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A UNIQUE DEGREE PROGRAM FOR THE SHIPBUILDING INDUSTRY

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This report describes a unique baccalaureate degree program designed to prepare graduates for a career in the shipbuilding industry. The program came into being because three elements came together at the same time in the same place. These elements were: (1) the need of an expanding shipbuilding industry for a type of personnel not being produced by any then existing educational program, (2) the creation of programs in engineering technology by the Legislature of the State of Mississippi and (3) the creation of the Sea Grant Program by the Federal Congress. They came together in South Mississippi, reaching a "critical mass" in 1968 even though each element had received its own emphasis at a different point in time.

The need of the shipbuilding industry for a larger number of men especially educated to provide technical and management leadership in the economical construction of ships had been heralded by the new Merchant Marine Law in 1970 which was to provide increased funding for merchant ships built in American yards. About the same time, the United States Navy made the decision to build more ships on the basis of single-source procurement. These decisions were bringing home to shipyards the fact that traditional shipbuilding methods would have to be replaced by faster and more economical methods. Two shipyards on the Central Gulf Coast were among the first to develop new shipbuilding systems, Avondale Shipyards, Inc., in New Orleans, Louisiana and the "Shipyard of the Future" built by Litton in Pascagoula, Mississippi. The need for a new type of personnel thus became evident in South Mississippi.

The Gulf Coast Technical Institute (forerunner of the Institute of Engineering Technology), a division of the College of Engineering at Mississippi State University, had been in operation in Gulfport, Mississippi since the fall of 1965. The Institute had been created in response to a 1964 law passed by the Mississippi Legislature to offer baccalaureate degree curriculums with an emphasis on the application of engineering principles. The Gulf Coast Technical Institute opened in Gulfport, Mississippi in September 1965.

During 1968, the Sea Grant Office of the National Science Foundation (now a division of the National Oceanic and Atmospheric Administration (NOAA) in the Department of Commerce) was making its first grants in response to implementation of Public Law 89-688 of October 15, 1966. This law envisioned the development of marine and ocean resources by a system of federal encouragement comparable to the Land Grant (Morrill Act) of almost a hundred years earlier. The Sea Grant Office would fund two-thirds of the cost of approved projects with the other third to come from other nonfederal sources supplied by the grantee.

These were the several conditions when representatives from Avondale Shipyards, Litton Shipbuilding Corporation and the Gulf Coast Technical Institute held a series of meetings early in 1968.

The consensus from these meetings was that the shipbuilding industry needed an input of highly competent technical manpower specifically educated for a career in shipbuilding. It was determined that the Gulf Coast Technical Institute could offer a curriculum in engineering technology whose graduates would be attractive to the shipbuilding industry, and that the Gulf Coast Technical Institute staff should proceed to develop a curriculum that would be submitted to the Sea Grant Office for funding.

The curriculum taught today is the result of studied evolution from that developed in the curriculum planning sessions. This evolution, the result of our learning experience, has led to a stronger and broader emphasis on the shipbuilding stream of the curriculum, rather than traditional naval architecture and marine engineering.

Before presenting the Marine Engineering Technology curriculum, we will digress to note the philosophy of the baccalaureate degree approach to engineering technology held by the Institute of Engineering Technology.

Baccalaureate degree curricula began to develop in the middle of the sixties as the result of the impetus resulting from changes in engineering education that had begun in 1955 and in fact are still continuing. Some of these changes in engineering education have been: (1) Higher mathematics entrance requirements and the addition of more advanced mathematics topics in the curricula; (2) The removal of an emphasis on the practical application of the topics of study from curricula, and (3) The addition of a more theoretical, scientific treatment of topics studied. These changes resulted in curricula that were most attractive to students with a strong scientific bent. Thus, the graduates of these new curricula, in greater numbers, went on to masters and doctoral programs and careers in teaching, research, development, and advanced theoretical design.

