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ABSTRACT

In 1993, a study was conducted to investigate the responses of associate degree programs in manufacturing and related technical programs to current technical education initiatives. The study focused on the relationships of associate degree programs to secondary and postsecondary education and industry, curricular trends, familiarity with the Department of Labor's Secretary's Commission on Achieving Necessary Skills (SCANS), inclusion of Total Quality Management (TQM) in instruction, and the use of nontraditional and distance learning capabilities. Survey forms were mailed to 286 program directors listed in the Society of Manufacturing Engineers' (SME's) 1992 "Directory of Manufacturing Education." Study findings, based on 140 usable responses (49%), included the following: (1) 42% of the associate degree programs in manufacturing listed in the SME directory were located in six states; (2) 84% of the responding program administrators reported relationships with secondary schools, while 52% reported relationships with universities; (3) curricular areas evidencing an increase in emphasis over the past 4 years included artificial intelligence, computer-aided design, computer-aided manufacturing, microcomputers, and quality control; (4) about 50% of the programs offered students opportunities for cooperative education experiences; (5) over 50% of the respondents indicated that faculty used industry experiences for skills upgrading, while 70% mentioned relationships between industry and their college for employee upgrading; and (6) 86% of the associate degree in manufacturing programs included TQM content, as did 71% of the related technical programs. Data tables, open-ended responses, and the survey instrument are included. (PAA)

An Analysis of National Surveys: Associate Degree Programs in Manufacturing Engineering and Related Programs. A Preliminary Report.

by Elizabeth A. Mathias

September 27, 1993

Analysis of National Surveys: Associate Degree Programs in Manufacturing Engineering and Related Programs

Introduction:

Results of three national surveys were analyzed to prepare this report on associate degree programs in manufacturing and related technical programs. National surveys were conducted by the Society of Manufacturing Engineers (SME) in 1990 and 1992. The self-report data submitted by cooperating community colleges, universities, and technical schools was compiled into publications titled *Directory of Manufacturing Education* issued in 1990 and 1992. This investigator designed a 1993 survey incorporating questions seeking program responses to current technical education initiatives such as relationships of associate degree programs to secondary and post-secondary education and industry, curriculum change trends, familiarity with the Department of Labor's Secretary's Commission on Achieving Necessary Skills (SCANS), inclusion of Total Quality Management in instruction, and program use of non-traditional and distance learning capabilities. A list of curriculum content areas to be checked by respondents and a question on whether programs offered cooperative education were common to all three surveys. Two-hundred-eighty-six survey forms were mailed in August, 1993 to program directors identified through the SME Directory across the United States. A second mailing was sent to non-responders in October, 1993. One hundred-forty surveys or a 49% response rate was achieved by November 18, 1993.

Summary of findings:

- SME's 1992 *Directory of Manufacturing* list reveals that 42% of the associate degree programs are located in six states.
- SME (Mr. Mark Stratton) states no data is kept on program enrollment statistics nationally for Manufacturing Technology Associate degree students.
- Eighty-four percent of programs report relationships with secondary schools; 52% reported relationships with universities.
- Percentages of colleges and universities offering particular curriculum content areas varies across three categories: 1) Manufacturing Associate degrees (MAA), 2) Related Technical Associate degrees, and 3) undifferentiated Associate/Bachelors degree programs.
- Curriculum content areas reported as increased in emphasis over the past four years included artificial intelligence, CAD, CAM, CIM, Microcomputers, Microprocessors, Modeling, Numerical Control, Probability and Statistics, Quality Control, Robotics and Automated Systems, and Simulation. Patterns of increases or decreases in percentages of programs offering particular content areas varied between MAA and Related Technology programs.
- No analysis of general education or academic coursework other than Economics was possible. Little focused activity was described when respondents were asked about academic and technical integration projects.
- About 50% of programs offered students an opportunity for cooperative education experiences.
- Only 19% MAA and 13% Related Technology programs report a parallel industry experience pathway for students.
- Advisory committee participation was reported almost universally; significantly fewer programs reported industry involvement in curriculum revision.
- Over 50% of programs responded that faculty use industry experiences for upgrading; over 70% mentioned relationships between industry and their college for employee upgrade.
- Large percentages of both programs reported integrating Total Quality Management concepts into their programs.
- About 30% reported familiarity with SCANS; however, of those familiar, close to 70% responded SCANS had an impact on their curriculum.
- About 40% report using some form of distance learning though not necessarily electronic based.

- Narrative responses when offered from program directors about the proposal for national industry/education cooperation in developing a high performance manufacturing curriculum design tended to be positive and supportive.

Methodology:

The 1993 survey respondents were provided with a copy of Dr. Arnold Packer's proposal titled, "A Design for an Associate of Arts Degree in High-Performance Manufacturing" suggesting methodology to involve industry and educator panels in constructing standards and a curriculum design for an Associate Degree in High Performance Manufacturing. Opinions of program directors were solicited. Mr. Mark Stratton, SME Education Director, and Dr. Arnold Packer reviewed this investigator's 1993 survey and offered comments that were incorporated into the final survey form. A list of curriculum content areas appeared in all three survey forms--the two designed by SME (1990, 1992) and the third (1993) designed for this study to allow for trend analysis. A mailing list furnished by SME provided program director contact names for 286 associate degree programs across the United States and was used for the mailing of the 1993 survey in mid-August with a second mailing in October.

As of November 18, 1993, 140 program directors or 49% responded. The 140 responses were further differentiated as to programs using the descriptive word Manufacturing (MAA) programs and those referred to as "Related Programs." Seventy-seven responses or 55% were MAA and 55 or 39% were "Related Programs." Six percent were unusable with the most frequently stated reason of program discontinuance. A greater response from MAA programs could be expected given that the focus of the project is High-Performance Manufacturing.

Findings:

Location of Programs

An analysis of program location based on a list in the *Directory of Manufacturing Education*, 1992 found the majority of the programs in six states: Ohio (24), Pennsylvania (23), California (22), Michigan (20), New York (17), and North Carolina (14). It is interesting to note that while today's industries, especially the multinationals, are no longer bound by location for resources and raw materials supporting a single comprehensive production process from beginning to end, 124 or 42% of SME identified associate degree level programs are concentrated in six of fifty states. As *The Economist* points out in the November 21, 1992 edition under "Education: Trying Harder", "Nation: states used to compete for control over natural resources. Today they are competing to produce the best educated labor force." Our educational resources in manufacturing technology are highly concentrated while our workforce distribution should reflect the changed industrial climate. It will later be shown that the ability to use non-traditional portable education and pedagogy strategies which could solve workforce distribution problems is largely untapped.

