A COMPARATIVE STUDY OF MARITIME TRAINING PROGRAMS

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BY

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ABSTRACT

This thesis develops the concept of a Canadian National Maritime University. This proposition follows directly from a comparative study of seven European, four Asian and two North American countries which was initiated by the convening of the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers, 1978. (STCWS)

It was considered that a synopsis of a country's general education system--followed by details of the shipbuilding and maritime training programs--examined, wherever possible, from the perspective of historical, philosophical, economic and sociological roots, would enhance an understanding of cultural differences and help provide guidance for officials and others. As the study proceeded, it appeared logical to provide an account of the American and Canadian systems for those unfamiliar with same since these also have important peculiarities.

It was from such considerations as these that the idea of a National Maritime University occurred since it appeared to be a logical development for Canada at this period in history and one that has already taken place in many of the countries examined. A careful perusal of the STCWS convention (Article XI) appears to substantiate such a development.

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I am particularly grateful for the personal assistance and information provided by the diplomatic staff and other officials of the various foreign embassies situated in the Ottawa region, the numbers of which preclude insertion here.

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GLOSSARY OF ACRONYMS

BNA Act	British North America Act
CEGEP	College d'enseignement general et professional
dwt	Deadweight tonnage
dt	Displacement tonnage
gt	Gross tonnage
ILO	International Labour Organization
IMCO	Inter-Governmental Maritime Consultive Organization
IMO	International Maritime Organization
INMARSAT	International Maritime Satellite Organization
LNG	Liquified Natural Gas
nrt	Net Register Tonnage
STCWS	International Convention on Standards of Training, Certification and Watchkeeping for Seafarers
TEU	Twenty-foot Equivalent Units (used in conjunction with container ships).
UMS	Unmanned Machinery Space
UNCLOS III	Third United Nations Conference on the Law of the Sea

CHAPTER 1

INTRODUCTION TO THE STUDY

In this study it is proposed to provide a synopsis of the general educational patterns, the recruitment details, the courses of study and maritime training arrangements and/or establishments of the countries concerned. It should be noted that national legislation enshrined as the Maritime Code or Merchant Shipping Act of a country will designate in general terms the qualifications required of its Merchant Ship's Officers. In the case of British, Canadian and I believe most Commonwealth countries, substance, technical, detail, and change are enacted by Order-in-Council. Most of this Maritime Legislation was first introduced during the latter half of the 19th Century with subsequent revisions and consolidations being introduced due to such international tragedies as the "Titanic," the "Morro Castle" and the "Andrea Doria." An aroused public opinion was the driving force that inspired national legislation to give effect to the "International Convention for the Safety of Life at Sea." The same was true of the British Merchant Shipping Act of 1876 which made mandatory the loadline marking on the sides of British Ships. It was not until 1930, however, that "The International Load Line Convention" was ratified by all the maritime nations. In areas where economics did not predominate, for example "The Collision Regulations" or "Rules of the Road," international agreement was reached at an early stage.

Economic considerations have also had an affect upon the education and training of both nautical and engineering ship's officers. When such individuals are in short supply, there is a tendency to maintain the status quo even though technological advances may have overtaken the standards laid down in the regulations. However, the increased frequency of potentially dangerous situations, collisions and groundings has pointed up the need for greater understanding and facility in the use of sophisticated navigational aids and the other engineering and safety devices. It has become increasingly evident that Certificates of Competency that in many countries are issued for the life-time of the individual are no longer an altogether satisfactory arrangement and should be supplemented by periodic retraining and updating procedures.

Furthermore, there is nothing equivalent to some universal minimum standard or measure by which comparisons may be carried out. Most maritime nations with a long established nautical tradition have evolved, and now demand, high levels of competence of their certified officers. Other countries, however, especially those whose vessels fly the so-called "Flag of Convenience" may be extremely lenient in this respect. This very laxness has been perceived by the shipowning fraternity and governments of the more established maritime nations as conferring an unfair economic advantage.

In 1958 the United Nations created the Inter-governmental Maritime Consultative Organization (IMCO) [renamed International Maritime Organization (IMO) May 22, 1982] as an agency to deal on an international scale with all matters pertaining to ships and shipping. On October 15, 1971, the Assembly of this organization in association with the International Labour Organization convened an International Conference on Training and Certification of Seafarers which was held at London from June 14th to July 7th, 1978.[1] The Final Act of this conference was completed July 7, 1978, and laid open to signatures from December 1, 1978, until November 30, 1979, after which it remains open for accession. This Convention will enter into force twelve months after the date on which not less than twenty-five (25) States, the combined merchant fleets of which constitute not less than fifty percent of the gross tonnage of the world's merchant shipping of ships of 100 gross register tons or more, have either signed it without reservation as to ratification, acceptance or approval or deposited the requisite instruments of ratification (Article XIV).

It may now be noted that with the deposit of the instrument of ratification of the Government of the People's Republic of Poland, April 27, 1983, all requirements for entry into force of the Convention have now been fulfilled and hence, in accordance with the provisions of Article XIV, the Convention will come into force April 28, 1984.[2]

Article VI deals with Certificates while Regulation 1/2 of the Annex indicates the form used which must include an English translation if the language used is not English. Chapter II, Regulations 1 to 4, define the minimum standards of knowledge which must be adhered to for Masters, Mates and Navigational Officers, while Regulation II/5 defines the mandatory minimum requirements to ensure the continued proficiency and up-dating of knowledge for Masters and Deck Officers. Similarly, Chapters III and IV define mandatory minimum standards for Engineers and Radio Officers respectively. It should be emphasized that these are minimum standards and are not to be construed as restricting a State from increasing its own standards should this be considered necessary.

For a more comprehensive picture of the various International Conventions relating to shipping, seafarers and the ocean environment including the relationship these have within the United Nations Conference on the Law of the Sea (UNCLOS III) framework consult: "The Evolution of Maritime Law as a Response to Technological Innovation: Illustrated by the Growth and Development of the Merchant Ship, Its Construction, Operation and Manning."[3]

The following chapters will consist of a comparative study of the general education system (Section 1) as well as the maritime training programs (Section 2) in operation within a selected number of countries of Europe (Part 1)

Asia (Part 2) and North America (Part 3). This material will help elucidate certain historical and philosophical trends that should have profound implications for the development of a rational Canadian maritime education and training policy.

PART ONE

EUROPE

CHAPTER 2

NORWAY

SECTION 1.

Elementary education has been free and compulsory for all Norwegian children between the ages of 7 and 14 since 1860. Most of the schools are coeducational and public, administered by locally appointed educational boards with the cost being shared by the respective municipalities and the national government. Excellent vocational schools offer training in engineering, industrial crafts, business procedures, agriculture, domestic sciences and seamanship. Secondary education consists of either the three year REALSKOLE or the five year GYMNASIUM. In the latter, courses are segregated into science, languages, economics, etc. and prepare students for admission to universities and colleges. During the late 1960s, the period of compulsory elementary education was increased to nine years with an extra optional year added.[4]

SECTION 2.

The education and training of Engineer Officers for the Norwegian Merchant fleet are prescribed in the Maritime Engineers Act of June 2, 1960, which supercedes those of April 14, 1917, and February 9, 1923. The Act designates three grades of Engineer which, reckoned from the lowest to the highest grade are: Second Engineer, First Engineer and Chief

Engineer. For each level of Certificate, a certain minimum of practical and theoretical training is prescribed plus success at a final examination for that grade. For each of the subsequent levels beyond the second grade additional sea service with increased responsibilities, more advanced theoretical training and possession of the appropriate Certificate for the previous grade are required before an individual is allowed to write the next higher Certificate examination. The final written examinations are also augmented by oral questions pertaining to any of the various sections of the curricula.

The requirements for these Certificates may be summarized thus:

(A) Second Class Engineer's Certificate

Applicants must have:

1) attained the age of 21 years
2) two years workshop school or three years experience in an engineering workshop
3) 18 months service in a ship's engine room
4) passed the Second Class Engineer's examination
5) satisfactory certificates for health and conduct.

A five months theoretical course of studies (800 hours) as follows:

Engineering (steam, motor, physics and mechanics)	260 hours

Electro-technology	80 hours
Refrigeration engineering	40
Mathematics	160
Norwegian	100
English	60
Fire Protection	10
Hygiene	10
Draughtsmanship	80
Total	800 hours

Of this at least 10 hours each must be devoted to laboratory work in steam, motor, refrigeration and electro-technology.

(B) First Class Engineer's Certificate

Applicants must have

1) Second Class Certificate
2) 24 months service as Second Class Engineer
3) passed First Class examination

A further five months course of studies as follows:

Engineering, steam	100 hours
Engineering, motor	100
Electro-technology	80
Refrigeration engineering	60
Mathematics	120
Physics and mechanics	120

Norwegian	80 hours
English	80
Work supervision	20
Draughtsmanship	40
Total:	800 hours

The laboratory time is the same as that for the previous Certificate.

(C) Chief Engineer's Certificate

Applicant must have:

1) the First Class Engineer's certificate
2) 24 months sea service as First Class Engineer
3) passed Chief Engineer's examination

A further ten months course of studies as follows:

Engineering, steam	200 hours
Engineering, motor	200
Refrigeration engineering	40
Electro-technology	160
Ship Construction	60
Thermodynamics	80
Mathematics	160
Physics and mechanics	160
Chemistry and mechanics of materials	80
Norwegian	80
English	120

Legal knowledge, insurance rules, etc.	40 hours
Hygienics	20
Accountancy	40
Draughtsmanship	80
Total:	1520 hours

Of this, 20 hours of laboratory work is devoted to steam, motor, electro-technology, chemistry and mechanics of materials.

(D) Ship's Electrician Certificate

Applicants must have:

1) attained the age of 21 years
2) two years experience in an engineering or an electrical workshop
3) twelve months sea service in the engine room
4) passed the ship's electrician examination

The course of study for this examination is as follows:

Mathematics	160 hours
Physics and mechanics	120
Electro-technology	480
Norwegian	80
English	80
Fire protection and first-aid	20
Practical work and instruction in laboratories	860
Total:	1800

It will be observed that an absolute minimum of 110 months or 9 years and 2 months is required to obtain the Chief Engineer's Certificate of Competency.[5]

CHAPTER 3

SWEDEN

SECTION 1.

In Sweden, universal compulsory primary education has been in effect since 1842. Prior to 1950 the Education Act provided for seven or eight years of schooling but the Act of 1950 stipulated nine years of compulsory education (7 to 16 years) in a comprehensive school (GRUNDSKOLA). This is followed by the GYMNASIESKOLE, a non-compulsory upper secondary school for 16 to 19 year olds. These schools offer a wide range of courses varying in length from two to four years and in their degree of vocational bias. About 80 percent of comprehensive school leavers go on to the gymnasieskole. Graduates from this type of institution will at least be at the level of those students who have completed the first year of a North American University.

The Swedish term for all institutions of higher learning is the HÖGSKOLA. As of 1980 there were six universities plus a number of other institutions situated in some twenty towns throughout the country.[6] Chalmers University of Technology located at the west port city of Göteborg was founded in 1829 by the Scot, William Chalmers. Its School of Mechanical Engineering and Naval Architecture offers the most complete study program in this field in the country. This is a five-year program leading to the degree of Master of Science -

Engineering.[7] This university is located in the same city as the Gotaverken shipyard which not only builds and repairs ships of all types and sizes, but also manufactures its own design of large bore marine diesel engines. The graduate courses lead to the degree of Doctor of Technology.

SECTION 2.

The prerequisites stipulated for entrance into the Engineering Department of a Swedish Naval College are successful completion of the grundskola plus the following practical requirements:

6 months in an engineering workshop

3 months in an electrical workshop

9 months in a shipyard

12 months at sea in a ship's engine room

A further 12 months sea service plus successful completion of the Technician course is required before the aspiring ship's engineer becomes qualified.

Many people consider this practical training as insufficient. The author of the article states that Swedish authorities and educators believe that theoretical studies are best absorbed when the students are young and also points out that the state of the Swedish labour market (1964) was such that Naval Colleges were forced to lower their entrance requirements in order to attract sufficient students. All students begin in the full-time Technician's Course which takes 9 months to complete. This course is both a preparation for entrance into the Ship's Engineers course and also a finishing course for the lower examination of Technician. The syllabus is as follows:

Mathematics (largely revision of Grundskola mathematics)

Physics

Chemistry

Engineering: Boilers, Steam Engines and Turbines, Diesel Engines, Gas Turbines

Cooling (Refrigeration engineering)

Electrical Engineering

Other subjects are studied to broaden the student's education and increase his knowledge of language.

After completing the Technician's course, the student may apply for the Chief Engineer's course. Only those students showing a propensity for theoretical studies are allowed to undertake this course. Since there are twice as many applicants as places, weeding out automatically occurs. Acceptance is based upon the marks obtained in the Technician's course thus: Pass - 1 mark; Credit - 2 marks; Distinction - 3 marks, with mathematics and engineering having doubled values. It is claimed that the method works well and provides heightened interest in the lower course. The Chief Engineer's course is highly theoretical and requires two full years of intensive study. The syllabus is as follows:

Mathematics
Physics and chemistry
Knowledge of materials
Mechanics and knowledge of durability
Mechanical engineering and machine drawing
Shipbuilding
Electrical engineering
Civil science
Swedish
English
German
Sociology
Works organization
Health and sick nursing
Physical training

The author states that while these courses were only developed in 1959, they are already out of date. A new course "Control Techniques" must be introduced. He states that students already have the mathematical and scientific background but lack practical training and knowledge of the different types of devices used. Also electrical engineering must be expanded to include radio engineering and electronics. A number of shipping companies have fitted out training ships where practical experience and theory are coordinated; these students write the college examinations along with the others as external students. This has produced good results to the level of the technician examination only.[8]

It should be noted that no mention was made of an apprenticeship system in either of these presentations. This prompted considerable controversy in the discussion papers. The pro-apprenticeship group considered practical experience on major repairs invaluable whereas the pro-technician group felt that modern communications has overtaken this aspect of training. Today, a number of firms specialize in on-the-spot repair work, supplying fully equipped teams of skilled mechanics to any part of the world on short notice. Such teams have retubed entire boilers while the ship proceded along using the other boilers.

No fees are paid by students being trained in the facilities provided but students can receive loans from the respective governments for living expenses during their stay.

Recalling that this symposium took place during 1964 when an acute shortage of skilled manpower existed in most European countries, a very real problem that runs like a litany through much of the discussion was: How to keep trained and qualified people at sea? In Sweden, the problem was tackled by an all round education and qualifications that will provide the opportunity for worthwhile employment ashore. Educational qualifications that are so specialized that a person is forced to remain in the same type of employment for his/her entire working life are looked upon with disfavour by the majority of young people.

CHAPTER 4

THE NETHERLANDS

SECTION 1.

The Dutch educational tradition may be traced to the activities of the Reformed Church in the seventeenth century when an effort was made to set up a system of universal education. The first modern school law dates from 1801, when the government laid down the principle that each parish had the right to open and maintain schools. Throughout the nineteenth century controversy raged between the proponents of denominational and non-denominational schools which was finally closed by legislating the equality of both and making each type eligible for state funding. The private or church school must provide a curriculum and period of instruction equivalent to that offered in state schools. The function of the Ministry of Education, Arts and Sciences is to supervise the quality of the educational process whereas the actual administration comes under the aegis of the local authorities. The Education Act of 1900 stipulated compulsory education from the age of seven to fifteen although most children start at age six.[9]

In Holland two main streams of secondary education exist which give students access to higher educational institutes. The following information was provided by the Embassy of the Netherlands in the publication, VADEMECUM.[10]

(a) Pre-university education (VWO) consists of the 'Atheneum' - no Greek or Latin, and the 'Gymnasium' - with both Greek and Latin. Both schools provide six-year courses, the Diploma from either entitling students to University admission with one stipulation; at least one course of the final seven examination subjects must be selected with the individual's proposed study plan in mind. In all cases, Dutch and one foreign language are obligatory.

(b) General Secondary education, upper level (HAVO) has five-year courses leading to diplomas that give students access to the various higher vocational institutes (HBO), such as teacher training, technical, commercial, agricultural and horticultural institutes. Admission to HBO institutes often depends upon the choice of the six final examination subjects of which Dutch and a foreign language are mandatory.

General secondary education, lower level (MAVO) is a third stream within the general secondary system. Courses are generally of four years duration, the diploma giving access to the senior secondary vocational education (MBO). The same mandatory stipulation exists here as in the previous case.

It should be noted that "Secondary Education" in Holland has, in some cases, a similar connotation to "post secondary education" in Canada and the United States of America.

Of particular importance to this study are the Institutes of Technology - HOGERE TECHNISCHE SCHOOL (H.T.S.), and the Nautical Schools - HOGERE ZEEVAART SCHOLEN - which come under the aegis of H.B.O. The four main fields of study at the H.T.S. are Mechanical Engineering, Electrical Engineering, Civil Engineering and Architecture but there are many variations. For example, the Delft Technische Hogeschool has a Department of Naval Architecture and Aeronautical Engineering. Because of the large size, diversity and quality of the equipment and research carried on here, it has become one of the world leaders in this field. H.T.S. graduates are awarded the 'ing' title, equivalent in practice to the 'Professional Engineer' title in Canada since the course includes 13 months of practical experience in the field or engineering workshop.

At the higher nautical schools (HOGERE ZEEVAARTSCHOLEN) it is possible to train as navigator, ship's engineer or radio-officer for vessels of the merchant marine. These are four-year courses of which the third year consists of a 12-months assignment on an ocean-going vessel to acquire practical experience, during which time he keeps a record or assignment book of his work. There are also a number of two-year courses at other nautical schools which are not nearly so intensive and require the student to serve an apprenticeship on board the ship.

SECTION 2.

The education and training of marine engineers - like that for other professions - is the result of an evolution by which advances in the pure and applied sciences have to some extent been modified by cultural values, geography and history. Holland, with the dubious distinction of being one of the world's most densely populated countries, lacking mineral wealth, created largely from swamp and land reclaimed from the sea, was almost entirely dependent upon agriculture and the fishery. However, with the eclipse of Spain and Portugal during the seventeenth and eighteenth centuries it successfully competed with England to become one of the leading trading and maritime nations of the world. The rigors of this competition placed an inordinate value upon innovation, and thus it was that the Dutch registered ship, H. M. CURACAO, in 1827 was the first steamship to cross the Atlantic using steam power alone.[11]

The first engineers were, of course, the craftsmen that had helped build the engines and whose skill and knowledge were passed on to some of their shipmates who subsequently took over the operation of the engines. The marine engineers of that period were trained aboard ship but the more industrious felt the necessity of improving their knowledge by taking courses run by private schools, tutors, etc. During the latter half of the nineteenth century, Certificates of Competency were introduced by some countries and to qualify for which the engineer had to pass a qualifying examination. To ensure a supply of men with at least some technical training, the requirement for admission to these examinations was at least three years workshop experience after attaining the age of 14 years. At this time the greater part of the lighter repair work and practically all the maintenance was carried out by the ship's engineers; hence, the prime concern was to ensure a supply of competent craftsmen.

The Netherlands Shipping Act of the period did not stipulate that Certified Marine Engineers be carried as part of the crew. Hence, the remarkable situation arose that certain shipowners, desirous of having properly qualified and certificated engineers on their vessels, hired English engineers certified by the British Board of Trade.[12] Because of such anomalies and other pressures, the Shipping Act was altered in 1903. The number of certificated engineers required for vessels of various classes, qualifying examinations for these certificates and a neutral Board of Examiners was set up and the first official certificate, registered as No. 1 was granted in 1904.[13]

As a direct result, several new schools were opened and existing private schools received a subsidy provided they fulfilled the requirements laid down for Government Schools. The law was revised in 1935 to accommodate the changes in technology and engineering practice. The courses were broadened both in depth and scope, more and better equipped colleges were opened and admission requirements were clearly defined. The law of 1935 had been astutely drafted to provide sufficient flexibility that it was able to accommodate technical change covering a period of 30 years with only minor changes in certain of its regulations.

The Certificates required by the Dutch Navigation Act are:

VOORLOPIG DIPLOMA (MVL)	= Provisional Certificate
ASSISTANT SOHEEPS WERKTUIGKUNDIGE (M. Ass.)	= Assistant Engineer
DIPLOMA A	= Certificate A = 3rd Engineer
DIPLOMA B	= Certificate B = 2nd Engineer
DIPLOMA C	= Certificate C = 1st Engineer (highest)

Certificate C entitles the holder to serve as first (chief) engineer in any ship in the Dutch Merchant Marine, however propelled. All certificates are valid for both steam and motor propelled ships. [14]

To be admitted to the examination for the MVL Certificate a candidate must have served an apprenticeship in an approved workshop for at least three years after his 14th birthday. He could then study by private tutor, correspondence or evening courses for the examination. However, because of the difficulties involved, largely because of insufficient initial education, only about 3 percent of all entrants reach their goal in this manner. This route is a relic of the past. With the advent of nautical colleges providing two-year day courses specifically for the purpose, most potential engineers follow this route which also includes practical experience in the college shops. Because of this formal and systemmatic training, the practical, on-the-job instruction is reduced to one year which may be carried out in the workshop or aboard ship. In the latter case each pupil must keep a daily memorandum book describing any maintenance, operating procedure or routine inspection he has witnessed along with other matters of consequence for the operation of the machinery. All entries must be approved and signed by the Chief Engineer.

Because of the prolonged periods of study required to acquire the theoretical knowledge for the advanced Certificates - candidates were already 25 to 28 years old - a Government Commission was set up consisting of representatives from the Ministry of Transport, Ministry of Education, Inspector of Nautical Education, principals of Nautical Colleges, shipowners and the Union of Seamen. In its report the Commission suggested that much of the theoretical studies - mathematics, physics, applied mechanics, etc., should be transferred from the higher examinations to the initial education carried out at the Colleges. Since it was thought that many otherwise capable young men may not be able to complete the added work in two years, the compromise was reached, whereby each college would provide both a two and a three year program with suitable transfer arrangements between them. Thus, particularly able young men would complete almost all of the theoretical work in two years. Under this scheme candidates for the higher grade certificates would only be examined on the more practical knowledge gained from the actual operation of the ship's machinery and cover overhauls, breakdowns, emergency procedures, etc. The range of subject matter may be gleaned from the following list intended for examination prior to 1964.[15]

- Dutch
- Arithmetic
- Algebra
- Geometry
- Goniotrigonometry
- Projections
- Physics
- Electricity (principles)
- Mechanics
- Applied Mechanics
- Geography
- English
- Electrical engineering
- Fuels-lubricants--materials
- Boilers
- Steam engines: Reciprocating and turbine
- Internal combustion engines
- Auxiliaries--ancillaries
- Ships' construction
- Special repairs and regulations
- First aid
- Drawing and reading of drawings
- Fitting-turning, etc.

At this juncture the close liaison between government agencies, educational authorities, institutions, employers and workers representatives should be stressed. The Secondary Education Act of 1963 provided for extensive changes and diversification coupled with an additional year of compulsory education to the age of 15. Thus, an opportunity to infuse the more intensive scientific education deemed essential to facilitate a relatively smooth and efficient transition to the newly proposed Marine Engineers Examination system of the period was provided for.

CHAPTER 5

ITALY

SECTION 1.

Although the Kingdom of Italy was not proclaimed until 1861, the principle of free and compulsory education dates from November 13, 1859, when this concept was enunciated by the Kingdom of Sardinia and was later extended to all regions of United Italy. Initially, the parent or guardian was given the opportunity of choosing between state schools, private schools, or tuition at home. At the present time 95 percent of compulsory school age children attend state schools while about 5 percent attend private institutions or have private tutors. In order to enforce attendance in the rural areas particularly, severe penalties were imposed - fines and/or imprisonment (for the parent), enforced attendance at army schools or prolonged compulsory military training (for the student). However, persuasion, the appeal to self-interest and increasingly obvious social incentives have made the more odious enforcement methods largely unnecessary.[16]

The period of compulsory education correspond to primary (6 to 11 years of age), intermediate and lower secondary school (11 to 14 years). The national system of education covers pre-primary, primary, secondary and higher education with a wide variety of technical and vocational courses available at the secondary level. The primary level consists of a two-year cycle followed by a three-year cycle with a primary certificate awarded at the end of the fifth grade. The middle level consists of a three-year period after which pupils write state examinations for admission to the different types of upper secondary institutions which consist of general secondary, technical-vocational and arts schools. The various types of general secondary education provide a path to higher education at universities or university institutes. All technical institute programs are of five years duration of which the first two consist of general education followed by three of intensive specialized technical education.[17]

SECTION 2.

The theoretical training of all ship's engineers in Italy is carried out in state navigation schools (Instituto tecnico nautico) administered by the Ministry of Education and providing a five-year program of studies in either navigation, marine engineering or shipbuilding. In 1964 there were 26 of these nautical institutes situated in various parts of the country. The marine engineering program is as follows:

First year

Italian language and literature	5 hours/week
History	2
Geography	3
English language	3

Mathematics	5 hours/week
Natural sciences	3
Physics	4
Mechanical drawing	2
Gymnastics	2
Religion	1
Seafaring practical exercises	4
Total	34 hours/week

Second Year

Italian language and literature	5 hours/week
History	2
Geography	3
English language	3
Mathematics	5
Chemistry	3
Physics	4
Mechanical drawing	2
Gymnastics	2
Religion	1
Total	30 hours/week

Third Year

Machines, machine drawing and practical exercises with machines	10 hours/week
Electrical technology	4
Mechanics applied to machines	4
Workshop	3

Italian literature	3 hours/week
History	2
English language	3
Mathematics	3
Gymnastics	2
Religion	1
Naval hygienics	1
Total	36 hours/week

Fourth Year

Machines, machine drawing and practical exercises with machines	6 hours/week
Mechanical Technology	4
Italian literature	3
History	2
English language	3
Mathematics	4
Elementary physics	3
Gymnastics	2
Religion	1
Rudiments of shipbuilding	2
Total	30 hours/week

Fifth Year

Machines, machine drawing and practical exercises with machines	12 hours/week
Electrical technology	8
Workshop	3

Italian literature	3 hours/week
History	2
English language	3
Gymnastics	2
Religion	1
Rudiments of ship theory	2
Total	36 hours/week

Upon completion of his studies, the young graduate will attempt to obtain a berth as a junior engineer on a ship. If successful, he will be required to serve 18 months as a junior engineer and, provided he is at least 21 years of age, may present himself for the oral examination of "aspirant chief engineer." After sailing a further four years, part of which must be served on both motorships and steamships and include one year as an officer, the young man may now act as Chief Engineer in vessels of a power, size and voyage limitation specified by the Regulations. The Chief Engineer's examination consists of a six-hour written and oral assessment of his capabilities with the further stipulation, the candidate must be at least 23 years old. After a further 10 years of engine room service, of which at least three were served in the capacity of Chief Engineer, he becomes eligible to obtain (without further examination) the qualification of Senior Chief Engineer. Thus, a young man aspiring towards the highest engineering qualification of the Italian Merchant Marine can look forward to 20½ years from the start of his theoretical studies until he reaches his goal. This latter qualification is essential before he may take charge of the machinery of any foreign-going Italian registered ship of the highest power.