If the new engineering curricula were more interesting to students with a mathematics-scientific bent, they were equally less attractive to students whose aptitudes were for the real world of operating systems, construction, manufacturing and the use of "established design criteria" to achieve better systems at lower costs. It is for this "applications" oriented group of students for whom we believe that baccalaureate degree curricula in engineering technology are particularly well suited. Further, we believe that BET curricula will prepare graduates for a career in an industry rather than for a competence in a discipline. Thus, our curriculum in Marine Engineering Technology is intended to prepare the graduates for a career in that broad segment of industry that builds, manages, and supports the development and operation of ships.

Now let us turn to the structure of our present curriculum in Marine Engineering Technology.

Unchanged from the original plan is the division of the curriculum in two parts. The first part, or Pre-Engineering Technology curriculum (see Figure 1), was the same preparatory program being required for admission to the then existing curricula in Electronic Engineering Technology and Construction Engineering Technology being offered by the Gulf Coast Technical Institute. This curriculum is very similar to most Pre-Engineering curricula with the exception that it includes *Algebra* and *Trigonometry* and does not require that the *General Physics* course be taught with *Calculus*. It is important to note that this Pre-Engineering Technology curriculum is available in all junior and community colleges. Quite evident in the listing of courses is the fact that, in the two years required to complete this preparatory curriculum, the student can determine whether or not by his basic aptitude, he will be happier in an additional educational program oriented toward the application of engineering principles or whether his personal aptitudes would best be rewarded by an engineering curriculum with its greater theoretical emphasis.

The Marine Engineering Technology curriculum (Figure 2), in its present state of evolution, is structured in three principle stems with a group of supporting courses.

Naval Architecture and Shipbuilding

The first course, *Introduction to Naval Architecture and Shipbuilding*, introduces the student to marine nomenclature, vessel design features, ship structure and powering. During the second term of the Junior year the *Shipbuilding Technology* course develops the history and character of shipbuilding in detail. Shipyards and their equipment are studied with particular emphasis upon fabrication and assembly techniques and the impact of production systems upon overall cost and manpower requirements. Modern shipbuilding procedures, with extensive capital investment requirements, are analyzed. The launching function is discussed in detail, including the relative attractiveness of end launch, side launch, graving dock construction, etc. The influence and inter-relationship of the construction procedure and the material handling and flows are developed.

This is followed in the next term by *Ship Outfitting and Auxiliary Systems*, which is a detailed development of the auxiliary equipment, piping systems, cargo gear and deck equipment, etc. The emphasis is on the installation of the equipment as the vessel is built. Preoutfit advantages are stressed and the methods of fabrication and installation are outlined for the various systems. The laboratory problems include engine room layout, piping drawings and problems relating to the installation and outfit.

Shipyard Management and Economics provides a background for future decisions involving engineering economy. The proper role of management is developed, including the various functions and responsibilities. Estimating, scheduling, work packages, control procedures and management information requirements are covered. The *Shipbuilding Laboratory* is discussed later in this portion of the paper.

Structures

Basic *Statics* is followed by a *Strength of Materials* course that concentrates on the stress, strain, and deformation of beams and columns, relating the components to the structure of a vessel. *Theory and Practice of Ship Strength*, which follows in the Senior year, deals with hull girder strength and bending. Scantlings are developed using theory and ABS Rules. The Laboratory provides an opportunity to work out I/Y and midship section data and draw various structural details. Rigging, rudder, and mast strength requirements are discussed. During the second term of the Junior year, a comprehensive course, *Metallurgy of Ships, Welding and Corrosion*, covers basic metallurgy, welding processes and procedures and the unique metallurgical requirements of the shipbuilder. The corrosion aspects of ship operation together with the effectiveness, economics and application of coatings are discussed.

The *Workboat Design* course will be discussed in conjunction with the previously mentioned *Shipbuilding Laboratory*.

Marine Engineering

Basic marine thermodynamics, heat transfer, perfect gases, internal combustion engines steam, entropy, turbines, etc., are covered in *The Theory of Marine Heat Engines* during the first semester, with a laboratory providing an opportunity to work realistic problems relating to operation of ship machinery.

During the second semester, curves of form, stability criteria, trim and floodable length are covered in *Ship Statics and Stability*. Both this course and the previously described introductory course utilize laboratory time during which ship lines are drawn along with hydrostatic curves and cross curves for stability.

