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Developing a New Program in Marine Engineering Technology

Anthony W. Dean
Department of Engineering Technology,
Old Dominion University
adean@odu.edu
Gary Crossman
Department of Engineering Technology,
Old Dominion University
gcrossma@odu.edu
Alok Verma
Department of Engineering Technology,
Old Dominion University
averma@odu.edu
Isaac L. Flory IV
Department of Engineering Technology,
Old Dominion University
iflory@odu.edu
Nidal Dahman
Department of Engineering Technology,
Old Dominion University
ndahman@odu.edu

Abstract

The Department of Engineering Technology, in the Batten College of Engineering and Technology at Old Dominion University, in conjunction with members of its advisory board and other industry representatives have begun a sustained effort to promote and develop a strong course of study in Marine Engineering Technology. Located in Norfolk, Virginia, Old Dominion University, and particularly the Department of Engineering Technology, is uniquely positioned to develop such a program. With strong ties to the world's largest Naval Base and superlative shipbuilding, maintenance and repair facilities, early qualitative research indicated high interest for development of such a program in support of one of the regions largest industries.

The Marine Engineering Technology program's goal is to provide the student with the skills necessary for success working in the commercial or naval ship design field and includes exposure to basic ship characteristics, the unique aspects of ship design, familiarization with ship construction processes and techniques, various shipboard systems, basic shipboard operations and maintenance principles and philosophies. This paper provides insight into expanding existing TAC of ABET accredited programs to meet the needs of an industry segment until the program is ready to seek independent accreditation. This paper also details the process and to-date progress of establishing this program. It also highlights the collaborative process between industry and academia in the development of new curricula to meet the needs of a particular industry segment.

Introduction

The Department of Engineering Technology [1] in conjunction with members of its advisory board has begun a sustained effort to promote and develop a strong course of study in Marine Engineering Technology. Old Dominion University, and particularly the Department of Engineering Technology, is uniquely positioned to develop such a program. Located in Norfolk, Virginia with strong ties to the largest Naval Base in the world and superlative shipbuilding, maintenance and repair facilities [2] (Virginia's Electronic Labor Market Access List names over 40 organizations employing individuals in Naval Architecture and Marine Engineering in Hampton Roads). This list includes Northrup Grumman Newport News, a $4 billion world-class shipbuilding enterprise, and the Norfolk Naval Shipyard and has resulted in high interest for development of such a program in support of one of the regions largest industries. A full scale program in this area will establish the Batten College of Engineering and Technology as a center of excellence in the area of Marine Engineering Technology. In taking full advantage of our proximity to some of the United States largest employers in this sector, opportunities for research funding and support are limitless.

Compatibility with Existing Programs

The Marine Engineering Technology program primary goal is to provide the student with the skills necessary for success working in the commercial or naval ship design field. Recommendations put forth by a panel composed of advisory board members of the Mechanical Engineering Technology (MET) program and local selected industry leaders in the Hampton Roads Maritime sector included: exposure to basic ship characteristics, the unique aspects of ship design, familiarization with ship construction processes and techniques, various shipboard systems, basic shipboard operations and maintenance principles and philosophies. Initial development has focused on creating an Emphasis in Marine Engineering Technology to complement the existing options (Manufacturing Systems, Mechanical System Design, and Nuclear Technology) in the Technology Accreditation Commission of the Accreditation Board for Engineering and Technology (TAC of ABET) accredited Mechanical Engineering Technology (MET) program [3]. Within the existing MET program, students have the flexibility to choose senior electives with options in either Mechanical Systems Design or Manufacturing Systems. Some times, students choose a combination of courses from the two areas.

Senior electives available to students in each of the two areas are given below in Table 1. A third option in Nuclear Technology is available to graduates of US Navy's Nuclear Power School or students who have completed a course of training for nuclear operators through an articulation agreement with Virginia Dominion Power [3]. These students must take MET 471, Nuclear Systems I, and MET 472, Nuclear Systems II, as part of their senior electives. By adding this fourth option in Marine Engineering Technology allows students to be in an accredited program, meeting the MET program criteria, as the new option evolves. Students in the existing options and the proposed Marine Engineering Technology Option would still take common courses in areas such as computer-aided drafting, statics, strength of materials, dynamics, thermodynamics, fluid mechanics, automation and controls, and computer solid modeling. All four options then

culminate in three senior technical electives and a senior project that integrates course work with a practical project assignment in the student's area of interest. Upper-division general educational requirements may be accomplished by completing a minor in Engineering Management.