Students

The question of how many students are in the Manufacturing Engineering Associate degree programs "pipeline" is currently unanswerable. SME informed this investigator that to their knowledge no comprehensive data on Manufacturing Technology Associate degree student numbers is tallied by any group. On a 49% response rate, the 1993 survey reports a "pipeline" of 5,906 full-time students and 6,730 part-time students taught by 544 full-time faculty and 497 part-time faculty.

Tech Prep Initiatives

Because of the Tech Prep movement, a federally supported initiative through the Carl D Perkins Act, questions were asked of respondents about their relationships with both secondary and university (baccalaureate) level education. Eighty-five percent of the respondents reported relationships with secondary education (Table 1).

Table 1

Self-report data indicating some associate degree articulation efforts with secondary education.

RESPONSE	MAA PROGRAMS (n.77)		AD RELATED PROGRAMS (n.55)	
yes	n.63	82%	n.49	89%
no	n.14	18%	n.6	11%

Fifty-two percent reported similar relationships with university bachelors level programs (Table 2). An hypothesis that associate degree programs offered on university college campuses would be more likely to report these relationships while programs that are autonomous within a state community college system would have more difficulty winning acceptance of their graduates was not tested. In this investigator's Maryland experience, academic upward mobility, i.e. ability of associate degree graduates to efficiently pursue a bachelors degree, is a factor that encourages student interest and recruitment. **A "seamless" educational experience encouraging continuing life-long education and supporting career upward mobility would encourage students to choose a career in manufacturing for growth potential.** In general, articulation of community college graduates to baccalaureate education is a matter of paramount concern for community college educators. **Voluntary standards could assist by establishing a level of academic and skill competency appropriate to the secondary, community college, and university levels, and could undergird more efficient articulation thereby resolving some of the current issues.**

Table 2

Self-report data indicating some associate degree articulation efforts with universities (BS degree). +

RESPONSE	MAA PROGRAMS (n.73)		AD RELATED PROGRAMS (n.49+)	
yes	n.40	55%	n.24	49%
no	n.33	45%	n.25	51%

\+ Ten surveys showed no response.

Curriculum Analysis (Technical)

Curriculum trends from the 1993 survey respondents indicate that the only technical content area to significantly decrease over the past four years was "welding," though the percentage of programs reporting decrease was less than one third. Meanwhile, increases in curriculum emphasis for MAA programs occurred in: CAD, CAM, CIM, Composite Plastics, Microprocessors, Modeling, Probability and Statistics, Quality Control, and Technology Strategy (n.4). Patterns in increases or decreases in "Related Technology" programs were slightly different.

The percentage of programs offering particular content areas reveals patterns of relative significance of technical subjects nationally. CAD and CAM are almost universal, while new technical areas such as artificial intelligence, expert systems, dynamic programming, and technical strategy are infrequently found in associate degree programs (Table 3).

Table 3

Survey response: Self-report of academic program content from colleges offering associate degree manufacturing or related technical programs. Programs differentiated according to the descriptive word of "manufacturing" in the title (n.77) and associate degree in related technical programs (n.55).+

CONTENT AREAS	% of Programs Offering Topical Content Areas	
	MAA Programs	AD Related Programs
1. Artificial Intelligence	4%↑	4%↑
2. Assembly	21	18
3. Automation	61	25
4. CAD	97↑	89↑
5. CAM	90↑	56↑
6. CIM	52↑	31↑
7. Coating/Finishing	5	0
8. Composite/Plastics	18↑	16
9. Control System	36	20

10. Design, Machine Tools	35	53
11. Design, Product	43	42
12. Economics	35	24
13. Electronics, Manufacturing	17	20
14. Engineering Materials	65	44
15. Expert Systems	1	9
16. Group Technology	17	7
17. Inspection	42	27
18. Machine Vision	13↑	13↑
19. Manufacturing Management	51	22
20. Manufacturing Systems	49	38
21. Materials	69	43
22. Material Forming Processes	48	31
23. Material Removal Processes	68	33
24. Material Handling	26	9
25. Microcomputers	53	55↑
26. Microprocessors	31↑	36
27. Modeling	21↑	15
28. Numerical Control	82	67↑
29. Probability and Statistics	47↑	29
30. Production Planning and Control	51	24
31. Production Planning and Control	57	29
32. Productivity, Manufacturing	30	24
33. Programming, Dynamic	10	4
34. Quality Control	87↑	51↑
35. Reliability	19	7
36. Robotics/Automated Systems	64	40↑
37. Simulation	17↑	11
38. Technology Strategy	5↑	0
39. Welding	45	38
40. Other	--	--

↑ or ↓ shows at least 33% of respondents indicate academic content increased or decreased in last four years.
\+ Survey defined substantial academic content as 15 hours or more of instructional activities.

Another type of curriculum analysis was done using the 1990 SME data by individually separating MAA (n.121) from "Related Technologies" programs (n.112). A second step compared the percentage of schools offering particular technical content areas with yet a third classification, "undifferentiated" AA/BA degree programs (n.30). Results appear in Table 4. Computer Aided Drafting (CAD) was the single common denominator across all programs. In many curriculum categories, it can be found that the difference between the percentage of programs offering selected technical content areas, in MAA and Related Associate degrees and the undifferentiated AA/BA degree is approximately one-third to one-half indicating that the longer span of time allows particular technical content to be added for the bachelors level student. For example, the topic of Economics reveals stability with slightly under 50% of associate degree programs reporting inclusion of this content area while in the undifferentiated AA/BA programs, 90% taught this topic. Given the importance of this topic should all programs include the topic of economics with one level of achievement identified for the associate degree graduate and a higher level for the baccalaureate student? A voluntary standard based on work place application could define such an issue with better educational efficiency as a result.

Table 4

Unofficial self-report of academic program content data from colleges offering associate degree in manufacturing (MAA) or related technical programs. Programs differentiated according to description of "manufacturing" in the title (n.121), associate degree (AD) in related technical programs (n.112) and colleges offering both an associate and a bachelors degree with academic content undifferentiated by level (n.30).

