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Adaptable Technologists for High-tech Ecosystems

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ABSTRACT

This paper presents a proven approach for accelerating workforce training of adaptable technologists needed for 100,000 hard-to-fill jobs nationwide.

Keywords

High-tech workforce, Adaptable technologists, Co-op, LabVIEW, PLC, Pareto, Long-tail

I. INTRODUCTION

Our model of Engineering Technology education at Finger Lakes Community College (FLCC) if adapted to high-tech ecosystems across the US will accelerate workforce training for 100,000 hard-to-fill technical jobs; and prepare 21st century workforce pre-adapted for disruptive innovations in the IoT era. We describe our innovative curriculum, AAS Instrumentation and Control Technologies[1] (ICT), for teaching fundamental concepts in automation of data acquisition (DAQ), motion control and machine-vision, robotics, process control; and quality monitoring to prepare students for high-tech employment across the whole spectrum of industries. We describe the key factors contributing to 75% student retention and our success in facilitating learning of mathematics, and physics through use of "Visual Apps" designed using MS Excel and LabVIEW[2]. A majority of large high-tech industries are well-served by conventional STEM programs established across the country. The small and medium enterprises (SME) in the "Long-Tail" experience difficulties in finding the right employee with unique combination of advanced technical skills. We collaborate with three dozen high-tech businesses in the 1500 square miles region near Rochester, NY and work with National Instrument[3], the leading provider of engineering tools and learning resources based in Austin, TX, to create a framework for educating technologists critical for designing, testing, manufacturing and quality control across a broad spectrum of high-tech industries. Our hands-on curriculum brings a systems approach to adaptable technical education to prepare students for high-tech employment. Students learn job/industry specific skills through required co-op and get an opportunity to prove themselves, leading to 90% job placement.

II. NATIONAL CHALLENGES

Our adaptable model has a track record of success (9 graduates each for the past three cohorts), and it could be scaled nationwide to addresses urgent high-tech workforce challenges, as follows.

a. Jobs going unfilled, while millions are unemployed

Nationwide 500,000 technical jobs are going unfilled[4]. Of those unfilled jobs, an estimated 100,000 are in a "hard-to-fill" category where employers are looking for a person with a unique combination of skills – a "unicorn" that they do not see among the hundreds of resumes they receive and dozens of applicants they interview. One major reason is the increased diversity of automation techniques and complexity of tools/processes for which typical STEM technician programs fall short. Re-shored jobs are not the same old jobs that were lost in out-sourcing avalanches of the past three decades – diverse advanced skills are required for these jobs, and the jobs that will emerge.

b. The technical workforce must be developed locally

High-tech jobs that require employees with baccalaureate or higher education are filled with individuals from anywhere, but associate-level technical employees are generally hired locally. Also, this local employee must have the specific skill set the employer is looking for. Our curriculum is a result of collaborations with local and regional stakeholders; county economic and workforce development offices; regional business and educational partnerships such as Finger Lakes Advanced Manufacturer's Enterprise[5] (www.nyFAME.org); and Rochester Regional Photonics Cluster (RRPC[6]).

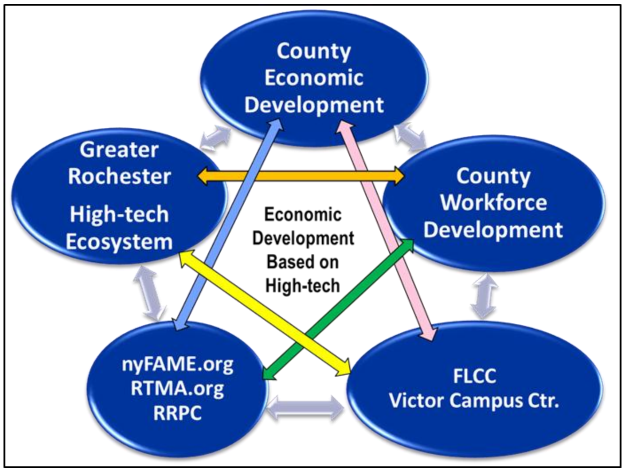

Figure 1. Collaborations focused on economic development based on high-tech.