The *Ship Resistance and Propulsion* course in the first semester of the Senior year covers the basic elements of ship resistance, power and propulsion requirements, propellors, shafting, stern gear, steering and rudders. *Ship Ventilation, Heating and Air Conditioning* outlines the requirements for such systems and develops in depth the problems of arrangement, installation, and testing of the systems. Ventilation and refrigeration system drawings are prepared in the problem-solving laboratory.

Supporting Subjects

The courses grouped under the heading of Supporting Subjects are simply that. *Applied Graphics* is in part computer graphics and in part graphical solutions, *Applied Calculus* is the application of calculus to the solution of industrial problems, and *Computer Language* is an introduction to computer programming. In the second semester, *Applied Mathematics* is chiefly applied differential equations. *Applied Dynamics* is simply that, and *Physical Oceanography* and *Geological-Biological-Chemical Oceanography* are essentially applied oceanography, with an emphasis on the influence of the marine environment on ship design and operation as well as its influence on the ecosphere. Neither of these two latter courses are intended to be the first courses leading to a major in the subject.

It should be pointed out that all the courses are taught using both English Units and Systéme International d'Unites (S.I.) version of metrication. It is our conviction that graduates should be comfortable with both systems because of the international nature of the shipbuilding industry.

Special Design Courses

The *Shipbuilding Laboratory* course, offered in the second semester of the Senior year, is designed to pull together into one course much of the material that has been covered previously in separate increments. The class, depending on class size, is divided into groups of three to six students. Each group is required to view itself as a shipbuilding company. All groups are then given the same problem to attack by the method that each individual group selects. As an example, the project for the senior class in the spring of 1973 was a design of a new shipyard to construct a large number of 250,000 DWT tankers. The highlight of the course is the Shipyard Design Presentation. For this presentation, the groups or companies prepare a one-hour oral presentation that is made before a Panel of Critics, made up of representatives from shipyards, design firms, United States Navy, United States Coast Guard, and other interested representatives from the maritime industry. In addition to making the presentation, the students must defend their presentation before the panel.

The *Workboat Design* course is the latest addition to the curriculum and will be initiated in the spring of 1975. In this course, the students will be required to focus upon the unique design and manufacturing problems associated with tugs, barges, and workboats up to 200 feet in length.

Efforts to relate the academic programs to the shipbuilding industry have been facilitated by the vigorous support which we have received from the shipyards and naval architects in private practice. Shipyards and governmental and private agencies have been generous in providing on-campus lecturers. These lecturers have visited the classroom to make in-depth presentations of specific areas of interest. For example, there have been presentations by Mold Loft Superintendents, Directors of Scheduling, the Director of Estimating, a Captain from the Coast Guard and so forth. This very active participation has brought six to eight visitors per year to campus and brought a substantial steel and salt water flavor to the program. In addition, we have been the recipients of many contributions of valuable data. We have received several large models, reams of data, plans and specifications of ships. In addition, our students have been the guests of numerous shipyards on field trips and tours of facilities. These tours have been "visits in depth" and have been particularly helpful in making the shipbuilding world real.

In 1973, at the conclusion of the Shipyard Design Presentation, the Panel of Critics was convened as the Curriculum Review Committee. The charge to the Committee was to review the curriculum in Marine Engineering Technology and suggest modifications either of addition or deletions. The review was to be conducted in the light of the performance of the graduates of three classes: 1970, 1971, 1972.

We were deeply gratified by the degree to which industry leaders had looked into the performance of our graduates and had familiarized themselves with the structure of the curriculum.

The results of the discussions are being utilized in the continued evolution of the curriculum in Marine Engineering Technology.

This is probably an appropriate time to summarize the changes that have been made from the original curriculum (shown in Figure 4).

At the suggestion of the Committee and in keeping with the previously stated decisions of the staff to increase the emphasis on shipbuilding, three types of changes have been made. First, significant changes have been made in content of many of the courses. Second, the sequence in which some of the courses are offered has been rearranged. Third, certain courses have been replaced in the curriculum by courses that supported the new emphasis.

The courses that have been removed are shown in parentheses on Figure 4.