CONTENT AREAS	% of Programs Offering Topical Content Areas		
	MAA Programs	AD Related Programs	AD/BS Programs
1. Artificial Intelligence	7%	4%	10%
2. Assembly	21	11	40
3. Automation	51	30	70
4. CAD	100	97	100
5. CAM	85	65	80
6. CIM	54	33	67
7. Coating/Finishing	2	2	13
8. Composite/Plastics	17	15	47
9. Control System	42	36	70
10. Design, Machine Tools	53	56	77
11. Design, Product	40	41	80
12. Economics	47	49	90
13. Electronics, Manufacturing	32	30	37
14. Engineering Materials	65	55	93

15. Expert Systems	7	3	7
16. Group Technology	12	5	23
17. Inspection	49	29	60
18. Machine Vision	16	10	37
19. Manufacturing Management	55	29	73
20. Manufacturing Systems	61	29	87
21. Materials	61	52	90
22. Material Forming Processes	44	29	70
23. Material Removal Processes	60	51	80
24. Material Handling	31	21	60
25. Microcomputers	78	79	80
26. Microprocessors	63	63	53
27. Modeling	13	4	40
28. Numerical Control	85	71	83
29. Probability and Statistics	58	49	80
30. Production Planning and Control	45	39	67
31. Production Planning and Control	53	33	80
32. Productivity, Manufacturing	25	16	50
33. Programming, Dynamic	9	6	27
34. Quality Control	77	52	93
35. Reliability	16	10	37
36. Robotics/Automated Systems	78	62	83
37. Simulation	14	5	27
38. Technology Strategy	5	2	10
39. Welding	54	59	67
40. Other	10	4	13

Source: *Directory of Manufacturing Education Society of Manufacturing Engineers*, Dearborn, Michigan. 1990 Edition.

Differences in curriculum content areas were found in many categories when contrasting MAA and Related Technologies programs. These categories were assembly, automation, CAM, CIM, Inspection, Manufacturing Management, Manufacturing Systems, Material Forming Processes, Modeling, Production Planning and Control, Robotics and Automated Systems. Fewer undifferentiated AA/BA programs offered Microcomputers content than both types of associate degrees. Could this skill be more closely related to a "technician" category?

Table 5 provides the percentage of programs offering selected technical content areas (1992) for comparison. No differentiation was made with the 1992 data to compare the undifferentiated AA/BA program.

Table 5

Unofficial self-report of academic program content data from colleges offering programs in Manufacturing or related technical programs. Programs differentiated according to Associate Degree programs (AD) with the descriptive word "manufacturing" in the title (n.153) and Associate Degree programs in related technical programs (n.135).+

CONTENT AREAS	% of Programs Offering Topical Content Areas	
	MAA Programs	AD Related Programs
1. Artificial Intelligence	5%	5%
2. Assembly	23	21
3. Automation	56	38
4. CAD	99	96
5. CAM	86	62
6. CIM	58	30
7. Coating/Finishing	5	4
8. Composite/Plastics	24	16
9. Control System	53	21
10. Design, Machine Tools	58	57
11. Design, Product	52	47
12. Economics	49	41
13. Electronics, Manufacturing	31	23
14. Engineering Materials	65	55
15. Expert Systems	5	4
16. Group Technology	14	7
17. Inspection	50	30
18. Machine Vision	22	12
19. Manufacturing Management	56	27
20. Manufacturing Systems	67	37
21. Materials	65	52
22. Material Forming Processes	40	40
23. Material Removal Processes	63	38

24. Material Handling	36	19
25. Microcomputers	72	74
26. Microprocessors	63	50
27. Modeling	20	10
28. Numerical Control	84	63
29. Probability and Statistics	59	41
30. Production Planning and Control	48	32
31. Production Planning and Control	59	36
32. Productivity, Manufacturing	34	30
33. Programming, Dynamic	11	6
34. Quality Control	83	47
35. Reliability	22	13
36. Robotics/Automated Systems	78	58
37. Simulation	23	10
38. Technology Strategy	9	2
39. Welding	56	51
40. Other		

\+ Institutions reporting both an AD degree and a BS degree not separated for separate analysis.
Source: *Directory of Manufacturing Education Society of Manufacturing Engineers*, Dearborn, Michigan. 1992 Edition.

Academic/Technical Integration

Neither SME surveys reported on the general education components of programs--a critical factor for comprehensive program analysis necessary to determine a foundation for competency achievement identified in the SCANS or other similar reports. Our American system of education provides autonomy to states for educational decisions. General education content is generally left to the discretion of college campuses with state governance bodies providing broad guidelines. A 1993 survey response from South Carolina indicates that their college along with industry has identified seven competencies. Those competencies are being integrated into curriculum courses "not just left to the Mathematics, English, etc. departments to teach". Apparently the technical faculty are taking matters into their own hands. Integration strategies could be more efficient.

Survey respondents in 1993 were asked about program efforts to integrate academic and technical coursework. Forty-three or 33% offered no reply. Narrative responses are available from the investigator. Though this is a federally supported direction under the Carl D. Perkins Bill reauthorized last year, results of this survey reveal little focused progress. A recent study disseminated through *Centerfocus* and published by the *National Center for Research in*

Vocational Education (No. 1/July 1993) reports a similar finding by Thomas Bailey and Donna Merritt. In "Youth Apprenticeship: Lessons from the U.S. Experience"

> Efforts to integrate academic and vocational content remain limited. Still conceptualized as a reform of vocational education, the integration strategy has barely penetrated traditional academic and college prep programs. Moreover, the trend toward integration remains primarily in the classroom and very little is known about how the work place can be used most effectively in this strategy. p. 4

Students and Workplace Integration

The workplace provided another focus for the 1993 survey. This investigator reviewed the SME 1990 and 1992 data to determine extent of program use of industry as a learning site. Table6 reveals slightly over fifty 50% of the programs reported availability of industry cooperative work experience for students. The 1993 survey finds the percentage offering a planned industry experience remaining stable with 50% of related programs offering that experience (Table 7). Types of experience were categorized as "cooperative education," "apprenticeship," and "internship." Of those programs reporting offering such experiences, the MAA used the classifications at 64%, 9%, and 26% respectively while related programs used the classifications at 56%, 20%, and 24%. MAA programs most frequently reported one semester of experience (50%) while related programs were more likely to report one to two semesters. Several programs indicated that their part-time students were employed. In this investigator's opinion, a parallel industry experience would be beneficial in preparing a graduate competent to integrate immediately as a fully contributing member of a workforce. Table9 lists "d" as a category of interaction between academic institutions and industry and directly asks respondents about parallel (sequential) industry experiences. Only 19% of the MAA and 13% of the Related AD programs identify themselves as having parallel experiences for their students.

Table 6

Unofficial self-report data on academic programs offering cooperative education at colleges listing academic programs in Manufacturing or related technical programs.