c. Mathematics/physics requirements contribute up to 50% attrition

Nationwide 50% of students enrolled in the engineering technology pipeline drop out due to the barrier encountered in physics and mathematics classes. We identify students with deficient mathematical skills and provide them with individualized mathematics training to help them succeed in the mathematics portion of the placement test. Students can then begin with college algebra in the first semester and have a shot at completing the program with a supportive cohort in two years. As indicated in the following diagram, using Excel and LabVIEW "Apps," we help students visualize mathematics to give them confidence in the quantitative skills essential for success in the curriculum. Starting out as users of some these Apps, by the end of the first semester students learn to be producers of new Apps. Use of advanced technologies such as LabVIEW Data Acquisition (DAQ) and Machine-Vision in introductory Applied Physics courses inspire students to invest more effort in learning quantitative methods, which in turn improves their abilities to use advanced technologies with confidence.

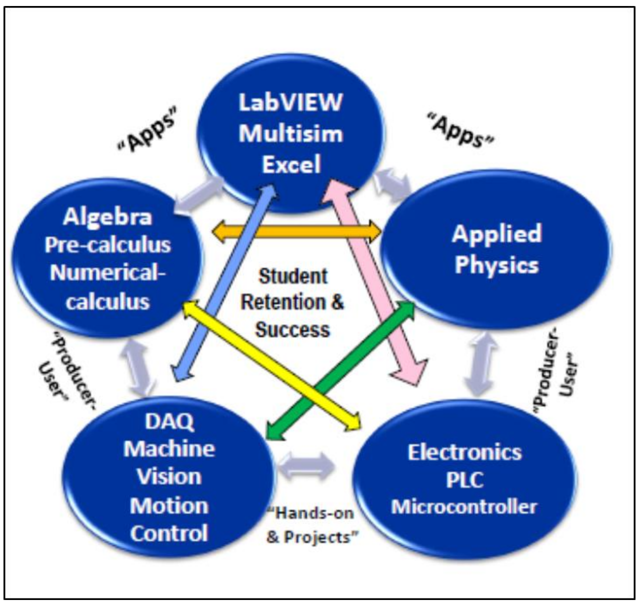

Figure 2. Focus on student retention and success

d. Skills must be adaptable across the high-tech industries

Using National Instruments™ hardware and software platform along with other techniques of automation control (microcontrollers, programmable automation controllers), precision motion control and machine vision we are able to teach adaptable skills such as trouble shooting through hands-on learning activities and projects. Although students are required to take only algebra and pre-calculus, we are able to teach concepts that would have required a half-dozen calculus-based courses through early introduction of numerical calculus in an applied physics I & II sequence.

Besides the college resources in our laboratory, our students use NI myDAQ[7] in six courses spread over the two years of the curriculum, and in the fourth semester students learn to program FPGA using NI myRIO[8]. Machine vision is first introduced as a LabVIEW "App" for kinematical measurements in physics; sophomore students learn to program machine vision systems. Hands-on projects help emphasize the importance of troubleshooting and technical problem solving.

Throughout the curriculum students learn teamwork and communication skills. The quality improvement (Lean Six Sigma) course, meant for the fourth semester, is often taken in the second semester by mature students. Our curriculum is also poised to capitalize on the Sensor Revolution[9] and "Big Analog Data™ [10] -- from energy efficiency/health of systems to control of the grid.

e. Diversity of skills is required for "Long-tail" businesses

The workforce needs of most large businesses are addressed through conventional STEM degree programs, combined with formal in-house training. Very few SMEs, however, have in-house training programs, often hire intermittently, and each has specific requirements, which most educational institutions cannot afford to address with dedicated degree programs. These SME businesses are in the "Long-tail" of the Size vs. Rank distribution for high-tech ecosystems; for which the conventional STEM degree programs are often not adequate.