Table 1 – Senior Electives within MET Curriculum

Manufacturing Systems	**Mechanical Systems Design**
MET 400, Computer Numerical Control in Production	MET 440, Heat Transfer
MET 410, Advanced Manufacturing Process	MET 460, Refrigeration and AC
MET 415, Introduction to Robotics	MET 450, Energy Systems
MET 430, Mechanical Subsystem Design	MET 430, Mechanical Subsystem Design
MET 445, Computer Integrated Manufacturi	EET 360, Elect. Power & Machinery
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Nuclear Technology
MET 440, Heat Transfer
MET 460, Refrigeration and AC
MET 450, Energy Systems
MET 471, Nuclear Systems I
MET 472, Nuclear Systems II
EET 360, Elect. Power & Machinery

Three new senior technical electives were developed, with the first being offered in Spring 2006. These electives [1], [3] are outlined as follows:

1. Principles of Marine Engineering I:
   This course of study includes: Fundamental Principles of Naval Architecture including nomenclature, geometry, stability, hydrostatics, structures, and motions; Ship Design Processes; and a basic introduction to Shipboard Systems such as HVAC, refrigeration, power generation, propulsion, hydraulics, electronics, cargo handling systems, seawater systems, freshwater systems, and fuel, lube and other oil systems.
2. Principles of Marine Engineering II:
   This course of study builds upon the previous course and provides a more in-depth look at shipboard systems and introduces topics such as basic shipboard operations, and ship specifications.
3. Principles of Maintenance Engineering:
   This course of study looks at maintenance systems: predictive, preventative and corrective; large scale maintenance systems, principles of reliability engineering, maritime logistics, planning for maintenance and repair, using and ordering spare parts, technical manuals, system specifications, and shipyard operations.

The development of the three additional courses, combined with existing courses at the MET senior elective level, produce the Emphasis in Marine Engineering Technology is as shown in Table 2.

Table 2 – Senior Electives within MET Curriculum
Marine Engineering Technology Emphasis

Marine Technology*
MET 440, Heat Transfer
MET 460, Refrigeration and AC
MET 450, Energy Systems
MET 475, Principles of Marine Engineering I
MET 476, Principles of Marine Engineering II
MET 485, Principles of Maintenance Engineering
EET 360, Elect. Power & Machinery

*It should be noted that additional senior elective courses are listed to accommodate those students with non-traditional degree paths with practical work experience or training in the Military and the Shipbuilding and Repair Industry. In those cases students with the assistance of the program advisor may elect to substitute a related course in lieu of MET 475, MET 476 or MET 485 based on applicable experience.

Target Student Population

Many students in the MET program enter with education and training from a wide variety of sources. Articulation agreements already exist with the Northrup-Grumman Newport News Shipbuilding Apprentice program, the Virginia Community College system, Virginia Dominion Power, and the US Navy Nuclear Power School. Many of the transferring students have some experience in the Maritime industry and are prime candidates for this program. Additionally, the Hampton Roads NROTC program (administered by Hampton University, Norfolk State University and Old Dominion University) is one of the largest NROTC units in the country. It is the belief of the MET Advisory Committee, and the special committee formed from academia, industry and the MET advisory committee, that the population exists within the region and within the existing programs to make this program is not only feasible but highly desirable to not only the student population but the employment market of this region.

The initial course offering of the course Principles of Maintenance Engineering in Spring 2006 as an elective attracted 25 students. An educational path incorporating the various routes into the program coupled with a proposed Master's level graduate program is shown in figure 1.

