

MANUFACTURING TECHNOLOGY CURRICULUM RESEARCH AND DEVELOPMENT FOR COMMUNITY AND TECHNICAL COLLEGES IN WASHINGTON STATE

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KEYWORDS

**MANUFACTURING TECHNOLOGY EDUCATION, MANUFACTURING CURRICULUM,
INSTRUCTIONAL MODULES**

ABSTRACT

Presented in the paper is manufacturing technology curriculum research and development for the 2 year institutions in WA state. This work is a part of the Puget Sound Consortium for Manufacturing Excellence (PSCME) that is one of the Advanced Technological Education (ATE) Centers of Excellence funded through the National Science Foundation (NSF). One of the key activities for the PSCME is to work with various community and technical colleges in WA state to gather and review the existing manufacturing

curricula and communicate with local industry leaders to clarify regionally focused industry skill standards. The curriculum research and development which are discussed in this paper resulted from this interaction.

INTRODUCTION

Manufacturing is one of the most important businesses in terms of workforces and money in Washington (WA) state. Aircraft manufacturing, metal fabrication/machine ship building and repair are among the top five industry cluster in two or three regions of the state. Statewide, about 34 percent of all projected job openings with short to moderate level skill requirements can be met by the completers of vocational/technical programs of the community and technical colleges (Paul Sommers and Deena Heg, 2002). Therefore, there is a demand for manufacturing technology programs at the community and technical colleges to provide quality education to the students. However, manufacturing companies are deeply concerned over the shortage of workers with the skills needed to keep pace with technology. According to a fall 1997 survey by the National Association of Manufacturers, 88% of manufacturers report a shortage of qualified workers in at least one job category (Manufacturing Technology Advisory Group).

Established in 2001, the Puget Sound Consortium for Manufacturing Excellence (PSCME) is a regional education-industry partnership that will enhance the connection between manufacturing technology education, student career goal, and private sector demand. One of the goals of the PSCME is to develop a manufacturing curriculum model and teaching materials for the manufacturing technology programs at the 2 year institutions. This paper will present the results of the existing manufacturing curriculum and review the current curriculum process. Then, the modularized manufacturing technology curriculum will follow.

EXISTING MANUFACTURING TECHNOLOGY CURRICULUM RESEARCH

To establish baseline enrollment data, the PSCME program targeted colleges with the State Board of Community and Technical Colleges (SBCTC) Classification of Instructional Program (CIP) code of 480501, which is a machinist or computer aided machining technology program. Baseline colleges include Bates, Bellingham, Clark, Columbia Basin, Lake Washington, Lower Columbia, Renton, and Shoreline. These colleges are located in ethnically and economically diverse areas of the state, which creates an opportunity for the program to impact enrollment of minority students and women. All existing

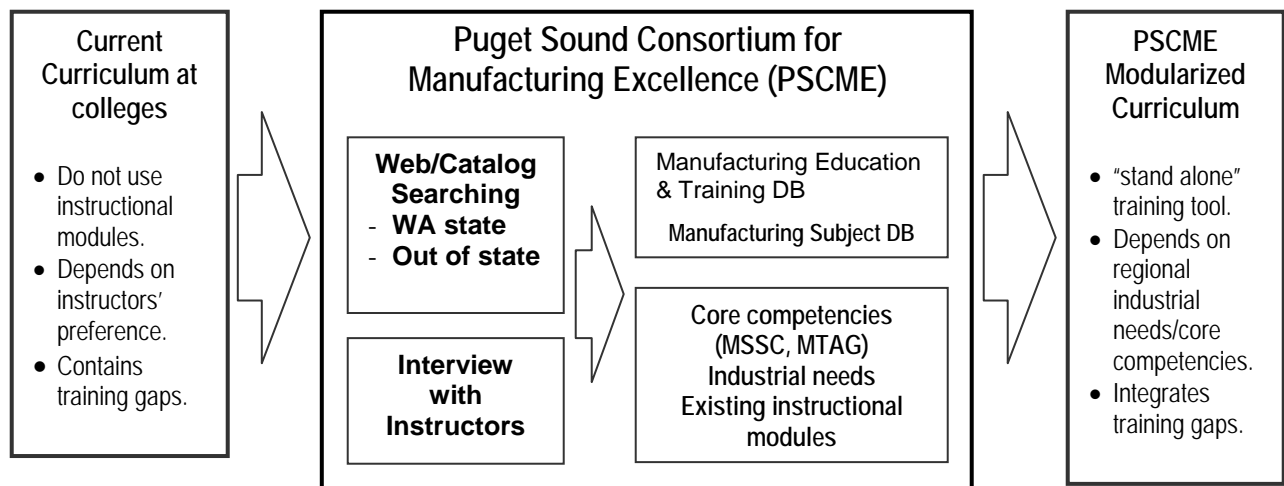


FIGURE1. DEVELOPMENT OF PSCME MODULARIZED CURRICULUM

curricula in the machining related programs (CIP 480501) have been collected. The existing manufacturing technology curricula in WA state have been identified throughout the web site and course catalog. Figure 1 shows that the activities for the PSCME include working with various community and technical colleges in WA state to gather and review the existing manufacturing curriculum.

