the study. One must realise, however, that it takes a long time to change education systems. The results of the present actions in relation to the average duration of study will only be apparent after a number of years. So far, the results have been encouraging*

Doability

18 The programmed study load for the four-year course is not in line with the actual study load. In the new Propaedeutic programmes, however, there is a good agreement.

19 The information about the educational courses given to potential students from VWO secondary schools is not entirely satisfactory. The study advice and information given to students is not entirely satisfactory either. The 'Study Guide' is good to excellent; the layout is very good. The Committee finds that the study guidance is too passive in nature although this point has already received more attention.

20 The doability of the four-year curricula is not satisfactory. The Committee thinks that the five-year programme will remove the most important bottlenecks.

Re 18: In the new form of education, this means an actual study load of 40 hours/week. This boosts the nominal study rate, as is already apparent, but is seen by the students as a more burdensome study. This is logical, a shorter actual study year means more intensive study.

Re 19: Much attention has been paid to PR during the last two years. A VWO network had been formed by the TU. The study guide, education examination regulations and student statures are now also available on the Internet. The site is updated daily. The study guidance by staff and student mentors is much more intensive. By means of the targeted participation of a large number of secondary schools in the annual design competition, an attempt is being made to improve the image of the educational programme structurally.

Re 20: see 12.2.2 point 17

Facilities

21 The facilities are generally excellent, but not sufficiently accessible to the students.

Re 21: Evening opening until 22.00 hours was introduced on 1-9-1997. Extra work places have been created and PCs acquired for the project education. Within the framework of the internal re-housing, work is in progress to increase accessibility and to extend the facilities for the students. It is anticipated that by Se[tember 2000 the facilities will have been completely renewed and extended.

Staff

22 Given the number of students enrolled and the number of graduates, the number of staff is on the generous side. The student/staff and the graduate/staff ratios are the lowest in the country.

23 The percentage of female members of staff in each of the faculties is more or less comparable. The number of PhD graduates on the staff is good.

24 The didactic skills of the staff are good.

25 The faculty is undergoing a process of reorganization. It is understandable that this demands the attention of the staff, which is given at the expense of their attention to teaching.

26 The feedback gained by means of discussions of performance is not entirely satisfactory for either programme. There are no performance discussions with the professors.

27 The education provided for and by the AiOs/OiOs is good.

re 22: Reorganization has raised these ratios.

re 23: Female staff, and more especially students are strongly represented in various consultative bodies and committees.

re 24: The new forms of education, in Thematic Project Education demand new skills. By means of courses, regular consultation and assessment, attention is being paid to this aspect throughout the faculty.

re 25: This attention has been considerably increased by the appointment of a Director of Education. Through the introduction of Thematic Project Education, lecturers from throughout the entire faculty have become involved *re 26: Develop a Quality Management Plan. The assessment of professors was started in 1997. The assessment and performance discussions now receive serious attention. All professors are assessed by the Dean.*

re 27: -

Internal quality control

28 The usefulness of self assessment studies did not entirely satisfy the Committee.

29 In general the response of Faculty to the remarks and recommendations of the previous Mechanical Engineering Committee is good and alert.

30 The Faculty possess a good system to record the progress of the study, but alas used this only to a limited extent.

31 The Faculty is well (ME) and excellently (MT), aware of how the graduates make their way.

re 28: The development and introduction of a quality assurance system must bring about improvements here. The Sub-Faculty deals seriously and energetically with the problems that occur.

re 29: The sub faculty does the same with the remarks of the Assessment Committee, described in this report.

re 30: the system is now also used in relation to the detection of problem cases (Flexible Propaedeutics), monitoring of groups, etc. For this students are followed from their first day and, if necessary, called to account. A new system (Volg++) is currently being introduced. This system provides more options.

re 31: This will continue.

12.2.3 Conclusions applying only to Mechanical Engineering

Educational philosophy

32 The programme is truly up to the minute.

Re 32: With the introduction of Thematic Education it is possible to take advantage of topical subjects. This system is so flexible that, if necessary, each year a different theme can be chosen. In practice that will happen only once in two or three years .

Programme

33 The orientating function of the Propaedeutic phase is not entirely satisfactory.

Re 33: The objectives for the Propeadeutic and second and third year examinations are determined by discussion with the professors on the specialist subjects. Through the introduction of Thematic Project Education the students have an excellent opportunity to orient themselves on Mechanical Engineering.

Theses, final thesis assignments and practical training periods

34 The guidance is not entirely satisfactory.

Re 34: The development of a quality management plan and the giving of targeted courses should also lead to improvements in the final stage.