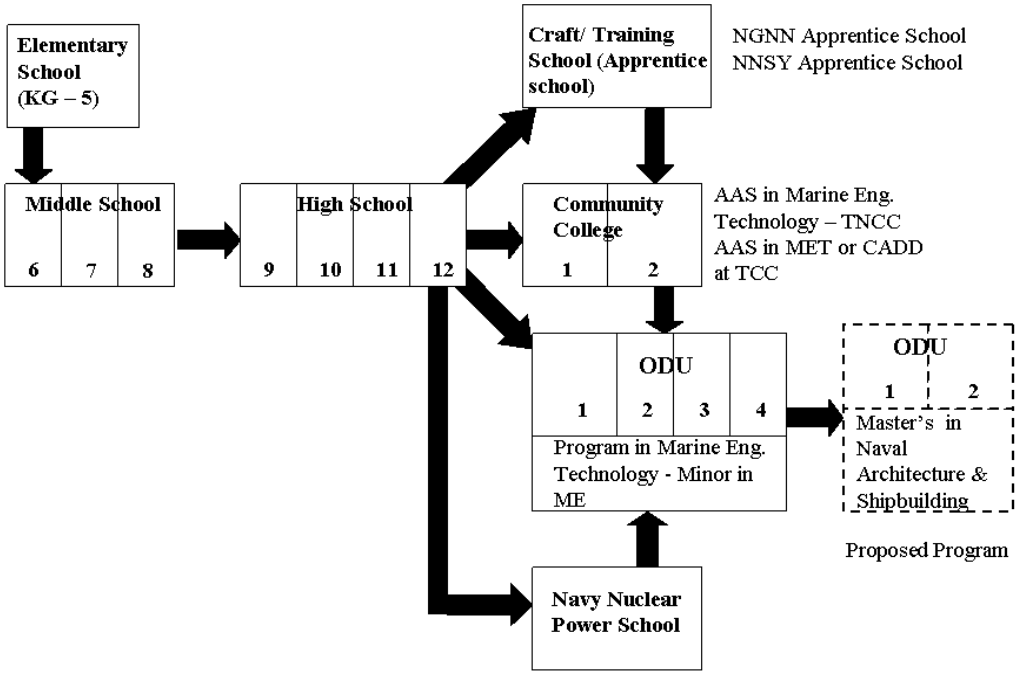

Figure 1 – Educational Path for Marine Engineering Technology Program

Comparison with Existing Marine Technology Programs

A search of TAC of ABET [4] accredited marine technology programs yielded two for comparison (California Maritime Academy and the Maine Maritime Academy). Other programs, such as the Marine Engineering Technology program at Texas A&M at Galveston, were not reviewed due to lack of TAC of ABET accreditation. The proposed program at Old Dominion University differs from these two existing programs in that it is not affiliated in a manner to obtain licensure as a 3rd Assistant Engineer from the US Coast Guard, but is focused to support the shipbuilding and repair operations of the Hampton Roads Area. The core curriculums of both accredited Marine Technology programs were very similar to the existing MET program at ODU. By adding the three electives at the senior level to create an Emphasis in Marine Engineering Technology this allows for the introduction of marine applications of theory taught in the core of the existing curriculum.

Laboratories

Current Laboratories have experimentation directly relating to the Emphasis in Marine Engineering Technology, and faculty have been requested to introduce new experiments in the existing courses to reflect the close relationship with the Hampton Roads Shipbuilding and Repair industry. In comparison to the full programs offered at the aforementioned schools, a great deal of the laboratory instruction is incurred during assignments to training on the schools training vessels and Merchant vessels. However, for students in the ODU program there is ample opportunity for Co-operative education and internships with a wide variety of Shipbuilding and maritime organizations [2] through out the region.

Faculty Expertise

Sufficient faculty expertise and work experience currently exists within the Department of Engineering Technology for initial development and implementation of some of the electives outlined by the spring 2006 semester. Existing faculty members have strong ties to the US Navy and the Maritime industry [1]. One served as an officer aboard submarines, another was a former enlisted nuclear operator aboard both aircraft carriers and nuclear cruisers and still another was a graduate from the US Merchant Marine Academy and spent several years as a Merchant Marine. Additionally, several faculty within the department are involved with various research projects with the US Navy, area ship repair facilities and Northrup Grumman Shipbuilding. Many of our faculty are active in the American Society of Naval Engineers.

Faculty expertise will be further strengthened by the addition two additional tenure-track faculty in the area of Marine Engineering Technology. One position will be housed within the MET program. Minimum qualifications this individual, as determined by the advisory board, would be a Master's degree in Marine or Mechanical Engineering, Technology or a related field. Registration as a professional engineer is preferred. Several years experience in the marine industry, with expertise in at least one of the following areas: naval architecture, ship operations, ship maintenance and shipbuilding is required. Candidates should have a demonstrable teaching proficiency. The other position will be housed in the Electrical Engineering Technology program and will require prior industrial experience and successful teaching experience in the areas of basic circuit analysis, electronics, and fundamental digital circuits. Additional expertise related to technology, communications, electromagnetics, and control systems as related to marine shipboard electrical technologies and the general maritime industry. Minimum educational background is a master's degree in electrical engineering or engineering technology or closely related area. A Ph.D. and/or professional registration are preferred.