It became evident in practice that an advanced course in *Engineering Graphics* including an introduction to computer graphics would be of value. This course replaced *Electronic Computing Technology*.

The course in *Fluid Dynamics* was removed. The necessary material was absorbed into *Ship Statics, Ship Resistance and Propulsion*, and *Ship Outfitting*. This opened time for another specialized course.

The four courses in *Electrical Circuits and Laboratory* were replaced by the two courses in *Applied Oceanography*.

The listing, naming and rearranging of courses is misleading if it leaves the impression that course outlines and textbooks are readily available. Actually, in the areas of applied Naval Architecture and Marine Engineering, very few formal teaching materials are available. In the areas of Shipbuilding Technology and Shipyard Operations, no American textbooks exist. We have used translations of a Russian text as well as British-published texts in an effort to put timely, printed material in the hands of the students. Publications of the Society of Naval Architects and Marine Engineers, and publications of the United States Navy have been used. The American Bureau of Shipping has been particularly gracious in supplying copies of their publications for student use. Additionally, the American Bureau of Shipping will, in 1974, include the Institute of Engineering Technology in that group of institutions to whom an outstanding senior is recognized by the award of a watch.

This scarcity of sources for curriculum material identifies one of the particular challenges faced by the teaching staff in creating and implementing the courses in the Marine Engineering Technology curriculum. The challenge has been met because of the combination of academic preparation and "real world" experience.

All faculty members hold a master's degree. Two of the present staff have degrees in Naval Architecture and Marine Engineering and one in Aeronautical Engineering. The experience of the present staff encompasses shipbuilding, ship design, marine engineering, marine transportation, structural design, manufacturing and testing. The motivating force that has welded the group together has been a deep belief that there is a career in today's world for a graduate who is interested in the application of engineering principles - engineering technology - to the building of ships.

The chart below summarizes the starting salaries which the graduates of the Marine Engineering Technology have received.

YEAR	NO. GRADUATES	NO. JOB OFFERS	LOW SAL. ACCEPTED	AVG. SAL. ACCEPTED	HIGH SAL. ACCEPTED
1970	7	13	800	833	960
1971	7	20	850	884	950
1972	6	11	850	893	950
1973	12	24	708	928	1,450

The average salary accepted by graduates is comparable to the national average of starting salaries for engineers over the same period. The number of offers per graduate has been gratifying because this period is one in which jobs have not been plentiful. The graduates of this curriculum have been employed by or are presently employed by the following companies: Avondale Shipyards, Inc.,Ingalls Shipbuilding, Newport News Shipbuilding and Dry Dock Company, Bethlehem Steel Corporation, Levingston Shipbuilding Company, J. J. McDermott Company, Main Iron Works, Inc., Mississippi Marine Corporation, Westinghouse Electric Corporation, SEDCO, Inc., Reading and Bates Drilling Company, Alabama Shipbuilding and Dry Dock Company.

Thus far, most of our graduates from this curriculum have been employed in the engineering design offices of shipyards. There is some evidence that there will be an increasing number of job offers made by the production departments of the shipyards. It is in the production departments that we anticipate that our graduates will be able to make a unique and valuable contribution toward an economical increase in productivity. Figure 3 is one view of the relationships in a shipyard that we believe that the graduates of the Marine Engineering Technology curriculum can fill in a particularly affective manner. As stated before, most of the graduates have gone to work in the Engineering Design Office and most carry the title of Naval Architect or Marine Engineer. In addition to taking positions in middle supervision in production, we feel that the breadth of their academic training will permit them to perform a role of liaison and coordination between design and production that, in time, could be of substantial value.

Thus far, relatively few of our graduates have accepted jobs or hold positions in industries that are particularly related to the production and transportation of petroleum products. We are confident that, as knowledge of the curriculum spreads and students perform well in industry, we will find an increasing number of them in industries whose principle areas of operation are in the offshore oil business.

In addition to curriculum evolution, in the future, we are looking forward to receiving applications for admission from students from high schools and junior colleges located near shipbuilding centers. To facilitate this growth, we have evolved two types of Cooperative Education programs that can be implemented with most junior colleges. These programs would permit the student to complete his Freshman and Sophomore years at a junior college near his home and completing several work periods in a sponsoring shipyard. He also would complete a work period during the summer between the Junior and Senior years.