In order to absorb a sufficient number of graduates, Italian law prescribes that ships of 4000 to 7500 gross tons must carry at least one nautical institute graduate as junior engineer and ships 7500 gross tons and over, two graduates. Because of the cyclic nature of the shipping industry, an accurate prediction of manpower requirements is extremely difficult. However, the Italians handled the problem by an examination of the technical requirements of the entire society rather than that of a single sector. Thus, the very large sums of public money invested in the graduate is not lost simply because for one reason or another he does not continue at sea. His training is broad enough and of a high enough standard that he can readily find employment in manufacturing or process industries on an equal footing with graduates in mechanical or electrical engineering.[18] Further, his studies have provided the background to allow him to proceed to advanced studies in engineering, science, industrial chemistry, economics and commerce, statistic and actuarial science, nautical studies and/or oriental studies should opportunity or fancy strike him.[19]

CHAPTER 6

FRANCE

SECTION 1.

During the euphoria accompanying the French Revolution, the National Assembly proclaimed (1792) the principle of free, compulsory education for all citizens. However, economic considerations, amongst others, precluded its practical accomplishment at that time. Primary education, almost entirely neglected by the ancien régime, fared little better with the revolutionists who showed greater concern for secondary education by establishing a score of central schools during 1795.

When Napolean became head of the French state, amongst his earliest acts was the diversion of the endowment of the Collège Louis le Grand (founded by the Jesuits in 1567) towards the establishment of four seminaries of military science and the replacement of the central schools by the lycée (national) and the collège (local). Like other despots before and since, he realized the first need was for an intellectual elite of scientists, technicians and top level professionals for the military and civil service administrative posts. The Higher Normal School was established in 1808 to prepare lycée graduates for teaching, and on March 17th of the same year he established the Imperial University. This latter institution was not a university in the usual sense but rather a mechanism to regulate and administer all public education. Specifically, it was intended "to assure uniformity of instruction and to mold for the state citizens devoted to their religion, their prince, their country and their families."

When Louis XVIII succeeded Napoleon, the name was changed to the University of France and its present head is known as the Minister of National Education.[20] Because of this historical accident, the French educational system is, perhaps, one of the most tightly structured, centralized and bureaucratic of any in the world.

While the principle of free education was enunciated in 1792, it remained for the lawyer, journalist and statesmen Jules F. C. Ferry while Minister of Public Instruction (1882) to sponsor the law inaugurating a system of free, compulsory and nonclerical primary education in which children were required to attend class from ages 6 to 13. The school leaving age was increased to 14 during 1936. In 1946 the Committee for the Reform of French Education headed by Paul Langevin recommended that the age for compulsory full-time attendance be raised to 15 and for part-time attendance, 18 years.[21] However, because many of its recommendations were in conflict with tradition or were considered economically unrealistic at the time, the proposals were not adopted.

The national education system is arranged as follows:

(a) Nursery Schools - attendance optional (ages 2 to 5). Rudiments of reading, writing and arithmetic taught in the older age section.

(b) Elementary Primary - 5 years (ages 5 to 10)

(c) Secondary Education - This consists of two parts, the lower cycle (4 years) is concerned with general education and has both a classical and modern language section. The upper cycle (3 years) also has two parts, one covers complete upper secondary education while the other is concerned with terminal secondary education. The lower secondary school certificate is called the BREVET d'ETUDES du PREMIER CYCLE while the upper secondary certificate is the BACCALAURÉAT de L'ENSEIGNEMENT SECCONDAIRE and leads to University or Polytechnic education, etc.[22]

SECTION 2.

The views and concerns of a French shipowner, Captain B. Sermier, provided the French contribution to the Education Group Symposium.[23] It was pointed out that in the design of the latest ships greater use is being made of monitoring and control instrumentation for the main propulsion machinery and its ancillary equipment. This has resulted in the placing of all important monitoring and control components in a single area, usually overlooking but isolated from the noise of the engines. Already, because of its relative simplicity and effectiveness, this mode of centralized control had been used for a number of years to oversee the cargo loading and discharge operations of a number of the large oil tankers. Thus, it was but a logical next phase of development to concentrate the entire control area at a single point, the wheelhouse. The advent of modern electronic technology has not only made this feasible but has considerably simplified the task. To cope effectively with these new developments will acquire the reorganization of the crew into "operating personnel" and "maintenance-repair personnel" rather than the traditional "deck" and "engine room" departments.

The fundamental advantages expected from automation are as follows:

(a) increased safety of operation by a continuous and improved monitoring system which by providing an early warning of operating abnormalities will reduce the time and expense involved in machinery repairs.

(b) achieve increased efficiency by optimizing operating conditions.

Thus, a clearly defined "typical program for manoeuvres will be recorded in the computer's memory which will enable these to be always carried out as if performed by the best chief engineer."

The advent of this technology has had the effect of developing two distinct philosophies:

(a) those who believe that most navigation and machinery operations in the vessel can be better controlled from the company's head office ashore, and

(b) those who believe it essential that the ship's officers control the equipment and retain all their usual responsibilities.

However, the author provides both practical and psychological reasons for following the latter concept and further suggests a new form of training for deck officers and engineers in that the requisite knowledge for both fields be taught and a single qualification used for each grade. The education should aim to provide a general literary and mathematical background that would train the reasoning faculties. It will, of course, require a careful pruning of outdated material from both the conventional navigating and engineering programs of study. Above all, these technical studies must not be purely theoretical. Practical training and knowledge are indispensable.

A certain degree of specialization will be necessary at some point in the studies, and these may well be navigation/operations, electronics and engineering. Officers in each of these areas will be able to rise to the position of command. In each case, before obtaining the final qualification, the individual will have had to serve as either the head of a repair department or a navigating officer of the watch.

Certificates of Competency for navigating and engineering are awarded by the Ministry of Transport. The training for these examinations is carried out in Ecoles de Navigation, controlled by the Ministry of Transport and all the teachers are civil servants. Supervision is carried out by the General Inspectorate of Marine Training whose head carries the rank of admiral. Pupils must pass a special entrance examination and the number of new entrants is set by a High Committee for Marine Vocational Training (Comité Superieur de la Formation Professionnelle Maritime) whose members consist of representatives of the administration, shipowners and unions. There are three grades of Certificates as follows:

Third Class Certificate

After completion of primary education, boys enter a Professional School where they learn a technical trade related to marine works, and, if successful in passing a practical trade test, are granted specialists certificates by the Ministry of Education. After this, they serve five years at sea in either the Navy or Merchant Marine as greasers or fitters, and this is followed by:

(i) the School of Navigation entrance examination

(ii) six months of school

(iii) the Third Class Certificate examination

If successful, they are entitled to be:

1. engineer in charge of a watch in ships under 4000 H.P.

2. second engineer in ships under 3000 H.P.

3. chief engineer in ships under 1000 H.P.

These officers are practical men with limited theoretical knowledge.

Second Class Certificate

To be eligible for this certificate, the young man must be a four-year graduate of a Technical College and have passed the "BREVET d'ENSEIGNEMENT INDUSTRIEL" examination. This is followed by:

(i) the School of Navigation entrance examination

(ii) one year at school

(iii) pass Part A of Second Class Certificate

(iv) two years at sea as "engineer cadet"

(v) pass Part B of Second Class Certificate

If successful, they are entitled to be:

1. engineer in charge of a watch in ships under 10 000 H.P.

2. second engineer in ships under 7500 H.P.

3. chief engineer in ships under 3500 H.P.

First Class Certificate

To have a reasonable chance of success at the School of Navigation, entrance examination candidates must have received seven years secondary education and the "BACCALAUREAT TECHNIQUE" diploma. This is followed by:

(i) one year at school

(ii) three months at sea

(iii) second year at school (as compulsory boarders at Le Havre) for theoretical training, also practical training on board two national training ships

(iv) examination for engineer cadet (ELÈVE OFFICIER MÉCANICIEN)

After this, the candidates go to sea for one year as engineer cadets in the Merchant Marine, after which they are called upon by the French Navy to spend five months at the School of Reserve Naval Engineer Officers plus one year's naval service in ships. The certificate of Lieutenant Mécanicien (Engineer Mate) is awarded after 18 months sea service. Two more years of sea service are followed by a further nine months of school (not compulsory, but generally done), after which candidates are required to pass the First Class examination. This certificate, generally obtained at an age of 27 - 28 years, gives the right to be chief engineer on any French ship, and, furthermore, is the only marine qualification recognized in industry ashore for the title of "Engineer." It is possible but difficult to proceed from Third to Second Class; it is vastly more difficult to pass from Second to First Class.

The training of deck officers and engineers is quite similar in pattern and duration, only the syllabi are different. The gap in general education between a Capitaine au Long-Cours (Foreign-Going Master) and a First Class Engineer is very narrow although the techniques are different. Because of this, certain forward looking French shipping companies suggested to the General Inspector of Marine Training that it might be possible to make alterations in the theoretical and practical work that would lead to the issuance of a single type of qualification, thus allowing the recipient to attain command of a ship. In November, 1963, two special courses were started as an experiment:

(i) In Le Havre, 15 First Class Engineers, chosen and paid by the shipping companies, were given deck officer training (theoretical and practical). The course was to last eight months after which they were to go to sea for five or six months as deck officers with their companies and then spend a further seven months at school.

(ii) In Nantes, the reverse was done with 15 deck officers (Capitaine au Long-Cours) who were trained as engineer officers.

It should be noted that this social experiment produced much violent reaction from shipowners, unions and even certain merchant marine officials. Much of this anxiety was justified because of: (1) the apparently confidential nature of the initiative and lack of explanations, and (2) the small number of candidates chosen, the selection criteria used, and the fear these super-officers would relegate those with traditional training to second-place positions.

The present author, in attempting to follow up the progress of this experiment, has learned that economic forces have largely relegated it to the status of a truncated scholastic exercise. Sufficient manpower was trained in the ensuing years, with the result that the added expense was not considered worthwhile. Furthermore, the economic downturn which has largely coincided with the worldwide decrease in the use of petroleum products has reduced the need for shipping, especially for tankers, to the point where even these highly skilled people have often found themselves redundant. From about 1975 onwards, a number of Asian countries, most notably Japan and Singapore, have produced highly automated ships utilizing unmanned engine rooms. These vessels carry only two engineers - a First and a Second Class Engineer - to comply with the Merchant Shipping Acts. These ships have a total complement of 16 or 17 men compared with European ships employing a crew of approximately thirty.

CHAPTER 7

GERMANY

SECTION 1.

Historically, three somewhat isolated influences have played an important part in shaping a distinctive German culture and education system.

The first influence is the religious schism, a consequence of the Reformation after which Protestant and Catholic states began to move in different directions creating tensions which hindered a peaceful development of a national education system.

Secondly, the individuality of German education is due to the emergence between 1250 and 1493 of a number of separate Territorial States which elect the German emperor. The Golden Bull (1356) enunciated by the Emperor Charles IV codified the procedures of imperial elections that had developed during the later middle ages.[24] The absolute rulers of these Principalities realized that schools were an ideal instrument for the enhancement of their power and cultural prestige. For this purpose compulsory education was introduced, first in Saxe-Gotha (1642) and then Prussia (1717).[25] In the process, the Church not only lost control of the school, but the school's function was altered to instill the concepts of obedience, efficiency and devotion to duty. This philosophy, by gradually permeating the education system, shaped the national personality, especially as it is reflected in political and social attitudes.

Thirdly, the stress on educational theory and the search for better methods of instruction emanating from such seventeenth century thinkers as Francis Bacon, Rene Descartes, Wolfgang Ratke and Comenius contributed to this individuality. These theoretical influences were carried forward into the eighteenth and nineteenth centuries by such educational pioneers as Basedow, Pestalozzi, Herbart and Christian G. Saltzmann and acted as a strong unifying force in a country constantly swept by strong countercurrents.

Eighteenth century German educational activities, accelerated by the "Enlightenment" retained an element of religious morality directed towards creating a "folk-culture". However, this movement was displaced by the "German movement" towards the end of the century because of its predominantly utilitarian concerns. This latter trend (BILDUNG) is thought by some to be the German counterpart of the French Revolution.[26] Whereas French tensions and aspirations tended toward political expression, those of Germany leaned toward introspection. In the forefront of this thought were the poets Goethe and Schiller, educators such as Pestalozzi, Fichte, Herbart, Baron Karl Wilhelm Von Humboldt (elder brother of Alexander Humboldt, scientist and explorer), J. P. Richter, Ernst Arndt, and many others. Here, humanistic rather than utilitarian values prevailed.

BILDUNG and its objective counterpart KULTUR eventually became extremely controversial until, by 1870, the "crisis of culture" flowered into a movement led by Nietzsche, Legarde and Langbehn that criticized the very foundations of culture and revolutionized the entire educational system. After 1900 another wave of reform swept in. It started with the reintroduction of arts and crafts into the school curricula but gradually expanded to revitalize and reshape the entire system. An important aspect of this revitalization was the "youth movement" (around 1918), the VOLKSHOCHSCHULEN or people's university based upon examples from Denmark and the British university extension programs, the education of the maladjusted, criminal, psychopathic and feeble-minded. While the moral cataclysm of national socialism corrupted and largely destroyed the impetus of the movement, many of its former trends were noticeable after 1945.[27]

At this point, one could very well probe the effect that 18th and 19th century German philosophers have had upon the educational system and the parallel, if any, with the British Philosophical Radicals and Utilitarians of the same era.

However, the above information has been provided in an attempt to indicate just a few of the forces that have contributed to the present day German educational system. Under Frederick the Great, the Prussian Codes of 1763 and 1765 required children to attend school from ages 5 to 13 or 14 and provided enforcement by taking a school census and imposing

During the nineteenth century, schools offering different curricula developed but were organized as separate entities and not as part of an educational ladder. However, at present the concept of a unified secondary system appears to be developing.

After completing the four required years at the GRUNDSCHULE, or lower division of the VOLKSSCHULE, the greater majority of students continue at the higher division or the VOLKSSCHULOBERSTUFE. Others continue their education at the general secondary school called MÄDCHENLYZEUM and MITTELSCHULE - REALSCHULE, while a smaller but much more highly selective group enter the classical GYMNASIUM.[29]

This section would be incomplete without mention of the University of Berlin founded in 1810 through the efforts of Stein to compensate for the loss of the Universities of Halle and Göttingen at Tilsit. Under the vigorous leadership of Wilhelm von Humbolt, all manner of subjects were investigated and put under the glass of critical analysis. The university fairly scintillated with scholars of the first rank - the historian Leopold von Ranke, the philosophers Hegel and Schopenhauer, the chemist Justus von Liebig and physicist Hermann von Helmholtz, the psychologists Gustav Fechner and Wilhelm Wundt and the mathematician Karl Friedrick Gauss, to name but a few. The university pioneered in training experts and researchers rather than teachers. Small wonder that fines on all parents of truant children. Under a 1938 law, basically still in effect, minimum compulsory attendance is required of children between the ages of 6 and 18, of which at least 8 years must be full time and the rest may be part time. More recently, longer periods of full-time attendance have become the rule.

The educational renaissance in northern Europe greatly influenced the organization of the secondary school system and its curriculum. In Protestant areas, Catholic Latin schools were transformed into Lutheran vernacular schools. A classical school (GYMNASIUM) was founded and directed for 45 years by Johannes Von Sturm at Strasbourg in 1537. It subsequently became the most famous classical school in all Europe providing a model for hundreds that were set up both in Germany and abroad. These Gymnasia were financed originally from monies confiscated from the monasteries.

The realistic movement of the sixteenth and seventeenth centuries gave rise to the REALSCHULE, the practical school of the middle classes, and offered more useful everyday knowledge than did the Gymnasium. Baron Heinrick Friedrich Karl Vom Und Zum Stein, Frederick the Great's leading minister, was reinstated as first minister by Napoleon after the Prussian collapse of 1806-1807. He was instrumental in reorganizing and rationalizing the entire civil administration including both the army and the educational system. He created the Department of Public Instruction in 1808.[28]

universities throughout the world attempted to emulate Berlin and its scholarship.[30]

SECTION 2.

On June 30, 1879, Imperial Germany issued its first regulations respecting the training and examination of engineering officers for its Merchant Marine. A period of service as an apprentice in an engineering works and of service at sea in an engine room was specified by these Regulations which were quite similar in substance to those of the British statutes of the period. An amendment of 1891 stipulated the inclusion of mathematics, mechanics and physics into the examination syllabus. A revision dated January 7, 1909, made compulsory a two-year, full-time course of study for the highest grade of marine engineer (SCHIFFSINGENIEUR). Further changes during 1925 stipulated that all new entrants to marine engineering must complete full-time courses at technical colleges operated by the government. The length of these courses varied with the level of the certificate.

In the Federal Republic of Germany, the provincial governments (since World War II) are responsible for education and job training, whereas the Federal Minister of Transport is responsible for all aspects of maritime transport including certification of ship's officers.

There were two career paths for sea-going engineers. The lower level or artificer - SEEMASCHINISTEN - was restricted to vessels up to 2000 H.P. The higher level, both SCHIFFSINGENIEURE Class I and Class II, required graduation from MITTELSCHULE (10 years formal schooling) plus a three-year apprenticeship or graduation from OBERSCHULE (13 years of formal schooling) plus a two-year apprenticeship. The highest grade or Schiffsingenieure I examination required the possession of the Schiffsingenieure II Certificate plus two additional years of sea service. The course of training for this examination consisted of one full year and covered the following subjects:

Fundamental Subjects:

- Introduction in political science
- Shipping economics
- English language
- Mathematics (differential and integral calculus) and advanced mechanics
- Technology
- Basic design
- Guidance and instruction of personnel

Engineering Knowledge:

- Marine engines
- Boilers
- Reciprocating engines
- Steam turbines
- Auxiliaries in steam plant, condensers, heaters, etc.

Diesel engines, gas turbines

Propellers

Pumps, compressors, refrigeration plants, etc.

Applied thermodynamics with experiments in laboratories

Modern measuring techniques

Modern technique of control and automation

Marine electrotechnology with an introduction to electronics

Naval architecture

Classification Societies' rules, assurance problems, etc.

Generally, the course and the standard of examination are similar to those of the syllabuses for the First and Extra First Class examinations of the British Ministry of Transport regulations for the examination of engineers in the British Merchant Navy.[31]

At the time of writing, certain changes were contemplated:

(i) Simplification of the workshop requirements

(ii) Raising of entrance qualifications to matriculation level (MITTLERE REIFE) because developments in automation and electronics require greater fundamental knowledge.

(iii) An extension of the period of theoretical studies to three years which is the same as that required of mechanical engineers.

(iv) Changes in the marine engineering examination regulations to more closely parallel those of mechanical engineering.

(v) Graduates of a Government College will have Graduate Engineer status in marine engineering (SCHIFFS-betriebstechnik).[32]

In the discussion that followed the paper it was pointed out that about 60 percent of the instructors in the marine engineering departments of the colleges were Diploma Engineers with special shipyard and sailing experience, whereas the other 40 percent were seagoing engineers with long practical experience. It was also the policy to obtain mathematics and physics teachers with marine experience wherever possible. Also, after three years of teaching experience, these instructors were obliged to take a special examination.

All colleges were well equipped with various laboratories for practical experiments on electrical, electronics, thermodynamics, controls and instrumentation, and nuclear techniques. About 20 percent of the course time was spent in the laboratories.[33]

CHAPTER 8

GREAT BRITAIN

SECTION 1.

The English education system is a complex of intangibles of which the class structure, the Established Church, the heavy population density (London - 27 000 per square mile) and a piece-meal evolution all played an important role. The Education Act of 1870 guided through Parliament by W. E. Forster established Board Schools to fill the gaps left by voluntary groups. However, it was the Education Acts of 1880 and 1891 that made free, compulsory school attendance for all children between the ages of 5 and 10 years mandatory.

While the Merchant Shipping Acts and Regulations are universally applicable throughout the British Isles, it is thought that an understanding of the origin and development of technical education in England and Wales would provide the most advantageous perspective for cross-cultural analysis of the various European systems already described.

Introductory

The Industrial Revolution marks the most fundamental transformation of human life in the history of the world. For a brief period of history an entire world economy was built around Britain. Beginning with the textile industry of Lancashire in the latter part of the eighteenth century, Britain was propelled from a largely agrarian economy into an industrial pioneer whose position of influence and power is unparalleled by any state of its relative size before or since. Social and economic historians have discussed the merits and demerits of being an industrial pioneer at great length and with varying conclusions. However, E. J. Hobsbawn (Industry and Empire) argues that the relative decline of Britain during the twentieth century has been due to its early and prolonged lead as an industrial power which allowed an archaic technology and business structure to become too firmly embedded into the social consciousness to be easily abandoned. Whereas later arrivals upon the industrial scene such as Germany and Switzerland were forced to critically examine their social, political and industrial apparatus and with it their educational structure and philosophy, Britain could 'muddle' along. When the competition became increasingly fierce, she could retreat into her less developed colonial possessions to weather the economic cycles inherent in laissez-faire capitalism.[34]

When one considers the Industrial Revolution, one almost automatically thinks of cotton and the vast textile industry that developed in and around Manchester in close proximity to the great colonial and slave-trading seaport of Liverpool. This early stage of industrialization was able to utilize old and relatively well-understood scientific knowledge and adapt it to the factory system.[35] The hand loom of the cottage weaver was speeded up by the 'flying-shuttle' developed in the 1730's. However, it was Samuel Crompton's fusion of Hargreave's 'Spinning-jenny' (1760's) and Richard Arkwright's 'roller-frame' (1768) with a spindle carriage that became the 'spinning-mule' (1779). The early factories were built close to streams, and the power was supplied to the looms by various forms of water-wheel. However, as the industry developed and the number of factories increased, it was the greatly improved steam engine that supplied the power requirements which the streams and rivers were no longer capable of providing in sufficient quantity. During this period too, innovations in the coal and iron industries substantially increased their output and efficiency, but it is important to realize that none of these developments required anything more than the most rudimentary scientific or engineering knowledge and technical skills, and these were well within the capacity of the practical mechanic of the eighteenth century.[36]

Just as the first, or textile, phase of British industrialization appeared to be reaching a climax, a new phase requiring substantial capital investments and considerably more scientific and engineering expertise was beginning to develop. This second phase which lasted from 1840 to 1895 coincided with the invention of the Bessemer converter (1855), the Siemens open-hearth furnace (1868) and the Gilchrist-Thomas basic-steel process (1879). The comparatively large quantities of relatively cheap Bessemer steel helped supply the impetus for the construction of the railway network that was being built throughout the country.[37] With the railway came the electric telegraph and numerous other scientific developments, which taken together, made 'railway' a sort of synonym for ultra-modernity in much the same manner that 'atomic' came to be understood after World War II.[38]

When Queen Victoria opened the Great Exhibition at the Crystal Palace May 1, 1851, it symbolized the High Noon of British Engineering, the pinnacle of the previous eighty years of industrial life. The spirit of optimism engendered by the Exhibition was backed by a growing material prosperity and a level of industrial production and foreign trade that set England far ahead of all other countries. Only a very few exceptionally perceptive individuals saw through this national euphoria with sufficient clarity to comprehend the inherent weaknesses of the British educational system.[39] Compared with Germany, France, and the United States of America, British technical education showed serious shortcomings. The British middle and upper classes rationalized this problem as they did their economics, with the liberal philosophy of Adam Smith's Invisible Hand.[40] The mark of the philosophical radicals is clearly stamped upon the development of English technical education.

The Rise of Technical Education

The term 'technical education' is used in Britain to describe a considerable variety of educational paths ranging from the Secondary Technical Schools where boys and girls from between twelve and fifteen are taught craft and trade vocational skills to the technological faculties or departments of universities where the highest level of research is carried out. The beginnings of the technical education movement can be traced back to George Birkbeck (1776-1841) who established a Mechanics' Institute in London in 1823. The following quotation from the Mechanics' Magazine dated November 15, 1823, is indicative of the enthusiasm with which the enterprise was welcomed:

> The large room of the Crown and Anchor Tavern, one of the very largest in the Metropolis, was engaged for the occasion, and at the time appointed for taking the chair, it was completely filled. It is said to hold 2500 persons; certainly more than 2000 were present. We were glad to perceive that they consisted chiefly of that class for whose good the institution was intended, namely, WORKING MECHANICS: and they showed, by their conduct and demeanor, that they comprehended fully the serious magnitude of the object for which they assembled, and came to the consideration of it with minds warmed apparently to enthusiasm in its support; yet keenly intent on examining and scrutinizing well the means by which they were to be invited to realize the promised good. It was a meeting of men resolved both to 'think and act for themselves ...' The earnest, discriminating, and orderly attention with which they listened to the whole of the proceedings, exceeded anything we had ever before witnessed in so numerous an assembly ...[41]

The Institutes with their altruistic aim of assisting the working class attain a measure of social emancipation were in fact given their initial impetus by successful and philanthropically inclined middle class industrialists who perceived their own interests as being bound to, and furthered by, a more knowledgeable workforce. The first resolution proposed at the very first meeting set forth the Institutes' functions:

> ... to improve extensively their (Mechanics) habits and conditions, to advance the arts and sciences, and to add largely to the power, resources and prosperity of the country.[42]

The workers, especially those more discerning individuals, when faced with such a plethora of middle class arguments were critical of the Institute from the beginning. One writer pointed out (Mechanics' Magazine - Dec. 1823) that the chief beneficiary of the Institute was the employer, while another writer argued that when a new invention is introduced, the "men whose labour is superseded must inevitably experience much IMMEDIATE DISTRESS."[43] The same man also suggested that increased education, together with at least partial ownership of the means of production, was needed in order that the newly educated workers were not sacrificed to the forces of uncontrolled capitalism.