In addition to course offerings with in the MET program, Old Dominion University's School of Business and Public Administration also houses the ODU Maritime Institute which offers courses in areas related to port operations, maritime transport, international supply chain management and logistics. Beginning in the Fall of 2006 the School of Business and Public Administration will begin offering a Bachelor in Science in Maritime Logistics [3]. Within the College of Engineering and Technology, there is a proposal requesting a Master's in Naval Architecture and Ship Building. Students interested in additional course work may continue their

education in those operations related to the maritime industry, with the possible attainment of a graduate degree in either Engineering or Business.

Current Status of the Program

The initial offering of the first course in the program was in the Spring of 2006. The course offered was the MET 485 – Maintenance Systems Engineering [3]. Since the development of the program occurred during the 2004-2006 ODU course catalogue, the initial course was taught as an MET 495– Topics course while awaiting the publication of the 2006 -2008 ODU course catalogue. Student response to the course offering was strong with a final registration of 25 students. Learning objectives for the course were as follows:

Learning Objectives:
Students taking this class will demonstrate understanding of:

1. Reliability concepts
2. Maintainability Concepts
3. Cost Associated with Maintenance
4. Parts/Supply Logistics Support
5. Equipment effectiveness
6. Maintenance Management Information Systems
7. Maintenance Planning
8. Measures of Effectiveness

Since the instructor felt that there was no one specific text currently available, "Reliability for Technology, Engineering and Management," by Paul Kales [5] was selected to emphasize the mathematical concepts of reliability engineering and its role in maintenance strategy , but was supplemented by many other sources available to the students specifically MIL-HDBK-470A – Designing and Developing Maintainable Products and Systems – Revision A, MIL-STD-471 – Maintainability Verification/Demonstration/Evaluation – Revision A, and MIL-HDBK-742 – Maintainability Prediction [6]. These documents are readily available online for access by the students.

Additionally the course was supplemented by the presence of guest speakers from the local shipbuilding and repair industry who developed and prepared cases for student discussion. Most notably Mr. John Galle, from AMSEC, LLC, who appeared twice before the class had an enormous impact on the students as he transformed the material the students had learned in the course and showed them the real world applications of the theory.

Assessment

Students' course evaluations ranked the class very high. When asked the question: "Overall, I have learned or benefited from this class?" The student evaluation average for this first course offering was a 4.53 out of a possible 5.0 (as compared to the departmental and college averages of 4.18 and 4.21 respectively) [7].

Faculty assessment of the course followed the assessment guidelines set forth by the Department of Engineering Technology [8]. The assessment instrument used in the first offering was the Final Exam which tested the competency of the student in all the course learning objectives. Figure 2 details the competency of the students in meeting the determined course outcomes based on their performance on the comprehensive final exam.

Course Assessment

MET-495, Maintenance Systems, Spring 2006

Obj.	Learning Objective	Method	Q-1	Q-2	Q-3	Q-4	Q-5	Q-6	Q-7	Q-8	% comprehensio
O1	Reliability concepts	Final Exam	84%	76%			78%		87%		81%
O2	Maintainability Concepts	Final Exam		76%			78%		87%		81%
O3	Cost Associated with Maintenance	Final Exam			96%	92%		87%			92%
O4	Parts/Supply Logistics Support	Final Exam				92%		87%		71%	83%
O5	Equipment effectiveness	Final Exam	84%		96%		78%		87%		86%
O6	Maintenance Management Informa	Final Exam						87%		71%	79%
O7	Maintenance Planning	Final Exam		76%	96%						86%
O8	Measures of Effectiveness	Final Exam					78%			71%	75%
							Final Exam Average Score				83%