Student numbers and pass-rates

35 The reduction in the intake of students (25% between 1990 and 1994) is a worrying development. The total number of students has declined less than the national average. The percentage of female students is lower than the national average.

re 35: In recent years, the intake has stabilised. Through the renewal of the education, the sub-faculty hopes that it will become more attractive to prospective students. The faculty is very active in its PR policy.

Graduates

36 The education is well attuned to the labour market and the prospects for work are good.

re 36: The new set-up of the basic study must ensure that this remains so in the future.

Facilities

37 Some of the laboratories are outdated.

re 37: The re-housing operation has been used to bring facilities up to date.

Staff

38 The Committee finds that more professors should participate in the Propaedeutic education.

39 The necessary provisions for didactic education or refresher courses are not entirely satisfactory.

re 38: The best teachers must provide the education, but there must be a clear link with the needs of the specializations. The professors and senior lecturers are involved in the educational reforms.

re 39: By using a number of sources of information, the teaching is assessed and lecturers are invited for discussions. An investigation is in progress into what is required to improve the teaching that is less good and, if necessary, action is taken. Through the development and introduction of the quality management plan this must be structured and embedded in the organization. The Executive Board is preparing a university policy on this subject.

Internationalization

40 Like the policy, the extent and nature of the activities in the area of internationalization are good.

Re 40: In 1999, the English language programme for the MSc was started. This is intended to attract more foreign students.

Internal quality control

41 The critical and analytical content of the independent study is not entirely satisfactory.

42 The internal quality control does not provide a satisfactory guarantee of the quality of the education.

43 The procedures for revision of the curriculum and teaching innovations are not entirely satisfactory and the Education Committee does not function entirely as it should. The involvement of students in the evaluation of the teaching is excellent.

re 41: Extra attention is paid to this aspect in the present Self Assessment Report.

Re 42: The development and implementation of a Quality Management Plan.

Re 43: The appointment of a Director of Education (DE) has clarified the organization. This has enabled the Education Committee (EC) to function as an advisory body without being troubled by organizational aspects. The EC is concerned with policy formation while the DE is responsible for both policy preparation and execution.

12.2.4 Recommendations applying to Mechanical Engineering and Maritime Technology

Educational philosophy

1 Formulate an objective in which more emphasis is placed on the broad education of an engineer.

2 The objective of the education programmes should be more clearly explained to the students.

3 Formulate final objectives that reflect the realization of the general goals that are minimally expected from graduate with regard to the knowledge and skills gained and the attitude developed.

re 1: This has been included in the educational policy plan.

re 2: This is given in the W-Patroon/studentenstatuut.

re 3: The objectives have been formulated.

Programme

4 Investigate whether chemistry should be added to the basic curriculum.

5 The students must be encouraged to pay more attention to the ethical and legal aspects of professional practice during the Propaedeutic phase.

6 The character and position of the managerial component in a number of the specializations must be reconsidered.

7 Improve the relation between the ways of working and the timing and succession of the courses.

8 Make greater use of oral examinations.

9 Add a short course on the use of libraries to the programme to optimise the skill of the students.

re 4: From a survey of lecturers, it appears that there is a real need for the subject of Physical Transport Phenomena and, in addition a Process project has been implemented in the 3rd year which will start in January 2000.As the majority of students have studied chemistry at VWO, it is felt that chemistry in the general phase of the study program is not necessary. For students specializing in Process Equipment additional chemistry courses are included.

Re 5: The non-technical aspects such as ethics, environment, sustainability and law are integrated into the thematic education.

re 6: See earlier comments,

re 7: Within TPE circa 45% of the basic study (first three years) is carried out in project form. Special attention is paid to capacities, so that circa 200 VWO entrants can complete it in the nominal time.

Re 8: This is very labour intensive, especially in the early years, but is often done in the senior years.
Re 9: This is now done within the context of the mentor system but this is not successful. It will be linked to a project so that the student has a goal.

Theses, final thesis assignment and practical training periods

10 Look for solutions to the problems detected in relation to the requirements that are placed on a final thesis assignment.

re 10: see re 3

Doability

12 Ensure that the new programmes equate the programmed study load with the actual study load.

13 Improve the tutoring, among other things by making better use of the study-progress recording system.

14 Solve the problems that occur in relation to the last generation of students of the four-year programmes, who have been caught up in the change to the five-year curriculum

15 Increase the doability by placing more emphasis on ways of working which promote independent study, through the implementation of more stimuli for weaker students and through more active tutoring.

re 12: In connection with the year schedule, it is particularly important to consider the distribution of the study load over the entire course of the study at both micro and macro levels (see 7).

re 13: see point 30.

re 14: Work on this in progress, specifically by the examination committee of ME.

re 15: Mentor system, stimulating bonus. The first experience of Thematic Education revealed that students worked for more hours than they did previously. This is related to the different ways of working and to the need to persevere from the very first day. Through this, a different culture slowly develops.

