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Developing a Distance Learning Curriculum for Marine Engineering Education

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ABSTRACT

Starting in 2013, Old Dominion University has been developing a distance learning curriculum for marine engineering education. This initiative is being carried out in response to industry and Navy demand to maintain a professional marine engineering workforce, and complements Old Dominion Old Dominion University's high rate of success in distance learning education and other marine engineering initiatives over the past 15 years. Prior to 2016, two marine engineering courses were developed for, and launched in, a distance-learning format. These courses are: Introduction to Naval Architecture and Marine Propulsion and Auxiliary Systems. In 2016, two additional courses are developed for, and launched in, a distance-learning format. These courses are Marine Power and Energy Systems and Maintenance Engineering. This paper presents an overview of the curriculum, traditional and unique pedagogical methods implemented in the distance learning courses, assessment of the course offerings, and recommendations to be implemented in the curriculum development and future course offerings of Old Dominion Old Dominion University's distance learning marine engineering education program.

INTRODUCTION

Old Dominion University, located in Norfolk in the metropolitan Hampton Roads region of Virginia, is a dynamic public research institution that serves its students and enriches the state, the nation, and the world through rigorous academic programs, strategic partnerships, and active civic engagement.

Hampton Roads region is a great location for naval and marine engineering with significant naval facilities supporting research and development, testing, operations, logistics and maintenance, and a robust industrial base in vessel design, construction and repair. The region also serves as the home port for United States Coast Guard, United States Army watercraft facilities, vibrant commercial ports and an abundance of recreational boating. Hampton Roads is home to approximately 83,000 active duty military personnel. Old Dominion University maintains close partnerships with the military branches of service, in particular the US Navy, as well as the maritime, shipbuilding and ship repair industries in the Hampton Roads region. In response to the needs of the maritime stakeholders from military, government and industry, Old Dominion University is expanding its faculty, research, curriculum, facilities infrastructure, and student engagement programs.

This paper discusses Old Dominion University's distance learning curriculum for marine engineering education. This initiative is being carried out in response to industry and Navy demand to maintain a professional marine engineering workforce, such as reported by the National Shipbuilding Research Program [1], and complements Old Dominion University's high rate of success in distance learning and marine engineering education over the past 15 years. Prior to 2016, two marine engineering courses were developed for, and launched in, a distance-learning format. These courses are: Introduction to Naval Architecture and Marine Propulsion and Auxiliary Systems. In 2016, two additional courses are developed for, and launched in, a distance-learning format. These courses are Marine Power and Energy Systems and Maintenance Engineering. This paper presents an overview of the curriculum, traditional and unique pedagogical methods implemented in the distance learning courses, assessment of the course offerings, and recommendations to be implemented in the curriculum development and future course offerings of Old Dominion University's distance learning marine engineering education program.

NEW NAVAL ENGINEERING AND MARINE SYSTEMS INSTITUTE

The Naval Engineering and Marine Systems Institute (NEMSI) was founded in 2014 in Old Dominion University with the vision to build a robust, sustainable center of excellence that supports the Naval Enterprise and Marine Industry in research and professional workforce development.

As outlined in Reference [2], NEMSI's vision is to:

- Expand Old Dominion University's research capabilities to assist the Navy and industry in addressing complex challenges in design, construction, operations and modernization of marine vessels for military, commercial and recreational use.

- Promote curriculum and lab advancements, faculty-student research at the undergraduate and graduate level, and student engagement and retention initiatives to produce an engineering workforce that meets the national competitive needs of the navy and marine industry constituencies.

- Build strategic partnerships with public and private stakeholders within Hampton Roads, State of Virginia and nationally and foster government-academia-industry collaboration.

DISTANCE LEARNING UNDERGRADUATE CURRICULUM

Old Dominion University offers undergraduate and graduate degrees in the following engineering disciplines: aerospace engineering, civil engineering, computer engineering, electrical engineering, engineering technology, mechanical engineering, and modelling, simulation and visualization engineering. Old Dominion University added a marine engineering minor to the list of available programs in response to demand signal from industry and the naval enterprise, including the report from Kiss (2011) regarding statistics on existing marine engineering programs within the United States [3].

MARINE ENGINEERING MINOR

Existing and new faculty with marine experience add significant value to Old Dominion University's Marine Engineering Minor, open to all engineering students. The minor is a four-course requirement at the 400-level. Courses include:

- Principles of Naval Architecture
- Marine Propulsion and Auxiliary Systems
- Marine Power and Energy Systems
- Maintenance Engineering

Starting in 2016, all courses are offered in a distance learning format. Old Dominion University is one of the nation's largest providers of online distance learning courses and has been a pioneer in technology delivered distance learning since the mid-1980s. Over 11,000 degrees have been conferred through online and distance learning programs.

Principles of Naval Architecture

This course includes fundamentals of ship and marine vessel design, including ship geometry, stability, structures, resistance and propulsion, and shipbuilding and construction of marine vessels. Students learn how these topics apply to naval and commercial ships, sailing vessels, and recreational small craft. This course includes lecture, hands-on learning methodologies, software and labs to reinforce the course concepts.

Course is offered in the Fall semester and consists of lecture 3 hours; 3 credits. Pre-requisites: strength of materials; fluids. Course was first offered in Spring 2014, Fall 2014 and Fall 2015.

Required Course Textbook: Applied Naval Architecture by Robert B. Zubaly, 1996 [5]. Course material supplemented with instructor material.

Software (online) / Labs: GHS, Rhino, ORCA 3D, Ship Stability Simulator, Shipyard tour, Principles of Sailing lab, overview of CFD for marine applications.

