

Design and Implementation of the Computer Integrated Engineering Enterprise (CIEE) – the Learning Factory at Robert Morris College

**Winston F. Erevelles
Robert Morris College**

I. Introduction

The engineering initiative at Robert Morris College seeks to enhance the technical and engineering abilities of the workforce in southwestern Pennsylvania through an innovative, industry-driven, hands-on, project-based system of education and training that integrates theory and practice in Manufacturing, Software, and Logistics Engineering. These activities are centered on the Computer Integrated Engineering Enterprise (CIEE) - the Learning Factory at Robert Morris College. This new facility will be used for teaching, research, lifelong learning, and recruiting activities by creating a new paradigm in engineering education featuring the integration of all experiential learning activities.

II. The Engineering Initiative at Robert Morris College

Robert Morris College is an independent, coeducational institution founded in 1921, and offers undergraduate and graduate degree programs that integrate the liberal arts with professional programs in business, applied sciences, teacher education, and communications. Total enrollment at the main campus in Moon Township (in Pittsburgh's western suburbs) and at the City of Pittsburgh Center is approximately 5,000. The College awards graduate degrees in 10 areas and undergraduate degrees in 35 areas of study.

The College began offering the Bachelor of Science in Engineering in the Fall 1999 semester. Currently three engineering disciplines are supported through the Bachelor of Science in Engineering degree with tracks in Software Engineering and Logistics Engineering, and the recently approved Bachelor of Science in Manufacturing Engineering degree (April 2000). The College's Board of Trustees and industrial representatives were active participants in the development of the engineering programs. Representatives from PPG Industries, PGT Trucking, Bayer Corporation, J&L Specialty Steel, Cutler-Hammer, Westinghouse Electric Company, Mine Safety Appliances Company, and LB International have guided the engineering initiative. Statistics obtained from the Pennsylvania Department of Labor show the importance and desirability of graduates in the disciplines supported by the College¹.

The programs in Logistics, Software, and Manufacturing Engineering emphasize an interdisciplinary approach to engineering education and build on existing strengths in business, communication skills, and mathematics. The engineering programs at the College are niche programs that are not typically offered at most educational institutions. The typical student in these programs enjoys problem solving, hands on learning, and being challenged with issues

from the real world. The programs have been designed to be accreditable by the Accreditation Board of Engineering and Technology (ABET) and have also addressed the competency gaps identified by the Society of Manufacturing Engineers (SME)^{2,3}.

III. The Computer Integrated Engineering Enterprise (CIEE) – the Learning Factory

No engineering curriculum is complete without a comprehensive suite of laboratories for students to conduct experiments to verify and analyze the theory covered in the classroom and its connection to reality. Education and training seek to provide enabling skills that will help incumbent workers function efficiently and effectively in the workplace. Superior programs must therefore enable seamless transitions from the classroom to industry⁴. However, this is not the norm in engineering education today.

Historically, engineering programs have been routinely reduced to a series of fragmented and compartmentalized experiences without exposing the student to the interrelationships between them. In order to prepare the workforce for the challenges of the 21st Century, a paradigm shift must be made in favor of a continuum of experiences that will provide students with integrated learning to reinforce and correlate subject matter covered in diverse areas. Snapshots of localized information would then be woven into a fabric of engineering knowledge and interpersonal skills that would be applicable to real world problems and situations. The Computer Integrated Engineering Enterprise – Learning Factory at Robert Morris College is being implemented with this synergy in mind.

All coursework will revolve around the activities of the Learning Factory. The mission of this \$4,000,000 factory is to support educational programs College-wide, serve as a test bed for research and development activities, support outreach and recruitment activities, and provide an environment for lifelong learning. The College has dedicated 7,500 square feet to the facility. The Learning Factory provides the framework for all experiential learning in Engineering Sciences and Engineering through the integration of computation, production, verification equipment, enterprise planning and control systems, and software into a full production system.

When complete, this scaled, industrial-grade, production system will allow students to take a product from concept through design and manufacture in a manner consistent with modern technology driven enterprise practices. The Learning Factory will support all engineering courses and will also support business, science, and mathematics courses in order to present students with a fully integrated engineering curriculum. The facility will support programs in Manufacturing Engineering, Logistics Engineering, Software Engineering, and Engineering Management and will also be available to faculty from different departments and programs across campus.