From the very beginning those Institutes founded in the industrial cities of the provinces placed science and the dissemination of scientific knowledge at the centre of their concerns and indeed, at the founding of the Liverpool Institute, it was proposed to ban all books of party politics or polemical religion.[44]

Inkster argues that since a large proportion of the individuals behind the formation and early scientific activities of many of these provincial institutes were professionals such as physicians, lawyers, teachers and clergymen, these institutes represented a method whereby this non-industrial class could affiliate with the more dominant industrial class. He suggests that these Institutes fulfilled the function of integrating socially definable subgroups into the national society. He further suggests that the rapid demise of these Institutes after 1850 developed because alternative organizations took over the social functions previously performed by the Mechanics' Institutes.[45]

Another aspect of Technical Education was the Victorian Art Schools. The Schools of Art, starting with the establishment of the Government School of Design at Somerset House in 1837, inaugurated an important period of initial experience for the encouragement of industrial design intended to help remedy the alleged artistic and other inferiorities of British goods. The Great Exhibition of 1851 had demonstrated flaws in Britain's industrial expertise in comparison with that of her rivals, a state of affairs generally attributed to the superior system of technical education on the Continent.[46] In 1852 the Board of Trade proposed the setting up of a Department of Practical Art which, by 1853, became the Department of Science and Art with the expressed intention of 'supplying scientific and artistic instruction to the industrial classes.'[47] During the 1850s and 1860s, a considerable number of these Art Schools were established in different regions of the country and these, together with the schools of science which developed simultaneously, may be considered as a sort of connecting link between the technical institutes of the 1890s and the relatively undisciplined Mechanics' Institutes of the 1820s. The prospectus of the Warrington School of Art (near Liverpool) described the technical function as 'not primarily intended to make artists .. but is of a technical kind aiming at providing industry with well qualified designers, engravers and the like.'[48]

The early stages of British technical education suffered from two major defects:

(1) The central philosophy was aimed at providing the scientific education underlying the arts and crafts. However, instead of attempting to produce a technical elite for research and management and thus raise the status of this form of education, it aimed at the commercial classes and at skilled and unskilled workers, many of whom were illiterate or barely capable of comprehending the instructional material even at the low level at which it was presented. While advanced technological studies were beginning to be integrated into the programs of the emerging universities, little support was forthcoming, hence courses in applied science tended to carry the stigma of 'Second Class' studies.[49]

(2) Technical education was bedevilled by the 'evening class' complex which persisted well into the twentieth

century. There were numerous complaints of students unable to concentrate after long hours in a factory. The 'drop-out' rate was extremely high, and those students successfully completing such a program of studies must be commended for sheer tenacity, perserverance, determination and physical stamina.[50]

If the Great Exhibition of 1851 had been the High Noon of British Industrial progress, the Paris Exhibition of 1867 was the late afternoon and proved of particular importance in that it focused attention upon the difficulties and deficiencies facing British technical education. One visitor to Paris, Professor Leon Levi, was certain that foreign countries were making great progress and that the inventions that had made England famous were by now the common property of all. Another distinguished visitor was Lyon Playfair who was so disturbed by his observations that he described his concerns in a letter to Lord Taunton, Chairman of the School's Inquiry Commission, which was subsequently published in The Times of May 29, 1867. He concluded his letter by suggesting that the Government should hold a public inquiry into technical education. These allegations were considered so serious that in a report to the Queen, July 2, 1867, the Commission recommended the setting up of a special inquiry '... into the state and effects of technical education abroad, and particularly in France, Germany, and Switzerland ...'[51] Another direct result of Playfair's letter was that very detailed information concerning the various systems of education of a number of foreign countries was collected via diplomatic dispatches requested by the Foreign Office. These reports indicated conclusively the attention and concern being given to technical education, and indeed to all levels of education, by Britain's industrial competitors.

Another eminent Victorian, Bernard Samuelson, after an on-the-spot appraisal of British and foreign industrial concerns and educational institutions voiced his concern with the lack of scientific knowledge shown by British industrial managers and workers which compared extremely unfavourably with the '... superior technical knowledge of the directors of works everywhere and by the comparatively advanced elementary instruction of the workers in some departments of industry ...'[52]

During the last quarter of the nineteenth century, the clamor for improvements to the system of general education and particularly of technical education intensified. A particularly scathing criticism of British education was delivered by the Yorkshire industrialist, Swire Smith, during the inaugural address at Dundee Technical Institute, October, 1888.

> The wealthy manufacturer ... sends his son to a classical school to learn Latin and Greek as a preparation for cloth manufacturing, calico printing, engineering or coal mining ... He enters his father's factory at 20 or 24, absolutely untrained in the chief requirements of the business he is

> called upon to direct.... Is it fair ... that he should have been taught nothing of chemistry, or of practical mechanics, steam, electricity, the methods of commerce, or even of modern languages.[53]

The immediate result of all this furor was: (1) The Royal Commission on Scientific Instruction and the Advancement of Science - 1875, chaired by the brilliant scholar, William of Cavendish, Lord Devonshire. This report was basically concerned with higher education but also considered the teaching of science in the elementary schools urging that greater attention be paid to the subject. (2) The Royal Commission on Technical Instruction, 1882-4, chaired by Bernard Samuelson, who besides having made his own comparative study of European technical education, had been a member of the Devonshire Commission. The Terms of Reference of the Commission were:

> To inquire into the instruction of the industrial classes of certain foreign countries in technical and other subjects for the purpose of comparison with that of the corresponding classes in this country; and into the influence of such instruction on manufacturing and other industries at home and abroad.[54]

This report detailed the deficiencies and shortcomings touched upon earlier and came up with three specific recommendations dealing with secondary and technical schools:

(a) that steps be taken to accelerate the application of ancient endowments, under amended schemes, to secondary and technical instruction.

(b) that provision be made by the Charity Commissioners for the establishment, in suitable localities, of schools or departments of schools, in which the study of natural science, drawing, mathematics and modern languages shall take the place of Greek and Latin.

(c) that local authorities be empowered, if they think fit, to establish, maintain, and contribute to the establishment and maintenance of secondary and technical (including agricultural) schools and colleges.[55]

'The Local Government Act of 1888 which set up the County and County Borough Councils was followed in 1889 by the Technical Instruction Act which authorized the new authorities to spend up to the product of a penny rate on technical and manual instruction. This in turn was followed by the Whisky Money grants from 1890, which diverted more funds to the counties and county boroughs, to be spent on technical and scientific education.'[56]

Subsequent to the development of the Mechanics' Institutes and the Arts Schools, two outstanding examples of private initiative have left an indelible impression upon British technical education. These are the City and Guilds of London Institute and the Whitworth Scholarships.

Joseph Whitworth (1803-1887) served a mechanical apprenticeship and later was employed at the Works of Henry Maudslay, the originator of the screw cutting lathe. He eventually established himself as a machine tool manufacturer at Manchester which became famous for the quality and accuracy of his products. He discovered the method of making a plane surface truly flat, developed a standardized guaging system and also a measuring device of great accuracy. However, he is best remembered for the system of uniform screw threads that bears his name. In March, 1868, he wrote the Department of Science and Art offering to endow thirty scholarships each worth £100 per annum over a three-year period; and when this was accepted, he followed it up with a further sixty preliminary exhibitions worth £ 25 per annum.. These scholarships and exhibitions were intended for the further education of young men "in the thoery and practice of mechanics and its cognate sciences, with a view to the promotion of engineering and mechanical industry in this country."[57] A number of these former Whitworth Scholars distinguished themselves in various branches of engineering and in their turn left their mark upon those coming afterwards.

Whitworth was taking on singlehanded the task that should have been undertaken by government, namely, the provision of a national scholarship scheme.[58]

The City and Guilds of London Institute is perhaps best known for the technical examination system which bears this name. During the 1870's, the feeling was developing that the considerable funds of the ancient guilds, originally intended for the instruction of the apprentice in his craft, could be more effectively employed to promote improvements in technical education. On July 21, 1873, the Prince of Wales conferred with the City of London Livery Companies upon the most effective method of accomplishing this objective with the result that J. F. D. Donnelly, an Inspector of the Department of Science and Arts, advised the Lord Mayor that the best help would be to endow scholarships and bursaries and assist in the establishment of engineering chairs and laboratories. At a meeting of the City of London Livery Companies at the Mansion House in 1876, it was resolved:

> that it is desirable that the attention of the Livery Companies be directed to the promotion of education not only in the Metropolis but throughout the country, and especially to technical education, with the view of educating young artisans and others in the scientific and artistic branches of their trades.[59]

The City and Guilds of London Institute for the Advancement of Technical Education was formally inaugurated November 11, 1878, with the Prince of Wales as President.

Starting with a budget of £12 000 in 1878, the Institute embarked upon three major projects: the creation of a 'Central Institution' at South Kensington which should aspire to be something like the status of the German Technische Hockschule, the first of its kind in England for higher technological education; the building of a model trades school at Finsbury; and the taking over and developing of the scheme of popular technical examinations launched in 1873 by the Society of Arts. All three projects were carried through, each becoming influential in its own way. The Central Institution eventually combined with the Royal College of Science to become the Imperial College of Science and Technology, the nearest approach, apart from the Manchester College of Technology, to the ideal of a technical university.[60] Finsbury College grew out of a scheme to build up the trade classes established by Dr. Wornell at the Cowper Street Schools into one of two metropolitan Trade Schools, 'to serve as models for others.'[61] The cornerstone of the College was laid in 1881 and the building completed in 1883. It is with the third project, the technological examinations inherited from the Society of Arts in 1879, that projects the image of the City and Guilds Institute known today.

Synonymous with the City and Guilds of London Institute is the name of Sir Philip Magnus whose dominant, perspicacious and able leadership was the chief motivation behind the development of the City and Guilds examination system to the pre-eminent position it ultimately reached. External examinations are an enduring and unique feature of the English education system. These became popular in the 1850s and 1860s as a cheap method of stimulating interest in secondary and scientific education. The South Kensington Science and Arts Department had used the 'payment-on-results' scheme for popularizing science instruction on an enormous scale without the commitment of vast expenditures for school buildings or teacher training. As J. F. D. Donnelly put it: 'If a teacher produces nothing he gets no pay, and very soon gives up the attempt to teach.'[62]

While not an original thinker, Magnus was an extremely capable administrator and soon after his appointment as Organizing Director and Secretary in March, 1880, he realized that the examination service would be sacrificed first if economies were required to be made. Hence, he systematically set about entrenching the system so that there could never be any doubt about either the results or the utility of the examination system. Magnus had served on the Samuelson Commission and was well informed on educational matters, in particular the desirability and the difficulty of obtaining the services of good and competent examiners. While the Science and Arts Department relied upon the Professors of the Royal Institution, the University Colleges of London and its own Schools of Science to set and mark examinations, the City and Guilds Institute was often forced to rely upon competent tradesmen with little academic background and often no teaching experience. Magnus offers this explanation:

> The difficulty of obtaining competent Examiners who are themselves actively engaged in the trade, and who possess a thorough knowledge of the principles and theory of a subject, tends to increase rather than diminish with the progress of Technical Education. This is due to the fact that technical knowledge is advanced not only in the workshop and factory, but also in the schools, and it becomes necessary therefore, in order to secure the proper combination of theory and practice in the question papers, to associate in many instances the practical manufacturer or craftsman with an experienced teacher or co-examiner.[63]

While Donnelly appeared content to let the payment system weed out poor teachers, Magnus insisted upon strict registration and control as his report indicates:

> Notwithstanding the care exercised by the Institute in registration of teachers, it will have been seen from the reports of examiners, that in many subjects, the standard of instruction is still at a low level; and the want is generally felt of competent teachers, familiar with the practice of the trade, who have received an adequate training in the methods of instruction and in the principles and application of science.[64]

The Register of Teachers maintained by the Institute was incomparably better than the system of teacher control used by the Science and Arts Department and was normally based upon the possession of the Full Technological Certificate for the trade issued by the Institute. Although Magnus never succeeded in developing a successful scheme of technical teacher training he did create an examination for the testing of Woodwork teachers in 1892 and this was later extended to other subjects thus foreshadowing the Institute's present Technical Teacher's. Certificate Scheme.[65]

Largely because of the public funds made available under the Technical Instruction Act of 1889, the succeeding decade witnessed a dramatic increase in the provision for technical education. By this time, however, much of the work in most of the important institutions was governed by the various syllabuses of the City and Guilds Institute. When Magnus retired at the age of 73, in his letter of resignation he comments upon the achievements of the Institute in building 'an educational fabric which, from very small beginnings, has grown and spread to all parts of the Kingdom and to the dominions overseas.'[66]

Twentieth Century Developments

The twentieth century witnessed State involvement with every aspect of education. Starting with the consolidation and control over the system provided by the 1902 Education Act, steady progress was maintained for the next thirty or forty years. The 1939-45 War placed enormous demands on facilities for providing different types of technical training for the Armed Forces and for industrial workers. Day-release of apprentices became much more general than heretofore. This trend continued into the post-war period with the retraining of ex-service men and also the population generally. It necessitated a very large expansion and building program and also the range and importance of the work undertaken was considerably modified. These developments and the attendent discussions lead to the 'Report of the Special Committee on Higher Technological Education appointed by the Minister of Education' (The Percy Report - 1945) with terms of reference as follows:

> Having regard to the requirements of industry, to consider the needs of higher technical education in England and Wales and the respective contributions to be made thereto by the Universities and Technical Colleges; and to make recommendations, among other things, as to the means for maintaining appropriate collaboration between Universities and Technical Colleges in this field.[67]

Both this Committee and the Barlow Committee (1946) on Scientific Manpower found evidence of serious shortcomings in both the quantity and quality of the training of technologists. The Percy Committee recommended a limited number of carefully selected technical colleges as 'Colleges of Technology' which would be allowed to build up full-time courses of degree standard. This report, together with the Barlow report, helped create a climate of opinion more favourable to the Sciences rather than a preoccupation with the Arts in the grammar school curriculum. There was a considerable controversy over the nature and name of the award or qualification to be bestowed by the selected colleges. While some members favored calling it a degree, others, depending upon their interests, insisted upon other names, and action on the main recommendation was considerably delayed.

An awareness of the advances of Russian technology, exemplified by the Sputnik experiment of October, 1957, brought home the unsatisfactory progress of scientific and technological education in Britain and also spurred other nations, notably the United States of America, towards a much greater expenditure of resources and effort in this direction. The result was the White Paper on Technical Education - 1956 which 'sought to increase full-time study by the extension of sandwich courses and, in particular by the creation of a new category of college, the Colleges of Advanced Technology, in which the major part of the advanced work would be concentrated.'[68]

The change in emphasis is illustrated in the following:

> 'Technical education must not be too narrowly vocational or too confined to one trade or skill. Swift change is the characteristic of our age, so that a main purpose of the technical education of the future must be to teach boys and girls to be adaptable. Versatility has been the aim of a classical education; technical studies should lead to a similar versatility and should, therefore, be firmly grounded on the fundamentals of mathematics and science.[69]

During 1961 the 'Report of the Central Advisory Council for Education (Wales) on Technical Education in Wales' put forth specific proposals for the reform of the apprenticeship system. A feature of the scheme was a network of Apprentice Training Centres, which an apprentice would enter for a three-year period of full-time training. Since the proposal would only be practical if adopted throughout Britain, it was shelved but reappeared in the White Paper on Industrial Training - 1962. The Industrial Training Act - 1963 carried out these proposals in a modified form, i.e. full-time, first-year courses for apprentices under the supervision of industrial training boards.[70]

The Industrial Training Act - 1963 empowered the Minister of Labour to set up Boards to be responsible for all aspects of training for individual industries. The range of functions of these Boards might be:

(1) Establishing policy for training in the industry, including such questions as admission to training (apprenticeship or otherwise) length of training, registration of trainees, and a provision for appropriate attendance at colleges of further education.

(2) Establishing standards of training and syllabuses for different occupations in the industry, taking into account the associated technical education required.

(3) Providing advice and assistance about training to firms in the industry.

(4) Devising tests to be taken by apprentices and other trainees on completion of training and, if necessary, at intermediate stages - for example, at the end of the first year.

(5) Establishing qualifications and tests for instructors.

(6) Establishing and running training courses in its own training centres.

(7) Paying grants to firms to reimburse them all or part of the costs incurred in the provision of approved training.

(8) Paying allowances to trainees not taken on by firms while being trained in public, or the Board's own, centres.

(9) Collecting money from establishments in the industry by means of a levy.

(10) Borrowing.

A levy on firms in the industry is an essential part of the proposals ....[71]

This part would not be complete without some mention of the various qualifications used to designate the different categories of technical education in Great Britain.

> The Ordinary National Certificate (ONC) is a qualification essentially obtained by part-time study extending over three years for a student leaving school at fifteen or two years if the student has obtained appropriate qualifications in the General Certificate of Education while at school. Very approximately the ONC is of the standard of advanced or scholarship level of the General Certificate of Education.[72]
>
> The Higher National Certificate (HNC) is the second step along this path. This is again obtained by part-time study for two years after obtaining an ONC. This standard may be considered as slightly less than that for an English University pass degree in a very restricted field.[73]

For each of the above qualifications, the individual institution prepares its own syllabus and examinations which are assessed by special Joint Committees of the Ministry of Education and also the appropriate professional institution such as the Institution of Mechanical Engineers, Institution of Marine Engineers, The Royal Institution of Naval Architects, etc. This process ensures a degree of uniformity in the level or depth of the studies while at the same time providing a measure of freedom to allow for local conditions.

The Council of Engineering Institutions was founded in 1962 and given a Royal Charter in 1965. This is now the official registration body for all higher or professional qualifications in the technical area. An individual registered by the Council is authorized to use the style and title of Chartered Engineer (C. Eng.).

The Report of the Committee on Higher Education (1963) (Robbins Report) recommended that students taking advanced courses in Regional and Area Colleges should have the same opportunities for degrees as those in a University or a College of Advanced Technology. The report further recommended the creation of a Council of National Academic Awards to perform the function previously carried out by the National Council for Technological Awards. The new Council would award degrees rather than Diploma in Technology or Membership of the College of Technologists introduced during 1959. This diploma was considered the equivalent of an Honours Bachelor's Degree whereas Membership in the College of Technologists, the equivalent of a Ph.D. degree.[74]

The Robbins Committee further recommended the development of five Special Institutions for Scientific and Technological Education and Research, comparable in size, standing and in advanced research to the great technological Institutions of the United States of America and the European Continent.[75]

It should be noted that the education system of Scotland developed earlier and evolved along somewhat different lines than that of England and Wales. However, a degree of reciprocity has developed over the years and Certificates, particularly at advanced levels, are mutually recognized in both countries.

SECTION 2.

In the case of Marine Engineer Officers, the British Merchant Shipping (Amendment) Act of 1862 required all foreign-going British Ships with engines over 100 nominal horse power to carry two certified engineers--one First and the other First or Second Class. Home-trade cargo ships were exempt from this requirement, but Home-trade passenger ships were required to have one engineer holding at least a Second Class Certificate of Competency.[76] These requirements were taken unaltered into the Consolidated Merchant Shipping Act of 1894 and remained largely unaltered until the 1970's. The Act did not prescribe any standards that must be adhered to but gave the Minister of Transport very wide powers to regulate the conduct of the examinations and the qualifications of candidates.

The present requirement is for not less than four (4) years service as an engineering apprentice or journeyman in a workshop suitable for the training of a marine engineer in the manufacture or maintenance of suitable heavy machinery.

In addition to this apprenticeship, a candidate requires to serve a further twenty-one (21) months at sea as an uncertified watchkeeping engineer before he may attempt the Second Class Examination. After obtaining the Second Class Certificate, another twenty-one (21) months of sea service as senior engineer in charge of a watch in a foreign-going vessel is required before attempting the First Class Examination. Thus, a minimum of ninety (90) months' service is required for a First Class Engineer who still remains restricted to operate in either a steam ship or a motor ship. If the engineer wishes to be qualified for both types of prime movers, then an additional six (6) months is required in a motor ship or nine (9) months in a steam ship before attempting the First Class Combined Certificate of Competency.[77]

During 1952 the British Ministry of Transport approved a new concept known as the Alternative Training Scheme as another option to the traditional apprenticeship training. In this program a four and one-half (4.5) year period of theoretical and practical training ashore and afloat takes the place of the traditional four-year apprenticeship. An individual having an Engineering Degree would require only two (2) years of practical workshop experience but must still complete the same amount of sea service as other candidates. Such a person, however, is generally exempt from the theoretical subjects of the examinations on a subject-by-subject basis. Reciprocal arrangements respecting equivalency of certificates also exist between the United Kingdom and certain Commonwealth countries. For Canada, this dates from January 1, 1887.

Syllabi for the Second, First and Extra First Class Examinations are as follows:

Second Class

Mathematics

Applied Mechanics

Heat and Heat Engines

Mechanical Drawing

Electrotechnology

Elementary Naval Architecture

Engineering Knowledge (3 papers)

(i) General Knowledge

(ii) Steam Engineering

(iii) Motor Engineering

First Class

Applied Mechanics

Heat and Heat Engines

Electrotechnology

Elementary Naval Architecture

Engineering Knowledge (3 papers)

(i) General Knowledge

(ii) Steam Engineering

(iii) Motor Engineering

The material for First Class is of greater depth and complexity than that of the Second Class.

Extra First Class Examination

This Certificate is intended for officers who wish to prove their superior qualifications and is the highest grade granted by the Minister. Although not a requirement for sea-going engineers, it is a necessary qualification for certain governmental and professional appointments. It gives the engineer the status of Chartered Engineer.

The syllabus for Extra First Class Examination is as follows:

Theory of Machines and Mechanics of Fluids
Strength and Properties of Materials
Applied Thermodynamics
Marine Heat Engines
English Essay
Engineering Drawing and Design
Electrotechnology
Naval Architecture
Engineering Knowledge

At a more advanced level the University of Strathclyde in Glasgow offers a four (4) year degree course in Naval Architecture and Shipbuilding and also post-graduate degrees in Marine Technology and Ship Production Technology.

The University of Newcastle upon Tyne also offers a range of studies and research activities in Marine Engineering, Naval Architecture and Ocean Engineering. The following information from the 1979-80 Prospectus indicates the thrust and examination structure of these programs.

The Department of Marine Engineering offers the only degree course in the country specifically designed for the needs of the young engineer who will be concerned with problems of mechanical engineering peculiar to the marine environment and especially to ships. Well-equipped laboratories and computing facilities have been developed especially for such work.

Undergraduate study in the Department of Naval Architecture and Shipbuilding is directed towards the design, production and operation of ships and other ocean vehicles and structures. Foundation studies in engineering science and mathematics lead to a variety of marine-orientated topics, which provide the basis for some optional specialisations in the final year such as shipbuilding technology, the art and science of design, or marine transport studies. The department has good experimental facilities, including a model-testing tank and one of the largest propeller test tunnels in the country.

Closely related to these two departments is the Ocean Engineering group. Its work is at present mainly research, with particular emphasis on sea-bed technology; but members also contribute to the teaching of offshore engineering at undergraduate and postgraduate levels.

Marine Engineering

Courses in Marine Engineering are three-year courses leading to the Honours degree or the General degree or the Ordinary degree.

Final Examination Parts I and II for the Honours, General and Ordinary Degrees

Part I

(a) Electrical Engineering I(S) (1 paper--NS 49?)
(b) Engineering Mathematics IA (examined by in-course assessment)
(c) Fluid Dynamics I (1 paper--NS 271)
(d) Machine Dynamics I (1 paper--NS 314)
(e) Marine Engineering I (examined by in-course assessment)
(f) Science of Materials (1 paper--NS 14M)
(g) Strength of Materials I (1 paper--NS 261)
(h) Thermodynamics I (1 paper--NS 272)
(j) Course Work I (including Manufacturing Technology and Machine Design I)

Part II

(a) Electrical Engineering II(S) (1 paper--NS 31)
(b) Engineering Mathematics IB (1 paper--NS 405)
(c) Either Engineering Mathematics II (1 paper--NS 485), or Metallurgy EII (1 paper--NS 121)
(d) Fluid Mechanics and Thermodynamics II (1 paper--NS 83)
(e) Machine Dynamics and Strength of Materials II (1 paper--NS 84)
(f) Marine Engineering II (1 paper--NS 91)
(g) Naval Architecture EI (1 paper--NS 318)
(h) Course Work II (including Machine Design II)

Final Examination Part III for the Honours Degree

(a) Marine Engineering III (1 paper--NS 93)
(b) Mechanical Engineering Science (examined by in-course assessment)
(c) Naval Architecture EII (1 paper--NS 139)
(d) Course Work
(e),(f),(g) and (h) Four subjects chosen from the following (i) to (x) with the approval of the Head of Department:
   (i) Applied Electronics (1 paper--NS 125)
   (ii) Automatic Control (1 paper--NS 324)
   (iii) Engineering Economics (1 paper--NS 100)
   (iv) Engineering Mathematics III (1 paper--NS 486)
   (v) Internal Combustion Engines (1 paper--NS 80)
   (vi) Marine Transport and Operation (1 paper--NS 243)

(vii) Metallurgy EIII (1 paper--NS 316)
(viii) Thermal Power Systems (1 paper--NS 92)
(ix) Turbomachines (1 paper--NS 81)
(x) Other approved subjects

Final Examination Part III for the General Degree

Either Course A or Course B

A. Naval Architecture
Marine Engineering III (1 paper--NS 93)
Mechanical Engineering Science (examined by in-course assessment)
Ship Design I (1 paper--NS 473)
Shipbuilding Science I (examined by in-course assessment)
Ship Hydromechanics I (examined by in-course assessment)
Ship Structures I (examined by in-course assessment)
Course Work

B. Electrical Engineering
Electrical Engineering 2.1 (examined by in-course assessment)
Electrical Engineering 2.2 (examined by in-course assessment)
Electrical Engineering 2.3 (examined by in-course assessment)
Electrical Engineering 2.4 (examined by in-course assessment)
Marine Engineering III (1 paper--NS 93)
Mechanical Engineering Science (examined by in-course assessment)
Laboratory Course Work and Reports

Final Examination Part III for the Ordinary Degree

(a) Marine Engineering III (1 paper--NS 93)
(b) Mechanical Engineering Science (examined by in-course assessment)
(c) Course Work

Naval Architecture and Shipbuilding

Courses in Naval Architecture and Shipbuilding are three-year courses leading to the Honours degree or the Ordinary degree.