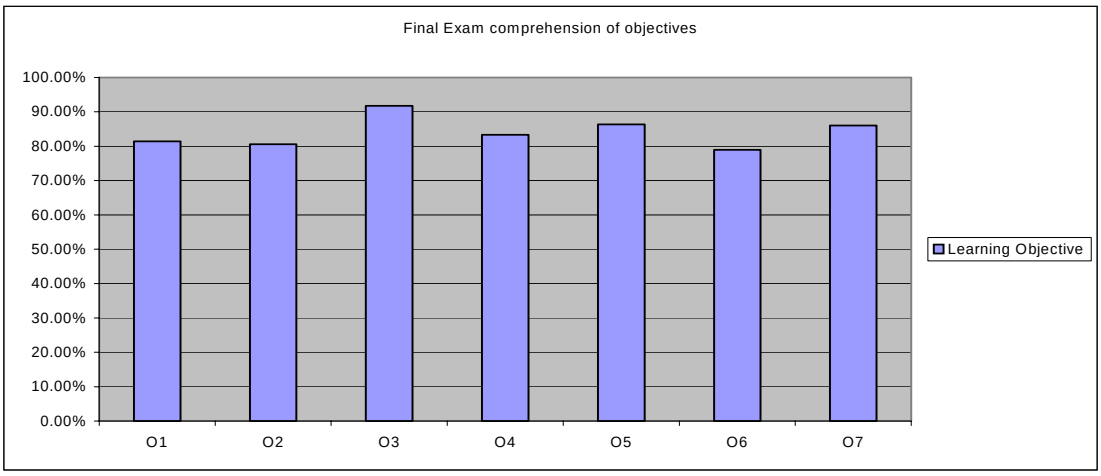

Figure 2 – Departmental Course Assessment for MET 495: Maintenance Systems

The assessment process for the full program will be in compliance with the existing Department of Engineering Technology assessment process [8], as shown in Figure 3. An industry advisory committee [has been established from the local maritime industry. Members include: Dr. James Hughes – Manager Academic Programs - Apprentice School- NGNN; Capt. Malcolm Branch, USN (ret.) – Executive Director – Virginia Ship Repair Association; Ms. Norine Bradshaw – Senior Manager – AMSEC, LLC; Mr. Doug Smith – Six Sigma College –NAVSEA; and Capt. Dick Whalen, USN (ret.) – Military Affairs Liaison – ODU. The industry advisory committee, program and departmental faculty, and the college's assistant dean for assessment will continually monitor and guide the program toward its initial accreditation.

