Int. J. Engng Ed. Vol. 13, No. 5, p. 363–368, 1997
Printed in Great Britain.

0949-149X/91 $3.00+0.00
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Student Development in Naval Architecture, Marine and Ocean Engineering Education at UNO*

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Recent changes in technology are impacting both engineering practice and engineering education. Over the past decade the UNO Naval Architecture and Marine Engineering program has grown in spite of a depressed shipbuilding/offshore industry as well as the present reduction in defense funding. The key factor of this growth is student development which is discussed in the paper.

INTRODUCTION

TODAY'S technology continues to make a large impact on engineering practice and engineering education. It has enlarged the role and scope of engineering education. This broadening is one of the focal points in the three-day NSF workshop on '*Restructuring Engineering Education: A Focus on Change*' [1]. Two of the NSF Workshop's observations were:

1. Most engineering graduates do technical work (engineering work) for only a few years after graduation, or not at all, and this appears to have had little impact on the curriculum'.
2. While engineers as leaders are needed for US competitiveness, there is the perception that upon graduation they do not aspire nor attain major leadership positions. This could be remedied by business, government and academic partnerships.

The situation has been further complicated by the reduction in the US defense industry activities and the reduction in research funding and military ship construction. This has forced a number of shipyards to pursue commercial shipbuilding projects for US and overseas operators. Taken together, the ongoing changes are occurring in three areas:

- US shipbuilding and marine industry due to the shift from US Navy/Defense activity to world-wide commercial shipbuilding.
- Technology developments in computer, software, and high-speed ship design which impact both industry and university education.
- The new ABET (Accreditation Board for Engineering) focus on integrated design curriculum.

These changes have been discussed by the author with a number of colleagues during 1993–1995 (Table 1).

These discussions included six important aspects of student development in our educational process:

- oral and written communication
- design experience
- computer experience
- laboratory experience
- student development and recruitment
- future view of naval architecture and marine engineering education.

They indicated that our experience at UNO with the Naval Architecture and Marine Engineering program had a number of unique points which are explained in this paper.

Lessons learned: growth of UNO-NAME 1981–1995

One of the NSF Workshop's recommendations is the need to recognize the needs of two groups of students:

1. traditional students who have a motivation to practice engineering;
2. non-traditional students who desire a curriculum path with significant technical content but focused on various non-engineering career objectives such as management, sales and business.

Meeting the needs of both these two groups of students was identified early in the start-up of the University of New Orleans (UNO) program in Naval Architecture and Marine Engineering (NAME) in 1981.

In 1981 the UNO-NAME classes were taught in the late afternoon and evening by a number of qualified part-time instructors. As the full-time NAME faculty were hired, these late afternoon evening classes continued. During the initial ABET

* Accepted 1 August 1997.

Table 1. Meetings reflecting current changes in US naval architecture and marine engineering education

Date	Workshop meeting	Sponsor	Attendees	Focus
10/93	US Marine Education	Office of Naval Research	Department chairs	US Marine Education
11/94	SNAME Scholarship Committee	Soc. of Naval Architects and Marine Eng.	Industry, goverment, academic	Scholarships
2/95	Research Needs	US Navy-UNO GCRMT Center	Industry, government, academic	Research & Development
9/95	ABET Evaluation Training	Soc. of Naval Architects and Marine Eng.	Academics, industry	New ABET criteria

visit in 1984, the class sizes were small, yet the complete NAME curriculum was taught. During the second ABET period 1984–1987 the number of NAME majors was 40–45 students. As of this third ABET (1994) review the number of NAME majors has increased by twenty-seven percent.

Today NAME classes are still taught in the late afternoon and evening, by full-time NAME faculty and one or two part-time instructors. Table 3 shows that the NAME enrollment has grown to the same levels at US peer institutions Webb Institute and the University of Michigan. With the present class schedule a UNO-NAME major can carry a reasonable course load and work in part-time in a marine design company for 12–20 hours a week.

Thus an effort was made to increase part-time industry jobs instead of scholarship funds so a majority of the NAME majors have worked their way through to graduation. This arrangement has reduced the number of part-time students to around 5% (4 to 5 students per term). In 1992 the University of New Orleans initiated tighter admissions requirements and subsequently increased its tuition fees. This resulted in a university-wide enrollment drop. Nevertheless, the NAME recruitment and part-time development stabilized its enrollment as shown in Table 2.

THE UNO-NAME PROGRAM AND STUDENT DEVELOPMENT

The UNO-NAME program follows the Accreditation Board for Engineering and Technology [2] accreditation guidelines. The required courses sequence and prerequisites as well as electives have been worked out so that the student can complete the Bachelor of Science NAME degree and meet all ABET and State general degree requirements. The UNO NAME curriculum has been arranged in a user-friendly flow chart. Each student has access to a personal computer file to record the courses completed.