Final Examination Parts I and II for the Honours and Ordinary Degrees

Part I

(a) Applied Mechanics I (1 paper--NS 490)
(b) Basic Naval Architecture (examined by in-course assessment)
(c) Electrical Engineering Principles I(S) (1 paper--NS 637)
(d) Engineering Mathematics IA (examined by (in-course assessment)
(e) Fluid Mechanics and Thermodynamics I(S) (1 paper--NS 496)
(f) Marine Technology (examined by in-course assessment)
(g) Science of Materials (1 paper--NS 14)
(h) Course Work I

Part II

(a) Engineering Mathematics IB (1 paper--NS 405)
(b) Marine Dynamics (examined by in-course assessment)
(c) Marine Engineering NAI (1 paper--NS 132)
(d) Resistance and Propulsion of Ships (examined by in-course assessment)
(e) Shipbuilding Science I (examined by in-course assessment)
(f) Ship Structures I (examined by in-course assessment)
(g) Strength of Materials II (1 paper--NS 262)
(h) Course Work II (including Computing)

Final Examination Part III for the Honours Degree

Candidates are required to have completed the examinations in Final Parts I and II before proceeding to a course approved by the Head of the Department and having the following constituents:

(a) Ship Design I (1 paper--NS 473)
(b), (c), and (d) Three subjects selected from the following (i) to (vi):
  (i) Marine Transport and Operations (1 paper--NS 243)
  (ii) Offshore Vehicle Design (1 paper--NS 140)
  (iii) Shipbuilding Science II (1 paper--NS 476)
  (iv) Ship Design II (1 paper--NS 474)
  (v) Ship Hydromechanics (1 paper--NS 477)
  (vi) Ship Structures II (1 paper--NS 475)

(e) One subject selected from the following (i) to (v):
  (i) Engineering Economics (1 paper--NS 100)
  (ii) Engineering Mathematics II (1 paper--NS 485)
  (iii) Marine Engineering NA II (1 paper--NS 478)
  (iv) Metallurgy EII (1 paper--NS 121)
  (v) Strength of Materials III (1 paper--NS 265)
(f) One other subject selected from (b) to (e) above or other approved related subject
(g) Project and Report

Final Examination Part III for the Ordinary Degree

(a) Ship Design I (1 paper--NS 473)
(b) Project and Report
(c) One subject related from the following (i) to (v):
  (i) Marine Engineering NA II (1 paper--NS 478)
  (ii) Marine Transport and Operations (1 paper--NS 243)
  (iii) Offshore Vehicle Design (1 paper--NS 140)
  (iv) Shipbuilding Science II (1 paper--NS 476)
  (v) Ship Design II (1 paper--NS 474)

Conclusion to Part One

This part has attempted to provide an historical review of the general educational development in the seven countries surveyed together with a fairly comprehensive examination of the system of technical education and training for the marine engineers of each nation.

Britain's dominance of the world's shipping during the latter half of the nineteenth century coincided with a period of vast and far-reaching technical development. First, wood was displaced by wrought iron as the ship's chief structural material but this, in turn, was soon superceded by steel. Sails were first augmented by engine driven paddle wheels, but the screw propeller quickly supplanted both. The trans-Atlantic passenger trade given its initial impetus by the migration of Europeans to America created a demand for larger and more powerful vessels which, in turn, spurred the development of the steam turbine. The twentieth century ushered in the Diesel engine, a German invention which initially, was more quickly adopted by European shipowners than by their British compeers.

The Diesel engine required an engineer with more highly developed theoretical and mechanical skills than did the reciprocating steam engine and the coal burning Scotch-Marine boiler. In the American built "Liberty" ships and most of the Canadian built "Park" ships of World War II, the Scotch boilers were replaced by oil-fired, water-tube boilers thus necessitating at least a rudimentary knowledge of boiler-water chemistry for their successful operation. At this stage, too, steam turbines which had heretofore been mainly employed in warships and high-powered passenger ships, were being installed in a great number of cargo vessels. Steam pressures doubled, tripled and, for a few experimental ships, increased by as much as six-fold over that previously used by the vast majority of merchant shipping. The higher pressures and temperatures used in the steam cycle necessitated the installation of a considerable amount of instrumentation and automatic control devices, all of which the engineer was forced to deal with. It soon became apparent that those engineers with a somewhat higher educational background could cope more successfully with these new demands.

The evolution of technical education in Britain has been discussed at some length because the emphasis still being placed upon apprenticeship and the comparatively narrow range of subject matter in the British marine engineer's examination syllabi reflects this historical development. With the exception of Italy, the Maritime Regulations of all the countries surveyed initially stipulated an apprenticeship as an important prerequisite to the training and certification for marine engineers. This not only reflects that particular stage of technical evolution but also the dominant effect of British shipping which was greatly admired and, to a certain extent, used as a model by other countries of the period.

Colonel Gargiulo (Italy) makes no reference to historical data, but it appears highly unlikely that an apprenticeship, per se, was even contemplated as a basic requirement. The technical institutes of Italy, of which the ISTITUTO TECNICO NAUTICO is an important representative, were set up in 1859 by the Casati Law[78] (see p. 28). These were designed initially to train the higher levels of middle management and have enjoyed a continued popularity for over a century, the only difficulties experienced being those adjustments required by growth and adaptation.

Most of the authors of the Symposium pointed out that their respective governments were either actively contemplating or already engaged in the process of adapting the Maritime Regulations to technical change. However, it is well to recall that this Educational Symposium took place in 1964 with the result that, while technical change has certainly accelerated, it has not necessarily followed any of the paths envisaged by the authors at that time. For one thing, the demands for labour mobility generated by the European Economic Community (E.E.C.) has created a need to acknowledge and accept the professional qualifications (degrees, diplomas, certificates) of the nationals of member states on a uniform and clearly defined basis. For example, the Chartered Engineer (C.Eng.) of Great Britain may, if he wishes, be registered as a Professional Engineer with the FEDERATION EUROPEENNE D'ASSOCIATIONS NATIONALES D'INGENIEURS (F.E.A.N.I.) at Paris, France, thus providing immediate reciprocity and recognition throughout the E.E.C. The International Convention on Standards of Training, Certification and Watchkeeping for Seafarers, 1978, has proved to be a remarkable feat of international co-operation. Most, if not all, of the countries represented at the Convention are already heavily involved in the process of changing national legislation to accommodate these new requirements. This is not nearly so simple a task as one may imagine because massive changes in a nation's maritime legislation may produce totally unexpected repercussions in other areas of the economy totally unforeseen by even the most perspicacious and conscientious of legislators.

Now that the Convention is ratified, it will mean a simplification of both the number of grades and the different types of qualifications of the officers; a five-year renewal system for licensees to update knowledge; establishment of a control system to prevent ships that have violated the convention from leaving port; and for those countries such as Britain that use Nominal Horse Power or Holland and Japan that use Gross Tonnage as a measure of engine capacity, changes will be required to utilize the actual propulsion power. Furthermore, existing law will require amending to include requisites for deck and engine room ratings forming part of a watch; for those engaged in handling of dangerous cargos; the issue of certificates of proficiency in survival craft; and of standards for keeping a watch.

During the discussions of the Symposium papers, a frequently asked question was: 'How to keep these highly trained young marine engineers at sea since most will only stay about 10 years?' In Italy, Holland and Germany the theoretical knowledge required of a Chief Engineer is of the same general standard as that of the Graduate Mechanical Engineer and, in fact, individuals so trained acquire the privilege of using the equivalent title of P. Eng. However, whereas Germany and France insist their potential Chief Engineers be graduates of the highest academic schools, both Britain and Holland kept the <u>Educational Ladder</u> in place so that those showing sufficient tenacity and perseverance could still attain their place in the sun. Colonel Gargiulo pointed out that the Italian Government had undertaken the entire cost of building, equipping and operating the Nautical Schools. Cognizant of the cyclic nature of the shipping industry it did not attempt to match graduates to employment opportunities. Rather, it made certain the graduates were equipped to function effectively in the larger society so the funds expended upon their education were not lost to the Nation. It appears that the Italian psyche is such that a fairly substantial number of young men are attracted to the sea life with its romantic overtones. The result is that a nautical life has a large measure of respectability in the Italian social consciousness. A perusal of the Italian Nautical School's syllabus is illuminating in that it provides a much more humanistic educational approach than the much narrower and more confining technical syllabi of most of the other countries. In this respect the Italians anticipated the British White Paper on Technical Education of 1956 (see p. 71) by fully 100 years.

Now that the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers, 1978, has finally come into force, the International Certificate of Competency provided for by Article VI may, because of its greatly expanded technical syllabus and concern for human relations, very well provide at least a partial answer to the question posed in the last paragraph.

PART TWO

ASIA

CHAPTER 9

REPUBLIC OF KOREA

SECTION 1.

This country has been included because of its phenomenal development as a shipping and shipbuilding nation. Before 1962 Korea had only built simple vessels, none of which exceeded 200 gross tons, whereas twelve years later she had produced a 258,000 ton tanker. At present that other oriental phenomenon, Japan, is carefully watching developments since Korea has already assumed second place as a world class shipbuilder and appears well on the way to overtaking the former in this field. During 1982 the DAEWOO shipyard had the world's largest number of new buildings on its order book. All of this activity has resulted from the implementation of a master plan for industrialization in which government, industry and labour cooperate.[79] A similar situation of vibrant growth has occurred in many other areas of the economy with the education system providing a fundamental part of the mosaic.

Article 27 of the South Korean Constitution stipulates that "all citizens shall be entitled to equal opportunities for education. The attainment of at least an elementary education shall be compulsory and free of charge."[80]

Primary school education for children aged 6 to 11 is compulsory and by 1961, after only ten years of operation, 86.2 percent of the school age children were enjoying this privilege with complete attendance expected in the near future. The three-year civic school (Kongminhakkyo) was established as a supplementary educational institution for those already past the compulsory school attendance age. Secondary education covers the six years, seventh to twelfth grades, and consists of middle school or a general orientation period and high school offering classical as well as elective subjects in the curriculum. Secondary schools have developed very rapidly after the 1945 liberation. Forty-seven percent of elementary school graduates enter the middle schools and 70 percent of middle school graduates enter the high schools. Graduates of the primary or civic schools may enter the technical school (Kisul-Hakkyo) consisting of one to three-year vocational courses which lead to the higher technical school (Kodeung Kisul-Hakkyo) with its more highly specialized technical education and training.

Higher education in Korea is provided in the university (Dae-Hakkyo), four-year professional school or college (Dae-Hak), primary school teachers college (Kyoyuk-Daehak), and the junior college (Chogup-Daehak). The first Dae-Hak was establisted in 473 A.D., but higher education in the modern sense began during the closing decades of the last century when a school of Western medicine and a school for diplomats were founded. After 1945 higher education expanded rapidly but most of this development was destroyed by the 1950-53 conflict and subsequently rebuilt. As of 1966, two-thirds of all the colleges and universities of the country were concentrated in the capital Seoul. However, in an effort to rectify this imbalance, a national university was established in each of the five provinces.

SECTION 2.

Complementing the education system outlined above and a basic necessity for a shipping industry is the Maritime University and the professional schools for seamen and officers. These institutions were planned and built as an integral part of the Korean government's master shipping plan aimed at strengthening the ocean-going fleet, improving the shipping balance of payments and expanding the liner services while at the same time closely cooperating with international maritime interests. The government is currently constructing and has opened several institutes such as the Busan and Incheon seamen's schools and has set in place a continuous examination system stressing navigational safety, pollution prevention and other maritime concerns. Regular retraining programmes are provided for upgrading seamen in preparation for the introduction of the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers, 1978 when this comes into force.[81]

While one cannot help but admire the perspicacity and energy of the Korean government and its people, all great undertakings exact a price.

Mr. R. V. Thompson, after recently touring Korean shipyards and educational institutions, points out that "in the major shipbuilding yards, all employees work a minimum eleven (11) hour day, six days a week, and enjoy four to six days annual vacation!"[82]

This statement may provoke a harsh judgement from a society that has grown up with an eight-hour day and a five-day work week. However, it is well to recall that British, European and also American workers toiled every bit as long while their own industrial revolution was gathering momentum. This points up some of the difficulties involved when one attempts cross-cultural comparisons.

The following data is condensed and reproduced from an undated descriptive booklet or calendar of the Korean Maritime University sent with a covering letter dated September 27, 1982, and signed by the University President, Min-Kyo Shin.

Mission

The mission of the Korea Maritime University is:

To educate students to become licensed officers in the Korean Merchant Marine;

To provide them with a well-balanced program of academic instruction in the fields of Nautical Science, Marine Engineering, Shipping Management, Maritime Law and Mechanical Engineering;

To impart a sound academic background by combining a nautical education with the courses of a university curriculum for successful maritime career;

To train them in leadership and to instill in them a determination to maintain the traditions of the Korean maritime heritage.

General Information

This is a four-year national university for the education of merchant marine officers and the teaching of maritime law, shipping management, and mechanical engineering essential for a successful leader in the Korean maritime industry.

Undergraduate enrollment: 520 freshmen

History:

November 5, 1945	The university was established at Chinhae.
January 30, 1947	The university moved to Inchon.
May 5, 1947	The university moved to Gunsan.
October 5, 1953	The university moved to Pusan.
November 25, 1955	Dongsam campus was completed with UNKRA funds.
October 17, 1958	ROTC was established.
April 16, 1960	Graduate school was established.
November 15, 1975	Chodo campus was completed and the HANBADA, the training ship, was christened.

Department Descriptions

(1) Department of Nautical Science.

This is a four-year course and the only one of its kind in Korea. It provides profound theory and practice for the safe and economical operation of ships and for shipping management. Its aim is to turn out distinguished personnel for the maritime industry.

(2) Department of Marine Engineering.

This is a four-year course. Its aim is to educate students to become both marine and mechanical engineers. Larger ships and the automation of marine engines are current world-wide trends, and modern marine engines and machines are becoming very complicated.

Marine engineers who must operate such machinery with the help of a limited number of hands on a ship are required to have a thorough knowledge of the ship and all its components as well as the required skills.

(3) Department of Mechanical Engineering

In recent years the ship building industry of this country has grown rapidly and has made remarkable progress. Nevertheless, the ship mechanisms, the most important parts of a ship, are imported. If we aim at being a first-class industrial nation, we must have home-produced marine machinery. As the government is encouraging home production of such machinery, training of competent engineers is necessary to support such a scheme.

(4). Department of Shipping Management.

The aim of the department is to turn out personnel who will be engaged in the maritime industry as administrators with managing skills and maritime knowledge.

In order to produce such personnel, the curriculum of the department consists not only of specialized studies on marine transportation and harbours but also basic specialized studies which are taught in the department of industrial administration of other universities. In addition to these, the department also provides selective courses taught in the departments of law and administration.

Most students who have completed such courses will be employed by shipping, trading, marine insurance and ship building companies while others will be government employees of the port authority.

(5) Department of Maritime Law.

This program provides courses on international conventions and precedents as well as background courses dealing with the basic knowledge of shipping. The aim of the department is to produce personnel who will become specialists in marine industries and maritime administration, but also specialists able to arbitrate maritime disputes between nations.

Curriculum

Korea Maritime University offers a four-year undergraduate program. The programs of the Departments of Nautical

Science and Marine Engineering lead to a Bachelor of Engineering and a Merchant Marine license as a Second Mate or Second Engineer. In addition, graduates are commissioned as Ensigns in the Korean Naval Reserve.

Three other major curriculums are offered: Shipping Management, Maritime Law, and Mechanical Engineering. General education courses comprise about one-third of each of the professional curriculums, and all students are required to take naval science and military training.

The academic year at Korea Maritime University is divided into two academic semesters. As an integral part of the academic program, students of the Departments of Nautical Science and Marine Engineering spend one semester of their junior year aboard the "Hanbada," the training ship of the university for practical experience at sea.

(A) General Education Curriculum

1) The Department of Nautical Science

Required:	Economics
Korean	Linear Algebra
Korean History	Calculus
Ethics	Differential Equations
Physical Education	Complex Variable
English Reading Comprehension	Vector Analysis
English Conversation	Physics
Commercial Law	Medical Care of Seaman

Electives:

Philosophy	French
History of Cultures	Japanese
Introduction to Law	Spherical Trigonometry
Management	Chemistry

2) The Department of Marine Engineering

Required:

Korean	Calculus
Korean History	Differential Equations
Physical Education	Complex Variable
German	Physics
Linear Algebra	Chemistry
English Reading Comprehension	Medical Care of Seaman

Electives:

Philosophy	Commercial Law
History of Cultures	Economics
English Conversation	Management
German	Engineering Management
Japanese	Vector Analysis
Introduction to Law	

3) The Department of Mechanical Engineering

Required:

Korean	Algebra (I)
Korean History	Algebra (II)

Ethics

Physical Education

Military Training

English Reading Comprehension

Physics

Chemistry

German

French

Electives:

History of Cultures

Philosophy

Japanese

Shipping Management

Engineering Management

Introduction to Public Law

Physical Experiment

Chemical Experiment

English Conversation

Introduction to Law

Introduction to Economics

4) The Department of Shipping Management

Required:

Korean

Korean History

Ethics

Physical Education

Military Training

English Reading Comprehension

Algebra of Management

Principles of Economics

Introduction to Maritime Industry

Introduction to Nautical Science and Marine Engineering

German

French

Electives:

Introduction to Public Administration

Introduction to Law

Philosophy

History of Cultures

Management Mathematics

Introduction to Engines

Logic

Japanese

5) The Department of Maritime Law

Required:

- Korean
- Korean History
- Ethics
- Physical Training
- Military Training
- English Reading Comprehension
- History of Cultures
- Principles of Economics
- Introduction of Public Administration
- Shipping and Harbour
- Introduction to Nautical Science and Maritime Engineering

Electives:

- German
- French
- Philosophy
- Psychology
- Sociology
- Logic
- Politics

(B) Professional Curriculum

1) Department of Nautical Science

Required:

- Dynamics
- Hull design and drawing
- Electrical Engineering
- Electronics
- Terrestrial Navigation
- Celestial Navigation
- Radio Navigation
- General Nautical Instruments
- Shipping Law
- International Law
- Marine Insurance
- Shipping Economics
- Trade Practice
- Maritime English
- Introduction to Marine Engines

Gyro Compass

Ship Maintenance

Ship Handling

Marine Cargo Operation

Oceanographic Meteorology

Specialized Cargo Carrier

Naval Architecture

SOLAS (Safety of Life at Sea)

Maritime Administration Law

Marine Traffic Law

Graduation Thesis

Strength of Materials

Fluid Mechanics

Electrical Engineering

Electronics

Radio Engineering

Electronic Computer

Automatic Control

Advanced Navigation

Radio Navigational Instruments

Electives:

Advanced Shipping Economies

Advanced Naval Architecture

Shipping Management

Advanced Marine Cargo Operation

Theory of Harbour Management

Oceanography

Advanced Maritime Law

Accounting

2) Department of Marine Engineering

Required:

Engineering Materials

Machine Shop

Strength of Materials

Mechanics

Electronic Engineering

Fluid Mechanics

Thermodynamics

Naval Architecture

Electrical Engineering

Material Science

Applied Electrical Engineering

Industrial Measurement

Automatic Control

Electronic Computer

Machine Drawing

Boiler

Steam Turbine

Internal Combustion Engines

Auxiliary Machinery

Hydraulic Machinery

Vibrations

Heat Transmission

Lubrication Engineering

Corrosion Engineering

Refrigeration and Air Conditioning

Maritime Regulations

Maritime English

Graduation Thesis

Electives:

Electronic Engineering

Mechanism

Machine Design

Engine Design

Combustion Engineering

Welding Engineering

Nuclear Engines

Introduction to Navigation

Marine Transportation Theory

Ship Design

Engine Maintenance

Engine Fitting

Applied Mathematics

3) Department of Mechanical Engineering

Required:

Engineering Mechanics

Strength of Materials

Thermodynamics

Fluid Mechanics

Machine Tools

Internal Combustion Engines

External Combustion Engines

Fluid Machinery

Dynamics of Machines
Mechanism
Mechanical Drafting
Machine Design
Engineering Design
Material Engineering
Computer Science
Mechanical Technology
Refrigeration and Air Conditioning
Auxiliary Machinery
Fitting of Ship's Machinery
Naval Architecture
Marine Engineering Regulations
Engineering Mathematics
On-the-Job Training

Electives:

Welding Engineering
Plastic Working
Instrumentation Engineering
Combustion Engineering
Heat Transfer
Ship Propulsion
Electrical Engineering
Electrical Machinery
Electronic Engineering
Applied Electronics
Automatic Control
Applied Mathematics
Elasticity
Finite Element Method
Mechanical Vibration
Nuclear Reactor Engineering
Gas Turbines
Lubrication Engineering
System Engineering
Corrosion Engineering

4) Department of Shipping Management

Required:

Principles of Business Administration
Introduction to Accounting
Maritime Economics
Financial Management
Port Administration

- Business Statistics
- Chartering
- Theoretical Accounting
- Personnel Management
- Maritime Management
- Marketing
- Marine Insurance
- Shipping Politics
- Shipping Practices

Electives;

- System Science
- Foreign Trade
- Business English
- Korean Economy
- Maritime English
- Shipping Geography
- Outlines of Commercial Law
- Operation Research
- Charter Parties
- Cost Accounting
- Marketing Management
- Business Policy
- Labour Relations
- Electronic Computer
- Organizational Management
- Bills of Lading
- Ship Management
- Production Management
- Market Research
- Audit
- Investment Deciding Theory
- History of Shipping
- International Law
- Business Analysis
- Business Administration Exercises

5) Department of Maritime Law

Required:

- Introduction to Law
- Constitutional Law
- Civil Law (I)
- Civil Law (II)
- Civil Law (III)
- Civil Procedural Law
- Introduction to Economics
- Anglo-American Law
- International Law

- Commercial Law (I)
- Commercial Law (II)
- Commercial Law (III)
- Administrative Law (I)
- Administrative Law (II)
- Criminal Law (I)
- Criminal Law (II)
- Philosophy of Law
- Law of the Sea
- Shipping Law
- Marine Insurance Act
- Maritime Law (I)
- Maritime Law (II)
- Law of Collision
- International Convention on Maritime Law

Electives:

- Introduction to Public Administration
- Legal History
- International Private Law
- Labour Law
- Comparitive Constitution
- Special Course in Maritime Law (I)
- Special Course in Maritime Law (II)
- Seminar in Constitution Law
- Seminar in Commercial Law
- Seminar in Social Law
- Seminar in Public Law
- Seminar in Criminal Law Practice

Graduate School

The establishment of graduate school of Korea Maritime University was approved in April, 1960, by the Ministry of Education. It offers both a Master Degree Course and a Doctor Degree Course in the fields of Nautical Science and Marine Engineering.

Curriculum

(A) Department of Nautical Science

1) Navigation Course

Advanced Navigation (I)

Advanced Navigation (II)

Advanced Navigation (III)

Advanced Navigational Instruments (I)

Advanced Navigational Instruments (II)

Advanced Navigation Planning

Advanced Ultra-Sonic Engineering

Advanced Navigational Control Engineering

Advanced Radio Engineering

Advanced Applied Electronics

Advanced Microwave Engineering

Advanced Navigational Simulations

Advanced Navigational Astronomy

2) Ship Steering Course

Advanced Hull-anti-Corrosion and Maintenance

Vibration

Ship's Theory

Advanced Ship's Maneuvring (I)

Advanced Ship's Maneuvring (II)

Theory of Ship's Motion

Advanced Fluid Mechanics

Advanced Strength of Materials

Advanced Theory of Marine Cargo Operation

Specialized Cargo Carrier

Advanced Hull Design

Hull Rigging

Ship Resistance and Propulsion

Law and International Convention for Safety at Sea

Analysis of Marine Accidents

Advanced Navigational Control Engineering

3) Ocean Environment Course

- Ocean Physics
- Ocean Dynamics
- Advanced Fluid Mechanics
- Ocean Chemistry
- Geophysics
- Oceanography
- Bottom Topography
- Maritime Meteorology
- Physical Climatology
- Marine Pollution
- Synoptic Meteorology
- Bathymetry and Chart Projection
- Seminar (I)

4) Marine Transportation Engineering Course

- Applied Statistics
- Advanced Operations Research
- Linear Programming
- Design of Optimal Transportation System
- Port Engineering
- Micro Economics
- Shipping and Planning Theory
- Marine Traffic Engineering
- Advanced Maritime Law
- Advanced Marine Policy
- Labour Management
- Management Science
- On Manager Seminar (I)
- Seminar (II)
- Seminar (III)
- Seminar (IV)

(B) Department of Marine Engineering

1) Heat and Fluid Engineering Course

- Advanced Thermodynamics
- Advanced Heat Transfer (I)
- Advanced Heat Transfer (II)
- Statistical Mechanics
- Advanced Fluid Mechanics (I)
- Advanced Fluid Mechanics (II)
- Advanced Fluid Engineering
- Non-Newtonian Fluid

Theory of Combustian

Advanced Refrigeration Engineering

Advanced Air Conditioning

Advanced Aero-Machinery

Advanced Gas Dynamics

Advanced Hydraulic Machinery

2) Electric and Control Engineering Course

Advanced Sequence Control

Advanced Electrical Machinery and Instruments (I)

Advanced Electrical Machinery and Instruments (II)

Planning of Engine Room

Advanced Operation Research

Advanced Linear Programming

System Engineering

Advanced Automatic Control (I)

Advanced Automatic Control (II)

Theory of Optimum Control

Advanced Industrial Measurements

Advanced Theory of Control Instruments

Advanced Dynamic Planning

3) Marine Material and Anti-Corrosive Course

Advanced Metallurgy (I)

Advanced Metallurgy (II)

Advanced Heat Treatment

Advanced Ferrous Materials

Advanced Strength of Materials

Advanced Machine Cutting

Theory of Metal Cutting

Advanced Welding Engineering

Advanced Electro-Chemistry

Advanced Metal Corrosion

Advanced Theory of Anti-Corrosion (I)

Advanced Theory of Anti-Corrosion (II)

Water Treatment

Testing of Oil

Testing of Corrosion

4) Marine Propulsion Engine Course

Advanced External Combustion Engines (I)

Advanced External Combustion Engines (II)

Advanced Atomic Power Engines

Advanced Engine Design (I)

Advanced Internal Combustion Engines

Gas Turbine

Advanced Engine Design (II)

Advanced Thermodynamics

Advanced Fluid Dynamics (I)

Advanced Theory of Ship's Propulsion

Advanced Mechanical Vibration

Advanced Dynamics of Machinery

Planning of Ship's Engine Room

5) Ship's Auxiliary Machinery Course

Advanced Thermodynamics

Advanced Fluid Dynamics (I)

Advanced Fluid Dynamics (II)

Advanced Ship's Auxiliary Machinery (I)

Advanced Ship's Auxiliary Machinery (II)

Room Heating and Cooling

Advanced Air Conditioning

Design of Heat Exchanger

Advanced Fluid Machinery

Advanced Aero-Machinery

Advanced Fluid Engineering

Advanced Ship's Fittings of Engine Room

Safety Appliance of Engine Room

CHAPTER 10

REPUBLIC OF CHINA (TAIWAN)

SECTION 1.