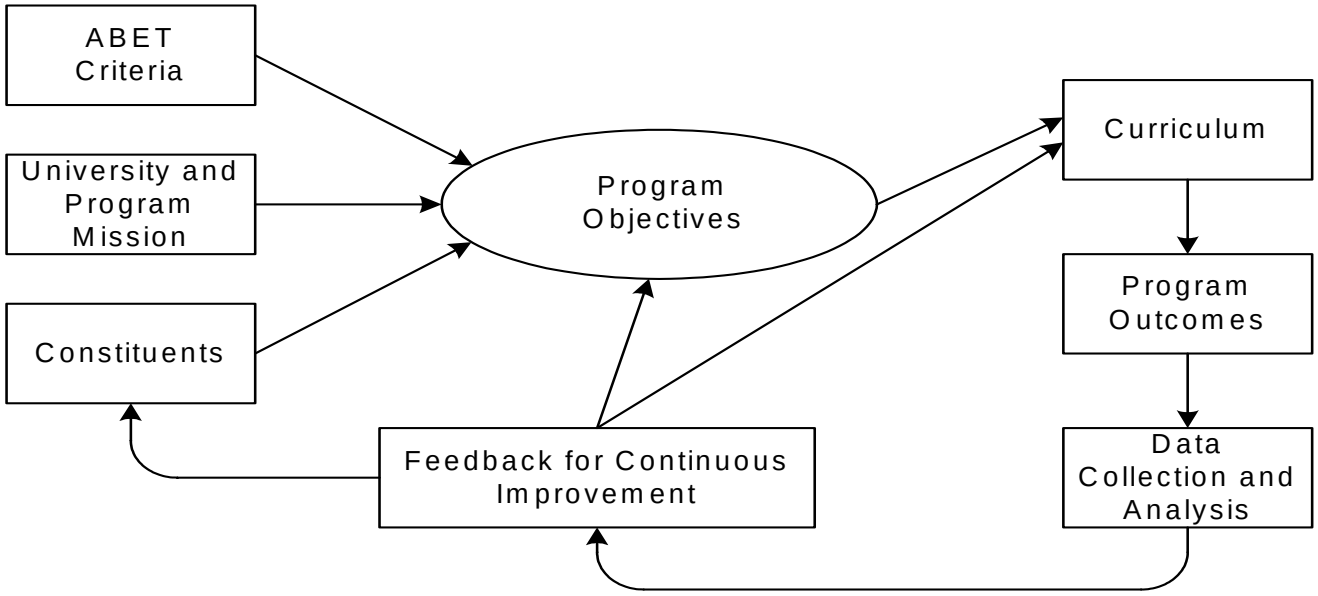

Figure 3 – Department of Engineering Technology Program Assessment Process

Conclusion

To continue the growth of the program, an instructor was hired to begin the fall of 2006 and course offerings for Marine Systems I and II have been added to the Fall 2006/Spring 2007 schedules. Additionally the Department of Mechanical Engineering is looking into the viability of cross listing one or more of the Marine Technology courses as electives for their students as well. Particular interest is in the MET 485 Maintenance Systems Engineering course.

With minor changes to the existing MET program will result in the ability to offer an interdisciplinary program in Marine Engineering Technology, which is compatible with current two-year programs in Marine Engineering Technology being offered at Thomas Nelson Community College, Tidewaters Community College, and the Northup Grumman Newport News Apprentice School. In this proposed curriculum, Marine Engineering Technology will be introduced at the freshman level with its incorporation into the colleges Freshman Engineering Program - Exploring Engineering and Technology 1and II. Additional courses in Basic Ship Building, Naval Architecture, Marine Electrical Systems, and Marine Husbandry and Support Facilities will be offered in the sophomore and junior years. The student will then take the currently developed MaET senior electives to round out the degree. It is also anticipated that this full degree plan will provide the regions maritime industry better prepared co-op and intern candidates, and allow for input back into the program to properly access the effectiveness of the courses being offered to develop the types of individuals needed to meet our regions largest industry. A four-year Bachelor of Science in Marine Engineering Technology has been in development. A conceptual plan for this degree, based on the current MET degree plan is presented in Table 3.

Table 3 – Proposed MaET Curriculum Marine Engineering Technology

Year and Semester	Course (Dept., Number, Title	Category (Credit Hours)				
		Communications	Mathematics	Physical & Natural Science	Social Science & Humanities	Technical Content
1-1	MET 100, Engineering Graphics					3
	ENGN 110, Explore Engineering & Tech I					2
	MATH 162M, Precalculus I		3			
	CHEM 115N, Foundations of Chemistry			4		
	ENGL 110C, English Composition	3				
1-2	MET 230, Computer-Aided Drafting					3
	ENGN 111, Explore Engineering & Tech. II					2
	MATH 163, Precalculus II		3			
	PHYS 111N, General Physics			4		
	Gen Ed, Literary Perspective (L)				3	
2-1	MaET200,Basic Ship Building Processes					3
	CET 200, Statics					3
	MATH 211, Calculus I		4			
	PHYS 112N, General Physics II			4		
	ENGL 131C, Intro to Technical & Scientific Writing	3				
2-2	CET 220, Strength of Materials					3
	OTS 231, Materials and Processes Technology					3
	MET 240, Computer Solid Modeling					3
	COMM 101R, Public Speaking	3				
	Gen Ed, Social Science Perspective (S)				3	
3-1	MET 300, Thermodynamics					3
	MET 310, Dynamics					3
	MaET 320, Basic Naval Architecture					3
	CET 345, Materials Testing Laboratory					1
	EET 305, Advanced Technical Analysis		4			
	MaET 350, Marine Electrical Systems Technology					3
	EET 355, Electrical Laboratory					1
3-2	MET 330, Fluid Mechanics					3
	MET 335, Fluid Mechanics Laboratory					1
	MET 350, Thermal Applications					3
	MaET 360, Marine Support Facilities					3
	MET 370, Automation and Controls					3
	MET 386, Automation and Controls Laboratory					1
	Gen Ed, Upper Div Cluster (or Minor)*				3	

Year and Semester	Course (Dept., Number, Title	Category (Credit Hours)				
		Communications	Mathematics	Physical & Natural Science	Social Science & Humanities	Technical Content
4-1	MET 387, Power and Energy Laboratory					2
	MaET Senior Elective (MET 475)					3
	MaET Senior Elective (MET 485)					3
	ENGN 401, Fundamental of Engineering Review					1
	Gen Ed, Upper Division Cluster (or Minor)*				3	
	Gen Ed, Historical Perspective (H)				3	
4-2	MaET 435W, Senior Design Project					3
	MaET Senior Elective (476)					3
	Gen Ed, Upper Division Cluster (or Minor)*				3	
	Gen Ed, Fine & Performing Arts Perspective (A)				3	
	Gen Ed, Philosophical Perspective (P)				3	
TOTALS REQUIRED FOR DEGREE		9	14	12	24	68
PERCENT OF TOTAL		7.1	11.0	9.5	18.9	53.5

* A minor requires one additional three credit course (a total of four). Most MaET majors may choose to Minor in Engineering Management or some other technical area which would increase the technical content of the program.