There are several advantages to these programs.

One advantage is the increased likelihood that the graduate will be a more stable employee in a position in a familiar geographic area. There is the financial advantage that the student would have to be away from home for only two academic years. A third advantage is the experience gained in shipyard employment as a part of his academic program.

We have several shipyards exploring these programs and we may admit the first students in the fall of this year.

CONCLUSION

A curriculum has been developed to prepare its graduates for careers in both the design and production divisions of shipyards.

The curriculum was developed with inputs from the industry and continuing review permits the inclusion of new topics that relate current shipyard practice.

The success of graduates seem to indicate that the philosophy is sound.

ACKNOWLEDGEMENTS

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We are indebted to many individuals and companies and organizations for assistance and encouragement during the development years. Unfortunately, all cannot be identified here by name.

Recognition must be given to John Serrie, Vice President for Operations, Ingalls Shipbuilding Company; Charles Morris, Engineering Services Supervisor, Avondale Shipyards; Joe Williams, Vice President, Mainstream Shipyards; Joe Miller of the American Bureau of Shipping for uncommon support of the Marine Engineering Technology curriculum, its students and graduates.

Appreciation is expressed for the contributions of Mr. Clyde Leavitt, Senior Naval Architect, Ingalls Shipbuilding Company, who as Adjunct Associate Professor developed the first courses in the curriculum and Mr. J. F. Hallock, Office of Supervisor of Naval Shipbuilding, Pascagoula, Mississippi as Associate Professor of Marine Engineering Technology was the first full-time faculty member in the program and did the initial development on many of the courses.

Professor F. G. Bartlett designed the chart used as Figure 2.

The Mississippi Sea Grant program is administered by the Universities Marine Center, Ocean Springs, Mississippi.

PRE-ENGINEERING TECHNOLOGY

FRESHMAN AND SOPHOMORE YEARS

62 SEMESTER HOURS

REQUIRED COURSES		ELECTIVES
ENGLISH COMPOSITION	6	COMMUNICATIONS
ALGEBRA & TRIGONOMETRY	6	HUMANITIES
CALCULUS	6-9	SOCIAL SCIENCES
GENERAL CHEMISTRY	8	
GENERAL PHYSICS	8	
ENGINEERING GRAPHICS	6	
	40-43	22-19

Figure 1

MARINE ENGINEERING TECHNOLOGY CURRICULUM

INSTITUTE OF ENGINEERING TECHNOLOGY

TOPICAL AREAS	1ST SEM.	2ND SEM.	3RD SEM.	4TH SEM.
NAVAL ARCHITECTURE & SHIPBUILDING	INTRODUCTION TO NAVAL ARCHITECTURE AND SHIPBUILDING LAB - LINES 4	SHIPBUILDING TECHNOLOGY 4	SHIP OUTFITTING & AUXILIARY SYSTEMS LAB - INTERFERENCES 4	SHIPYARD MANAGEMENT & ECONOMICS 3 SHIPBUILDING LAB 4
STRUCTURES	STATICS 3	STRENGTH OF MATERIALS 4 METALLURGY OF SHIPS WELDING & CORROSION 3	THEORY & PRACTICE OF SHIP STRENGTH LAB - MIDSHIP SECT 4	WORK BOAT DESIGN - LAB 3
MARINE ENGINEERING	THEORY OF MARINE HEAT ENGINES LAB - PROBS 4	SHIP STATICS & STABILITY LAB - CURVES OF FORM 3	SHIP RESISTANCE AND PROPULSION 3	SHIP VENTILATION, HEATING & AIR CONDITIONING LAB - SYSTEM LAYOUT 4
SUPPORT SUBJECTS	APPLIED GRAPHICS 2 APPLIED CALCULUS 3 COMPUTER LANG. 1	APPLIED MATH 3	APPLIED DYNAMICS 3 PHYSICAL OCEANOGRAPHY 3	GEO - CHEM - BIO OCEANOGRAPHY 3

1-1474 F.G.B.

Figure 2