Cooperative Education +

RESPONSE	MAA PROGRAMS		AD RELATED PROGRAMS		AD/BS PROGRAMS	
yes	68	55%	56	53%	17	65%
no	56	45%	49	47%	9	35%

\+ not all respondents answered this question
Source: *Directory of Manufacturing Education Society of Manufacturing Engineers*, Dearborn, Michigan. 1990 Edition.

Table 7

Self-report data indicating planned industry experience for students as a component of the AD academic program.

RESPONSE	MAA PROGRAMS (n.77)		AD RELATED PROGRAMS (n.55)	
yes	n.41	53%	n.25	45%
no	n.36	47%	n.30	55%

Program/Industry Contacts and Relationships

Also of interest was the number of industry and academic program contacts and the types of interactions that occur. Table 8 indicates that the majority of responding MAA programs work with more than 10 industries (40%). Related technologies programs similarly report more than 10 industries (34%).

Table 8

Survey response self-report data indicating number of academic/industry contacts per year.

MAA PROGRAMS (n.77)				AD RELATED PROGRAMS *			
1-4	21%	8-10	12%	1-4	21%	8-10	15%
5-7	26%	10+	40%	5-7	30%	10+	34%

* - based on 53 responses

Table 9

Self-report data indicating level of interaction between academic institutions and industry.

TYPE OF INTERACTION		MAA PROGRAMS	AD RELATED PROGRAMS
a.	Advisory committee	95%	100%
b.	Activities focused on curricula revision	31%	40%
c.	On-site learning experiences for students	61%	65%
d.	Parallel industry experience (sequential) ex. school-to-work	19%	13%
e.	Hire program graduates	51%	65%
f.	Provide industry experience for faculty	54%	53%
g.	Industry contract with college for employee upgrade	74%	71%

h.	Applied research	25%	16%
i.	College serves site for industry employee training	64%	69%

Other: **MAA programs:** Regional network for manufacturing strategies, faculty attend industry sponsored workshops, professional societies, college manufacturers parts for industries, make high school students aware of manufacturing (educational) programs, Partnership Center for Industry, develop partnership with industry, and sponsor seminars.

Other: **AD Related programs:** College experiments with advanced technologies for regional industries/technology transfer, consulting.

Type of interaction 1993 found in Table 9 reveals that Advisory Committee participation is virtually universal. Significantly fewer report industry involvement in curriculum revision projects (MAA, 31%; Related Technologies, 40%). Over 60% of both types use industry for on-site learning experiences. Over fifty percent of the programs report using industry experience for faculty development. Relationships between industry and colleges to provide employee upgrade appear very healthy with close to 75% of academic programs reporting these relationships. Twenty-five percent of MAA programs are involved in applied research activities, while only sixteen percent of Related AD programs report this activity. Specific responses indicated that a few colleges have formed regional networks. One college reported that faculty attend industry sponsored workshops. This last item represents an excellent approach to developing industry/education linkages and should be encouraged for all programs.

Total Quality Management Curriculum Content Integration

The evolution of the Total Quality Management (TQM) movement with the resultant change in workforce supervision and organization prompted the question on inclusion of TQM as a function of curriculum change. The 1993 survey found that TQM has been well integrated into programs with 86% of MAA programs and 71% of Related AD Technologies programs reporting content inclusion (Table 10).

Table 10

Self-report data indicating inclusion of Total Quality Management theory.

TQM THEORY		MAA PROGRAMS	AD RELATED PROGRAMS	
yes	n.66	86%	n.39	71%
no	n.11	14%	n.16	29%

SCANS Impact

The SCANS report provides recommendations for education change in both academic content and pedagogy necessary to achieve competencies correlated with high skill (high pay) work in our industry sector.

Based on extensive national workforce research, the 1991 SCANS report published by the U.S. Department of Labor identifies three Foundation Skills and five Competencies representing hallmarks for expert workers in high performance organizations. Considered as universal, SCANS skills and competencies are flexible supporting both technical and personal competence consistent with evolving patterns of expectations for workforce performance.

The 1993 survey revealed that approximately 30% of program directors were familiar with the SCANS report. And, of those familiar with SCANS, MAA 68%, AD related 65% responded that the SCANS report did have an impact on their curriculum (Table 11).

WORKPLACE KNOW-HOW

The know-how identified by SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance. These are:

WORKPLACE COMPETENCIES: — Effective workers can productively use:

- **Resources**—They know how to allocate time, money, materials, space, and staff.
- **Interpersonal skills**—They can work on teams, teach others, serve customers, lead, negotiate, and work well with people from culturally diverse backgrounds.
- **Information**—They can acquire and evaluate data, organize and maintain files, interpret and communicate, and use computers to process information.
- **Systems**—They understand social, organizational, and technological systems; they can monitor and correct performance; and they can design or improve systems.
- **Technology**—They can select equipment and tools, apply technology to specific tasks, and maintain and troubleshoot equipment.

FOUNDATION SKILLS:— Competent workers in the high-performance workplace need:

- **Basic Skills**—reading, writing, arithmetic and mathematics, speaking, and listening.
- **Thinking Skills**—the ability to learn, to reason, to think creatively, to make decisions, and to solve problems.
- **Personal Qualities**—individual responsibility, self-esteem and self-management, sociability, and integrity.

SCANS 1992. Learning a Living. A Blueprint to High Performance. Washington, D.C., U.S. Department of Labor.

Table 11

Self-report data indicating knowledge of SCANS report. Respondents further queried as to impact on curriculum.

FAMILIAR WITH SCANS	MAA PROGRAMS		AD RELATED PROGRAMS	
yes	n.24	32%	n.17	31%
no	n.52	68%	n.38	69%

Non-traditional/Distance Learning Implementation

Experience in pursuing non-traditional educational delivery formats encouraged framing a 1993 survey question on program use of emerging technologies or other distance learning strategies. Access and academic flexibility are needed to encourage development of the skills needed of our workforce in highly fluid work environments. Internet and the technical expertise to communicate globally is a reality, while poor literacy and computing skills in our workforce are a national concern. Only about 40% (Table 12) of the respondents make use of any form of distance learning. Broader use of existing telecommunication pathways would support dissemination of exemplary education programs from basic literacy to higher technology skills and knowledge for our nation as well as worldwide as the global economy opens new market relationships.

Table 12

Self-report data indicating some use of distance learning pedagogy.