The facility will also be used for tours, career fairs, programs for middle and high school students, and other similar recruitment efforts. These will include teacher/counselor education and outreach, and initiatives aimed at K-12 students with an emphasis on women and underrepresented minorities. The Learning Factory will be used to support contract research and as a test bed for ideas that may generate external funding. A significant purpose of the facility will be the development and delivery of short courses that will raise the technical and

engineering abilities of the workforce in Southwestern Pennsylvania – these short courses will integrate theory and practice in Manufacturing Engineering. A layout of the facility appears in Figure 1.

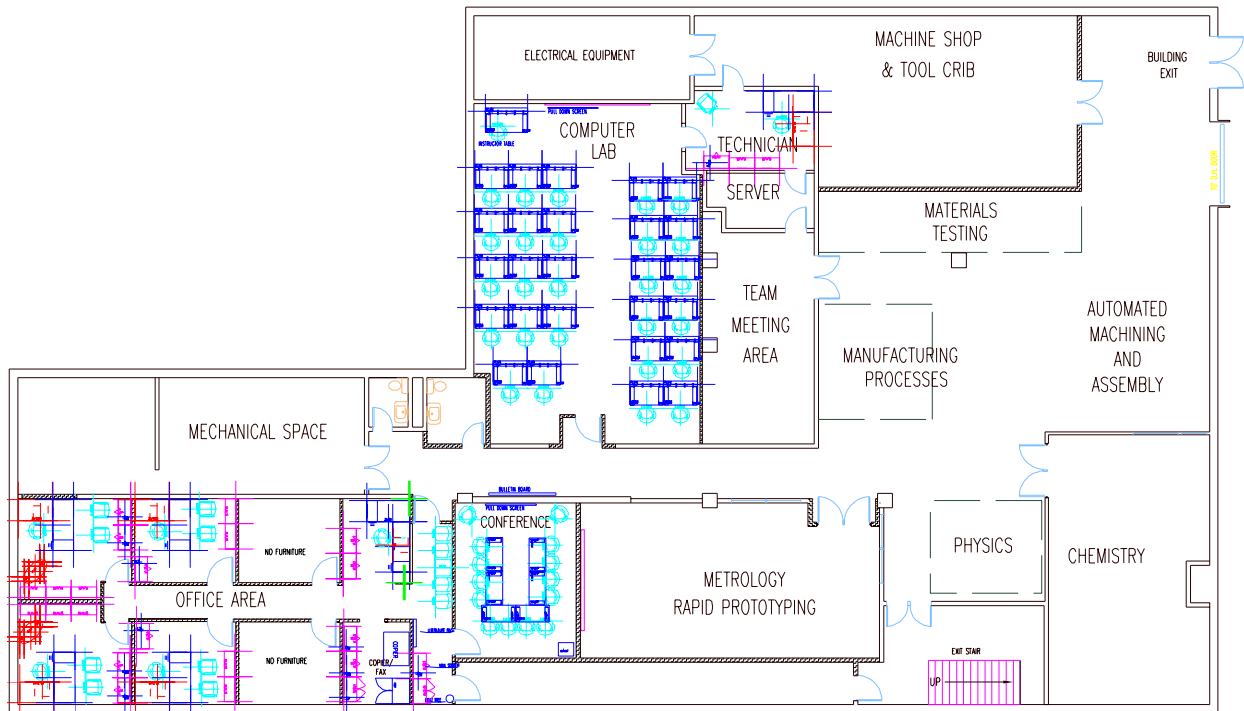


Figure 1. Learning Factory at Robert Morris College

The floor plan includes areas for experiential learning in Physics, Chemistry, Electronics, Automated Machining, Automated Assembly, Rapid Prototyping, Materials Testing, Metrology, and Manufacturing Processes. Office space for faculty, a technician, and support staff are included along with project discussion areas for students, and a conference room for meetings, presentations, and seminar series. A computer learning center and tool room/fabrication area complete the components of the Learning Factory.

IV. Development and Funding Strategies

Table I is the proposed development plan for the CIEE- Learning Factory. The table lists areas in the facility and proposed hardware/software for that area or topic.