Facilities

16 Improve the accessibility of the facility to students.

red 16: From September 1997, evening opening was introduced. In addition, various types of workspace were provided.

Staff

17 Offer members of staff who place the greatest emphasis on education equally good career prospects as those who primarily concentrate on research.

re 17: The Faculty is endeavouring to pay attention to this point. It must be controlled at the central level. The Director of Education and Head of Personnel Department have contributed to the development of policy at central level. Associate and Assistant Professors must perform well in both education and research to make a successful career.

12.2.5 Recommendations applying only to Mechanical Engineering

Reports, final assignments and practical work periods

18 Improve the guidance.

re 18: The guidance of the students in the early years has been improved by the extension of the mentor system.

Internal quality control

19 Improve the system of internal quality control.

re 19: Quality Management Plan. This is being developed.

13 Strengths and weaknesses

In this chapter the results of the actions taken during the past five years, the present strengths and weaknesses of Mechanical Engineering and the actions to be taken in order to remove the weaknesses and to take full advantage of the opportunities are discussed.

13.1 Actions taken

During recent years, a large number of measures have been taken and changes have been implemented. The most imported actions realised so far are:

- five-year curriculum
- TPE in first and second years
- international MSc programmes for three specializations
- facilities extended and improved

The results of these combined actions are summarized below:

- the Propaedeutic efficiency has increased
- the number of students receiving positive study advice has increased
- the design contests have improved the image of the Delft Mechanical Engineering education programme
- the motivation of the students has improved
- feedback from the project shows that students spend more time on the study
- the motivation of teachers with respect to TPE and the communication between the teachers has improved;
  some of the most sceptical members of the staff are becoming more enthusiastic

The effects of a number of measures are not yet visible, because they act in the long-term:

- The above observations relate to the four-year curriculum. Results for the five-year curriculum, which was introduced in 1994, are not yet available.
- Improvement of the final pass rate cannot yet be established.

A number of targets have not yet been reached:

- shorter duration of specialization phase
- higher intake
- increased proportion of female students

In a few cases actions have not yet been taken or completed:

- to date the progress monitoring system is being used for the first year only
- PR policy should be developed further; ad hoc actions are successful, but more structured actions should be developed
- Guidance in the specialization phase (12.2.3 point 34) has not yet been improved. This action was not given the highest priority, because very few complaints are received from students in the final phase. Almost all criticism is from students concerns the general phase.
- Measures to increase the number of practical training periods abroad have not yet been taken. Targets and requirements have to be formulated.
- Supply of information via the Intranet can be further improved, especially the frequency of updating.

The previous review committee recommended investigating whether chemistry should be added to the basic curriculum. Consequently, chemistry courses have been introduced into the Equipment for the Process Industry and Energy Systems specializations, but not into the general phase. The reason for this is that most VWO students have some knowledge of chemistry, which proves to be sufficient for the other areas of specialization. Instead, physical transport phenomena are introduced into the projects of the Process theme in the third year, where physical separation processes are studied.

13.2 Strengths and weaknesses; opportunities and threats

The strengths and weaknesses mentioned in this chapter are those that exist and that have occurred since the last review committee visited Mechanical Engineering in 1995/1996.