DISTANCE LEARNING	MAA PROGRAMS +		AD RELATED PROGRAMS *	
yes	n.27	36%	n.23	42%
no	n.48	64%	n.31	57%

\+ based on 75 survey responses; two no answers provided.
* based on 54 survey responses; one no answer provided.

Distinctive/Exemplary Programs

Question 13 in 1993 asked respondents about distinctive or exemplary aspects of their programs. Many wrote about equipment, their relationships with industry, and other aspects that brought them pride. Narrative responses are available from the investigator.

Opinions Expressed About the Proposed Project

A last question in 1993 asked for respondents' opinions about the project; namely developing specifications for an associate degree in manufacturing with employer organizations such as the National Association of Manufacturers. While there were spaces left blank, there were many highly positive responses. Not one response was negative or discouraging; responses often conveyed a sense of excitement and expressed desire to be involved. Narrative responses are available from the investigator.

Conclusions:

- A 49% response rate points to a high level of interest on the part of educators in national level collaboration to jointly develop standards as a basis for a voluntary model curriculum. Collaboration and cooperation nationally can bring change and make the essential contribution to insuring a competitive workforce in our future. Competition and fragmentation would be costly and inefficient.

- Some community colleges proudly report close partnerships, involved faculty, and superior facilities. Opportunities for benchmarking any national model curriculum are evident. Working national networks to communicate information on success and achievement and to engage people in dialogues on workforce issues need to be supported.

- Cooperative partnerships to formulate strategies for the development of a parallel education industry experiences pathway are clearly needed (School-to-Work Transition). Relevant, sequential, planned learning activities for faculty and students in context should be incorporated as a component in any educational program. Such relationships enrich all partners nurturing and enhancing the self-esteem and productivity of both current and future workers.

- The U.S. Department of Labor should be encouraged that close to 70% of the educational programs who responded and whose faculty are aware of SCANS, report it has had an impact on their program. It is disappointing that the penetration reported is only about 30%. Dr. Packer reports that Florida has replicated and is endorsing SCANS. This investigator has reviewed *Smart Job Strategies: Texas Skills Development Program* (Texas Department of Commerce, Austin, TX, 1993) that similarly endorses integration of SCANS findings.

- Some Manufacturing Technology and Related Associate Degree programs are reporting patterns of curriculum change to meet the evolving needs of industry. However, most change seems highly technical in focus while manufacturing employers are expressing a need for employees who are flexible generalists. Education and training to prepare flexible generalists requires foundation skills and competencies as well as technical breadth. Little information was available on the locally dictated general education components. Little progress is reported in integrating technical and academic learning. Relatively few programs have incorporated SCANS skills. This investigator perceives a need for a model curriculum design to prepare a flexible manufacturing generalist.

- More use should be made of distance learning strategies for education accessibility, student assessment, non-traditional academic scheduling, and pedagogy enhancement.

Recognition:

This investigator is grateful for the advice and assistance of Mr. Mark Stratton, Education Department Manager for Society of Manufacturing Engineers. The Society of Manufacturing Engineers is a non-profit technical society that counts 75,000 members internationally, and sponsors chapters in the United States, Canada, Argentina, Australia, Hong Kong, Ireland, Israel, Japan, Singapore, Taiwan among others. Mr. Stratton in his role works closely with ABET, a voluntary accrediting body for engineering programs. SME completed a national level meeting in September, 1993 to discuss evolving technical program competencies.

This investigator expresses appreciation to Dr. Arnold Packer for providing the suggestion that prompted this study, for attentive review and suggestions on the questionnaire, and for providing endorsement through a cover letter. His parentage of the seminal study *Workforce 2000* became a cornerstore for the SCANS report. His "intellect, commitment, dedication, and

leadership" was acknowledged in the SCANS documents and continues in this most recent project.

Sloan Foundation funding has provided an impetus for the formation of a network of key industries, organizations, and educators to bring to national focus manufacturing workforce education and preparation issues.

REFERENCES

U.S. Secretary of Labor's Commission on Achieving Necessary Skills (SCANS) (1991). What work requires of schools. Washington, D.C. U.S. Department of Labor.

"Education: Trying Harder." *The Economist.* November, 21, 1992.

Bailey, Thomas and Merritt, Donna. "Youth Apprenticeships. Lessons From the U.S. Experience." *Centerfocus*, NCRVE, University of California at Berkeley. No.1/July 1993.

Question 7: **Describe efforts to integrate academic (general education or supportive coursework) and technical (work related theory and skills) courses within your program(s).**

College academic faculty senate insist on traditional liberal arts/general ed. as course support "degree."

We are writing articulation agreements with several local high schools. Our admissions office supplies prep. on higher level committee groups.

The college has been implementing a collegewide competencies program for the last three years. The college in conjunction with industry has identified seven competencies all graduates will have. These competencies are being integrated into curriculum areas, not just left to the math, English, etc. departments to teach. The infusion of these competencies is bringing a change in course content and classroom methodology to the technical courses.

English 103, Technical Report Writing, integrates the technical aspects of the program into reports using computer support with the English course.

The four English courses required for all Engineering Technology students concentrate on materials for each student's specific career.

Former apprenticeship program (in Machine Tool Technology).

Strong general education component in major. All graduates tested for general education outcomes (College Base Exam).

Program has 15 semester hour core of general academic courses. There is little current integration of technical work into these courses.

Technical writing course now required.

Less than 57% of students are returning adults participating in industrial "upgrade" programs.

A little over half of each program consists of technical credit (almost two-thirds of contact hours). The remaining coursework is split between so-called basic courses (math, physics, computer science) and so-called general courses (communications, sociology, chemistry).

Provide general education with practical applications from technical instructors' experiences.

Part of program includes academic coursework. As of this academic year, students will select two electives which may be of an academic nature.

Question 7 (cont'd.):

Academic assessment of skills at entry, parallel on a JIT basis academic coursework, academic assignments.

Minimal special efforts.

Team group activities are becoming a more important part in program content coordination.

Program was designed to meet ABET requirements.

We require 18 semester hours credit for our degree program.

(Not enough space here.) Pioneered Writing Across the Curriculum on campus. Have TQM approach to define outcome needs of graduates to supporting course. Make overt effort to guard against less than collegiate rigor in all courses.

Academic courses are prerequisites or corequisites for technical classes. Technical faculty work with academic faculty in course development. Some technical courses are designed around academic work. Course work in technical classes is graded for grammar, spelling, mathematics, etc.

We have coursework in Occupational Communications, Human Relations, Quality Management, and most courses include a need for comprehensive reading, following directions, and report writing. We also require students to take 2 courses in technical math, 2 courses in physics, and a course in technical communications.