Table I: Development Plan

Area/Topic	Proposed Equipment
Tool Room / Fabrication	Manual mill, lathe, drill press, band saw, grinder, hand tools, power supplies, oscilloscope, multimeters, function generators, electronic components
Computer Learning Center: Programming & Controls	High end personal computers, engineering server, peripherals
Materials Testing	Universal Testing Machine, Hardness Testing Machines, Fatigue Testing Machine, Impact Testing Machine
Machining Cell	CNC Machining Center, CNC Turning Center, Machine Loading Robot

Automatic ID	Bar code scanner and decoders, RF Tags, Magnetic stripes
Assembly	Assembly robot with vision system
Rapid Prototyping	Stereolithography Apparatus and Post Cure Apparatus
Metrology	CMM with Reverse Engineering hardware/software Vision systems, Optical Comparator, Roundness Tester, Contour Measurement Machine, Laser scanner, Gage R & R Software, Process Capability Analysis Software
Manufacturing Processes	Bulk Deformation and Sheet Metal Forming, Powder Metallurgy, Injection Molding, Non Traditional Machining (EDM), Electronics Assembly and PCB Fabrication, Joining/Assembly
Machine Tool Monitoring	Hardware and software for power, force, vibration, and acoustic emission sensors
Material Handling	Conveyors, Automated Storage/Retrieval Systems, Automated Guided Vehicles
Virtual Enterprise	Simulation software
Software	Computer Aided Design and Manufacturing Circuit Simulation and Analysis – Virtual Instruments Systems Integration, Computer Programming Process Monitoring and Control Enterprise Resource Planning, Simulation Testing and inspection, Quality control
Outreach	Mobile laboratory with selected manufacturing and assembly processes with bench top machines and robots and small controllers

The delivery of successful engineering programs at Robert Morris College is based on the ability of the College to provide strong, challenging, and real world “hands on” education and training situations for its students. The Learning Factory is central to that mission and directly provides the desired capabilities in integrated experiential learning. The process of designing and implementing the Learning Factory is an involved one and demands significant investment and commitment from the College and a diverse body of supporters that include private foundations, corporations, the Federal and State government, professional societies, and individual donors. In the first year of its existence the Learning Factory has received over a million dollars in funding from its supporters. In addition, the College is receiving the ongoing advice, participation, and guidance of industry partners including PPG Industries, Cutler-Hammer, J & L Specialty Steel, Cimulus Automation Systems, LB International, Alcoa, Westinghouse Electric Company, and Mine Safety Appliance Company in the development of the Learning Factory. These efforts build upon the \$700,000 that the College has invested in the Learning Factory since its inception.

V. Summary

The learning factory concept has attracted the interest of students, industry, and funding agencies and is expected to have a lasting impact on engineering education at Robert Morris College. At the time of this writing the following components of the learning factory have been completed or are in progress: tool room & fabrication, computer learning center, materials testing, machining cell, assembly cell, rapid prototyping, metrology, programming & controls, automatic identification, and chemistry. The infusion of funds has allowed the College to stay well ahead of the projected schedule. In its quest for excellence, Robert Morris College is actively seeking

additional partners to help the College educate a superior cadre of men and women who are prepared for the challenges of working in manufacturing in the 21st Century

Bibliography

1. PA Department of Labor and Industry Statistics, 1994
2. SME Manufacturing Education Plan: 1999 Critical Competency Gaps, "Industry Updates Competency Gaps Among Newly Hired Engineering Graduates", Society of Manufacturing Engineers, 1999
3. "EAC Accredited Programs for 1999", Accreditation Board for Engineering and Technology, World Wide Web Site - <http://www.abet.org/>
4. Barr, R. & Tagg, J., "From teaching to learning: A new paradigm for undergraduate education", Change, 13-25. (1995, November, December)

WINSTON F. EREVELLES

Winston Erevelles is the Associate Dean of the School of Engineering, Mathematics, and Science at Robert Morris College. He also serves as the Director of the PRIME (Partnership for Regional Innovation in Manufacturing Education) coalition – an industry-driven, five-college system delivering innovative manufacturing education and career development in Southwest Pennsylvania. His teaching, research, service, and publishing interests are in the areas of Manufacturing Processes, Automation, Robotics, Rapid Prototyping, Programmable Logic Controllers, and Computer Integrated Manufacturing. He has worked as a Manufacturing Engineer and Plant Manager at Mykron Engineers, India. Dr. Erevelles earned his B.S. in electrical engineering from Bangalore University, India and his M.S. and Ph.D. in engineering management (manufacturing engineering emphasis) from the University of Missouri-Rolla.