Students must conduct an independent research project on a topic pertaining to naval architecture. The instructor gives several suggested topics to show the breadth of topics that could be selected. All students are required to submit their proposed topic and abstract to the instructor for approval. Students could also work in pairs, however the requirements (depth of research and length of paper) are increased accordingly. Students submit a draft and the instructor provides feedback. Students then submit the final paper along with an oral presentation and have the option of presenting in person to the class or creating a pre-recorded lecture on their topic.

Students are assessed of their course knowledge and understanding based on homework assignments, quizzes, and comprehensive final exam.

Marine Propulsion and Auxiliary Systems

This is an introductory course in marine engineering propulsion and auxiliary systems, including principles of energy conversion and operation of internal combustion engines, marine gas turbine engines, conventional and nuclear steam plants, and operating principles of shipboard auxiliary systems and components. At the completion of this course, students will possess the engineering knowledge to understand, analyze and communicate effectively on technical topics regarding shipboard engineering systems.

Course is offered in the Spring semester. Lecture 3 hours; 3 credits. Pre-requisites: thermodynamics; fluids. Course was first offered in Spring 2015 and is currently offered in Spring 2016.

Required Course Textbook: Principles of Naval Engineering: Propulsion and Auxiliary Systems by Matthew Carr, 2012 [6].

Software / Labs: Will incorporate software and labs from upgraded Fluid Power Systems Lab (2016). Ship tour planned.

Students are assessed of their course knowledge and understanding based on homework assignments, quizzes, and comprehensive final exam.

Marine Power and Energy Systems

The main objective of this course is to provide an introductory understanding of electrical power and energy systems for marine platforms including ships and submarines. The course covers AC and DC marine systems, power distribution design, power generation, energy storage, electric

propulsion, power management, system protection, condition monitoring, electrical system maintenance and class rules.

Course is offered for first time in Spring 2016 and will be offered in the future in the Fall semester. Lecture 3 hours; 3 credits. Pre-requisites: Fundamentals of Electrical Technology, Introduction to Electrical Power, Electrical Power and Machinery, or equivalent.

Required Course Textbook: Shipboard Electrical Power Systems by Mukund Patel [7].

Software / Labs: MATLAB, will incorporate labs from planned Marine Power and Electrical Systems Lab (2016).

Students are assessed of their course knowledge and understanding based on homework assignments, quizzes, and comprehensive final exam.

Maintenance Engineering

This course 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. Course uses a mixture of theoretical and application engineering techniques geared toward the Marine Industry to introduce the student to different best practices.

Lecture 3 hours; 3 credits.

Software / Labs: Will incorporate software/lab from upgraded Fluid Power Systems Lab (2016). Shipyard and ship tour planned.

Required Course Textbook: Maintenance Engineering Handbook, Eight Edition [8]. Course material supplemented with instructor material.

Students apply knowledge gained through course to 4 real-world case studies.

Students are assessed of their course knowledge and understanding based on homework assignments, quizzes, and comprehensive final exam.

PEDAGOGY

Faculty integrate technology, hands-on learning, individual research and professional development in the marine engineering minor courses. Faculty include assignments where students use advanced design software tools used in industry, which are accessible to students using Old Dominion University's virtual computer lab so students can access software from anywhere in the country. Faculty host guest lectures from industry leaders including virtual lectures so speakers can log in remotely and interact with the class from their own office.

Old Dominion University faculty capitalize on the diversity in their classrooms, which includes traditional students (high school direct to college), active duty and military veterans, students with

work experience pursuing an engineering degree. This diversity brings much more depth and peer-to-peer learning to the classroom, as discussed in [2]. All courses are taught in distance learning format. Students can attend "live" lecture on Norfolk campus, at Old Dominion University centers throughout the region, or watch the course through Adobe Connect / Webex at home. Recordings are available as archive lectures through semester.

Expanding teaching and research lab capabilities in the Marine Dynamics Lab, Marine Power and Energy Lab, Fluid Power Systems Lab and Advanced Manufacturing Lab will further enhance student learning in marine engineering courses.

ASSESSMENT

Student feedback has been very positive, and reflects that faculty are enthusiastic and very knowledgeable about the subjects; that lectures and in-class examples complement the textbook; and that the course work is challenging.

Some of the anonymous student feedback:

- The class was interesting as well as the instructor.

- The instructor was exceptional! Her knowledge of the material was vast and she did an excellent job in explaining it to us. She was not only helpful in the course material but gave us plenty of time to read the book and comprehend the homework assignments.

- She has been one of the best instructors I have had in my collegiate career and I look forward to taking more of her classes in the future.

Faculty feedback has been very positive. Some faculty critique include:

- Will continue to include more examples (both real world and worked/calculations type examples) on Blackboard during the particular unit so that students can have more contact hours outside of lecture.
- Will continue to integrate virtual labs and software into the curriculum.
- Will structure the course so that students carry out analyses for each of the learning modules on the same design (hull form) so students get to personally experience the "design spiral" that is fundamental to ship design.

CONCLUSIONS

The Naval Engineering and Marine Systems Institute serves as a focal point to connect the Navy and industry partners with high-quality research carried out by Old Dominion University faculty and also serves as a pipeline for engineering students, educating them on the different facets of marine engineering, and helping to develop the next generation of naval engineers. Over the past several years, NEMSI offers a marine engineering minor delivered both on campus and in a

distance-learning format. This program will continue to evolve and improve based on feedback from all stakeholders including students, graduates, faculty, Navy and industry leadership.

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