Recommend text for Technical English taught in English department. Technical Math II satisfies general education math competency requirement.

We require students to write extensively in technical classes and present written and oral reports to the class.

All students must complete university gen. ed. requirements.

Oral, written reports, current readings (*New York Times*), Intro of TQM, Deming, Learning Through Writing courses in technology, Intro to applied software.

Associate degree programs integrate general education coursework.

English/math all use computer software and is required in technical courses. Example: WordPerfect is required for doing labs/projects, etc. in quality control, plant layout, etc.

Our college provides a competency based instructional approach for curriculum/program/course offerings--general ed. and technical ed. and college ed. competencies are interwoven.

Question 7 (cont'd.):

Both required for BS degree in Industrial Technology. Manufacturing Tech. is an area of emphasis within the Industrial Technology program.

Committees with the various academic area faculty and the technical faculty meet to discuss needs.

We meet all requirements of the Virginia Community College system for inclusion of general education courses.

We expect our students to take the following course to complete their education at our institution: Communications--6 credits, Humanities--3 credits, Social Science--3 credits, Math/Science--19 credits, Technical courses--36 credits, and PE--2 credits = 68 credits.

Projects in courses.

Fifteen semester hours of gen. ed. dictated by state for AS degree. The remaining sixty hours are technical.

Writing Across the Curriculum activities.

We view academic and technical areas as fully integrated within our programs; however, statewide general education requirements force situations where students must take math classes to fulfill math requirements. A student may not use math experiences in NC programming, for example, to satisfy math general education requirements.

A final semester assessment team taught course for each graduate. This course requires the student to demonstrate performance in major areas that include general and technical.

Tech Writing and Applied Math are part of curriculum.

Mentors and industrial advisors participate in curriculum revision and development, advising, and selection of student coursework.

Tech Prep goals to provide exposure to technology in academic courses. Very little otherwise.

Some academic courses prepare students for technical courses--math, physics, English. We believe in Writing Across the Curriculum. We have goals and objectives for all academic courses that reflect technical students' needs.

Minimum efforts being made. Mostly talk.

Students make oral presentations and write technical reports as part of many courses. Math and physics used in many courses. Interpersonal and team skills are encouraged in many courses.

Question 7 (cont'd.):

No effort--it's done. Curriculum contains both general education and technical courses.

Curriculum requires three credit hours of "Technical Writing."

Students in this program also take 21 semester hours of general education courses if they plan to receive the AA degree. If they only receive a certificate of completion they take math, physics, chemistry, technology and society, and a level two English. Also electronics, engineering drawing using CAD, plus 21 units of specific Manufacturing Technology coursework.

We have emphasized the importance of technical writing and computer programming courses in our associate degree programs.

Most courses have lab components.

We provide a minimum of 30% as general education requirement for associate degree (21 of 60 credits).

College algebra, college trigonometry, and other academic courses.

All advanced level courses are focused on problem solving skills and interpretation of complex data.

These four programs, Manufacturing Engineering Technology, CAD/CAM, Manufacturing Processes, and Quality Assurance, are being replaced with one new program entitled Manufacturing Technology. This program has been redefined (as a result of working with a consultant and industrial advisory board) to attempt to meet the occupational needs of manufacturing today, incorporating both academic and vocational/technical skills. Program implementation begins in September, 1993.

Use of field trips, industry speakers in classrooms, industrial advisory committee input and curriculum review.

Our program from inception has had college parallel courses like ENG 101, MATH 110, PHY 100, Technical Writing as part of the technical courses which compose 85% of the program.

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All instructors work together to relate individual courses. Courses in prototype development and construction integrates skills, theory, and related courses.

Question 7 (cont'd.):

Application of physics to solve design problems, math also, English and speech for technical reports and presentations.

Efficient integration of general education/technical via interaction with/industry community!

Our faculty works closely with the math science department.

Our curricula for associate degrees require our students to take courses in writing, oral communications, psychology, math, physics, and business management.

Fully integrated program.

12 hrs. of general education
35 hrs. technical occupation and related courses
13 hrs. math and science
3 hrs. technical writing
2 hrs. electives
65 credit hours

Discussions are currently being conducted which will lead to broader integration of academic and technical skills within the institution.

Each course with a laboratory requires that written and oral presentations be made. Reports and presentations are graded with regard to grammatical construction.

No formal approach at this time, however, most instructors attempt to integrate math, writing, and English skills in all courses.

Senior Project (capstone course).

Many of our technical programs have a one year certificate, two year certificate, and by completing a two year certificate and all core curriculum competency degree requirements, receive an associate in applied science degree in one of seven technically oriented programs.

Already doing this.

63 total semester hours are required of which 24 hours are general education courses.

Combinations of curriculum requirements for various degrees, i.e. business management and mathematics areas. Actually very little effort has been made up to this point.

About one third of the program is general education.

Question 7 (cont'd.):

All AAS programs now include college's general education plan.

Basic skills (communications, computation, problem solving, team building, diversity) are integrated into each class. Case history problems are addressed, discussed, and presented by teams.

Our school has an arts, sciences, and business department that provides a broad range of general education courses to support and augment the technology curricula.

Academic -- the nature of the associate degree requires 6 credits of English and 6 credits in political science and humanities. Within our courses we require a series of written reports and math coursework.

Technical -- that's what our program is.

AAS degree requires a 25% general education core, a 25% technical core, and remaining 50% defines the specific concentration.

Some integration is done in mathematics and humanities (discovers and inventions). English report writing does not seem to be industry oriented.

1. Tech report writing
    a. write memos
    b. tech reports
2. Tech math
    a. applied problems
    b. problem solving
3. Tech physics
    a. problem solving
    b. team work
    c. critical thinking

Writing across the curriculum where engineering and writing classes were taken concurrently by students, E100 and Writ101.

We do writing across the curriculum along with having general education core requirements such as ethics, computing, oral and written skills, and problems solving in our technical courses.

We have worked closely with the academic faculty by holding workshops and seminars on the needs of industry and implementation of academic subjects in the main curricula.

Broome Community College has developed an integrated program of general education in every course of study.

Question 7 (cont'd.):

English, science, and math are integrated into the program. Students are also provided integrated study skills during the first term of the program.

Efforts will be made to adapt technical electives consistent with the needs of supporting industries.

Establishing a CIM lab.

All of our AAS (Associate in Applied Science) degrees require a minimum of 25% by credit hours of general education courses. We are taking steps to incorporate speaking and writing activities into the technical courses to improve skills in these areas.