The Naval Architecture and Marine Engineering ABET guidelines were developed by the Society of Naval Architects and Marine Engineers. These are summarized in Table 4 along with the UNO courses which satisfy the ABET criteria. The new 1995 ABET criteria has focused on several important aspects of student development.

Oral and written communication

The development of competence in oral and written English communication for NAME majors begins with the English Department's proficiency/placement test for new students. Based on the test results, students with deficiencies are placed in remedial classes. International students are enrolled in a course sequence of intensive English as a second language (ESL) if necessary. Competence in remedial and ESL classes is continually monitored. At the end of the required freshman composition classes (1157/1158) all students must pass a proficiency exam administered by the English Department to receive credit. The year-by-year breakdown in Table 5 illustrates the emphasis given to written and oral communication in the UNO-NAME course sequences. The senior design courses include a project summary and an oral presentation which is part of the final grade.

UNO-NAME ship and offshore structure design coursework

The importance of developing a continued design experience is also reflected in the NAME program. UNO-NAME student design experience begins in NAME 2150/2160 where the overview

Table 2. Growth in UNO-NAME program and US engineering graduates 1988–1995

Year	UNO-NAME majors	UNO-NAME BSE graduates	Sudent papers	US engineering graduates
1988	67	4	1	71 386 (Base)
1989	92	6	2	68 824 (96%)
1990	97	6	2	65 967 (92%)
1991	101	17	2	63 967 (90%)
1992	89	8	3	63 653 (89%)
1993	85	8	3	65 001 (91%)
1994	89	10	4	64 946 (91%)
1995	91	10	5	65 020 (91%)

Table 3. Total enrollment in US Marine Education 1994

Institution	NAME[1]	ME[2]	NA[3]	OE[4]	Totals
University of Calfornia-Berkeley			18		18
California Maritime		201			201
Flordia Atlantic University				266	266
Flordia Institute of Technology				227	227
Great Lakes Maritime		18			18
Maine Maritime		324			324
Massachusetts Institute of Technology	1			9	10
University of Michigan	80				80
University of New Orleans	90				90
State University of New York Maritime College		74	57		131
Texas A & M University at College Station				108	108
Texas A & M University at Galveston		52		90	142
US Coast Guard Academy	68				68
US Merchant Marine Academy		523			523
US Naval Academy		50	52	222	324
Virginia State University and Polytech Institute				31*	31*
Webb Institute of Naval Architechture	75				75
TOTALS	314	1242	127	953	2536

Source: The Society of Naval Architects and Marine Engineers Education Committee data.
* Freshmen, sophmores, and juniors are General Engineering.
[1] Naval Architecture and Marine Engineering.
[2] Marine Engineering.
[3] Naval Architecture.
[4] Ocean Engineering.

of ship and offshore structure design in naval architecture is introduced. Here the students deal with the classical naval architecture topics of hydrostatics, stability, and lines plan development.

Their design experience is then expanded in the junior and senior courses. Structural design and analysis aspects are taught in NAME 3120. The NAME 3120 project is the design of a ship's midship section following the ABS classification requirements. Machinery selection and propeller matching are taught in NAME 3130. In NAME 3130 the students learn how to determine engine/propeller operating points and vessel speed. Computer-aided design software are used in NAME 3140's design exercises. These software exercises include ship hydrostatics packages, the use of ship design data bases as well as optimization software. The fundamentals of ship resistance and propulsion are taught in NAME 3150. In NAME 3150 ship propulsion and propeller design problems are solved by systematic series and model test data. The fundamentals of ship vibration theory are described in NAME 3160. Various examples of ship hull/accommodation vibration, random forcing, hull vibration and ship motions are given throughout the course.

Depending upon the student's interests, he or she will complete design electives. These include:

NAME 4120—Advanced Structural Design Analysis;
NAME 4130—Advanced Marine Machinery;
NAME 4151—High-speed Craft;
NAME 4160—Advanced Hydrodynamics;
NAME 4162—Ship Motions.

The capstone design course sequence NAME 4150/4155 is then taught over two semesters, the first of which is concerned with general requirements of principal dimensions, hull form, powering, stability, outfit, and structural design. In the second semester course NAME 4155, the design project is refined and modified by the students following the instructor's suggestions as well as complying with regulatory and safety codes. The course grade is based on the report as well as the delivery of an oral presentation. With the co-operation of the Gulf Section of SNAME, UNO-NAME junior and senior level students have presented student papers at the SNAME Gulf Section of SNAME (Table 3).