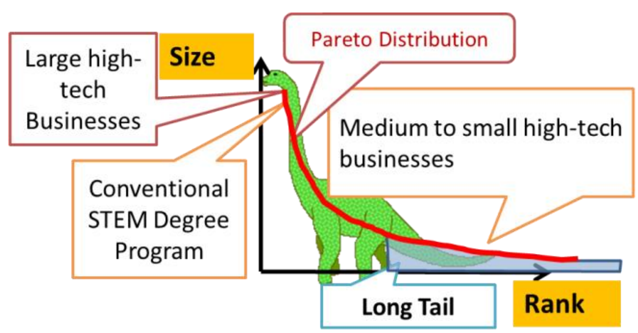

Figure 3. Pareto distribution in high-tech ecosystems

Our analysis of employment data within the Optics, Photonics, Imaging and Display industries in the 1500 square-mile greater Rochester region show they are "Long-tail" businesses (falling along a Pareto distribution with a very long tail) [Data from Dr. Paul Ballentine, Executive Director of CEIS, University of Rochester].

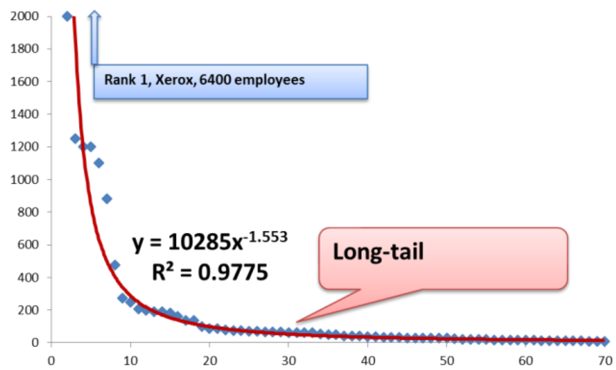

Figure 4. Size of Business (Employees) vs. Rank, plot of Optics, Photonics, Imaging and Display industries in the greater Rochester, NY region.

Through collaboration with local businesses, we have been able to include a co-op requirement with local businesses where students learn job-specific skills and get a chance to prove themselves to their employers. Because of those collaborations, we have a track record of placing (90+ %) students (27 graduates) across a wide spectrum of industries. To serve as an illustration, below is a selected list of our sophomores' successful co-op and work positions.

•Building a robotic system for masonry, Construction Robotics[11], in Victor, NY

•Performing accelerated testing on prototype gasoline direct fuel injectors, Trialon Corporation[12], Delphi Technical Center[13], in Henrietta, NY

•Building Programmable Logic Control systems at Unique Automation[14], in Palmyra, NY

•Automating a sapling planter for apple orchards at LaGasse Works[15], in Lyons, NY

•Building optics manufacturing machines at Optipro Systems[16], in Ontario, NY

•Precision machining and growing OLED films at Trovato Manufacturing[17], in Victor, NY

•Building component and systems for automated control of railroad switching at Railcomm[18], in Fairport, NY.

III. CONCLUSIONS

The engineering technology graduates with an associate degree can help address urgent workforce challenges for the nation; through a curriculum in which students learn adaptable skills crucial for innovations across an entire high-tech ecosystem of businesses of all sizes and diversity of industries. The requirement of co-op is the missing ingredient that may prove pivotal in the nation's ability to fill a large fraction of hard-to-fill jobs where the diversity of skills required of a single individual may be the hidden barrier that is impeding the growth of businesses and their ability to stay competitive. This need is urgent, especially in view of our nation's widespread unemployment/underemployment, and will remain a major challenge for the American businesses that are leading a resurgence in manufacturing across the nation.

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IV. ACKNOWLEDGMENTS

The advice and support from the Ontario County Economic Developer[19], Mike Manikowski, has been critical for the development and success of the curriculum. Collaborations with leaders of Finger Lakes Advanced Manufacturer's Enterprise[5] (Mike Mandina and Ron Golumbeck), and other leaders of high-tech businesses in greater Rochester high-tech ecosystem has been crucial for adaptability of our curriculum, teachers and students.

REFERENCES

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[8] NI myRIO resources http://www.ni.com/myrio/

[9] Sensor Revolution http://www.nsf.gov/news/special_reports/sensor/overview.jsp

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[13] Delphi Technical Center http://delphi.com/manufacturers/testing-services/rochester-technical-center/tcr-engine-testing-lab

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[15] LaGasse Works http://lagasseworks.com/

[16] Optipro Systems http://www.optipro.com/index.html

[17] Trovato Manufacturing http://www.trovato.org/

[18] Railcomm http://railcomm.com/

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