1. Technical writing skills taught by the English Department.
2. Math courses taught by academic instructor.

None.

Question 13: What is it about your manufacturing or related program that you feel makes it distinctive or exemplary?

Complete ENC programming CURR from formatted programs to interactive graphics. Industry tours. Work with local companies like Hous, Fadel, Surfcam. Student SME chapter has entered WESTEC CAD/CAM CHALLENGE contest every year. Outstanding graduates.

Our program graduate success stories combined with our nearly 100% industry placement record really tells the story. Staff members are truly concerned about helping students develop their potential and become successful, productive members of society. We also utilize a large amount of industrial grade equipment including industrial robots, CNC machine center, and other automated equipment.

Upper level students work on "real" design problems from local industries. Faculty does no consulting work; instead, that work is given to the students. All students that have transferred to a four year university have done very well.

Before TQM was a "buzz" work, we had established a working relationship with our advisory council. The concept of external and internal customers was recognized by our faculty as critical to the viability of our graduates. The education a current work experience of the faculty. Responsive students.

Individualized classes.

Curriculum content was established by local industry engineers via a DACUM process.

Nothing.

The commitment of the instructors and the hands on training.

Real activities/problems in applied research, interdisciplinary teams, capstone manufacturing teams as independent businesses, practical hands-on current related to local industry projects/assignments. A Computer Integrated Manufacturing (CIM) lab.

Graduates of the program have almost 100% placement in jobs for past six years, indicating their education is applicable to needs of employers.

Qualifications and enthusiasm of instructors. Willingness to do the extra work to provide industry with the best possible graduates.

Ceramic Engineering Technology -- only 2 year technical ceramics program in the country. Material Engineering Technology -- one of less than six 2-year programs incorporating technical aspects of ceramics, metals, polymers, and composites as well as manufacturing processes.

Industries are using sub-modules of the program to upgrade their employees.

Question 13 (cont'd.)

The coursework is closely coordinated with industry needs and used extensively (especially in evening) for employee upgrade.

Closely tied to area industry. Strong general education core.

Because of the heavy influence of manufacturing in the area, we must keep abreast of technology. As the companies in the area advance, so must we.

Our program is small in size, unique in design, integrating the micro computer throughout all four semesters, a hands-on approach to all areas of the program and designed for both career as well as transfer to a BT degree program.

GE is using it at Erie works as part of last GE apprenticeship program. The program is being outreached in small manufacturing in Cory, PA through Cory Higher Education Council. We have 40% of total Penn State System 2 MET students.

We feel that through the close association with industry that we are teaching the technical skills required. We feel that through our collegewide competencies program we are integrating academic competencies in to the technical classroom.

Our students take a significant amount of coursework in business/management and a heavy load in liberal studies.

Heavily involved in TQM but not in a manufacturing program.

Our program has a mixture of both theory and hands-on applications.

Interaction with industrial advisory committee. Returning adults--major number of students work full-time in industry in quality control, material handling, process control and planning, etc. Utilizing adjunct faculty from industry provides current, relevant experience to program. An expanding, growing co-op experience.

Our coursework is geared toward employees and/or employment in small manufacturing companies.

New manufacturing emphasis--MET Department will review program in fall 93 semester.

Focuses on integration of manufacturing and automation components into an operating system, i.e. machining center, robots, conveyors, vision system, plcs, pcs. We also have manufacturing programs in electronics and CAD/CAM.

High academic standards/direct route to a local university to complete a four year degree at our site with televised university classes. Possibility exists to complete a masters degree in Systems

Question 13 (cont'd.)

Engineering through two other state universities at a local site.

We try to keep up with the needs of our graduates and their employers.

The emphasis is practical hands-on coupled with theory. The program addresses the needs of our service area.

We have full size industrial robots and CNC lathes/mills. We have a department chair with 25 year's of progressive manufacturing experience (from mechanic to plant manager).

The curriculum is current with industrial needs and technology. Completed about a year ago. It was based on needs, not what other schools are doing.

I am concerned about trends observed in the last three years. We were leaders in several technology areas (CAD, CAM, electronics), but we are losing our grip. The economy here (aerospace) is very depressed, and the word is out to switch from manufacturing to service industry. SCARY!

Simulated industry situations. Hands-on experiences emphasized.

Our college, a DCCCD institution, offers a graduate guarantee to students and employers by keeping our curriculum current and competency-based.

Individual mentors, increased aid, high quality students, increased graphics, CAD, sketching, concentration on manufacturing process, and coordination with industry.

Designed as a result of direct interaction with industry.

State-of-the-art labs (CAM and robotics). Laboratory work similar to on-the-job experience.

We have the state-of-the-art equipment and a strong faculty development program.

We feel our program is quickly responsive to our local industry needs without sacrificing the rigor associated with a solid educational foundation. Our technical/academic environment created by both our staff and facilities often draws an excellent group of students.

Up-to-date equipment.

Question 13 (cont'd.)

CAM--well equipped labs. Good CNC programming course sequences. SMARTCAM training center.
CAD--AUTOCAD, CADKEY training center. Forty-two training stations (486 + latest audo CAD version).
QET--excellent selection of QA fundamentals. QET certificate--excellent preparation for ASOC certification. Draws 100 students from area (technicians to quality managers).

Practically industrial.

Extensive use of machine tools, especially CNC machine tools.

Excellent, extensive hands-on student labs--latest equipment. Motivated, creative instructors.

The manufacturing program at our college is unique. Students entering into the program have two options: 1) metal cutting or 2) plastics. The core classes remain the same. They get practical experience through the internships. They are also exposed to a variety of areas in manufacturing. In the near future engineering design and electronics students will also be able to use the manufacturing labs for CAD/CAM integration and industrial automation respectively.

Good labs.

Our design program has ABET accreditation. Our CIM program has courses and lab work in CAD/CAM, robotics, CNC machine programming, and programmable controllers. We are preparing to go for ABET accreditation for our CIM program.

At the present time the program is in transition. A new department head has been hired. The experience has helped greatly. Better relations with both industry and high schools have helped. Within 2-3 years we can become distinctive, but not yet. This is, however, the first NAIT accredited 2 year program.

We mix tech skills with management concepts and liberal education to provide a student with a solid foundation applicable for many industrial positions.

Our program is a branch campus of a major four year university. Our program is ninety credit hours long. We are the only college in our state that teaches a vocational high school secondary program on campus. The campus has a CIM center that is being utilized for advanced automation process for manufacturing.