The educational system of the Republic of China was brought to the island of Taiwan from the mainland during 1949. It is derived from the Constitution of 1947. Part 5, Article 159 (Education and Culture) of the Constitution states that all "citizens shall have equal opportunity to receive education." State control and centralization of education is provided for by Article 162 whereas Article 164 prescribes that not less than 15 percent of the total national budget is to be devoted to educational, scientific and cultural expenditures.

The aim of the educational system may be summarized by the "Three Principles of the People" originally enunciated by Sun Yat-Sen, April 18, 1929. These are:

1. Nationalism; as a concept of equal and cooperative partnership among nations.

2. Democracy; with an emphasis upon civil rights and popular participation in government.

3. People's welfare; emphasizing the equal distribution of wealth and mutual assistance among the citizens.[83]

Some of the difficulties faced by the education authorities may be gleaned from the following statistics:

Period	Birth Rate	Total	Population
1950-1959	40/1000	1950	7 554 399
1960-1968	30/1000	1968	13 650 370

The 1968 statistics indicate that over 50 percent of the population are under 20 years of age and 45 percent are 14 years or younger. During 1968 the National Government spent 26 percent of its annual budget for education while the city and county governments together contributed 45 percent of their total budgets.[84]

Initially, the national system of education provided compulsory, free education for all children from six to twelve years of age. The elementary program is subdivided into primary and elementary levels which consist of four years and two years respectively. Supplementary or adult education was provided for those citizens above school age that were unable to receive an elementary education. Starting with the 1968-69 school year, free, universal education was extended to a period of nine years with the six-year elementary and three-year junior high school systems integrated as two distinct stages of a single program. These latter institutions will be comprehensive schools.

Secondary education is subdivided into a three-year junior program and a three-year or senior program. A great deal of teacher training was carried out in normal schools which admit junior high school graduates and have a status equivalent to senior high schools. However, in an effort to improve the quality of teacher training, normal schools have been elevated to the status of normal junior colleges admitting junior high school graduates for a five-year training period. Senior high school graduates may also enter these institutions but only require one further year of study. Several universities now have faculties of education.

Because of the extremely large imbalance (45:1 ratio) between students choosing academic rather than vocational or technical education, government policy has been directed to reversing this trend. To assist in changing social attitudes, the educational standards and equipment of these latter institutions have been greatly enhanced. It is hoped that better employment prospects and pay incentives will assist in this process. A new pattern of junior technical colleges offering five-year programs take in junior high school graduates and, as a further incentive, the tuition fees have been deliberately set much lower than those of the senior high schools to facilitate the change. Part of the government's long range strategy has been to limit the establishment of new universities and academic colleges in order to accelerate technical and vocational education to meet the requirements of the country's economic and industrial development. In line with these developments, much greater emphasis has been placed upon pure science, research and engineering.[85]

All colleges and universities require at least four years of study for the first degree. Those institutions having research facilities admit superior students possessing a bachelor's degree as research students and after a further two years of suitable research, more advanced study, submission of a thesis and successful conclusion of a final examination, these are awarded the Master's degree. Doctoral candidates require a further two years of advanced study and research beyond the Master's level and a special examination which usually related to some aspect of their research thesis.[86]

SECTION 2.

The Evergreen Shipping Line of Taiwan plans to launch a round-the-world container service in early 1984 and has plans to build twelve new vessels for this purpose. The Onomichi Shipbuilding Corporation is to build four 1900 twenty foot equivalent units (T.E.U.) highly automated vessels for this trade with delivery scheduled for 1983-84. The aim is for a ten-day, round-the-world service, with a separate Mediterranean-U.S. East Coast Service. There are also plans to re-establish its Far East-Middle East Gulf Service. The Yangming Shipping Company also has plans to go ahead with its Northern European Service and intends to use four 1800 T.E.U. vessels built by the China Shipbuilding Corporation. This shipyard is owned by the Taiwan Government[87] and can undertake the building, repair or conversion of any size of vessel up to 1 000 000 Dead Weight Tons (DWT). So far (May, 1982), the largest building has been a 445 000 DWT tanker. It is equipped to handle a variety of work including container ships, mix-product tankers, bulk carriers, product carriers, offshore drilling and production platforms, etc. It has four dry-docks and one slipway and has a total building capacity of 1.32 million DWT.[88]

To train the highly skilled and specialized work force and management personnel required to design, build and operate these ships and the shipping companies that own them, the Tamkang University located at Taipi, Taiwan operates a Department of Marine Engineering and a Department of Navigation. A list of the courses has been taken verbatim from the October, 1981, calendar, a micro-filmed copy of which is located in the Memorial University of Newfoundland library.

Marine Engineering and Navigation: Tamkang University
Taipei, Taiwan - October, 1981

Department of Marine Engineering

Chairman: Hsiao, Yeh-ju
M. S. Tamkang University
Associate Professor of Steam Turbine, Boiler, Industrial Management

CURRICULUM

Course No.	Credit	Course
First Year		
ES1 001	4/4	Chinese
ES1 002	2/2	The Thoughts of Dr. Sun Yat-sen
ES1 003	4/4	English
ES1 004	2/2	General History of China
ES1 033	3/3	Calculus

*ES1 305	3/3	General Physics
ES1 551	2/2	Engineering Graphics
ES1 373	1/1	Workshop Practice
ES1 412	-/2	Engineering Drawing
ES1 701	0/0	Boat Handling and Swimming
ES1 851	1/1	English Language Lab Work I
ES1 853	2/2	Introduction to Computers
ES1 993	0/0	Male Military Training I
ES1 996	0/0	Male Physical Education

Second Year

ES2 005	2/-	History of Contemporary China
ES2 009	-/2	Logic
*ES2 102	3/3	Japanese I
ES2 307	-/3	General Chemistry
ES2 352	3/3	Engineering Mathematics I
ES2 356	2/-	Engineering Mechanics
ES2 360	3/3	Thermodynamics
ES2 373	1/1	Workshop Practice
ES2 701	0/0	Boat Handling and Swimming
ES2 854	2/2	Computer Applications to Engineering
ES2 903	3/-	Introduction to Ship-Building
ES2 906	3/3	Maintenance and Repair of Engineer
ES2 910	-/3	Marine Practical Practice
ES2 994	0/0	Male Military Training II
ES2 996	0/0	Male Physical Education

Third Year

ES3 304	3/-	Applied Mathematics
ES3 357	3/-	Fluid Mechanics
ES3 374	2/-	Dynamics
ES3 379	-/2	Electronics
ES3 411	1/1	Electrical Engineering Lab
ES3 902	2/2	Marine Electrical Practice
ES3 911	2/2	Machine Design
*ES3 912	-/2	Introduction to Ship Propulsion
ES3 915	2/2	Marine Engineering (3) (St. Eng.)
ES3 916	-/3	Marine Auxiliary Machinery
ES3 917	-/3	Marine Boiler
ES3 936	2/2	Maritime Engineering (2) Int.Comb.Eng.
*ES3 932	-/2	Shipping Management
ES3 996	0/0	Male Physical Education

Fourth Year

*ES4 319	3/-	Industrial Management
ES4 379	2/-	Electronics
ES4 906	0/-	Maintenance and Repair of Engine
ES4 907	-/2	Engine Room Management

SN2 912	1/1	International Signalling
*SN2 919	2/-	Traffic Transportation
SN2 922	2/-	Applied Mechanics
SN2 994	0/0	Male Military Training II
SN2 996	0/0	Male Physical Education

Third Year

SN3 006	2	International Organ. and Relat.
*SN3 106	3/3	Spanish I
SN3 904	2	Geo Navigation
SN3 906	2/2	Seamanship
SN3 914	2	Gyro-Compass
SN3 916	2/2	Cargo Work
*SN3 920	1	International Etiquette
SN3 924	2	Container Transportation
*SN3 926	2	Nuclear Energy Engineering
SN3 928	3/3	Electronic Navigation
SN3 996	0/0	Male Physical Education

Fourth Year

SN4 428	1/1	Marine Engineering
SN4 906	2/2	Seamanship
SN4 910	2	Regulation for Prevent Collision
SN4 915	2	Meteorology for Mariners
SN4 918	2	Damage Control and Salvage
*SN4 923	2	International Marine Law
SN4 925	2/2	Celestial Navigation
SN4 930	2/2	Marine Automatic Control
*SN4 933	1	Sea Pollution
SN4 996	0	Male Physical Education

ES4 908	-/1	Introduction to Navigation
ES4 916	3/-	The Marine Auxiliary Machinery
ES4 923	-/2	Refrigeration and Air Condition
ES4 930	-/2	Automatic Control
ES4 936	2/-	Mar. Eng. (2) Int. Com. Eng.
*ES4 937	2/-	Nuclear Engineering
*ES4 937	2/-	Nuclear Engineering
*ES4 938	3/-	Kinematics
*ES4 939	2/-	Container Transportation
ES4 940	0/-	Engineering Practice
ES4 941	-/2	Damage Control
ES4 996	0/-	Male Physical Education

Department of Navigation

Chairman: Yang, Shu-tse
Chinese Naval Academy, Kao-lu-tao College
Professor of Seamanship
Boat Handling and Swimming, Maritime Orientation
International Etiquette

CURRICULUM

Course No.	Credit	Course
First Year		
SN1 001	4/4	Chinese
SN1 002	2/2	The Thoughts of Dr. Sun Yat-sen
SN1 003	4/4	English
SN1 004	2/2	General History of China
SN1 305	3/3	General Physics
SN1 307	3/-	General Chemistry
SN1 701	0/0	Boat Handling and Swimming
SN1 851	1/1	English Language Lab Work I
SN1 853	2/2	Introduction to Computers
SN1 903	1/-	Spherical Trigonometry
SN1 921	3/3	Mathematics (Calculus)
SN1 993	0/0	Male Military Training I
SN1 996	0/0	Male Physical Education
Second Year		
SN2 005	2/-	History of Contemporary China
*SN2 032	2/-	Economics I
SN2 379	2/2	Electronics
SN2 410	3/-	Electrical Engineering
SN2 701	0/0	Boat Handling and Swimming
SN2 854	2/2	Computer Appl. in Engineering
SN2 904	3/3	Geo Navigation
SN2 906	2/2	Seamanship

CHAPTER 11

PEOPLE'S REPUBLIC OF CHINA (MAINLAND)

SECTION 1.

At least 2000 years before the birth of Christ--during the Hsia and the Shang Dynasties--the Chinese were busily engaged in developing a refined and complex culture which made use of bronze implements, wheeled vehicles and a written script.

> Nevertheless for long periods between 200 B.C. and 200 A.D. (the Han Empire) the Chinese Empire rivalled that of Rome and, from 600 until 1500 A.D., it was the world's most advanced power, after which China entered a long period of decline.[89]

Over the centuries, a system of education was developed which transmitted the rich cultural heritage of the Chinese people, but it was based upon the conception of a static and hierarchical society. The 1911 Revolution led by Sun-Yat-Sen marked the emergence of a new concept which attempted to distribute the benefits of this cultural heritage more equitably. A system of public education was developed but because of the vastness of the population, the lack of a sufficient number of teachers and insufficient financial resources, universal education was largely but a dream for the majority of citizens. Prior to the establishment of the People's Republic of China, the organization of formal educational institutions followed the pattern described in the last section (Taiwan, p. 110) and this was retained during the first ten years of Communist

Government. Although considerable progress was made, it was not able to proceed quickly enough to cope with a large and rapidly increasing population. A radically new approach was adopted, 'the great leap forward', in an effort to increase production and extend education simultaneously.

Expressed Government policies in education are as follows:

> The fundamental programme of the Chinese Communist Party, set out in 1949, established the following main points of educational policy.
>
> Article 41. 'The culture and education of the Chinese People's Republic shall be the culture and education of the new democracy, that is, naturalistic, scientific and popular. The culture and educational work of the People's Government shall deem its principal tasks to be those of raising the cultural level of the people, training of personnel for national construction, eradication of feudalistic and facist ideologies, and promotion of the ideas of serving the people.'
>
> Article 46. 'The educational method of the Chinese People's Republic shall be to integrate theory and practice. The People's Government shall systematically and by stages reform the old educational system, the content of education and the methods of pedagogy.'
>
> Article 47. 'The People's Government shall systematically and by steps carry out universal education, strengthen secondary education and higher education, emphasize behavioural education, consolidate the spare-time education of labourers and the education of cadres now on duty, and give revolutionary political education to young and old intellectuals, so as to satisfy the widespread needs of revolutionary work and national construction.'[90]

The policy of 'Walking on Two Legs', that is, the provision of schools by both the education authorities and local communes, agricultural cooperatives, mines, factories, etc., resulted in a tremendous expansion of educational institutions at all levels. While the buildings were often inadequate, teachers untrained and often poorly educated themselves, at least some measure of education was brought for the first time to tens of millions of people who would otherwise have had none. A second aspect of the new policy was the linking of education with productive work. The 'half-work, half-study' movement aimed to increase productivity and make the schools self-supporting while at the same time provide that unity of theory and practice which is a key element in Marxist-Leninist thought. Thus, schools and universities established productive workshops, factories and farms while at the same time farms and other enterprises established schools. Half-time and spare-time study became the norm with school time tables adjusted to the productive activities.

Two distinctive types of institutions developed during this period: the agricultural junior school which provided a three-year, work-study course for young people 13 to 15 years of age who had completed primary education, and workers universities, mainly of a specialized nature putting on programs closely related to the basic production requirements of the district.

This tremendous expansion of educational effort was not unaccompanied by grave difficulties. Guiding the work of the young people required considerable effort from the skilled workers resulting in production losses the economy could ill afford. Also, there was a severe shortage of trained teachers. Between 1961 and 1963 several attempts were made to improve standards by increasing the teacher training facilities, converting many half-work, half-study schools to specialized vocational schools, eliminating sub-standard schools, raising the entrance standards of senior secondary schools while at the same time stressing the application of theory to the problems of production.

Some concept of the magnitude of the problems encountered may be gleaned from the following statistics which, it is stressed, are but very rough approximations. By 1960, 90,000,000 children, perhaps 90 percent of the relevant age group, were attending primary schools; 40 percent of the relevant age group were attending junior middle schools; and probably not more than 3 to 4 percent of the relevant age group attended senior middle schools.

During the same period 60,000,000 were attending literacy classes and 30,000,000 were enrolled in some form of spare-time education. There were 800,000 attending universities and 280,000 students enrolled in teacher-training institutions.[91]

The political unrest ensuing prior to and during the exposure and subsequent trial of the 'gang of four' has now subsided resulting in a period of stability that has allowed attention to once again focus on the task of improving the education system. To this end interest has been revived and actively cultivated in the area of international exchange of scientific scholars and other technical experts. China has also arranged for some of its key people to either visit, study or undergo specialized training at various foreign institutions or engineering works.[92]

Mr. Cheng Jian-Hua, Second Secretary of the Embassy of The People's Republic of China, Ottawa, Canada, has provided the author with very interesting information on China's educational system, which for reasons of brevity has not been included herein. This material includes a list of key universities and colleges (1981), enrollment statistics for the 1980 academic year, as well as information on the organization and management of the educational system.

SECTION 2.

The two major shipping corporations of the People's Republic are the China National Chartering Corporation and the China Ocean Shipping Corporation. The former, as the name implies, charters vessels to carry cargoes to and from China while the latter owns its vessels. During 1980, some 10 000 000 dead weight tons (DWT) were chartered, roughly one-half of this through London-based companies. The China Ocean Shipping Corporation (COSCO) has expanded very rapidly to 400 vessels totalling 7 500 000 DWT as of June, 1981. In addition three Hong Kong and Macao based companies, China Merchants, Ocean Tramping and Yick Fung controlled by the Ministry of Communications owns 2 000 000 DWT between them. The fleet consists of: tankers - 20 percent by DWT; general cargo vessels - 35 percent with a somewhat larger percentage being bulk carriers. COSCO estimates it now carries 70 percent of the overseas Chinese cargoes. Such rapid growth has not been devoid of problems. At times, all the vessels have not been fully utilized. The Corporation has also provided arrangements for many crew members to sail on foreign vessels in order to gain experience and update their knowledge.

Many of the smaller vessels have been built in domestic yards, and a few have been ordered abroad. However, by far the greater number are second-hand acquisitions from Europe bought for cash at rock-bottom prices. As of June, 1981, forty-seven vessels aggregating 1 800 000 DWT were on order from foreign yards with expansion plans calling for a fleet of 20 000 000 DWT by 1990.

Another development is a joint venture with a foreign shipping company registered in Burmuda. The foreign partner controls the operation but also has access to Chinese shipyards and potential charters. In exchange, not only is China provided with an opportunity to export her ships, but more importantly, to improve the technical and managerial skills of her shipping officials. This arrangement has also provided valuable training experiences for ship's officers and crews.[93]

Another area for technology transfer is licensing arrangements with foreign engine builders and ship's machinery manufacturers. The January, 1983, Marine Engineer's Review (p. 22) reports the first Pielstick 12 PC 2.5 diesel engine built under license by the Engineering Division of the Hu Dong Shipyard in Shanghai fully satisfied all operational and manufacturing standards established by the parent company while operating on the test bed at the engine works of the builder. The China Corporation of the Shipbuilding Industry acquired the license for the Pielstick engine from the Société d'Etudes de Machines Thermiques (S.E.M.T.) during 1978.

The specialized educational requirements of seafarers, harbour design and management people and shipping company personnel have been catered for by two Maritime Training Colleges. The Shanghai College of Marine Transportation conducts various types of courses including a five and one-half year Shipbuilding program.

The other, Dalian (Darien) Marine College in Liaoning Province, was founded in 1953 and provides five-year programs in the following faculties:

Marine Economics
Marine Engine Construction
Marine and Inland Waterways Transportation
Navigation
Shipbuilding

This institution is considered to be the largest of its type in the world and, as of March, 1981, housed more than 2800 students enrolled in the various faculties--1 000 in engineering and 845 in navigation. The college is equipped with some of the most modern and sophisticated teaching aids, a recent acquisition being an advanced navigational and engineering simulator. The M.V. Yuhong, a 10 288 DWT general cargo vessel is the largest of the College's training ships accommodating 60 students on world-wide voyages. At present there are approximately 600 professors and other instructional staff attached to this institution.[94]

CHAPTER 12

JAPAN

SECTION 1a.

General Education

(a) History:

The Meiji Restoration in 1867 set the stage for the subsequent development of modern education in Japan. The foundation, however, had already been laid by the Tokugawa Shogunate in Edo (present-day Tokyo) which had a higher educational institution under its direct control. The Fundamental Code of Education was promulgated in 1872 under which education was organized into three progressive stages--primary school, middle school and university--and by 1886 three or four years of primary education had been made compulsory.

Before the turn of the century, secondary vocational schools, normal schools, higher normal schools and university preparatory schools had been added and by 1900, the period of compulsory education was extended to four years and the tuition fee for public primary schools was abolished. By 1908 the compulsory primary school program was extended to six years.

(b) Basic Principles of Education:

Extensive changes to the education system were inaugurated after World War II. Article 26 of the 1946 Constitution not only guaranteed a free, basic education to all children but also obligates the parents or guardians with respect to school attendance. The Fundamental Education Law of 1947 defines the aims and principles enunciated in the Constitution. Thus, the development of self-reliant citizens with a respect for human values is considered an essential ingredient of a democratic state and to this end, considerable emphasis is placed upon social studies in the public school curricula. The law explicitly prohibits discrimination based upon race, creed, sex, social or economic status. Further enactments decentralized the educational system, established the 6-3-3-4 school sequence and reoriented the curricula, textbooks, teaching methods and administration.

(c) Organization of the Education System:

Pre-school institutions such as kindergartens administer to children from three to five years of age with appropriate courses for this level. Most kindergartens are privately operated. Day nurseries for infants from birth to five years are operated by local governments as social welfare institutions and cater to those children requiring institutional care. The instruction provided in both types of institution is the same for children aged three to five years.

Compulsory, free education is provided for all children between the ages of six and fifteen. Elementary education is provided during the first six years while the next three years is taken up by the lower-secondary program. The national and local governments provide children from needy families with grants for such expenses as school excursions, supplies, lunches and medical care.

The upper-secondary school program leading to the high school or matriculation diploma may be completed by (1) three years of full-time study, (ii) correspondence courses, (iii) part-time (mainly evening) courses. These institutions offer general (academic), technical, commercial, domestic arts and other types of programs, although (as of May, 1971) 60 percent of all upper-secondary school students were enrolled in academic courses.

Higher education is provided by universities, junior colleges and technical colleges. Undergraduate programs leading to the bachelor's degree require four years of study (medical programs - six years) while the master's program requires an additional two years. The doctoral program requires five years of study beyond the undergraduate degree. Junior colleges offer two and three-year programs to upper-secondary school graduates, credits from which may be used towards a bachelor's degree in the appropriate field. Completion of the lower-secondary school program is required for admission to the technical colleges which offer five-year, full-time programs for the training of technicians. This type of training was introduced during 1962.[95]

All of these institutions select their new entrants upon the basis of special entrance examinations imposed by the individual institution. These examinations, especially those used by the more prestigious universities, have had such a profound effect upon Japanese society that a great deal of controversy respecting the necessity of such rigorous elimination procedures has developed. Many people feel that the price exacted by this annual catharsis is excessive - a steep increase in the suicide rate occurs each year during the examination period - and that better and more humane selection methods must be devised.

SECTION 1b.

Technical and Vocational Education

Upper-secondary education in Japan is divided into general and specialized vocational education. The percentage of lower-secondary school graduates going on to upper-secondary schools has rapidly increased to more than 93.5 percent on a national average in 1979. The curricula of some upper-secondary level courses, especially those taken part-time or by correspondence, generally require four years or more but such graduates qualify for university entrance examinations on an equal basis with those from full-time institutions.

In upper-secondary vocational courses, education is given with an aim to develop the qualities and abilities essential for various kinds of work. In the general course, the curricula also includes some vocational subjects. As of 1978, vocational subjects were taught in 66.4 percent of all public, general, full-time, upper-secondary schools.[96]

SECTION 1c.

Industrial Relations

Because of Japan's rapid evolution from a semi-feudal state to become an industrial nation of the first magnitude in a period of little more than 80 years, it would be well to examine certain other facets of Japanese life since it is unlikely that education of and by itself can fully account for this phenomenon.

In 1867 the fifteenth Tokugawa Shogun re-established an Imperial government with the Emperor as the head of a unified state. During this era, (1867-1912) known as the Meiji Period, "National Prosperity and Military Strength" was the shibboleth as Japan strove to catch up with the advanced nations of Europe. During this period, the rapid and thorough assimilation of Western concepts, institutions, learning and technology placed Japan firmly on the way toward becoming a modern industrial nation. In tune with the imperialistic ambitions of the major European powers of the period, she used defense and economic reasons to justify her military adventures first in China and then Russia. The subsequent victories enhanced her international prestige and provided the stimulus for the annexation of Korea during 1910.

In the larger metropolitan centers, the Japanese with the assistance of various European corporations were busily introducing the latest technological wonders: the telephone, electric light and power systems, electric trolleys, steam railways, steamships and many other marvels of the age were constructed during this period.

During World War I, Japan fought along with the Allies and in the process her industry underwent such a phenomenal and spectacular development that by the end of hostilities she was recognized as one of the Big Five. However, such rapid development did not come about without a tremendous strain being placed upon the social, economic and political fabric of the society. This was exacerbated by the world-wide depression of the 1930's. National policy, wallowing in the euphoria of military success and dominated by the military establishment, attempted to reconcile the difficulties by imperialistic measures, first in Manchuria and then in other areas, culminating finally in World War II. The Japanese Peace Treaty was signed in September, 1951; and after approximately one year, she had joined all the specialized United Nations agencies. She was admitted to full United Nations membership during December, 1956. This acceptance by the world community appears to have triggered a release of new energy that has been cited as at least one of the factors that helped fuel the unparalleled economic and technological growth of the subsequent decades.[97]

Labour legislation, in conformity with Article 28 of the Constitution, is codified under various laws and regulations. These deal with health and occupational safety, hours of work, paid vacations, protection of women and young workers, etc., and are basically similar to those in most modern industrial states.

The Japanese Industrial Revolution started approximately 100 years after that of most European countries with the result that there were practically no workers experienced and familiar with foreign production methods and technology. Japanese industry adapted to this dilemma by hiring young people straight from school and training them in the new technology right on the factory floor. These young people soon became key personnel because they were more adaptable and quicker to learn than older workers.

As a result, occupational skills have come to be developed within individual enterprises--unlike European practice--and highly-skilled workers in one establishment are not necessarily rated by another firm as equally skilled. This practice in conjunction with the growing complexity of the industrial process caused employers to offer exceptionally worthwhile inducements in order to retain a stable, dependable and loyal work force that had a vital and sustained interest in their work. The so-called "life-time employment" practice, seniority wage system, the provision of welfare and recreational facilities for workers and their families and the especially generous retirement allowances--all provided by the employer--play an important role in employee morale, thus providing a deep sense of identity between the worker, his family and the employer.

