National Center Of Excellence For Advanced Manufacturing Education

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Abstract

The National Center Of Excellence For Advanced Manufacturing Education (NCE/AME) was established in Dayton, Ohio in 1995 as one of the first three National Science Foundation national centers of the Advanced Technological Education (ATE) program. * The NCE/AME is managed through the Advanced Integrated Manufacturing Center (AIM Center), a partnership between Sinclair Community College and the University of Dayton. One major goal of the NCE/AME is to develop novel curriculum materials for the manufacturing engineering technology field that are based on constructivist principles. This paper will describe the basic nature of the instructional materials, curriculum design, and educational services offered.

A Novel Modular Curriculum for Manufacturing Engineering Technology

The primary product of the NCE/AME is the design of a novel instructional module development process called *The Module Architecture*©[1].

This process is being used to develop instructional modules for an associate degree in manufacturing engineering technology that are activity-based, competency-based, contextual, industry-verified and teamwork-based with assessment embedded at every stage. Reference 2 provides a comprehensive description of the program, the pedagogy on which it is based, and each of the 67 modules.

An associate degree program has been designed that utilizes 67 modules aligned within nine subject matter clusters, listed below.

Manufacturing Processes and Materials	Mathematics
Design for Manufacturing	Science
Production and Inventory Control	Humanities, Communications and Teamwork
Quality Management	
Manufacturing Systems and Automation	
Enterprise Integration	

In addition, the complete curriculum includes six courses from the traditional offerings of a college in the areas of humanities, social science, oral communication, and English composition. The design of the curriculum is novel in its content in addition to being primarily modular in structure with extensive use of activity-based instruction.

The content was highly influenced by two landmark documents on manufacturing education produced by the Society of Manufacturing Engineers. [3, 4] Generally referred to as *Curricula 2000* and *Curricula 2002*, these extensive reports outline the recommended philosophy and content of manufacturing-oriented programs at the associate, baccalaureate, and master's degree levels in both engineering and engineering technology. In addition, guidance was taken from the following:

- Accreditation criteria of the Technology Accreditation Commission of the Accreditation Board for Engineering and Technology (TAC of ABET)
- Standards and recommendations of the National Council of Teachers of Mathematics
- Standards and recommendations of the American Association of Teachers of Mathematics in Two-Year Colleges
- Recommendations of the National Science Education Standards
- The SCANS competencies developed by the U.S. Department of Labor Secretary's Commission on Achieving Necessary Skills
- Several national industry skill standards

Basic Description of the (NCE/AME) Module Architecture©

The Module Architecture© is based on constructivist principles that call for assisting learners to build on their own experiences and to use experimentation and problem solving in authentic contexts to acquire new competencies. Further, learners are asked to demonstrate their competence in ways that emulate how the competencies are used in real-world work and life situations. [5]

The elements of the module architecture are:

- **The Big Picture:** Before specific theories and skills are tackled, instructors and students together construct a framework for learning by defining the value these theories and skills have and the ways in which they might be used on a day-to-day basis.
- **Competencies:** A competency is a specific ability that has been adequately developed by the learner so performance is consistent in a variety of situations and over time. A module typically has multiple related competencies.
- **Contexts:** In order to mesh theory with practice, specific settings are described or replicated in the classroom, so that learning tasks can be pursued with an understanding of why and how the competencies of a module are performed in the real world.
- **Authentic Learning Tasks (ALTs)©:** Authentic learning tasks are a series of discrete learning events that build experience and competencies related to the module's goals. This is an important element of the constructivist learning theory. Typically each ALT integrates two or more competencies. Each module contains several ALTs so that students experience a variety of contexts as they acquire the complete set of competencies for the module.

- **Closure:** Each ALT concludes with a closure segment in which the instructor leads a discussion with the students to revisit the Big Picture and to project the newly acquired competencies to other real-world situations.
- **Transfer Activity:** Each module ends with a transfer activity that presents a more complex learning activity designed to help participants develop relationships among the learned competencies and to provide experience in applying these in new ways. This, too, is an important characteristic of constructivist learning theory. Transfer activities of the several modules in the curriculum also provide a means for unifying the entire program into a cohesive learning experience. The NCE/AME curriculum accomplishes this through the *integrating manufacturing experience* described next.
- **Integrating Manufacturing Experience:** The transfer activities of most of the modules in the curriculum are unified by the integrating manufacturing experience in which students follow a specific line of products from concept through execution and delivery. The NCE/AME curriculum uses a hypothetical company called *Robotic Grippers Incorporated (RGI)*. [+] RGI designs, manufactures, and markets a line of robotic grippers for customers in product producing, commercial, and scientific enterprises. Descriptions of the company, its products, and its manufacturing capabilities have been defined to aid the developers of transfer activities in identifying contexts that are relevant to the competencies of a given module. Participants thus gain a cumulative series of experiences that emulate the tasks they will be expected to perform in their future work environment.
- **Generalization:** Generalization unites the series of ALTs and the transfer activity in a module and helps participants build a bridge between the known, specific tasks they have just completed and the anticipated but unknown applications for the competencies they will eventually encounter.
- **Capstone Experience:** At the end of the program, participants complete a final project that requires them to reapply the competencies of the entire program. Ideally, the capstone experience is designed to meet a real industry need.

Impact and Results Generated by the NCE/AME

The impact of the work of the NCE/AME is extensive and far-reaching, beyond the Module Architecture©, the manufacturing engineering technology (MfgET) curriculum, and the instructional modules themselves reported thus far in this paper. A summary of impact and results is available in References 6 and 7. Highlights are listed here.

- The MfgET program initiated at Sinclair Community College that implements most of the instructional modules developed by the NCE/AME
- Dissemination of the Module Architecture© through workshops, books, papers, presentations, national conferences, and many other outreach activities
- Direct consultation with dozens of academic institutions providing faculty development services focused on the implementation of activity-based, modular instruction
- Pilot testing of modules involving 27 academic institutions in 15 states, 150 facilitators, and over 2200 student participants

- Adaptation and implementation of elements of the curriculum design and Module Architecture© by many faculty members in several institutions
- Outreach programs for community college faculty and secondary school teachers and students that focused on direct contact with manufacturing industries, school-to-work, and teacher pre-service sessions

NCE/AME Products and Services

The National Center Of Excellence For Advanced Manufacturing Education offers a variety of products and services to assist academic faculty members and industrial training professionals in implementing the Module Architecture© within their own instructional environments.

Available are:

1. The set of completed instructional modules
2. A Module Development Kit to enable users to develop their own module to meet a specific instructional need
3. An ALT Development Kit to assist users to develop focused authentic learning tasks to be integrated within existing courses as a means of implementing activity-based learning
4. Consulting services to assist academic institutions, industries, or individuals in implementing the Module Architecture©

Information about these products and services can be found on the AIM Center web site, www.aimcenter.org.

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[+] The concept of *Robotic Grippers, Inc.* is based on a project developed by Professor Thomas E. Endres of the Mechanical and Aerospace Engineering department at the University of Dayton.

References

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