13.2.1 Strengths/opportunities

- Mechanical Engineering covers a very broad area of applications
  There are 12 specialization subjects as mentioned in chapter 4.3
- Mechanical Engineering has a number of excellent research groups
  According to the last research review, a number of research groups have performed excellently
- TPE employs synergy between theoretical courses and project education
  The subjects from the 4 lecture courses are operationalized in the thematic projects
- TPE is very flexible with respect to developments in the fields of interest.
  Within a theme the subject of a project can easily be changed. In the Propaedeutic phase, the subject changes every two years
- Internationally, Delft University of Technology has a good reputation
- Mechanical Engineering participates in a broad range of international exchange programmes
  Chapter 11 gives an overview of these programmes
- The curriculum is evaluated and adjusted continuously, as a whole and in detail.
  The central co-ordination and evaluation of the curriculum provides opportunities to readjust the curriculum as a whole. The courses and projects are also evaluated individually, internally and partly externally.
- The many intensive contacts with industry, for research and graduation projects.
  The research groups have many contacts with industry, research institutes and government organizations. Through these contacts, graduation assignments are often carried out externally or in co-operation with these contacts.
- The educational facilities are up to date and satisfy the demands relating to the organizational aspects .
  In recent years and during the current year, the educational facilities are being modernised. With the renewal of the manufacturing facilities and the creation of the educational building the renewal operation will be completed. During this operation, much attention has been paid to the logistic of the curriculum in relation to the number of facilities for the different projects.
- The new BSc degree, with regards to student exchange.
  The new BSc degree allows students to graduate for their MSc degree at other universities within the Netherlands or abroad. The faculty hopes to make Mechanical Engineering more attractive to students by offering them this opportunity.
- The new international MSc program.
  This program attracts students from all over the world to follow the MSc course in Mechanical Engineering in Delft. The programme started in September 99 and it is the aim of the faculty to expand the number of students who participate in this program to 20-30 per year
- The new design contest for high school students in relation to public relations.
  This design contest has been carried out as a pilot project in 1999. It will be given a structural character with the objective of making Mechanical Engineering Delft well known to high school students. In 2000, the target is to have 40 high schools participating in the design contest.
- The reorganizations in the recent years
  The reorganizations and the changes in the management structure have contributed to the climate in which TPE could be developed and implemented
- The renovation of the Mechanical Engineering building
  The large scale renovation of the Mechanical Engineering building has made possible the adaptation of the building, in particular its educational facilities, to the requirements of a modern university and to the special requirements of TPE.
- The merger with Industrial Design
  The merger with Industrial Design improves the potential for co-operation and the exchange of

expertise, especially with respect to design education and the exchange of expertise on the field of CAD software.

13.2.2 Weaknesses/threats

- The consequences of the reorganizations in the past years
  Due to the large number of staff members that left the faculty, it is sometimes difficult to perform all the tasks
- The consequences of the renovation of the building of Mechanical Engineering
  Due to the renovation of the building, 40% to 50% of the building is temporarily unavailable. This affects the availability of facilities, especially meeting rooms.
- The age distribution of the scientific and supporting staff
  Due to the many reorganizations and the failure to hire young scientific staff, the average age of the scientific staff is high.
- The policy of the university towards educational aspects with regard to careers of the scientific staff.
  It is still difficult for members of the staff who focus on education to pursue a scientific career. It is almost impossible for staff who are 80%-100% occupied in education to become associate professors. More credit is gained by doing research.
- The inflow of students has stabilised, but at level that is too low.
  The inflow of students has decreased from more than 400 per year in the period 1986-1991 to a number between 200 and 210 in the last 5 years. Regarding the capacity of the facilities in the new educational building, an inflow of 250-300 is possible and desired.
- Continuously changing circumstances, not enough time for consolidation of changes
  Educational processes have a time constant of many years. If the curriculum is changed, for example by the development of TPE, it will be about 5 to 7 years before the results will be visible at post graduation level. It is no use trying to change processes with a large time constant too quickly, without giving the process the possibility to consolidate.
- The merger with Industrial Design
  In essence, the merger with Industrial Design has turned out to be a merger of the supporting departments (finance, personal, etc.). Owing to many changes in these supporting departments it is not always clear to people in the faculty how things are organised.
- The organization of TPE requires constant attention
  TPE requires a complex organization with central co-ordination. Continuous attention has to be paid to the organizational aspects.
- The number of simultaneous changes in the curriculum, the organization and the infrastructure, creates a built in risk of start-up phenomena being magnified by each other
- The Quality Control System has not yet been fully developed
- The large number of foreign partners on institutional level is not fully utilised
- The number of foreign students is relatively low

13.3 Actions to be taken

To take full advantage of the strengths and opportunities and to eliminate the weaknesses as far as possible, a number of actions are being taken. Further details are given in the 'Onderwijsbeleidsnota' [17], together with a number of actions that were defined earlier.