Computer experience

Developing student competence in the engineering application of computers in Naval Architecture and Marine Engineering is an important aspect of the NAME curriculum. It is reinforced when the students begin their part-time marine industry. In the freshmen year, a NAME major completes CSCI 1201 (FORTRAN Programming) along with ENME 1781 (Computer-Aided Engineering Graphics). These courses are organized to develop the students ability to write programs and use CAD and other software. As a policy, NAME majors have computer exercises in each engineering course.

The NAME faculty has adopted a policy of including at least one computer exercise in each NAME course. Table 6 gives a brief summary of computer use in the UNO-NAME course sequence.

In order to support these computer activities, NAME has acquired software packages such as *SHCP, AutoYacht, Autoship, Nautilus, MacSurf, AUTO-CAD*, and *3-D BOAT*, as well as

Table 4. ABET breakdown of UNO-NAME curriculum

Science category	Course title	Course no.	Credits	Eng. hours
I. Fluid Mechanics	Fluid Mechanics	ENME 3720	3	3
	Form Calculations and Stability	NAME 2160	3	3
	Ship Resistance and Propulsion	NAME 3150	4	2
	Ship Hydro II	NAME 4160 (elective)	3	1
II Strength	Statics	ENCE 2350	3	3
	Mechanics of Materials	ENCE 2351	3	3
	Offshore Structure and Ship Strength I	NAME 3120	3	1.5
	Offshore Structure and Ship Strength II	NAME 4120 (elective)	3	1
III. Materials	Mechanics of Materials Lab	ENCE 2311	1	1
IV. Dynamics	Dynamics	ENCE 2750	3	3
	Offshore Structures and Ship Dynamics I	NAME 3160	4	4
	Offshore Structures and Ship Dynamics II	NAME 4162 (elective)	3	1
V. Energy Engineering Systems	Thermodynamics	ENME 3770	3	3
	Basic Electrical Circuits	ENEE 2500	3	3
	Electrical Machinery	ENEE 3521	3	3
	Marine Engineering I	NAME 3130	3	2
	Marine Engineering II	NAME 4130 (elective)	3	3
VI. Engineering Labs	Fluid Dynamics	ENME 3716	1	
	Mechanics of Materials	ENCE 2311	1	
	Electrical Engineering	ENEE 3518	1	
	Resistance and Propulsion	NAME 3150	1	
VII. Capstone Design	Ship Offshore Design	NAME 4150	3	
	Ship Offshore Design	NAME 4155	3	

various spreadsheets, *FEM, Mathematica*, and other packages.

Laboratory experience

One of the major issues in student development is their laboratory experience which serves to combine elements of theory and practice. The ABET laboratory experience criteria for Naval Architecture and Marine Engineering requires the laboratory program should provide experience with instrumentation for measuring physical phenomena related to naval architecture and/or marine engineering, as well as emphasizing good experimental procedures such as experiment design, data collection, analysis, and the writing of formal reports.

UNO-NAME majors complete six laboratory classes, including use of the UNO 38.3 m × 4.6 m × 0.3 to 2.1 m variable depth tow tank for the EHP and propeller labs in NAME 3150 (Table 5). The test data is collected on computer discs. The students using spreadsheet software obtain the statistics of the test data records. The average model test values are obtained and used in the final laboratory calculations in their laboratory reports.

The support of the UNO Towing Tank Laboratory has been an ongoing activity. Over $650,000 of equipment has been installed over the 1989–1995 period [3]. It can be appreciated that maintaining adequate computers, software, as well as laboratory equipment is a big challenge for the University administration as well as faculty. This has been in part met by equipment donations from the local marine industry.

Table 5. Oral and written communication in UNO-NAME courses

Year	Course	Oral	Written
Freshman (1st)	ENGR 1000	C	H
	ENGL 1157	C	E, P
	ENGL 1158	C	E, P, T
	PHYS 1063		LR
Sophomore (2nd)	ENGL 2152	OP	E, P, T
	CHEM 1023	C	LR, T
	NAME 2150	C	H, T
	NAME 2160	OP	H, T
	ENCE 2311		LR
Junior (3rd)	ENEE 2500		LR
	NAME 3120	C	H
	NAME 3130	C	H
	NAME 3140	C	H, T
	NAME 3150	OP	LR
	NAME 3160	C	H
Senior (4th)	ENGR 3090		H, T
	NAME 4150	OP	P, T
	NAME 4155	OP	P, T, SP
	NAME 4151	OP	P, T, SP
	NAME Elective	OP	SP

Key: C = Class Participation, E = Essay, LR = Lab Report, OP = Oral Presentation, P = Term Paper, SP = Student Paper for professional meeting, T = test.

Table 6. Computer usage in UNO-NAME courses.