The instructors and representatives of these colleges were interviewed in order to survey their needs and to identify the existing curricula. From the communications with the instructors, it was found that most existing curricula had been developed based on class textbooks, instructors' preferences (or experiences), existing instructional modules, departmental history and equipment, and discussion with the

advisory committee on the program. As a consequence, there is no modularized curriculum on manufacturing in WA state, thus making it is possible to have training gaps in the program.

There are some disagreements between college instructors regarding the manufacturing technology curriculum. The first disagreement is whether to teach computer aided drafting (CAD) in the machining program. Some instructors think that most machinists will not use CAD in industry, so students do not have to learn CAD. However, other instructors believe that students should learn CAD because machinists should know how drawings are created, and they might work with or go to design/engineering/

Colleges	PSCME Baseline Colleges								Reviewed at the request of SBCTC		
	Renton	Lake Washington	Shoreline	Clark	Columbia Basin	Bellingham	Bates	Lower Columbia	Clover Park	Green River	Spokane
Manufacturing Subjects											
Shop Safety											
Measurement											
Blueprint											
Engineering Math											
GD&T											
Materials											
Bench work (hand tool)											
Manual Lathe											
Manual Mill											
Grinding											
Nontraditional Machining (EDM)											
CAD											
CNC Programming											
CNC Mill											
CNC Lathe											
CAM											
Heat treating											
Quality Control											
Process Planning											
MFG Handbook use											
MFG Economics											
MFG Resource management											
Communication											
Workplace Ethics											
Group dynamics											
Hydraulics											
Welding											
Co-op											

 Class offered  Class not offered

FIGURE 2. TRAINING GAPS IN THE MANUFACTURING PROGRAM (CIP 480501)

Now that we have reviewed the existing curricula, our goals are to identify training gaps and develop a curriculum to meet those specific gaps. The information database has been created for all existing curricula to find the specific training gaps. Two databases have been developed: one is the Manufacturing Education and Training Database, and the other is the Manufacturing Subject Database. The Manufacturing Education and Training Database contains all manufacturing subject offerings in each college. The Manufacturing Subject Database includes the subtopics and textbook information on each manufacturing subject. The information databases are posted on the PSCME web site. According to the information databases, each college has several training gaps in their curricula as shown in Figure 2.

MODULARIZED MANUFACTURING TECHNOLOGY CURRICULUM DEVELOPMENT

In order to establish modularized manufacturing technology curriculum, there is a need to clarify the training gaps. The existing curricula were evaluated using industry standards which are the Manufacturing Skills Standards Council (MSSC) and Manufacturing Technology Advisory Group (MTAG) as well as the existing instructional modules. In addition, the percentage offerings of baseline colleges were reviewed and a modularized curriculum structure was established as shown in Figure 3. The modularized curriculum consists of Core technical subjects and Support subjects. Core technical subjects are offered by more than 50% of baseline colleges, and both skill standards and instructional modules cover them. Support subjects are offered at about 40% of baseline colleges, and either skill standards or instructional modules cover them. However, there is a need to add industrial inputs on the modularized curriculum. According to the NSF National Visiting Committee (NVC), it was figured that several manufacturing subjects were missing on the existing curriculum, which has 21 subjects. During the NSF NVC meeting, five manufacturing subjects were chosen for the training gaps of all baseline colleges. These are

- Manufacturing Processes

- Technical English as Second Language
- Manufacturing Internship
- Manufacturing Resource Management
- Manufacturing Economics

Table 1 shows the manufacturing technology subjects in the modularized curriculum for the two year of the program. The core manufacturing subjects are highly recommended to be offered in the manufacturing technology program. And the support manufacturing subjects may be good for the electives for the program. Each individual college can offer these classes based on their needs and availabilities.

TABLE 1. RECOMMENDED MANUFACTURING SUBJECTS IN THE MODULARIZED CURRICULUM

Core manufacturing subjects	Support manufacturing subjects
Shop safety	Non-traditional
Engineering Math	machining
Materials	Process planning
Blueprint reading	Manufacturing
Manufacturing	Resource
Processes	Management
Machining theory and manual machining lab	Manufacturing
Measurement and	Economics
inspection	Manufacturing
CAD	internship
CNC machining theory	Technical English as a
and lab	second language
CAM	

Quality control	
Heat treatment	

The PSCME concluded to develop three instructional modules; Manufacturing Processes, Manufacturing Internship, and Technical English as Second Language (TESL). The technical content for these three modules was then developed in accordance with local industry needs and national and state skill standards.