According to a 1971 survey by the Labour Ministry, non-statutory expenses for welfare and recreational facilities constituted 4.1 percent of total labour costs while statutory welfare expenses amounted to 5.1 percent. Retirement allowances paid to employees with 30 years service with the same firm average 23.4 times their final monthly wage.

In recent years, a change has been noted in the type and nature of the skills required. Skills mastered by experience alone have tended to be discredited in favor of the greater theoretical understanding demanded by new technological innovations. The efficiency of young workers often exceeds that of older, experienced workers when performing new functions. This has resulted in a re-examination of the seniority wage system in an endeavour to reflect the changed conditions.[98]

SECTION 2.

Maritime Affairs

For a considerable period now, Japan's maritime transport industry has been playing a very significant role both socially and economically. The fleet of ocean-going vessels has been carrying the nation's import and export cargoes at low and stable freight rates, and while enjoying a steady growth, has contributed substantially to the improvement of Japan's balance of payments account.

Japanese imports and exports account for 20 percent of world cargo movements. However, the tonnage of Japanese flag vessels has declined with the number of ships reaching a peak during 1972 and the gross tonnage peaking during 1976. To offset this trend, Japan has made greater use of chartered vessels of foreign registry. Japan is rapidly losing her competetive position on the international shipping scene and one of many factors involved in this phenomena is the high cost of crews. The report of the Ship and Shipbuilding Rationalization Council - an advisory body to the Minister of Transport - taking into account the fluid nature of the world economic situation has suggested a flexible approach aimed at highly automated vessels, modernization of the crew working conditions and national economic security. This last consideration requires sufficient Japanese flag carrying capacity for a stable energy supply. At present, Liquified Natural Gas (LNG) carriers have assumed greater importance since this energy source has shown an increase in both demand and desirability.[99]

The 1973 oil crisis triggered a worldwide depression in shipbuilding from which Japanese shipbuilders have not yet recovered. Lloyd's Register of Shipping statistics indicate that Japan had approximately 17 000 000 gross tons of new building on its order book in 1975, but by 1979, the low point, this had dropped to 4 700 000 gross tons or 28 percent of the peak. A rapid increase in shipbuilding bankruptcies ensued reaching 46 by the end of February, 1979. Many other industries were also suffering from the shock of the energy crisis with the result the government enacted the Law for Temporary Stabilisation of the Designated Depressed Industries, May, 1978, and this was proclaimed for shipbuilding in August, 1978.[100]

In July, 1978, the Shipping and Shipbuilding Rationalization Council pointed to the need to stabilize the nation's shipbuilding industry by closing excess production capacity which was subsequently reduced to 35 percent of its previous value. The total number of employees was reduced from 117 000 at the end of October, 1974, to 57 000 by April, 1980. During the same period, the number of sub-contractor's employees dropped from 49 000 to 18 000. This reduction was carried out, first of all, by stopping all new recruitment, secondly by transferring those in shipbuilding to other divisions of large companies, and thirdly by encouraging voluntary retirement of older workers.

Such drastic action is quite unusual where lifetime employment has been traditional. However, by arrangements agreed upon by unions, management and government, it was worked out relatively smoothly.

Even this drastic surgery left surplus capacity during the low point, but this was absorbed by the building of government sponsored vessels and the replacement of ships owned by public agencies.

In general, the recovery was largely supported by orders for small and medium tankers and for bulk-carriers where the over-tonnage was not so bad. The expectation of a future increase in the sea-borne steam coal trade and the increase in grain shipments to the U.S.S.R. and China contributed to an increased number of orders for bulk-carriers during 1980 and 1981. During the years of high economic growth and abundant resources, the Japanese shipbuilding industry attempted to meet the increased demand for ships. However, in a slow-growth, resource and environmental conscious economy, it is prudent to consider the limiting factors and plan for an appropriate and sustainable level of building.[101] The present worldwide depression has had a drastic effect upon Japanese shipbuilders with new orders for the first half of the 1982 financial year (April 1 - September 30) dropping by 60 percent compared with the same period of 1981. These figures were released by Mr. H. Imamura, Director of the Shipbuilding Division of the Japanese Ministry of Transport, during a recent London visit.[102]

Those sections of the Japanese Shipping Laws pertaining to the number, training and qualifications of ship's officers and the manning of ships are largely unchanged from the Meiji era. These now require extensive revision in order to adequately provide for the technical innovations that have taken place since that time. During 1969 the first ship having an 'unmanned-machinery-space' (UMS) was placed in service. Such vessels now account for 30 percent of Japanese ocean shipping. During 1977 a study was undertaken with the cooperation of the seamen's union, shipowners and other experts in this field to determine how such qualifications, training and duties should be updated.

This study resulted in proposals being formulated and tested on an experimental basis. Based upon these investigations, a committee has developed a model for a future manning system which has been tested on 14 recently built, fully automated vessels. The data thus accumulated will provide a substantial and solid background to guide the direction of the manpower modernization program.[103]

This high level of maritime activity, including the sophisticated methods of dealing with the present slump, has not taken place in an educational vacuum. Educational institutions formed specifically to deal with maritime concerns at all levels are an integral part of the Japanese industrial scene. A considerable number of institutions offer programs dealing specifically with shipbuilding, marine engineering and the training of ships officers and ratings. However, the two top level institutions catering to the entire spectrum from ship and machinery design to the management of shipping companies and maritime law, are the special Maritime Universities situated at Kobe and Tokyo. These have rigorous admission standards and are somewhat similar to the American Merchant Marine Academy at King's Point, New York.

Tokyo University of Mercantile Marine

Objectives

Under 'The National School Establishment Law,' Tokyo University of Mercantile Marine[104] was established on December 30, 1949. The origin of this University can be traced back to the Mitsubishi Nautical School (Mitsubishi Shosen Gakko) which was established in November, 1875, for the purpose of training merchant marine officers for Japan emerging as a new nation. The purpose of this University is to study and instruct a variety of sciences related to the navigation of ships, and because of this special purpose, it is quite unique among all the national universities of Japan.

The Undergraduate Course

The Faculty of Mercantile Marine Science was created in 1949 based on the foundation of the Nautical College (Koto Schosen Gakko). The faculty at that time had two departments: Navigation and Engineering. Thereafter, two more departments were established: that is, Department of Control Engineering in April, 1977, Department of Transportation Engineering in April, 1978.

Chairs and Subjects - Professional Education:

Department of Navigation

Positioning and Sailing

Marine Traffic Routing

Navigational Instrument

Environmental Science of Navigation

Electronics and Communication Engineering

Ship Maneuvering

Navigation Law

Naval Architecture

Department of Transportation Engineering

Engineering of Transportation Management

Engineering of Transportation Facilities

Accident Prevention Engineering

Information and System Engineering

Department of Engineering

Marine Steam Engineering

Marine Diesel Engineering

Nuclear Ship Engineering

Marine Auxiliary Engineering

Machine Design

Engineering Materials

Applied Mechanics

Thermo- and Fluid-Dynamics

Department of Control Engineering

Control System Engineering

Plants Administration Engineering

Electrical Engineering

Electronic Engineering

Related Subjects

Applied Mathematics

Applied Physics

Economics of Marine Transportations

Maritime Law

General Education

Philosophy

History

Jurisprudence

Economics

Mathematics

Physics

Astronomy	Chemistry
English	German
French	Health and Physical Education

The Graduate School

The Graduate School was started in June, 1974, with two research courses: Navigation and Engineering. The courses lead to the Master's degree. The Degree of Master of Mercantile Marine Science is conferred upon only those who have followed the course of two years or more, obtaining more than 30 credits, and submitting a thesis for Master's degree. The requirement for obtaining credits is the same as in the undergraduate course. As the staff of the Graduate school is also that of the undergraduate course, research subjects are similar to, but more advanced than, that of the undergraduate course. The following gives the name of the chairs of the masters course.

Division of Navigation

Positioning and Sailing	Marine Traffic Routing
Navigational Instruments	Environmental Science of Navigation
Information Processing in Navigation	Electronics and Communication Engineering
Equipment and Maintenance of Ships	Ship Maneuvering
Transportation Engineering	Navigation Law
Naval Architecture	Maritime Safety

Division of Engineering

Marine Steam Engineering	Marine Diesel Engineering
Nuclear Ship Engineering	Marine Auxiliary Machinery
Electrical Engineering	Electronics Engineering
Engineering Management	Control Engineering
Machine Design	Engineering Materials
Applied Mechanics	Thermo- and Fluid-Dynamics

Related Chairs

Applied Mathematics	Applied Physics
Maritime Law	Economics of Marine Transportations

Sea Training Course

The graduate who has earned Shosen Gakushi does not of itself mean that he is qualified to be a merchant ship's officer. He has to enter the Sea Training Course upon graduation and undergo a six months' sea training. When he has completed the training course, he is entitled to sit for the National Examination Qualifying Sea Technicians.

Only the graduates from the Department of Navigations and the Department of Engineering of our university can enter the Sea Training Course.

CONCLUSION

Of the four countries examined, only Japan was heavily industrialized prior to World War II. All of the others have developed their industrial and manufacturing base subsequent to the cessation of hostilities. Shipping and shipbuilding activities in particular have really only been developed within the last two or three decades.

While certain heavily industrialized areas of Japan sustained substantial bombing damage, others such as the steel works at Sasebo on Kyusho Island, were not seriously incapacitated, although this latter city is located only about 50 kilometres from Nagasaki, the site of history's second atomic bomb. Of perhaps greater importance, the essentials of an industrial society, the skills, the work ethic and an advanced and universal education system, although confused and seriously disrupted, were not completely destroyed.

The relatively long period under martial law, when American aid and expertise of all kinds was made available, provided the opportunity to rebuild old and outmoded industries and equip them with the latest machinery and technological processes. At the same time, Japanese society, freed to some extent from the more conservative of social mores, was able to adapt its institutions to correspond more closely with the realities of the second half of the twentieth century. During these and subsequent years, far reaching changes occurred in the social, legal and educational fabric of the Nation. Thus, Japan--the same thing occurred to some extent in certain areas of Europe--was in many ways provided with the latest and, in some cases, far more efficient methods of production than that generally in use in continental U.S.A. during the same period. Much the same thing can be said about the rebuilding of the Korean Republic after the Armistice except that by this time many European countries were able to actively participate in the rebuilding program. Here again, even later technological processes were made available so that in many respects the South Koreans were placed in a particularly favourable position to successfully compete in the world market place after their own basic needs were catered to.

American foreign policy of the forties, fifties and sixties, not only favoured but physically protected the Republic of China (Taiwan) against the forces of the People's Republic. There can be little doubt that it was the fear of American retaliation that prevented the armies of the People's Republic from subjugating the island of Taiwan. Since the Nixon Administration's rapport with the People's Republic of China, economic activities, at least in the shipbuilding area, appear to have lost some of the earlier momentum. Further, one of my colleagues at the College of Trades and Technology states that when he returned to Taiwan for a visit during June, 1982, the impression was of a beleaguered country with strict censorship and martial law the order of the day.

With respect to the education and training of marine engineers, it is to be noted that no mention of a mechanical engineering workshop apprenticeship was to be found in the literature and other research documents. However, it would appear highly probable that an apprenticeship may still be one avenue for recruitment of engineering officers in the Japanese merchant service. It is well known that prior to, during, and after World War I, a large number of Japanese engineers in training studied in British educational institutions or served an apprenticeship in British engineering works. This period corresponded with the zenith of British merchant shipping, which in many ways made it the model for countries engaged in establishing a national merchant marine.

However, the other countries surveyed arrived on the scene much later when the applications of the new technology had rendered a mechanical apprenticeship something of a anachronism. The training facilities provided by these countries for their merchant service personnel operate at a very high theoretical level. Operating experience is provided by the use of electronic stimulators and specially equipped training vessels for hands-on, real life experiences.

There is yet another concept that ought to be considered in a comparative study of this nature. Japanese industrial relations are based upon concensus rather than the confrontation techniques practiced by the proponents of the so-called "free enterprise" system. The method of consensus is nothing more than the practical application of sound social psychological principles. When some form of change is being contemplated, the concept is at once introduced to all the employees involved including the worker on the shop floor. All facets of the concept are discussed after which it passes upward through the management hierarchy where further refinements or difficulties may be explored. Upon reaching the Chief Executive Officer or topmost manager, who may either accept or reject the idea, it is extremely unlikely that outright rejection would occur unless some totally unforeseen or external force had made the entire concept redundant or at least extremely tenuous. Outright rejection without good and valid reasons would place the manager in the socially unacceptable position of "losing face" after utilizing the finest minds of the enterprise. No sensible manager would take such a risk.

While it is not entirely clear if this process ensues in the two Chinas, it would be safe to assume that it is utilized to some degree in Korea since it was a Japanese Province until fairly recent times and a very large interchange of trade does take place.

PART THREE

NORTH AMERICA

CHAPTER 13

UNITED STATES OF AMERICA

SECTION 1.

The Massachusetts Bay Colony, a Calvinistic theocracy founded in 1620 by the Puritans, had an inordinate effect upon the subsequent development of the American educational system. The concept of compulsory education was enunciated in a law of 1642 and a further enactment of 1647 (the "Old Deluder Satan Act") provided for tax supported, state controlled education. This latter law required every town of 50 householders to appoint and pay a teacher of reading and writing and every town of 100 families to establish a Latin grammar school to prepare the young for the university.[105] These laws subsequently became the model for similar legislation in other New England colonies except Rhode Island.

The first institution of higher learning in the British Colonies of North America was established October 28, 1636, when the General Court of Massachusetts Bay Colony voted £400 for the establishment of a college primarily intended to train young men for the ministry. Amongst the Puritan immigrants were over 100 graduates of Oxford and Cambridge universities, and these people wanted their sons to enjoy an education similar to their own. One of their number, a young clergyman named John Harvard, died in 1638 leaving £800 and his library of nearly 400 volumes to the new college which had been relocated across the Charles River in Cambridge. It was named Harvard College March 13, 1639, in recognition of his generosity.[106]

On July 4, 1776, the Declaration of Independence proclaimed the thirteen original colonies as free and independent states of a United States of America, and this became reality with the cessation of the War of Independence (1775-1783). The Constitution of this new nation became effective April 30, 1789, when George Washington assumed the presidency; but even before this document was adopted, a large number of amendments had been proposed from which ten were finally ratified on December 15, 1791. Nowhere in any of the seven Articles form- the Constitution is the question of education addressed.[107] Hence, it is the Tenth Amendment which has been invoked to affirm the philosophy of a decentralized system of education controlled and regulated by the individual states. Because of this, the regulation and licensing of both private and public education has evolved in somewhat different directions although all states have certain common elements in their laws and regulations.

Because the Tenth Amendment effectively blocked any national legislative effort to provide federal aid to education, the "Common Defense and General Welfare of the United States" clause (Article 1, Section 8) was broadly interpreted to allow legislative action for the development of federal-state-local partnerships which greatly enhanced the quality, amount and availability of the educational effort. It was under the aegis of this section that the Federal Office of Education was established in 1867. Federal support for vocational educational programs (1917), the establishment of the National Science Foundation (1950), the Manpower Development and Training Act (1962) and the Vocational Education Act (1963) were among others introduced by virtue of this more enlightened interpretation.[108] However, these developments may be considered as motherhood issues unlikely to evoke much adverse controversy. This was certainly not the case with the historic opinion handed down by the United States Supreme Court on May 17, 1954, (Brown v. Board of Education of Topeka) respecting educational rights of minority groups, particularly Negros. Here, in a unanimous decision, the Court ruled:

> To separate them from others of similar age and qualifications solely because of their race generates a feeling of inferiority as to their status in the community that may affect their hearts and minds in a way unlikely ever to be undone ... We conclude that in the field of public education, the doctrine of 'separate but equal' has no place. Separate educational facilities are inherently unequal.[109]

Over the years the American public education system has evolved in a manner that provides eight years of elementary education followed by four years of secondary or high school education. During the twentieth century, this pattern has gradually altered so that most school systems now provide six years of elementary education followed by three years (grades

7, 8 and 9) in a junior high school plus a further three years in the senior high school. The concept of the junior high school was introduced to assist the adolescent to cope more successfully with a particularly difficult and traumatic period of his or her life. Most of these institutions not only have trained counsellors, but also offer a varied social program to assist the youth of both sexes in social development and integration.

Another important aspect of the junior high school is the industrial arts program or manual training as it was once called. In most school systems participation in these programs is required of all children since it not only provides an opportunity to explore other facets of knowledge but also to apply some of the theoretical concepts such as arithmetic and elementary science, etc. At the senior high school level industrial arts programs offer more advanced work and a more penetrating study of industry and the problems of a technological society.

Higher education consists of a further four years of study beyond the high school diploma for most liberal arts programs, although professional schools such as medicine, engineering, law or teaching require an additional year or more to obtain the baccalaureate degree.

Private colleges and universities have a special place in the American education system. Many of these institutions trace their origins to the sectarian interests of another age although time has often blunted such concerns. While most are probably quite ordinary in their didactic efforts, others, such as Harvard, Yale, Princeton, etc., have gained international acclaim and prestige in certain fields. Because these institutions largely depend upon endowments and private funding for their survival, the fees charged students can be rather steep. Some federal assistance has also been provided mainly in the form of scholarships for especially able students.

Because of the decentralized education system mentioned earlier, no single standard exists to relate the level of achievement indicated by the high school diploma from one state to another, or for that matter, from one school to the next. There is no national public testing of elementary or secondary public school pupils. However, public and private colleges and universities usually insist that all aspiring entrants take scholastic achievement tests or college-board examinations. Similarly, students seeking admission to graduate school must submit to a standard achievement examination or Graduate Record Examination.

SECTION 2.

Water borne shipping upon the great lakes, inland waterways, and the world's oceans has played an important role in the nation's economy for a very long time. At present 40 percent of the country's daily fuel requirements amounting to

250 000 000 gallons (1 136 500 kilolitres) of oil is imported plus 85 percent of some 77 critical commodities required in industry. With only 6 percent of the earth's population the American economy alone consumes over 33 percent of its total raw material production. This vast trade is almost entirely transported by ships which are also used to carry manufactured goods to home and overseas markets. While a great deal of this activity employs foreign bottoms, it has been deemed expedient for defense and other reasons to have a substantial portion carried in American flag vessels. As of January, 1981, the American merchant fleet consisted of 723 vessels totalling 24.1 million dead weight tons (d.w.t.). At the same time 45 merchant ships aggregating 1.6 million d.w.t. were under construction or on order as part of the shipbuilding revitalization program ensuing from the Merchant Marine Act of 1970.

The Merchant Marine Act of 1936 provided for the establishment of the United States Merchant Marine Corps which came into existance March 15, 1938. Originally, training and instruction was carried out on board various merchant ships and later at temporary shore establishments pending the acquisition of the Walter P. Chrysler estate during March, 1942. This estate, comprising 76 acres of land, is situated at King's Point about 20 miles east of New York City. The first class entered the new facilities in September, 1943, and by the end of the war 6634 officers had graduated from its two-year programs. At the cessation of hostilities, a four year, college-level program was inaugurated and the institution elevated to degree granting status by a Federal Act dated August 18, 1949.[110] The following information has been taken directly from the 1981-82 catalog of the United States Merchant Marine Academy.

> The United States Merchant Marine Academy offers a four-year undergraduate program which leads to a Bachelor of Science degree and a merchant marine license as a Third Mate or Third Assistant Engineer or both. In addition, graduates are commissioned as Ensigns in the United States Naval Reserve. The Academy is accredited by the Middle States Association of Colleges and Schools.
>
> Three major programs are offered: Nautical Science for the preparation of deck officers, Engineering for the preparation of engineering officers, and a combination of the two, a Dual License program, which leads to a license in each specialty. The Nautical Science and Dual License programs each offer a single curriculum. Engineering students must select one of two curriculums, either Marine Engineering or Marine Engineering Systems. In addition to a major, Nautical Science and Marine Engineering students may also take concentrated elective programs offered by the Departments of Engineering, Nautical Science, Maritime Law and Economics, Mathematics and Science, and Humanities. All midshipmen must take naval science courses prescribed by the Department of the Navy.
>
> The academic year at the Academy is divided into four academic quarters which span eleven months, generally from the last week of July to the end of June. As an integral part of the program, midshipmen spend one-half of both their sophomore (second) and junior (third) years sailing on merchant vessels in a practical cooperative educational program.[111]

The Program of Study.

All first-year students follow a common program during the first two quarters of the academic year as follows:

First Quarter	Quarter Credit Hours
Calculus and Analytic Geometry I	4
General Chemistry I	4
English I	3
Engineering Graphics I	1
Marine Safety I	2
Introduction to Nautical Science I	5
Physical Education	1
Total	20

Second Quarter	Quarter Credit Hours
Calculus and Analytic Geometry II	4
General Chemistry II	4
English II	3
Engineering Graphics II	1
Introduction to Marine Engineering I	3½
Engineering Shop I	1
Physical Education	1
Total	17½

Third Quarter	Quarter Credit Hours
Calculus and Analytic Geometry III	4
Physics I	3½
Nautical Science II*	5
Engineering Graphics III***	1
Introduction to Marine Engineering II***	2½
Engineering Shop II***	2
Fundamentals of Naval Science	3
Physical Education	1
Total	16½*- 17**

Second Class (Third Year)	Quarter Credit Hours
Marine Materials Handling I, II	6
Marine Electronics I	3
Seamanship I	2
Navigation I	4
Meteorology	3½
History II, III	6
Business/Maritime Law	5
Naval Operations I	3
Physical Education	1
Elective	3

First Class (Fourth Year)	Quarter Credit Hours
Marine Materials Handling III	3
Marine Safety II, III	5
Seamanship II	3
Navigation II	3
Marine Electronics II, III, IV	9½
Principles of Naval Architecture I, II	6
Humanities Sequence or Comparative Culture Sequence or Foreign Language Sequence	12
Marine Transportation II	3
Marine Insurance	3
Naval Operations II	3
Physical Education	2
Electives	15

MARINE ENGINEERING AND MARINE ENGINEERING SYSTEMS CURRICULA

Third Class (Second Year)	Quarter Credit Hours
Introduction to Linear Differential Equations	4
Physics III, IV	7
Safety of Life at Sea I	1½
Introduction to Computer Engineering	3
Introduction to Materials Engineering	3½
Engineering Mechanics I, II	7
Thermodynamics I	3
Economics I, II	6
Naval Weapons Systems	3

Fourth Quarter	Quarter Credit Hours
Calculus and Analytical Geometry IV	4
Physics II	3½
Nautical Science III*	5
Safety of Life at Sea I	1½
Nautical Science IV	5
Engineering Graphics IV**	1
Introduction to Electrical Engineering ***	2½
Metal Cutting Processes I***	1½
Metal Joining Processes I**	3/4
English III	3
Physical Education	1
Total	18* - 18 3/4**

*Nautical Science majors only
**Marine Engineering and Marine Engineering Systems majors only
***Marine Engineering, Marine Engineering Systems, and Dual License majors

The following summary shows the programs of study during the upperclass years:

NAUTICAL SCIENCE CURRICULUM

Third Class (Second Year)	Quarter Credit Hours
Physics III, IV	7
Safety of Life at Sea I	1½
Engineering Science	3
Electrical Science	3 3/4
Introduction to Computer Engineering	3
History I	3
Economics I, II	6
Marine Transportation I	3
Managerial Process	3
Naval Weapons Systems	3

Second Class (Third Year)	Quarter Credit Hours
Strength of Materials	4½
Principles of Naval Architecture	3
Fluid Mechanics I	3½
Thermodynamics II, III	7½
Electric Circuits I, II	7½
History I	3
Managerial Process	8
Naval Operations I	3
Physical Education	1
Elective	3
or	
For Marine Engineering Systems:	
Differential Equations I	3

First Class (Fourth Year) - Marine Engineering	Quarter Credit Hours
Marine Refrigeration	3 3/4
Alternating-Current Machinery	3 3/4
Electronics I	3 3/4
Marine Engineering I, II, III	13 1/4
Internal Combustion Engines I, II	7 1/2
Elective	3 - 3 3/4
Marine Transportation	3
Naval Operations II	3
Physical Education	2
History II, III	6
Humanities Sequence or Comparative Culture Sequence	9
Electives	15

First Class (Fourth Year) - Marine Engineering Systems	Quarter Credit Hours
Fundamentals of Engineering Design	3
Machine Design I	3
Marine Refrigeration	3 3/4
Alternating-Current Machinery	3 3/4
Electronics I	3 3/4
Marine Engineering I, II, III	13 1/4
Internal Combustion Engines I, II	7 1/2
Automatic Control Systems I	3 3/4
Design Elective	6
Marine Transportation	3
Naval Operations II	3
Physical Education	2
History II, III	6
Humanities Sequence or Comparative Culture Sequence	9

DUAL LICENSE CURRICULUM

Third Class (Second Year)	Quarter Credit Hours
Metal Joining Processes I	3/4
Introduction to Computer Engineering	3
Engineering Mechanics I, II	7
Thermodynamics I	3
Business/Maritime Law	5
Economics I, II	6
Introduction to Linear Differential Equations	4
Physics III, IV	7
Naval Weapons Systems	3

Second Class (Third Year)	Quarter Credit Hours
Marine Electronics I	3
Marine Materials Handling II	3
Seamanship I	2
Meteorology	4
Navigation I	4
Strength of Materials	4½
Principles of Naval Architecture	3
Fluid Mechanics I	3½
Thermodynamics II, III	7½
Electric Circuits I, II	7½
Physical Education	1

First Class (Fourth Year)	
Alternating-Current Machinery	3 3/4
Marine Refrigeration	3 3/4
Marine Engineering I, II, III	13 1/4
Internal Combustion Engines I, II	7 1/2
History I, II, III	9
Humanities IV	3
Marine Transportation	3
Managerial Process	3
Marine Insurance	3
Marine Materials Handling III	3
Marine Safety II, III	5
Communications	1
Seamanship II	3
Navigation II	3
Marine Electronics III, IV	6
Naval Operations I, II	6
Physical Education	2

Electives

In addition to completing the required core curriculum in Nautical Science and Marine Engineering, every midshipman is also required to complete a specific number of elective courses. The Nautical Science major must complete 21 quarter-credit-hours of electives, and the Marine Engineering major must complete 18 quarter-credit-hours. Dual License and Marine Engineering Systems majors are not required to complete an elective program since these curriculums are elective.

