

## **Project-oriented MS Degree in Engineering Technology Emphasizes Educational Depth**

**Ralph A. Carestia, Douglas W. Lynn and J. Robert Burger**

**Graduate Faculty, Computer Systems Engineering Technology Department,  
Oregon Institute of Technology, Klamath Falls, OR 97601**

### Abstract

Engineering technology at Oregon Institute of Technology (OIT) today maintains a hands-on, practical mode that not so long ago characterized much of engineering education. Since 1967, the Technology Accreditation Commission of the ABET has accredited many colleges who now grant thousands of baccalaureate degrees in engineering technology each year. Recently, in response to a demand from the high-tech industry, OIT in 1995 created a new Master of Science in Engineering Technology. Ideally, we grant the degree after 4 quarters of full-time graduate work, including core courses in research methods, ASIC design technologies, data communications, and computer systems architectures. Of the 48 quarter-hours minimum required, 12 hours are for a project, the most important part of the program. Because OIT is not a research organization for doctorates, our terminal MS degree in engineering technology is considered first rate on this campus. Below we describe the program as it now exists, including case histories of our first graduates.

### I. Introduction

Peterson's Graduate and Professional Programs (An Overview 2000) obtained entries from 127 institutions, each advertising their graduate programs in the area of Computer Engineering. Within this category, only 23% offer a master's as their highest available degree. Of these, mere handfuls offer the Master of Science degree pertaining to Computer Engineering Technology<sup>1,2</sup>. Why so few?

It is partly because teaching is very different from research. Many believe that the quality of research is a standard indicator of the quality of a graduate school<sup>3</sup>. In other words, under this approach, if you want quality, you must have strong research. Strong research implies doctorates, not masters degrees.

Another reason for so few MS programs in computer engineering technology is because laboratories are expected in such programs, in the author's experience. This means there must be space, and a budget for laboratories. Having significant graduate laboratories for graduate courses does not fit well into research programs. For example, UCLA and Berkeley, Dr. Burger's alma maters, have very few graduate laboratories associated with graduate courses<sup>4,5</sup>.

For many decades now, the standard model of a graduate education is one that culminates with a doctorate at the top. There are good financial reasons for this, although some are now evaporating. Graduate schools have been driven by money from the government for big projects, including space exploration, missile defense, and military research. For financial and other reasons, graduate students are engaged directly and indirectly to help with the research. The need for funding has directed many a career in academia, and government funding obviously affects the material that is actually taught.

This research-based, doctorate-driven model has disadvantages for an MS student. To be practical, MS and Ph.D. candidates must share the same classes with the same faculty. Unfortunately, the material needed for a doctorate is quite different from the material needed for the MS degree. Doctorates use more theory and fewer labs. Heavy laboratory support in graduate school is rare, since a healthy research effort would fill available space with specialized equipment.

The National Science Foundation (NSF) seems to recognize the problem, at least abstractly. For example, the power of government funding is now being used to pressure university researchers funded by the NSF to develop curricula<sup>6</sup>.

MS degree programs that double as a step in the doctoral process tend to shape themselves to the doctorate model with a core that is heavy with classical engineering. Such broad-based cores can be a problem if a student does not learn enough about a professional specialty. MS students need a professional orientation. This worldly objective differs significantly from the goals of a doctoral program, which includes approaching a frontier of knowledge, and to gain a teaching credential.

To better serve graduate students, we need options; for example, courses with laboratories for MS students that are separate from those Ph.D. students take.

## II. Project-oriented Model

The alternative to research-oriented education is a project-oriented education. There is a classical model that can be traced to Aristotle, "For the things we have to learn before we can do them, we learn by doing them." Our spin on Aristotle is that we can indeed learn by doing, even for the things that we do not need to know until tomorrow. Clearly many things in life are learned by doing, for examples, musical instruments, dance maneuvers, and computer operating systems.

Under this model, funding comes partly from industry in one form or another. The following ideas come to mind: 1) equipment grants, 2) contracts for marketing work, 3) contracts for prototype design, 4) agreements for co-operative education, 5) recruiting deals, 6) part-time jobs to support and educate faculty, 7) funding for joint efforts in product development, and 8) continuing education support.

So called institutional funding comes from the state in the case of public colleges; private colleges rely on alumni in most cases, as can be judged by the existence of powerful alumni organizations. A survey in 1996-97 indicated that a total of 4,009 institutions whose programs are 4 years and more, 613 were public, 1,510 were private non-profit, and 144 were private for-profit<sup>7</sup>. Public usually means state, since there are few federal universities. However, there are exceptions such as Naval Postgraduate School<sup>7</sup>.

The OIT MS degree is supported significantly by local industries that are in the business of high technology. Supporters include such famous names as Intel, LSI Logic, Sequent, Mentor Graphics, Tanner Research, OrCAD/Cadence, Altera, Xilinx, Synopsys, Hewlett Packard, and others. We constantly need and seek support because of the persistent growth in technology.

Thus we arrive at the concept of a project-oriented MS degree in Computer Engineering Technology, in which learning is driven by two roughly equal factors: class work and lab work.

### III. History of the Oregon Institute of Technology MS Degree

Originally, the Engineer's Council for Professional Development accredited an associate's degree in Surveying and Structural Engineering Technologies in 1953. Bachelor's degrees were accredited by ABET (Technology Accreditation Commission) in 1970. In 1989 the State Board authorized OIT to grant master's degrees, first offered in 1995. So far there are only 3 graduates from the MS degree program. The Klamath Falls campus can accept about ten students per year into the MS degree program. In contrast, undergraduate computer engineering technology (CET) is currently about 100 per year. Another 100 per year eagerly go into software engineering technology (SET).