Intake, study duration and yield

- information on the Internet for VWO students will be improved
- monitoring of students during the general phase will be intensified, in order to detect problems and potential drop-outs at an early stage
- a study progress monitoring system will be developed for the specialization phase

Curriculum and teaching staff

- to increase the synergetic effects provided by TPE, the way the knowledge of theoretical subjects is operationalized in the projects will be improved
- the mentor system will be reinforced

Organization

- the organization and logistics of the general phase will be improved
- during the renovation of the building and facilities actions will be taken, e.g. by creating temporary facilities, to avoid any interference with the study progress of the students

Quality control

- the quality assurance system for education will be further developed and implemented, in co-operation with Maritime Technology and Technical Informatics (Faculty of Information Technology and Systems)
- the new Course Evaluation System will be used for all parts of the curriculum as soon as it is made available
- the educational performance of teaching staff will be included in the appraisal interviews
- teaching staff who are involved in project and design education will be given further training

Internationalization

- to reinforce international recognition an ABET accreditation is applied for and actions will be taken to keep up to the ABET standards in future
- a PR policy will be drawn up for the internationalization
- better use will be made of existing and new partnerships, in relation to mutual improvement of curricula, exchange of staff and students
- extra attention will be paid to foreign students
- parts of the curriculum will be presented in English; to this end, the teaching staff will be provided with training.

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15 Abbreviations

AiO	Trainee research assistant
AKO	Advisory Committee Quality of Education
CAD	Computer Aided Design
CAI	computer-assisted instruction
CBS	Statistics Netherlands (Centraal Bureau voor de Statistiek)
DUT	Delft University of Technology
DISC	Dutch Institute of Systems and Control
DIOC	Delft Interfaculty Research Centre
ECTS	European Credit Transfer System
EEA	European Environment Agency
EU	European Union
HAVO	senior general secondary education (hoger algemeen voortgezet onderwijs)
HBO	higher professional education (hoger beroepsonderwijs)
HTS	formerly: Higher Technical Education (Hogere Technische School) to date included in HBO
KIM	Royal Netherlands Naval College (Koninklijk Instituut voor de Marine)
KNAW	Royal Netherlands Academy of Arts and Sciences (Koninklijke Akademie der Wetenschappen)
MAVO	junior general secondary education (middelbaar algemeen voortgezet onderwijs)
MBO	senior secondary vocational education (middelbaar beroepsonderwijs)
MUB	University Government (Modernization) Act (Wet modernisering universitaire bestuursorganisatie)
OiO	Trainee research assistant
TLE	Theme Linking and Embedding
TPE	Thematic Project Education
VSNU	Association of Universities in the Netherlands (Vereniging van Universiteiten)
VWO	pre-university education (voorbereidend wetenschappelijk onderwijs)
WO	university education (wetenschappelijk onderwijs)

16 List of terms

Nederlands	Engels
afstudeerfase	specialisation phase
afstudeeropdracht	Masters assignment
afstudeerrichting	specialization
afstudeerverslag	Masters thesis
afstudeerwerk	final project
afstuderen	graduate
arbeidsmarkt	labour market
assistent in opleiding (AiO)	trainee research assistant
begeleider (experimenteel deel project)	instructor
begeleiding	supervision
begintermen	entry qualification
cijfer	mark
computerondersteund onderwijs	computer-assisted instruction (CAI)
docent	teacher
docent-mentor	staff mentor
docent-opdrachtgever	project co-ordinator
eindtermen	attainment levels
examencommissie	examining board
HBO	higher professional education
HTS	higher technical education
herkansing	resit
hogeschool	College of Professional Education
hoogleraar	professor
instroom	intake
kernhoogleraar	co-ordinating professor
kernleerstoel	core chair
keuzeonderdelen	optional components
keuzevak	option / optional course
KIM	Royal Netherlands Naval College
leerdoel	instructional objective
leermiddelen	teaching material
omzwaaien	change (over)
onderwijs- en examenregeling	teaching and examination regulations
onderwijsgevend personeel	teaching staff
onderwijsprogramma	curriculum
post-propedeutische fase	specialisation phase
practicum	practical (training)
	laboratory course; skills lab
probleemgestuurd onderwijs (PGO)	problem-oriented education
proefschrift	doctoral thesis
propedeuse	propaedeutics

rendement	success rate
stage	practical training period
studeerbaarheid	do-ability (of the study programme)
student-assistent	student assistant
student-mentor	student mentor
studieadvisering	student counselling
studieadviseur	student counsellor
studiebegeleiding	student supervision
studiepunt	credit
studievoortgangscontrole	monitoring of students progress
tentamen	interim examination
themaleider	theme co-ordinator
thematisch onderwijs	Thematic Project Education (TPE)
toets	test
uitstroom	number of graduates
universitair docent (UD)	assistant professor
universitair hoofddocent UHD	associate professor
visitatie	review
visitatiecommissie	review committee
vooropleiding	previous education
voortgezet onderwijs	secondary education
voorbereidend wetenschappelijk onderwijs (VWO)	pre-university education
wetenschappelijk (WO)	university education
zelfevaluatie	self-assessment
zelfstudie	self-study
zij-instroom	additional intake

17 List of tables.

18 List of figures.