To meet the elective requirements, midshipmen may choose any elective course for which they have the prerequisites, or they may complete a prescribed sequence of courses leading to a concentration in a specific academic discipline. The offering of all elective courses is subject to a minimum enrollment of ten midshipmen and the availability of instructional staff.[112]

The elective courses and complete course outlines are listed in the Academy catalog.

Although the United States Merchant Marine Academy is closely connected with the armed forces capability of the nation, there are a number of strictly civilian institutions offering marine related programs. One of the more noteworthy of these is the combined Naval Architecture and Marine Engineering degree program offered in the Department of Ocean Engineering by the Massachusetts Institute of Technology (M.I.T.) at Cambridge, Massachusetts.

The Ocean Engineering and Naval Architecture/Marine Engineering undergraduate programs have a common core, the details of which have been taken from the M.I.T. Ocean Engineering Fact Book, 1979-1980 and are as follows:

General Institute Requirements

i) Satisfaction of the basic science requirement (Mathematics, Physics, Chemistry or Biology)

ii) Satisfaction of the science distribution requirement

iii) Satisfaction of the laboratory requirement (Ocean Engineering Laboratory I and II)

iv) Satisfaction of the Humanities and Social Sciences requirement

Departmental Requirements

i) Required subjects:

Thermodynamics, Marine Applied Mechanics, Dynamics, Applied Ocean Engineering, Differential Equations, Linear Systems and Random Processes and a Survey of Ocean Engineering.

ii) Planned Electives:

This requirement is again so planned as to allow the student, subject only to his or her faculty advisor's approval, the maximum flexibility in structuring his or her program in accord with the student's educational objectives. The Department requires that the student satisfactorily complete at least one subject in each of the following areas: Design, Hydrodynamics, Materials and Fabrication, Power and Propulsion, and Structures. The intent of this requirement is to assure that the student has been exposed to all the areas that form the basis of the field of naval architecture and marine engineering. In addition, the Department requires that the student satisfactorily complete a suitable Special Problem in Ocean Engineering (of at least 9 units). The intent of this requirement is that the student be exposed to the situation where he or she has to apply the knowledge he or she has accumulated in a realistic problem selected from the field of naval architecture and marine engineering. Beyond these two specific requirements, the student is at liberty to select subjects which will allow him or her to specialize in an area of the student's own choosing or select subjects that will expose the student to other areas of naval architecture and marine engineering until the Planned Electives requirement is satisfied.

iii) Unrestricted Electives

Identical with the requirements given under the S.B. in Ocean Engineering.

From the above, it can be seen that the proposed curriculum leading to the S.B. in Naval Architecture and Marine Engineering satisfies all the educational goals set by the Department and the output of such an education is a well-rounded and sufficiently specialized person ready to effectively meet the ever-increasing challenge posed to him or her from the field of naval architecture and marine engineering.

Guidance on Subject Selection for Undergraduate Planned Elective Requirements

The following is a list of subjects considered suitable for meeting the Planned Elective requirements for the degrees of Bachelor of Science in Ocean Engineering (OE), and Bachelor of Science in Naval Architecture and Marine Engineering (NAME). A parenthetical subscript (OE) or (NAME) is used to indicate a subject particularly appropriate for one of the two programs. Subjects are listed in general order of suitability; however, the most suitable subject for a particular student is a matter to be decided between the student and his or her faculty advisor. Graduate subjects are underlined.

Planned Elective Area	Suitable Subjects
Acoustics and Vibration	13.80J
Design	13.48 (OE), 13.412 (NAME), 13.411
Hydrodynamics	13.021, 18,354, 2.25
Instrumentation	6.012, 6.071
Materials and Fabrication	3.141, 2.30, 13.15J
Ocean Environment	13.014, 13.85, 12.21
Power and Propulsion	13.21 (NAME), 13.25J, 13.27 (OE)
Structures	13.10J, 13.111, 13.112J, 13.121, 13.122

[113]

All of these programs have engineering internship arrangements whereby students gain professional work experience related to their theoretical studies. As one of the world's leading technological universities much of the academic thrust is placed upon fundamental research in the various technical and scientific disciplines. In Ocean Engineering for example, statistics for the 1978-79 academic year indicated a total enrollment of 164 students of whom 38 were undergraduate and 126 were graduate students working towards masters or doctoral degrees. Of the total enrollment 108 were American citizens and 56 were foreign nationals. Approximately two-thirds were seeking degrees closely related to ship or ocean vehicles whereas the other one-third were concerned with the broader aspects of ocean engineering.[114]

CHAPTER 14

CANADA

SECTION 1.

French colonists formed the earliest European settlement in Canada if we discount that established in northern Newfoundland by Leif Ericson around 970 A.D. It was not long after Champlain founded the colony at what is now Quebec City (1608) when the RÉCOLLETS - Reformed Franciscans - established the first permanent mission during 1615. Brother Pacifique started a school for Indian children at Three Rivers in 1616 and Father LeCaron at Tadoussac in 1618. In 1635 the Quebec settlement had barely 200 people when the Jesuits opened the "Petite École" or elementary school for boys with an enrollment of 20. Latin was introduced in 1636, and by 1655 the school provided the full seven-year classical course of studies similar to those given in the Jesuit Colleges of France. The nuns of the Ursuline Order started a school for girls in 1639, and Marguerite Bourgeoys founded the Congregation of Notre Dame at Ville-Marie (Montreal) in 1659 which, over the years, supplied hundreds of teachers.

With the blessing and support of the Intendant Talon, the first bishop of Québec, Mgr. François de Laval-Montmorency founded a seminary for training future priests in 1663, and by 1668 he established a school to give elementary vocational instruction to young boys. Upon Talon's suggestion, the Jesuit college appointed a layman to teach such practical mathematical subjects as surveying, hydrography and navigation, and by 1707 this work was taken over by the Jesuit Professor of Mathematics. Except for certain craft or specialist teachers all such work was carried out by the clergy. Occasionally an immigrant, either unwilling or unable to work, started teaching in some rural area. This practice resulted in an ordinance of 1727 requiring all teachers to be licensed by the bishop and king's intendant or manager.[115]

Acadia at this period in history covered parts of what are now Prince Edward Island, Nova Scotia and New Brunswick. The first permanent settlers came to Acadia in 1604 and during the following year established a colony at Port Royal (Annapolis Royal). There is evidence of mission schools prior to 1640, and these catered to the children of the settlers as well as the Indians. Although this and other settlements were constantly threatened and often destroyed by the English, perhaps the most striking proof of the effectiveness of the missionary work is indicated by the difficulty the English encountered in attempting to win the friendship of the Indians and the failure to convert them from the Catholic to the Protestant faith.[116]

The Treaty of Paris (1763) ceded New France to Britain, and this together with the Quebec Act (1774) gave French Canadians full religious freedom. However, the British, in harmony with the situation prevailing in England at that period, gave scant consideration to the educational needs of the people with the result that such opportunities as had existed withered away. By 1791 the colony was divided into Lower Canada - mainly French and Catholic, and Upper Canada - mainly English and Protestant. The first school law of 1801 created the Royal Institution for the Advancement of Learning, but because of the preponderance of appointed Anglicans, it did not live up to expectations. After the two provinces came under a single government, the Education Act of 1841 provided a superintendent with an assistant for each province, a school tax to be levied on land-owners and the religious minority in any locality to establish a separate school with government aid. The denominational schools of Ontario and Quebec evolved from this Act.[117]

After Halifax was founded in 1749, one of the early acts of the provincial assembly was to proclaim the Church of England as the Established Church although other Protestant dissenters were allowed freedom of worship. King's College, the first Anglican College in Canada, was founded in 1789 at Windsor, Nova Scotia.

Another King's College established at Fredericton, New Brunswick in 1800 subsequently developed into the non-denominational University of New Brunswick. There are a number of liberal arts universities scattered about Nova Scotia and New Brunswick all of which trace their beginnings to sectarian concerns.

The British North America (B.N.A.) Act proclaimed July 1, 1867, brought the colonies of Nova Scotia, New Brunswick, Upper Canada (Ontario) and Lower Canada (Quebec) together as a federal state called the Dominion of Canada. Manitoba entered Confederation in 1870 and by 1905 all the others had followed except Newfoundland, which joined in 1949. The word 'Dominion', which implies subordination, was deleted from the title some years ago, and the B.N.A. Act has now been superseded by the Constitution Act, 1982, (also known as the Canada Act) finally confirming complete political independence. Section 93 of this Act and of the 1867 B.N.A. Act which it supplanted, deals specifically with education and assigns provincial governments with the primary responsibility in such matters. It is, however, very explicit with respect to denominational schools.

Canada is one of the very few major industrial nations which do not have either a national ministry of education or a federal office of education. This lack of a single coordinating authority has resulted in much confusion and a great deal of inefficiency in the operation of the educational system. A continuous debate for the implementation of such an authority has been carried on for years. Opponents point out the manner in which denominational rights have been disregarded by the court decision respecting the New Brunswick

Common School Act of 1871 but more particularly, the action of the Manitoba legislature which in 1893 abolished the Catholic-Protestant public, but separate, school system which had been established at the time it entered into Confederation. Catholics could still set up their own schools but in addition were taxed for the support of the public schools. This development not only had a profound effect on Canadian education because of the religious aspects but by creating a climate of distrust it exacerbated French-English tensions.[118]

Section 93 of the B.N.A. Act has, however, not precluded Federal Government involvement both covertly and overtly in the education process. In the case of primary and secondary education this has been largely accomplished in a discreet and unobtrusive manner. The Technical Training Act of 1919 and subsequent statutes have had the effect of substantially and openly increasing Federal involvement with relatively little jurisdictional animosity. Present difficulties are largely perceived in terms of the amount of federal financial assistance or in the direction and thrust of the training effort.

The formal education system of Canada is organized along similar lines to that of the United States (see Chapter 13). Originally arranged with eight years of primary followed by four years of secondary education--in most, but not all provinces--the trend for many years has been the 6-3-3 system with the junior high school performing an important role in the development of the adolescent child. Until fairly recent times high school was the end of the formal education process for most of the population except for those attending schools of nursing, teacher's colleges, private business colleges and a very small number of technical institutes. Of course university education was available to properly qualified students that were able to afford it. This pattern has been drastically altered by the relative affluence prevailing throughout Canadian society since the end of World War II.

Higher education consists of a further four years of study beyond the high school diploma (Junior Matriculation level) or three years beyond the Senior Matriculation level (Ontario Grade 13) for most liberal arts and science programs to obtain the baccalaureate degree. Engineering, law and medicine require an additional year or more.

During the 1960s and 1970s there has been a phenomenal growth of non-university, post-secondary education in the form of technical institutes, agricultural colleges, art schools, etc. These areas of study are often carried out in a single institution that is generally known by the generic name of community college. These provide various levels of trade and vocational courses as well as two or three-year, post-secondary programs. Under the terms of the Technical and Vocational Training Assistance Act passed by Parliament during December, 1960, the Federal Government supplied 75 percent of the capital cost and 50 percent of the operating cost for all new facilities. During 1952-53 there were approximately 3 000 full-time students attending post-secondary technical institutes but this increased to 20 000 by 1964-65 as a direct effect of this financial bonanza.

A revision of this Act took place during October, 1982, as a partial response to the growth and development of the new technologies. The major thrust provided complete federal funding of certain types of courses for up to 80 weeks from the former limit of 40 weeks. This change was instituted in response to a perceived need for certain types of skilled manpower for advanced technical occupations. At the same time greater emphasis was placed upon the training and retraining of women, native people and minority groups.

The College d'enseignement général et professionnel (CEGEP), Quebec's contribution to this phenomena, was perhaps the most innovative of all. The Royal Commission of Inquiry on Education in the Province of Quebec (Chairman, Alphonse-Marie Parent, Vice Rector of Laval University) examined various European, American and British educational models and recommended eleven years of elementary and secondary education followed by either two or three years of attendance at such an institute. The two-year courses were intended to prepare students for university entrance while the three-year courses were terminal in character and prepared graduates for various occupations.[119]

SECTION 2.

In a land of dense forests and great distances the only practical method of travel available to the explorers and early settlers was by ship or canoe upon the lakes and river systems of the country. Records exist which indicate that two small vessels were built at Port Royal in 1606 and that ten (10) merchant vessels were built on the banks of the Charles River (across from Quebec City) during 1732. The importance attached to these activities may be implied from the fact that navigation was being taught at the Jesuit College at Quebec before 1700. A British Parliamentry Report of 1720 states that most of the 'Poole' vessels prosecuting the Newfoundland fishery were built in the colony. Other records indicate that a Christopher Spurrier of Poole, Dorset, established a ship-yard at Burin, Newfoundland, in 1718 where brigs, barques and full-rigged ships were constructed.[120] At a somewhat later date the influence of ship-building may be inferred from the following quotation:

> Some very handsome ships are annually built at Quebec and Montreal: they are contracted for by the carpenters at about 10l. currency per ton, exclusive of sails and rigging, which are imported from Britain, as well as every article of copper that may be necessary. Most of the iron work may be found of Canada manufacture. This business is of immense advantage to Quebec and Montreal, as it gives employment summer and winter, to a great many carpenters, and other tradesmen and labourers. There is not a less sum than 20,000l. annually circulated in Quebec and Montreal in the business of ship-building; and as it is a winter as well as a summer employment, they have a resource in it when all others fail them.[121]

The tremendous forest resources of the British North American colonies became the basis for a wooden ship-building industry that completely eclipsed that of Europe. The introduction of steel ships, however, brought about a slow decline that accelerated during the closing decades of the nineteenth century. There was a brief respite due to the demands of World War I when composite steam ships were built. These had steel keels and framing but wooden decks, bottoms and side planking, the steel structure allowing much larger vessels to be constructed.

The Great Lakes along with the interconnecting canal system and the St. Lawrence River constitute a water route traversing almost one-half of the North American continent. Very large bulk carriers especially designed to make the fullest use of the canal locks and arranged for rapid loading and discharging, transport vast quantities of grain, iron ore and coal to various destinations situated on the lakes. After the settlement of the western plains, grain cargoes bound for international markets assumed great significance. Prior to the building of the St. Lawrence Seaway during the 1950s, this grain had to be off-loaded into storage elevators at Kingston and nearby ports on Lake Ontario and then transhipped to Montreal in the much smaller vessels designed to fit the locks of the St. Lawrence canal system. Now international shipping is able to load grain at Thunder Bay and take it directly to its destination.

The shipping season lasts approximately nine months during which time a tremendous amount of activity takes place which requires close and effective control as well as good management if collisions, accidents, etc., are to be avoided. Over the years Canada and the United States have developed special rules respecting load-lines, collision regulations, etc., for Great Lakes vessels that differ significantly in detail from the corresponding international rules and conventions. Until well into the 1950's the majority of these lake vessels were propelled by reciprocating steam engines but from around 1960 onward most new ships were fitted with diesel motors while some were equipped with steam turbine propulsion machinery.

By 197[illegible] Canada had become the world's third largest exporter of dry bulk materials. With practically no ocean-going vessels registered in the country, she is almost completely dependent upon the shipping of other nations for transporting these cargos. Thus, we have the paradox of Canadian coal being shipped from the country's west coast in Japanese vessels and Canadian wheat being carried in Russian bottoms. The St. John's Evening Telegram dated November 3, 1983, reported that during the Montreal proceedings of the Macdonald Royal Commission on the Economy some commission members appeared surprised to learn that Canada has a deep water fleet of 178 vessels of which 108 fly foreign flags.

This evidence was provided by Andrew Boyle of the Seafarer's International Union and Paul Martin, President of Canada Steamship Lines. Martin stated:

> "There is little profit motive now" to have a domestically-based fleet, ...
>
> "We can build ships in Korea, register them in Panama and staff them with Filipinos. To bring the fleet home there would have to be a revision in tax laws."
>
> Canada does $160 billion in foreign trade and $55 billion of this is with offshore countries. Yet, 95 percent of Canadian exports are carried by foreign vessels.
>
> Boyle said Canada's lack of presence on the high seas contrasted with its Canadian-owned, highly developed rail and air transportation industry.[122]

In 1981 during the euphoria generated by the Arctic and offshore petroleum resources, the Canadian Shipbuilding and Ship Repairing Association (CSSRA) conducted a survey of major Canadian ship owners, oil and gas companies and government departments which indicated a need--over a ten (10) year period--for hundreds of vessels and floating equipment of all types. This vast expansion was estimated at costing over $33 000 000 000 in 1981 dollars and would represent an immense potential for broad industrial, technological and employment benefits for all regions of the country.[123] In general, the shipbuilding industry was making ready for such an eventuality with Dome Petroleum Limited having plans ready and negotiations underway to proceed with a world class yard capable of building 300 000 dwt Arctic Class ice-breaking tankers and liquified natural gas (LNG) carriers.[124] The severe world-wide shipbuilding depression has placed many of these companies in serious financial difficulties and at the time of writing it is not at all clear if the Dome project will ever get underway.

Over the years, various Canadian governments while expending substantial sums of public monies on the Canadian Coast Guard, harbour development, the Seaway Authority and related canal systems, have consistently refused to subsidize or otherwise assist a Canadian Merchant Marine. With the exception of the two world wars, merchant shipping has been confined almost entirely to coastal and inland shipping upon the Great Lakes. In an effort to assist fishing companies, it is still possible to import fishing vessels over 100 feet in length, duty free. However, the "New Policies Respecting Offshore Jurisdiction and Onshore Benefits" announced by the Canadian Government January 6, 1983, are intended to help alleviate some of the distress suffered by the shipyards. These are summarized thus:

1. Extension of customs laws to goods used in the resource exploration and development from the current 12 mile limit to the limits of Canada's continental shelf.

2. Closing of loop-holes in existing customs jurisdiction--resulting in 25% duty to all ships and 20% for offshore drilling rigs.

3. Retention of the 3% Performance Incentive Grant and extension of the 9% SIAP subsidy for ships delivered by 30 JUNE '85.

> Regrettably, these new policies were not in place two years ago as over \$1.3 billion worth of domestic orders have gone abroad since then.[125]

The severity of the Canadian winter precludes navigation upon the St. Lawrence-Great Lakes system for approximately three months of each year during which time many navigating and engineer officers attend classes to enhance their qualifications. All of the early schools for this type of training were operated as private undertakings by ex-marine engineers or naval personnel that had a keen interest in passing on their knowledge and experience to a younger generation. Ellwyn Hopkins (his wife taught mathematics) operated such an engineering academy in a suite of offices off Hastings Street in Vancouver, British Columbia, where individuals could study the theoretical aspects of the subjects stipulated for the various levels of both the marine and power plant engineering examinations. Mr. Hopkins had acquired the school from the previous owners, Hyne and Downie, upon their retirement during the 1930s.

In St. John's, Newfoundland, during the 1930s, a Mr. John Pollack, later to become superintendent of the Newfoundland Dockyard, taught evening classes in premises situated on King's Wharf. A number of men received their Second Class Certificate because of his assistance, but the small number that obtained the First Class Certificate were forced to study at Sothern's College in Glasgow or at some other United Kingdom centre.

Commander A. E. Shott set up a similar type of operation in Halifax after the Second World War.

The Dominion Marine School in Toronto operated during the winter freeze-up in space made available by a group of interested ship owners. In the early 1950s the late Thomas Pallas who was employed as a Steamship Inspector by the Steamship Inspection Branch of the Department of Transport (renamed Ship's Safety Branch, Canadian Coast Guard), assumed teaching duties at the school during the winter months. Somewhat later, and in a similar capacity, Mr. Reg Parsons, a former instructor at the Poplar Technical College, London, England, carried on the work.

About this period the Federal Government along with certain provinces took an active interest in this aspect of manpower training. The federal authorities provided a considerable amount of expensive machinery such as engines, boilers, tensile testing apparatus, etc. and in some cases paid the salaries of the instructor. One of the earliest institutions to take advantage of this new thrust in Federal policy was the Vancouver Vocational Institute which organized a marine engineering department for the training and upgrading of aspiring Marine Engineering Officers. The marine engineering school in St. John's, Newfoundland, was first set up during March, 1954, in temporary quarters on the south side of St. John's harbour and subsequently moved into an annex adjacent to the old Memorial University building. The late Mr. James B. Smith was the first instructor. This school was initially incorporated as a section of the St. John's Vocational Institute but found a new home when this institution was absorbed into the College of Trades and Technology during 1963.

By an enactment dated June 10, 1964, the Legislative Assembly of the Province of Newfoundland formally sanctioned the establishment of a college to deal specifically with all aspects of the fishery and maritime training. This Act reads in part:

> The Lieutenant Governor in Council may establish in the province a College to be known as the College of Fisheries, Navigation, Marine Engineering and Electronics, designed to furnish technical and vocational training and to conduct research in:
>
> (a) fisheries
> (b) navigation
> (c) marine engineering
> (d) electronics, and
> (e) any other science or art relating to all principal aspects of the marine and fishing industries, including Naval Architecture and Shipbuilding, and Food Technology (Marine Products and By-Products).[126]

Formal education and training in the College comes under the following departments: Academic, Electrical Engineering Technology, Food Technology, Mechanical Engineering Technology, Nautical Science, Naval Architecture and Shipbuilding and Extension Services. The College calendar lists the following programs:

Three-Year Diploma of Technology

Electrical
Electronics
Food Technology (Marine Products)
Marine Engineering
Power Engineering
Nautical Science (Merchant Marine)
Nautical Science (Fishing Technology)
Naval Architecture

Graduates of the three-year program in Marine Engineering Technology are eligible to write the Fourth Class Combined Marine Engineers examination and are also exempted from the whole of Part A of the Third Class and all of the theoretical papers for both First and Second Class statutory examinations for Certificates of Competency issued by the Ministry of Transport.

The Diploma Program in Nautical Science Technology has two options--Fishing Technology (3 years) and Merchant Marine (4 years). Through arrangements with the Canadian Coast Guard, students opting for the latter are able to obtain the Watchkeeping Mate and First Mate Intermediate Trade Certificates of Competency prior to graduation. Successful graduates of these programs are eligible to apply to the Canadian Armed Forces as Commissioned Officers in the Naval Operations Branch.

Two-Year Certificate of Technology

Small Craft Design
Industrial Instrumentation
Marine Electronics
Radio Officer

One-Year Vocational Certificate

Refrigeration Plant Operation
Marine Diesel Mechanics
Marine Steel-work
Marine Electrical Practice

Extension Programs

These consist of short programs ranging from one to twelve weeks or more in duration and cover a diversity of practical courses in such areas as net mending, record keeping, basic navigation and engine repair for fishermen. These are the so-called "travelling schools" designed to assist fishermen in their home communities.

Ministry of Transport Certificate Programs

All courses for practising Marine Engineers and Deck Officers leading to Ministry of Transport Certification are carried out under the aegis of the appropriate technology departments of the College. For the merchant service these are:

Fourth Class Steam, Motor or Combined
Third Class Steam, Motor or Combined
Second Class Steam, Motor or Combined
First Class Steam, Motor or Combined

For fishing vessels, these are:

Chief Engineer of a Motor Driven Fishing Vessel
Watchkeeping Engineer of a Motor Driven Fishing Vessel

Marine Emergency Duties (MED) Certificates

There are three levels or grades of certificates. MED I is intended for the crews of small vessels. MED II is the basic course and a pre-requisite for all grades of nautical and engineering certificates. MED III is an advanced course providing experience in taking charge of life-saving and fire-fighting training and direction. MED I is a five-day course on life-rafts, survival and fire-fighting techniques, etc. MED II is divided into three sections--lifesaving appliances, fire-fighting, survival and rescue--each of which require five days to complete.

At present these courses are conducted at a number of sites around St. John's, but it has just been announced (St. John's Evening Telegram dated September 9, 1983) that a new facility for this purpose, financed by the Federal Department of Public Works, is to be built on an 8.5 hectare area located 25 kilometres from the city. This site was chosen because of its remoteness to residential areas since considerable smoke and noise is emitted during operation. The centre is scheduled for completion in the autumn of 1984 and will have a steel ship mock-up for fire-fighting and damage control simulation and also an 864 cubic metre survival training tank equipped for a future helicopter underwater escape trainer.

From these rather humble beginnings there are now six provincial and two federal institutions providing three-year marine engineering programs. Besides the College of Fisheries, Navigation, Marine Engineering and Electronics discussed above these are:

Nova Scotia Nautical Institute; Halifax, Nova Scotia
Institute Maritime du Quebec; Rimouski, Quebec
St. Lawrence College; Cornwall, Ontario
Georgian College of Applied Arts and Technology; Owen Sound, Ontario
Pacific Marine Training Institute; North Vancouver British Columbia
Canadian Coast Guard College; Sydney, Nova Scotia
Transport Canada Training Institute; Cornwall, Ontario

The Pacific Marine Training Institute was only opened during 1981. It is a 63 000 square foot (6 000 m^2) waterfront facility housing an extensive library, workshops, hydraulic and pneumatic laboratory, electrical and electronics laboratory, survival techniques training tank, and, of course, classrooms and science laboratories. Unlike the College in Newfoundland, this institution appears to extend its greatest efforts towards preparatory courses leading to the statutory certificate examinations conducted by the Ministry of Transport for deck and engineering officers and upon practical marine emergency courses. Perusal of the latest calendar indicates that a 33-month Marine Engineering Diploma program has been carried on since 1980 but no list of individual courses is provided. It also states the Diploma provides automatic entrance to the Fourth Class Combined Marine Engineers examination and exemption from Part A subjects of the statutory examinations for Third and Second Class Certificates. However, the passage of time will doubtless see an expansion in both the depth and variety of these Diploma programs.

To lend weight to the thought, a survey conducted during 1981 by R. Cook of the Merchant Service Guild found a significant number of Canadian sea-going engineers were 55 - 65 years of age with an undue proportion being over 60 years old! It has been estimated that over a five-year period at least 7 000 properly qualified marine engineers will be required simply to keep the vessels operating, and this does not include projected requirements for Arctic and off-shore operations or for marine engineers employed by various government agencies, shipyards or marine insurance companies, etc.![127]

Besides the marine technology programs already described, a number of Canadian universities have introduced courses in Marine Engineering, Naval Architecture, Shipbuilding and Ocean Engineering. Centres of Excellence for Research and Development in marine technology have also been created by the Federal Government in association with universities or with provincial research associations. The most important of these are: the Centre for Transportation Studies, the Centre for Cold Ocean Resources Engineering (C-CORE) and the Arctic Vessel and Marine Research Institute at Memorial University of Newfoundland; the Canadian Marine Transportation Centre at Dalhousie University, Halifax, Nova Scotia; the Centre for

Transportation Studies at the University of British Columbia at Vancouver; and the Centre for Ocean Engineering established with the British Columbia Research Council.