The Oregon Institute of Technology, part of the Oregon University System (OUS) now offers the Master of Science degree with an emphasis on application specific integrated circuits (ASIC's), application and design. Details are available on the Web<sup>8</sup>. The Northwest Association of Schools and Colleges accredits the MS degree, and all of OIT. The (ideal) curriculum map at OIT in Klamath Falls for a 48 quarter-units program appears in table 1.

**Table 1. – Core Curriculum**

Fall	Winter	Spring	Summer
<b>Research Methods</b>	ASIC Design II	Advanced ASIC Design	
ASIC Design I	<b>Masters Project I</b>	Advanced Computers	
Data Communications	Advanced Computer Architectures	<b>Masters Project II</b>	
Technical Elective*	Technical Elective*	Technical Elective*	<b>Masters Project III</b>

\*Either Semiconductor Device Physics & Processes or a Graduate Seminar (Such topics as Design Automation, Mixed Signal ASIC's, MEMS or Professor's choice).

All of our courses support student projects, but the most important course, we think, is Research Methods. This is where our students learn about the scientific method, about finding out what others have done in a given area, about statistical methods, and about how to write a proposal for an MS project. With their embryonic proposals, they produce a finished product in Master's Project I, ready for our graduate faculty to evaluate. Master's Project II and III involve a product whose functioning is the sole responsibility of the student, although there will be close faculty supervision.

Table 2 lists institutes that offer an MS degree related to Computer Engineering Technology (Source is Web).

**Table 2. – Institutes (OIT Hemisphere) Offering the MS Degree Relating to Computer Engineering Technology**

	Type	Research Methods Course?	Units of Project Work	Location
ASU-East	State	3 Semester Hours	3 Semester Hours	Arizona
BYU	Private	No	9 Quarter Hours	Utah
CSUN	State	No	6 Semester Hours	California
OIT	State	3 Quarter Hours	12 Quarter Hours	Oregon
RIT	Private	No	9 Quarter Hours	Western NY
IIT Delhi	State	Unknown	Unknown	India
Swinburne	State	Unknown	Unknown	Australia
Massey	State	Unknown	Unknown	New Zealand

Undoubtedly, there are many other institutes throughout the world that offer the MS degree in Computer Engineering Technology whose Web pages do not provide the information needed for the table. The above table shows that a research methods course, in conjunction with the project, results in a full year of project related work at OIT.

Our curriculum was developed and originally evaluated with reference to MS degree engineering technology at Arizona State University East<sup>9</sup> and Brigham Young University<sup>10</sup>.

#### IV. Case Histories at Oregon Institute of Technology

The project really is the most important part of the program here. The projects of three recently graduated students appear in table 3.

**Table 3. – Case Histories of Recent MS Graduates at OIT**

<b>Student</b>	<b>Project Topic</b>	<b>Now Employed By</b>
Ed Hennesy	FPGA based slot machine design	International Gaming Technology
Brian Harms	Reconfigurable PC design using VHDL	International Gaming Technology
Troy Scevers	0.5u VLSI timer design	Cadence Design Systems

Each student knew that his project must meet all technical standards as set forth in the proposal as a requirement for graduation.

The program at OIT can provide students with an opportunity for advanced study in ASIC Engineering Technology. In the process of their studies, it is hoped that our graduates learn important lessons for their futures. Chiefly we want them to know what to do when the technology has changed completely. Also, we want them to develop the technical competence required for leadership roles in industry.

#### V. Conclusions

The learning-by-doing model inspired by Aristotle could serve well today. A Master of Science degree in Computer Engineering from OIT is characterized by a strong scientific orientation that includes verifying and proving things in the lab. Working with one's hands is considered as important as working with one's brain.

MS degree objectives differ from Ph.D. degree objectives, since the MS is considered a professional degree, as opposed to a step in the Ph.D. process. Unlike Ph.D. courses, each MS core course at OIT is 25% laboratory. Although the MS program is small, we think that the objective at OIT is special, mastery of a well-defined area of technology, both theoretical and practical. We at OIT hope to attain such objectives with a project-oriented education that begins as soon as the student arrives at his or her first graduate course.

#### References

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RALPH CARESTIA – Professor of Computer Systems Engineering Technology at OIT, holds a B.S. in Engineering and Physics and a M.S. in Computer Engineering. He has 15 years experience in computer system design and application with NASA as a principal engineer and group leader. Carestia has developed and taught courses in Computer Design with Programmable Logic, Advanced Microcomputer Design, and many others.

ROBERT BURGER – Professor of Computer Systems Engineering Technology at OIT, holds a B.S. in Electrical Engineering, an M.S. in Nuclear Engineering, and a Ph.D. in Electrical Engineering and Computer Science. Burger has 10 years experience in designing electronics for spacecraft while living in Southern California in the 1970's. Since then Burger has developed courses in computer design, microprocessors, and integrated circuits.

DOUG LYNN – Professor of Computer Systems Engineering Technology at OIT, holds a B.S. , M.E., and Ph.D. in Computer and Electrical Engineering. Lynn has 12 years of experience, primarily in teaching. He has developed and taught courses in digital logic, microprocessor interfacing, computer architecture, data and computer communications, linear systems, and digital signal processing.