Based upon interviews with instructors it was determined that modularized curriculum should include a detailed lesson plan and all supporting resources such as slides (Power Point base), handouts, and skill check or assessment units. The format utilized for the modularized curriculum is: Introduction, Lesson Plan, Class Curriculum, Handouts, Assessment, Overheads and Resources. Using this format, an instructor can identify module content by reading the Lesson Plan. The Class Curriculum section provides instructors with an overview of topics, content knowledge, and activities for the module. All instructional resources, including PowerPoint Handouts and Overheads, are included so that the curriculum is provided ready for instruction. Skill checks and assessments are interspersed throughout the module so that instructors can monitor and evaluate student progress. This modularized curriculum is made using electronic files to allow for flexibility so pieces of the module can be modified as needed.

Manufacturing Subject	% Offerings (baseline college)	Skill standards		ATE's			Etc.		Modules
		MTAG	MSSC	WMCC	AIM	SC ATE	MAST	NIMS	
Shop Safety	88%	O	O				O		C*
Measurement	75%	O	O	O			O		C*
Blueprint	75%	O	O	O			O		C*
GD&T	38%						O		
Engineering Math	63%	O			O	O	O		C*
Materials	63%	O	O	O	O		O		C*
Bench work (hand tool)	88%	O	O	O			O	O	C*
Manual Lathe	100%	O	O	O			O	O	C*
Manual Mill	100%	O	O	O			O	O	C*
Grinding	75%	O	O				O	O	C*
Nontraditional Machining	25%	O					O	O	S**
CAD	38%	O					O		
CNC Program	100%	O	O				O	O	C*
CNC Mill	100%	O	O				O	O	C*
CNC Lathe	88%	O	O				O	O	C*
CAM	75%	O	O				O	O	C*
Heat Treating	50%	O					O		C*
Quality Control	50%	O	O	O	O		O		C*
Process Planning	38%	O	O	O	O		O		S**
MFG Handbook use	38%								C*
MFG Economics	13%	O	O						
MFG Resource Mgmt.	0%	O	O	O					
Communication	13%	O	O		O	O	O		S**
Workplace Ethic	25%	O	O		O		O		S**
Group dynamics	25%	O	O		O		O		S**
Leaderships	13%		O				O		
Job Preparation	13%						O		
Hydraulics	13%								
Welding	13%	O					O		
Co-op	38%								S**

WMCC: The Wisconsin Manufacturing Curriculum Consortium

AIM: The Advanced Integrated Manufacturing (AIM) Center

SC ATE: The South Carolina Advanced Technological Education Center of Excellence

MAST: The Machine Tool Advanced Skills Technology Program (Texas State Technical College)

NIMS: National Institute for Metalworking Skills, Inc.

*C: Core Technical subject

**S: Support subject

FIGURE 3. EVALUATION THE EXISTING CURRICULA AND THE PRELIMINARY MODULARIZED CURRICULUM ESTABLISHMENT

The modularized curriculum should be reviewed, tested, and modified based on the reviewers' comments. Both student and instructor module evaluation forms are included in each module for this purpose. Consortium partners for each module being tested have been established and Table 2 presents

them. To meet regional industry skill requirements, regional industrial leaders need to review the instructional modules as well.

TABLE 2. PILOT MODULE TESTING COLLEGES FOR THE PSCME INSTRUCTIONAL MODULES

Module	Colleges
Manufacturing Processes	Columbia Basin Community College
	Highline Community College
	Lower Columbia College
Manufacturing Internship	Lake Washington Technical College
	Lower Columbia College
Technical English as a second language	Renton Technical College
	Green River Technical College

CONCLUSIONS

The PSCME's 2 year experience of manufacturing technology curriculum research and development for the community and technical colleges in WA state was described. The existing manufacturing technology curriculum were evaluated using the skill standards. Through the survey with consortium and industry partners, the PSCME made recommendations for updating manufacturing technology curriculum. There are some training gaps between local industry needs and manufacturing technology programs. To fill out those gaps, three instructional modules were developed. They are now being reviewed by the consortium partners, and will be distributed to all the manufacturing technology programs after review and update.

REFERENCES

Paul Sommers and Deena Heg, Report for the State Board for Community and Technical Colleges and Workforce Training and Education Coordinating Board, October 2002.

Manufacturing Technology Advisory Group Web Page, <http://www.wa-skills.com/html/mfgtech.html>.