The "Arctic Vessel and Marine Research Institute" in Newfoundland is a "world class", $35 000 000 facility being constructed for the National Research Council. The laboratory consists of a 200 metre, clear-water towing tank, a 75 metre stability (wave) tank and an 80 metre controlled environment ice tank which will employ 100 full-time scientists when fully operational.[128]

A report in the St. John's Evening Telegram dated October 8, 1983, states that the first two contracts for the new $41 800 000 Fisheries and Marine Institute have just been awarded. When completed, this Institute will replace the present Fisheries College which has become far too small to cope with the demand for this type of education and training.

PART FOUR

THE INTERNATIONAL CONVENTION ON STANDARDS OF TRAINING, CERTIFICATION AND WATCHKEEPING FOR SEAFARERS, 1978

CHAPTER 15

INTERNATIONAL CONVENTION ON STANDARDS OF TRAINING, CERTIFICATION AND WATCHKEEPING FOR SEAFARERS, 1978

At this point it will be appropriate to examine in some detail the major implications of this document insofar as it deals with the training of seafarers generally and of engineering officers in particular. The complete document is obtainable through the International Maritime Organization's offices in London, England.

This Convention is by far the most comprehensive and far reaching effort so far attempted toward rationalizing the educational shortcomings of training schemes designed around and predicated upon national regulatory controls. These have often, by their very nature, created problems due to their inability to deal satisfactorily with situations that are beyond the realm of national jurisdictions. A case in point is the difficulty accruing from attempts to ensure adequate certification of the officers and crew of vessels trading in foreign ports. Such questions are specifically addressed and, to a large extent, will become academic, as the officer and rating personnel attain the educational level laid down as the minimum mandatory standards.

The Convention itself is quite short consisting of seventeen Articles, whereas the details are expanded in the form of an Annex containing six Chapters and twenty-two (22)

Resolutions. Article I deals with General Obligations under the Convention, Article II with Definitions, Article VI with Certificates, Article X with Control and Article XI with the Promotion of Technical Co-Operation. As pointed out in the Introduction, the Convention will enter into force (Article XIV) April 28, 1984.

Article X, Control, defines the manner in which inspection and enforcement is to be carried out and Regulation I/4 of the Annex defines the Control Procedures. Article XI, Promotion of Technical Co-Operation, is included below since it has a direct bearing upon the subject matter of this thesis.

ARTICLE XI

Promotion of Technical Co-Operation

1. Parties to the Convention shall promote, in consultation with, and the assistance of, the Organization, support for those Parties which request technical assistance for:

   (a) training of administrative and technical personnel;

   (b) establishment of institutions for the training of seafarers;

   (c) supply of equipment and facilities for training institutions;

   (d) development of adequate training programs, including practical training on sea-going ships; and

   (e) facilitation of other measures and arrangements to enhance the qualifications of seafarers;

   preferably on a national, sub-regional or regional basis, to further the aims and purposes of the Convention, taking into account the special needs of developing countries in this regard.

2. On its part, the Organization shall pursue the aforesaid efforts, as appropriate, in consultation or association with other international organizations, particularly the International Labour Organization.

The six Chapters of the Annex are as follows:

Chapter I	General Provisions
Chapter II	Master-Deck Department
Chapter III	Engine Department
Chapter IV	Radio Department
Chapter V	Special Requirements for Tankers
Chapter VI	Proficiency in Survival Craft

Regulations III/2 and Appendix III/2 are given verbatim below:

Regulation III/2

MANDATORY MINIMUM REQUIREMENTS FOR CERTIFICATION OF CHIEF ENGINEER OFFICERS AND SECOND ENGINEER OFFICERS OF SHIPS POWERED BY MAIN PROPULSION MACHINERY OF 3000 KW PROPULSION POWER OR MORE

1. Every chief engineer officer and second engineer officer of a sea-going ship powered by main propulsion machinery of 3000 KW propulsion power or more shall hold an appropriate certificate.

2. Every candidate for certification shall:

(a) satisfy the Administration as to medical fitness, including eyesight and hearing;

(b) meet the requirements for certification as an engineer officer in charge of the watch, and

(i) for certification as second engineer officer, have not less than 12 months' approved sea-going service as assistant engineer officer or engineer officer;

(ii) for certification as chief engineer officer, have not less than 36 months' approved seagoing service of which not less than 12 months shall be served as an engineer officer in a position of responsibility while qualified to serve as second engineer officer;

(c) have attended an approved practical fire-fighting course;

(d) have passed appropriate examination to the satisfaction of the Administration. Such examination shall include the material set out in the Appendix to this Regulation, except that the Administration may vary these examination requirements for officers of ships with limited propulsion power that are engaged on near-coastal voyages, as it considers necessary bearing in mind the effect on the safety of all ships which may be operating in the same waters.

3. Training to achieve the necessary theoretical knowledge and practical experience shall take into account relevant international regulations and recommendations.

4. The level of knowledge required under the different paragraphs of the Appendix may be varied according to whether the certificate is being issued at chief engineer officer or second engineer officer level.

Appendix to Regulation III/2

MINIMUM KNOWLEDGE REQUIRED FOR CERTIFICATION OF CHIEF ENGINEER OFFICERS AND SECOND ENGINEER OFFICERS OF SHIPS POWERED BY MAIN PROPULSION MACHINERY OF 3000 KW PROPULSION POWER OR MORE

1. The syllabus given below is compiled for examination of candidates for certification as chief engineer officer or second engineer officer of ships powered by main propulsion machinery of 3000 KW propulsion power or more. Bearing in mind that a second engineer officer shall be in a position to assume the responsibilities of a chief engineer officer at any time, examination in these subjects shall be designed to test the candidate's ability to assimilate all available information that affects the safe operation of the ship's machinery.

2. With respect to paragraph 4(a) below, the Administration may omit knowledge requirements for types of propulsion machinery other than those machinery installations for which the certificate to be awarded shall be valid. A certificate awarded on such a basis shall not be valid for any category of machinery installation which has been omitted until the engineer officer proves to be competent in these items to the satisfaction of the Administration. Any such limitation shall be stated in the certificate.

3. Every candidate shall possess theoretical knowledge in the following subjects:

(a) thermodynamics and heat transmission;

(b) mechanics and hydromechanics;

(c) operational principles of ships' power installations (diesel, steam and gas turbine) and refrigeration;

(d) physical and chemical properties of fuels and lubricants;

(e) technology of materials;

(f) chemistry and physics of fire and extinguishing agents;

(g) marine electrotechnology, electronics and electrical equipment;

(h) fundamentals of automation, instrumentation and control systems;

(i) naval architecture and ship construction, including damage control.

4. Every candidate shall possess adequate practical knowledge in at least the following subjects:

(a) operation and maintenance of:

(i) marine diesel engines;

(ii) marine steam propulsion plant;

(iii) marine gas turbines;

(b) operation and maintenance of auxiliary machinery, including: pumping and piping systems, auxiliary boiler plant and steering gear systems;

(c) operation, testing and maintenance of electrical and control equipment;

(d) operation and maintenance of cargo handling equipment and deck machinery;

(e) detection of machinery malfunction, location of faults and action to prevent damage;

(f) organization of safe maintenance and repair procedures;

(g) methods of, and aids for, fire prevention, detection and extinction;

(h) methods and aids to prevent pollution of the environment by ships;

(i) regulations to be observed to prevent pollution of the marine environment;

(j) effects of marine pollution on the environment;

(k) first aid related to injuries which might be expected in machinery spaces and use of first aid equipment;

(l) functions and use of life-saving appliances;

(m) methods of damage control;

(n) safe working practices.

5. Every candidate shall possess a knowledge of international maritime law embodied in international agreements and conventions as they affect the specific obligations and responsibilities of the engine department, particularly those concerning safety and the protection of the marine environment. The extent of knowledge of national maritime legislation is left to the discretion of the Administration but shall include national arrangements for implementing international agreements and conventions.

6. Every candidate shall possess a knowledge of personnel management, organization and training aboard ships.

The following Resolution 22 has been included since it is indicative of the greater attention now being given to humanistic concerns whereas earlier considerations had tended to be rather narrowly focussed upon technical concepts.

RESOLUTION 22

HUMAN RELATIONSHIPS

THE CONFERENCE

HAVING ADOPTED the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers, 1978,

RECOGNIZING that not only safe operation of the ship and its equipment but also good human relationships between the seafarers on board would greatly enhance the safety of life at sea,

NOTING that the knowledge of personnel management, organization and training aboard ships is required for certification of supervisory personnel,

RECOMMENDS that this knowledge include knowledge of basic principles in human relationships and social responsibility,

INVITES all Governments:

(a) to establish or encourage the establishment of training programmes aimed at safeguarding good human relationships on board ships;

(b) to take adequate measures to minimize any element of loneliness and isolation for crew members on board ships;

(c) to ensure that crew members are sufficiently rested before commencing their duties.

Brevity has precluded a more expansive treatment of the Document but a perusal of the syllabus for the Chief and Second Engineer Officers indicates that many of the concerns expressed by the Europeans during 1964 have now been adequately dealt with. Furthermore, the very narrow concern for technical matters illustrated by a number of the syllabi described in the chapters comprising Part I of this study will at last be partially expanded by the anthropomorphic illumination emanating from Resolution 22.

It should be noted that the Regulations contained in the Annex describe the MINIMUM REQUIREMENTS and MINIMUM KNOWLEDGE expected of Ship's Officers and does not in any way preclude a State from increasing these requirements should it deem this necessary.

In summary, the articles of the Convention will be of most concern to government administrators, lawyers and such people. The annex will be of greatest interest to ship owners and seafarers. The resolutions, which are not mandatory, contain material elaborating upon the regulations and upon which the conference could not agree. It is expected that administrations will include them in their domestic regulations wherever possible.

A direct effect of this Convention has been the provision of greater maritime educational opportunities on a world-wide basis.

PART FIVE

CONCLUSION

... The training of future engineers is particularly important at this time. It is not enough to ensure professional competence, it is equally vital to develop the right philosophical attitudes to social, economic and conservation problems if technology is to serve the best interests of mankind in the long term.*

*[Message from H.R.H. Prince Philip at the opening of the Fifth International Congress of Engineers held at London, September 27 to October 1, 1971, upon the twentieth anniversary of the Fédération Européene d'Associations Nationales d'Ingénieurs (FEANI)].

CHAPTER 16

CONCLUSION

In Part One we saw that technical education in Great Britain evolved along a slow and devious path with practical matters presenting an overriding concern. This was a direct result of England being in the vanguard of the Industrial Revolution and of the constraints imposed by the late developments of a comprehensive public education system. The German preoccupation with philosophy and the theory of learning enhanced its position as an educational leader and as industrialization proceeded, the German State placed great emphasis upon the education and training of its citizens and upon the development of carefully thought out technical programs. There have been many reasons advanced in efforts to explain these fundamental differences, but in one form or another most of the European nations developed modified versions of these divergent educational philosophies.

Because the British syllabi for nautical studies and marine engineering have been enshrined in statutory regulations over relatively long periods of time, they may be considered as the fossilized remnants of a philosophical anachronism. From this perspective, the engineering syllabus adopted by the International Convention, 1978 (Chapter 15, page 189) may be viewed as a compromise or an attempt at reconciliation of these divergent developments. Furthermore, the maritime curricula of the Commonwealth countries which, of course, are former British Colonies, also exhibit many of these same features albeit overlaid with differences that have come about due to geographical or environmental conditions.

The Asian countries described in Part Two became involved in world-wide maritime transportation quite recently in time and, hence, were able to avoid many of the difficulties and shortcomings the more established maritime nations encountered. With the exception of Japan, there was little in the way of heavy manufacturing or engineering and, hence, no need for an extensive apprenticeship system. This lack of trained manpower necessitated the development of an entirely different approach to the ship manning problem. Already by the 1960s, many of the European regulatory bodies were beginning to realize that such a long and expensive period of workshop training for the higher levels of technical personnel was something of an anachronism. Since then, technological innovation, such as the unmanned engine room, has made this even more apparent.

In attempting to formulate a maritime training strategy for Canada, one must be fully cognizant of the differences outlined in the preceding paragraphs. Canada, by reason of its history, has inherited much of the maritime technical education concepts of England, while at the same time it still remains in many ways a largely undeveloped country. Having very few large engineering works from which to draw a trained supply of apprentices for its junior engineers, it was necessary to utilize engine room ratings who, after a prescribed period of sea-service, were allowed to write a Fourth Class Examination. A majority of the people attracted to the sea under these conditions generally had a very weak educational background and, while they might successfully pass the Fourth or even the Third Class examination, most found the Second and First Class examinations beyond their capacity. The general effect was that the country had to rely, for its senior engineers, to an inordinate extent upon immigrants from other countries, mainly Great Britain. However, over the last two to three decades, there has been a noticeable improvement in the general level of education which is reflected in the number of examination successes at the higher levels. In the field of maritime technology, also, Canada has been excessively dependent upon foreign nationals for the resolution of problems peculiar to this country.

At this stage in the country's development, with advanced technology waiting in the wings, so to speak, it appears more pressing than ever that a National Maritime University be brought into existence. Since nautical affairs are the preserve of the Federal Government, what is more logical than the creation of such an institution? While its location will undoubtably be a political decision, it should, nevertheless, be as free from parochial polemic and bickering as possible. While there are many excellent locations available for such a facility, this should be decided upon in the light of any further, and as yet unannounced, maritime policy. The author, not being privy to such prognostications, would venture to suggest that proximity to St. John's, Newfoundland, would be an ideal site, because the Arctic Vessel and Marine Institute and the Fisheries and Marine Institute are both being constructed here. In fact, it is conceivable that this latter Institution could be enlarged in concept to become a National Maritime University with a much smaller outlay of public funds than would be required were the facility to be constructed in some other area of the country. Further, since we are speaking of a national institution, is it reasonable to expect a single provincial government to undertake such a large and highly specialized undertaking? It is a well-known fact that provincial governments faced with ever increasing demands from dwindling tax revenues have not been so generous in responding to the increased funding requirements of universities as they were able to be in the past. Thus, a federally funded and controlled institution would appear the most sensible approach.

Since Memorial University of Newfoundland already has a very good advanced program--at the Doctoral level--in Ocean

Engineering, it would be unthinkable to disband such an effort or place it under the aegis of the National University. Rather, a cooperative arrangement--perhaps like that presently in effect between Carleton and Ottawa Universities--may be considered so that students would have the added advantage of a larger choice of options available to them.

The smaller, older or less complicated vessels will be around for a long time to come; hence, there will still be a very large demand for a less sophisticated type of training for the operators of these vessels. Is it unthinkable to provide some form of educational ladder so the more able First or Second Class Marine Engineer can proceed to advanced studies if he or she is sufficiently motivated? When such an individual finally completes the theoretical training, he/she has the additional advantage of invaluable practical experience combined with a sound theoretical background and thus is much more quickly available for work in an advanced capacity.

The question of potential students must also be addressed because the present population of Newfoundland cannot and should not constitute the deciding factor. Potential students might be chosen on a provincial quota basis in a manner not unlike that used by the Merchant Marine Academy at King's Point, New York, described in Chapter 14, Section 2. Furthermore, a truly first class institution of this type will not be long in attaining international stature and will attract foreign students on special Commonwealth Scholarships or similar financial arrangements. To a certain degree, this has been the case with the present College of Fisheries largely through the efforts of its first president, the late Dr. William Hampton. Again, the type of institution envisaged here will not be confined to engineering design, naval architecture, telecommunications, or nautical studies but will be expanded to encompass the entire gamut of maritime affairs, including shipping company economics, organization and management and the study of International Maritime Law. Thus, it would appear that by having all aspects of maritime studies carried out in one institution, a more rounded graduate will emerge with a better and broader understanding of other aspects of the ship and shipping than simply the specialized knowledge of his particular discipline. For a number of years, shipping industry leaders have pointed out that engineering programs in particular are too insulated from the practical concerns related to an industry's financial affairs and to good personnel relationships. An appropriate mix of this type of material with the technical studies should greatly enhance the graduate's ability to understand management's difficulties and, by the same token, management's understanding of the constraints imposed by technical problems.

The equipping of workshops, laboratories, and other facilities also requires examination. During the author's student days at Southampton Technical College, a new institution was being constructed and the faculty were overwhelmed with offers of large and very expensive pieces of equipment freely donated to the new facility by the manufacturers. The biggest problem was the lack of space to accommodate same. In another context, a fairly large and expensive diesel motor was to be donated to an educational institution, but the opportunity was lost because the government of the day refused to pay the salary and expenses of the factory trained service engineer the engine builder stipulated be in charge of assembly of same. We are talking here of very specialized equipments such as steering gear, large bore diesel motors, boilers and marine steam turbines, etc. Of course, the usual thermodynamics, fluids, electrical, electronics and instrumentation laboratories will also be required, but this can hardly be considered specialized in the same sense as the foregoing.

Again, specialized simulators to provide instruction for operating personnel are becoming important new training aids in both the nautical and engineering branches. So too, computer-aided design and computer-aided manufacturing (CAD-CAM) are important new concepts in the area of mechanical design.

Another very important aspect of training is the exposure to actual operating conditions aboard a ship engaged upon foreign voyages world wide and also in Coast Guard ice-breaker/supply vessels working in the Arctic. While work-term training in a shipyard will round out the potential graduate's understanding of such matters as new construction techniques, damage repairs and survey operations, the sea-going experience will enhance his comprehension of design and operational details in a manner no other form of instruction will even begin to approximate, particularly if heavy weather conditions prevail. Furthermore, one or more especially designed and constructed training ships will not only provide an important part of the practical training and experience for all types of students but will show the Canadian flag in foreign ports.

As an example, the National Maritime Polytechnic of Manila, Philippine Republic has just placed in operation an especially designed, 27 000 dwt (M.S. Filipinas) bulk carrier-training ship. Besides having six holds with a total grain capacity of 1 238 000 ft^3 (35 061 m^3), it has a bridge, an engine control room, classrooms and laboratories for the accommodation of eight (8) classes consisting of 240 student engineer and navigation officers.[129]

The entire telecommunications industry has been revolutionized within the last decade or so by the advent of communications satellites. The earliest marine efforts were expended in improving satellite navigation systems which have proved extremely reliable especially in the polar regions. An article entitled "Satellite Revolutionizes Ship-to-Shore Links" reported in the Financial Post, dated September 10, 1983, states:

The "RADIO ROOM" of the motor ship 'Atlantic Superior' consists of a compact box of electronics, a teleprinter, and a touch-pad telephone, representing a huge advance in maritime management: fast, private satellite communications.

From the ship's bridge the captain can direct-dial any telephone or telex in more than 70 countries around the world, including Canada and the ship's administrative office in St. Catherine's, Ontario. And vice versa, of course. ... On a world wide basis, the use of maritime satcom has been growing. ... The International Maritime Satellite Organization (INMARSAT), London, reports that two or three ship-earth stations are going into commission daily. With about 1 700 users today, INMARSAT expects to have 8 000 by the end of this decade.

The implications of this new technology for ship-board entertainment and news but especially for teaching are obvious. Furthermore, to enhance the learning process, the system can be made interactive so the student can ask for clarification of some obscure point not immediately apparent in the lecture or demonstration. Since the system is world-wide in scope, it is entirely feasible for arrangements to be made to tune in on special lectures or demonstrations given by experts in some particular aspect of, say, oil pollution prevention or the handling of dangerous chemical cargoes, etc., etc., from almost any place in the world.

The foregoing has only been touched upon in an endeavour to indicate some of the exciting new concepts of information transfer presently available. The future will surely open vistas which, at the moment, are scarcely perceived.

Having explored some of the more important questions pertaining to the establishment of a National Maritime University, we come now to the most crucial concerns of all: How best to capitalize upon previous knowledge to facilitate the rapid development of the institution and upon what area or areas should the national effort be expended?

A crucial element towards the attainment of first class status is that the teaching faculty not only be fully qualified in their specialty but also up-to-date and doing advanced research in their area of concern. Since this type of Canadian talent is scarce in the extreme, perhaps the most appropriate manner in which to bring the enterprise to fruition would be to enter into an arrangement with one or more European and/or Asian institutions for curriculum and staff support and also for assistance for a predetermined period after which a continuous association would provide a valuable link for research and post-graduate studies. In a nut-shell: Why reinvent the wheel?

Another area where specific assistance may be obtained is the World Maritime University of Malmö, Sweden. The specific aim of this institution--which started its first classes July 4, 1983--is to provide top-level training for personnel from developing countries for senior positions in marine administration, marine training institutions, shipping companies and other key sectors.[130]

With respect to the second question, an area of study which immediately springs to mind is the Arctic. Here, at least, Canada has accumulated considerable knowledge and expertise over the years. Her navigators can certainly be classed as the most knowledgeable of any in this type of environment. Likewise in ice-breaker design and construction, a large amount of detailed information has accrued over the years. Since very few countries have any amount of expertise in this field, it would certainly appear to be the most worthwhile area to pursue particularly in the light of the Arctic oil and gas exploration program already underway. So, too, the oil and gas exploration program off Canada's East Coast has presented problems never before encountered in any other part of the world. Memorial University's Ocean Engineering and C-Core have demonstrated methods of towing icebergs to avoid colliding with drilling rigs, which have been utilized in real situations on a number of occasions. However, the real test of the technology will be in the exploitation process where it may be impossible to move the collecting platforms or pipelines out of the way of the icebergs.

This chapter would be remiss if it neglected to discuss employment opportunities for graduates. Perhaps the most obvious are those related to the various aspects of the design and operation of merchant ships, naval craft, ferries, ice-breakers, fishing vessels, etc., either as employees of government departments, shipyards or ship owners. The Canadian Coast

Guard, Fleet Operations Branch require substantial numbers of Marine Engineers, Naval Architects and Electrical Engineers with marine experience, and the Ship's Safety Branch advertises periodically for marine surveyors many of whom are required to be bilingual. The National Harbours Board, Department of Public Works and Department of Fisheries and Oceans also employ graduate or certificated marine engineers or those with marine experience. The Classification Societies have difficulty obtaining surveyors with a sound theoretical background plus the experience associated with a First Class Combined Marine Engineers Certificate. Lloyd's offer employment in a great many parts of the world which may appeal to a young person. Marine Insurance Companies also require individuals with this type of background to conduct machinery, hull and cargo damage surveys and, for well-qualified graduates with good communications skills, technical equipment sales may offer appealing opportunities. Finally, teaching opportunities in these very specialized areas exist not only in this country but through the Canadian International Development Agency (CIDA), in many other parts of the world. Most of the employment opportunities suggested here carry better than average salaries for similar educational backgrounds and experience.

Many people may think that the idea of a Canadian National Maritime University is simply an attempt to gratify the vested interests of a very small segment of society. The author would point out, however, that the United Nations Conference on the Law of the sea (UNCLOS III)--of which Canada is a Party--specifically requests the signatories to concern themselves with certain matters laid down in the Informal Negotiating Text. The most relevant of these are:

PART VII: THE HIGH SEAS. This implies that States deal with the question of the safe and efficient manning of ships. This has been complied with by the Convention described in Chapter 15.

PART XII: PROTECTION AND PRESERVATION OF THE MARINE ENVIRONMENT. The International Convention for the Prevention of Pollution of Ships, 1973, as modified by the Protocol of 1978 became law October, 1983.

PART XIII: MARINE SCIENTIFIC RESEARCH

PART XIV: DEVELOPMENT AND TRANSFER OF MARINE TECHNOLOGY. These latter parts relate not only to Marine Transportation but also to the intelligent exploitation of sea life, minerals and energy for the benefit of all mankind--Arvid Pardo's concept of the Common Heritage of Mankind.

Where best can these divergent demands be accommodated than at an institution especially established to consider every facet of marine relationships? Thus, it is not enough to be simply an institution to teach people to design ships or seafarers to operate them. Rather, the quotation at the beginning of this chapter is apropos here for it implies that technology must be the servant rather than the master of mankind. Viewed from this perspective, the National Maritime University has the responsibility of inculcating attitudes that will not compromise long-term interests for short-term gains. This requires the development in all graduates of that greater vision, that larger perspective and social consciousness that can only be acquired by a judicious mixture of social and technical science.

We conclude this study by quoting that illustrious oceanographer, Jacques Piccard, to illustrate that vast panorama which must be appreciated if we are to truly comprehend the importance of the oceans and man's place in relation to them.

> When we consider the question of pollution, we must recall the fundamental importance in the worldwide ecological equilibrium of the upper layers of the sea. Here the phytoplankton absorb solar energy and produce nourishment for zooplankton and consequently for all living species of the ocean. More than half of the world's production of oxygen is fabricated by this marine phytoplankton which has the further task of absorbing the excess of carbon dioxide that is produced by animal respiration and, for several generations past, by human industry. It is not difficult to see the important role played by this thin oceanic layer. And yet we annually discharge into it hundreds of thousands of tons of lead, mercury, detergents, and various insecticides, not to mention a million tons of petroleum, an amount equal to about one percent of world production. In all these ways, the phytoplankton is directly threatened by pollution. If it were to disappear, life in the sea would become extinct and possibly after a brief interval much of terrestial life, ... would also cease to exist.
>
> The sea must continue to play a vital role for the whole human race, even though today all the old priorities that existed until recently have disappeared. It is not so much a question of nourishing humanity. But rather, we must guard against preventing the sea from carrying out its irreplaceable contribution to our respiration. In short, what we take out of the sea is no longer as important as what we do not put into it.[131]

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*10l = 10 livre. The livre is a former French silver coin originally equivalent in value to a pound of silver. In a footnote (p. 17) to Louis Davory's Crime recorded in Louisbourg Portraits (Toronto, 1983) by Christopher Moore, it is stated that in 1740 a labourer's daily wage was about 3 livre and while this may not correspond with the wage at Quebec 70 years later, it provides a rough measure of its worth. It should be noted that by this period of history the livre was much debased and no longer equivalent to one pound of silver.

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