References

[1] Engineering Technology Department, Frank Batten College of Engineering and Technology, Old Dominion University. http://www.eng.odu.edu/et/academics

[2] Commonwealth of Virginia, Employment Outlook, www.velma.vec.state.va.us

[3] Old Dominion University, University Catalog 2006 – 2008

[4] Accreditation Board for Engineering and Technology (ABET) http://www.abet.org/schoolareatac.asp

[5] Kales, Paul, "Reliability: for technology, engineering and management," Prentice-Hall, Upper Saddle River, NJ, 1998

[6] Military Standards and Handbooks Relating to Reliability, http://www.weibull.com/knowledge/milhdbk.htm

[7] Old Dominion University, Course Evaluation-Aggregate MET 495 Topics: Maintenance Engineering Spring 2006, https://jasper.ts.odu.edu/Apps/CES/CES06SP.nsf/b24b769d1d3bbbfe85256e450065aa7e/5c0bad53e4ac109985257176004e3083?OpenDocument

[8] Self Study Report – MET Program , Engineering Technology Department, Frank Batten College of Engineering and Technology, Old Dominion University, 2005

Biographies

ANTHONY W. DEAN is Assistant Professor of Engineering Technology at Old Dominion University. He received a Ph.D. in Engineering Management and a B.S. in Engineering Technology from ODU. Additionally, Dr. Dean received an MBA from the College of William and Mary. Prior to his appointment, Dr. Dean was Director of Operations and Business Development for Clark-Smith Associates, P.C., and served as a Nuclear Electrician in the U.S. Navy aboard the USS South Carolina and the USS Enterprise.

GARY R. CROSSMAN is Department Chair of Engineering Technology and Professor of Mechanical Engineering Technology at Old Dominion University. Professor Crossman has over 35 years of experience in engineering technology education. He holds a Bachelor's degree from the U.S. Merchant Marine Academy and a Master of Engineering degree from Old Dominion University. He has been very active in the Engineering Technology Division and the Engineering Technology Council of ASEE, holding several positions in ETD, including chair. He has also been active in TAC of ABET as a commissioner and the American Society of Mechanical Engineers.

ALOK K. VERMA is Ray Ferrari Professor and Director of the Mechanical Engineering Technology program at Old Dominion University. He also serves as the Chief Technologist of the Lean Institute at ODU He received his B.S. in Aeronautical Engineering, MS in Engineering Mechanics and PhD in Mechanical Engineering. He joined the Mechanical Engineering Technology Department at ODU in 1981. He is a licensed professional engineer in the state of Virginia, a certified manufacturing engineer and has certification in Lean Manufacturing. His publications are in the areas of Fluid Dynamics, Advanced Manufacturing Processes, CAD/CAM, and Robotics. Alok Verma has co-edited the proceedings of the International Conference on CAD/CAM & Robotics for which he was the general chairman. He is active in ASME, ASEE and SME.

ISAAC L. FLORY IV is an Assistant Professor of Engineering Technology at Old Dominion University, teaching courses in power distribution, energy conversion, electronics and technical analysis. He has received B.S. (1984) and M.S. (1993) degrees in Electrical Engineering from Virginia Tech and is currently pursuing his Doctorate from the same institution (a.b.d.). He served in many positions as an employee of Hubbell Lighting Incorporated including Manager of Electrical Engineering and Intellectual Property Coordinator. He as been awarded 25 United States Patents and is a licensed Professional Engineer in the Commonwealth of Virginia.

NIDAL DAHMAN is currently the coordinator of the surveying engineering and Geomatics program at ODU. He holds a Ph.D. in civil and environmental engineering from the University of Wisconsin-Madison. He is a certified Photogrammetrist by the American society of photogrammetry and remote sensing (ASPRS) he is also an ASPRS-certified Remote Sensing Mapping Scientist and an ASPRS-Certified GIS/LIS mapping scientist. His research interests are modern geomatics, digital photogrammetry, active and passive remote sensing and in modern sensors and sensor data fusion.