Course	Computer programs	Computer project
NAME 3140	Hull curvature pump-pipe matching	SHCP hydrostatics
NAME 3150	Wave pattern calc. propeller chart calc.	EHP data analysis lab
NAME 3160		Vibration project
NAME 4131	Optimization calc.	Dynamic programming
NAME 4150	Various design ex.	Design project
NAME 4151	Design calc.	Database development project
NAME 4155	Design calc.	Design project calc.
NAME 4162	Design calc.	Run ship motions program

Professional development

The professional development of NAME students includes introduction to engineering procedure, interaction with industry through part-time work, and student organizations.

The importance of the student's understanding of ethical, social, safety, and economic considerations in engineering practice, as well as engineering professionalism, are areas which complement the technical education.

In addition to these required courses, NAME majors enroll in technical elective courses such as Admiralty Law, NAME 4171 taught by Admiralty Law lawyer, Maritime Management, NAME 4096, NAME 4131, Reliability, Availability, and Maintenance of Marine Systems, which covers a number of topics in the development of safety and engineering economics. These are summarized in Table 7.

The interaction between UNO-NAME students and the marine industry professionals occur in a number of ways which include:

- participation in SNAME-Gulf Section Meetings and holding a meeting each year at UNO with student papers;
- schedule of one or two field trips to shipyards and ships each semester by student section of SNAME and Propeller Club;
- seminars/visits by practicing naval architects and marine engineers;
- arrangement of part-time jobs with local naval architecture firms and shipyards.

The part-time jobs have resulted in three mutual benefits:

1. NAME students network with jobs so they can easily find employment before and after graduation.
2. The local industry gets talented young engineers and has the opportunity to develop them professionally.
3. NAME graduating senior placements is 100% in spite of down-turn in navy shipbuilding. These have in turn resulted in the development of leaders who are now taking their place in the marine industry.

FUTURE VIEW OF NAVAL ARCHITECTURE AND MARINE ENGINEERING EDUCATION

By the year 2000, a student in naval architecture and marine engineering will complete a multi-course sequence using a hull described by numerical methods such as the panel method. The students will then complete a sequence of curriculum-based course exercises to evaluate the hydrostatics, resistance, sea motions, as well as identify the structural loads for the finite element analysis of the structure. A parallel laboratory sequence will begin with the computer fairing hull definition transferring offsets into a PC-driven milling machine and cutting the hull for evaluation/validation in wind tunnels and towing tanks. Later, this hull form will be used to develop the production plan for the hull plate arrangement, curved plate forming and schedule, and production costs estimation. The classes will be run on networked personal computers. Continuing education

Table 7. Development of engineering professional practice in UNO-NAME courses

Year	Ethical	Social	Saftey	Economics
1st year	ENGR 1000 (L)	ENGR 1000 (L)	ENGR 1000 (L)	ENGR 1000 (L)
2nd year	Design mission: NAME 2150 (L) NAME 2160 (L)	Design mission: NAME 2150 (L) NAME 2160 (L) Technical Writing: ENGL 2152	Ship stability codes: NAME 2150 (L H T) NAME 2160 (L H T)	Design mission: NAME 2150 (L H T)
3rd year	Structural design: NAME 3120 (L)	Marine engineering: NAME 3120 (L)	Structure codes: NAME 3120 (L H T)	Engineering economics: ECON 2000 (L H T)
4th year	Design exercise: NAME 4150 (L T P) NAME 4155 (L T P)	Design exercise: NAME 4150 (L T P) NAME 4155 (L T P)	Design exercise: NAME 4150 (L T P) NAME 4155 (L T P)	Design exercise: NAME 4150 (L T P) NAME 4155 (L T P)
Electives	Admiralty law: NAME 4171 (L H)	Admiralty law: NAME 4171 (L H)	Admiralty law: NAME 4171 (L H T)	Maritime management: NAME 4096 (L H T)

Key: H = Homework, L = Lecture, P = Project, T = Test.

classes/workshops will also be tailored to returning engineers and offered off-site via a UNO-NAME educational web site.

CONCLUSIONS

The present slump in military and large commercial shipbuilding has raised questions on the future US programs in Naval Architecture and Marine Engineering. In contrast, the UNO-NAME program has found its niche in providing graduates who work in the Gulf Coast shipyards and design offices on a variety of commercial and military craft. The key to this has been a focus on student development.

While the NAME program is small its ratio of students (100) to faculty (5) is 20:1; this has enabled the undergraduate program to grow rapidly. It is expected this success within the area of student development will continue with the establishment of the US Navy sponsored Gulf Coast Regional Maritime Technology Center at UNO and the introduction of the Ph.D. in Applied Science and Engineering.

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