Majority of courses include a laboratory component. Courses provide appropriate level technical theory with practical applications.

Question 13 (cont'd.)

We share projects between our mechanical, manufacturing, and quality programs. An example: Mechanical students apply tolerances and design based on results of capability studies performed by quality students. Our quality students teach the manufacturing students how to control their processes--many courses are common.

Hands-on experience, machining equipment and welding, robots, CAD, computers utilized in most all technical courses.

Small class size which allows us to provide a very directed program and the ability to focus on student needs <u>not</u> college needs!

AutoCAD, Algor, Smart CAM, Intergraph, microstation use, strong welding and machining courses. Strong statics/strength of materials course.

We are meeting the needs of business and industry. The program is adaptable to change with new technologies.

Final semester culminating project. Students form a company and design and manufacture a project in our CIM lab. All design, fixturing, programming, interfacing, development, etc. is student led in a team operation. Each class begins from scratch. There are no "canned" projects.

We have changed our two programs to CADD technology and CAM technology to keep up in recent trends in industry.

1. Instruction is very experienced based. Students have extensive <u>hands-on</u> training by instructors with <u>current</u> industrial experience.
2. Our facilities (CIM Lab, CAD Lab, metrology lab and welding labs) are some of the best in the country.
3. Our students are mature and motivated, i.e. our placement is 90+%.

Our program has two options--supervisory and automated manufacturing. We also offer a +2 program in automated manufacturing technology. We offer our associate degree on site for local industry.

Overall program quality. Quality of laboratory equipment and experiences.

Question 13 (cont'd.)

We feel it is exemplary in its vast offering of CAD 2D through solid modeling with today's latest software, its three courses in CAM, from G-Code programming through 3D smart cam on industrial based machines, its studies of networking pc's, relational dBase in SQL, Bar coding, its manufacturing systems management and controls to the coop training for one semester applying principles learned to local manufacturing. In a two-year AAS degree program.

Sound basic program designed both for entry level positions in industry following two years of education or continuing education in a four year BSET program. Involvement in large number (10) of tech-prep consortia.

Our program is structured with a good balance of theory and practice. Students completing our program have the basic skills needed for modern employment. Our program has both one of the highest placement rates and salary levels for the College of DuPage. (Which is one of the largest community colleges in the U.S.)

Advanced lab facility that allows immediate application of theory to hands-on application in an industrial grade simulation system. (Fully integrated flexible manufacturing work cell).

I would prefer to use the term successful, to a large extent it is due to the cooperation and communication of our advisory board. The input of our board has helped us to keep our program in line with the changing times as much as possible, I would be remiss if I did not include the dedication of faculty to give that extra 50%.

The program has been recently restructured.

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The depth and breadth of our program provides the student with fundamental knowledge and experiences in several areas of the machine tool field as well as concentrated study in jibs and fixtures and CNC. This background permits our graduates to select the area of major interest or employment opportunity.

The hands-on training.

Constant interaction with industry.

That we are presently in the process of converting the existing drafting and design program into a transferable engineering technology program.

CAD/CAM systems.

Computer integration in the Manufacturing Plant Quality Control certificate program.

Question 13 (cont'd.)

Program is based upon local manufacturing needs.

State-of-art industrial grade equipment.

We have both an Engineering Technology-Design option and a Production option. Both curricula have CAD/CAM as a major part of their degree in associate in applied science.

Our program has considerable amount of laboratory hours that will enhance the hand-on experience and the skills of the students, in the machining, automation CAD/CAM/CAE, robotics, statistical quality control.

WE have a strong emphasis on a hand-on approach to technology. We try to subscribe to Dewey's theory that we "learn by doing."

We are in the process of restructuring the program in partnership with industry. The most recent example is a joint project with IBM utilizing the Catia 4 Rise Good System. We are attempting to integrate the engineering technology program electromachanical, electronic, biomedical, and CIM with our machining and drafting programs via CATIA, Autocad, CIM.

If there is a distinguishing characteristic about the listed programs at our institution, it is that we have built curriculum that balances "heads"-on and "hands"-on activities based on practical and relevant contemporary practices in industry.

Ability to customize program to specific goals.

We have coop education and an active employer advisory board to insure we are meeting the needs of local industry. Also close ties with SME.

New facilities state-of-the-art.

The implementation of our new Ford Asset program. We have been offering TQM and Basic Mechanics at offsite locations.

- APICS classes incorporated into the 2 year degree.
- CPIM certification can be obtained. All tests can be taken at our school.
- Also has a chemical process Tech option to the APTOS Aroduction and Inventory option.

Really nothing--most students are on our 4 year CIM or Manufacturer's program--it takes care of a small number of people who work full-time and want a degree.

Students are given a good basic foundation in machine shop equipment and concentrate on CNC equipment during the last semester or quarter of training.

Question 13 (cont'd.)

Continuous improvement applications in the classroom.

Our mechanical design technology program included three machine design courses. We feel this better prepares the individual for today's computerized workplace. Our automated manufacturing technology program has two options; CNC programming and post-processor development and manufacturing systems.

ABET/TAC approved.

Our mechanical engineering technology is TAC/ABET accredited.

The intensive applications/hands-on orientation of the program which maximizes the students' exposure to a wide variety of manufacturing related tasks; utilizing both conventional and computer aided/integrated industrial machine tools and processing equipment. This approach yields technicians capable of integrating into the manufacturing spectrum with the distinct knowledge of design for "manufacturability" for the overall goal of productivity improvement.

- Faculty that have recently joined the department with a broad range of knowledge of cutting edge industries.
- A solid curriculum that emphasizes cost, quality, and timeliness aspects of manufacturing as well as technologies.
- CIM hardware and software that allows students to use CAD data as input to a fully automated manufacturing cell.

Continuous improvement and team building are integrated into the curriculum and enforced throughout. Tech Prep associate degree is a four year curriculum beginning in the 10th grade.

Our emphasis on manufacturing processes and CAD/CAM/CIM. Our equipment including: Cistern, AKIMBO MSCVA, Bridgeport, Hitachi both. We are running: Autocad, Ideas, Catin, on AS/400 and RISL/6000.

<u>New</u> emphasis under Industrial Technology program.

1. All faculty have kept current on changing trends by attending workshops or industrial partnership training. We follow our students closely through the program updated.
2. We keep our staff/faculty fully involved and active to all changes within the system. This helps promote "buy-in."

We have what we call a "Teaching Factory" where we have all aspects of a shop floor environment where the students design, run, trouble shoot, have suggestion input, etc.

It's not.

Question 13 (cont'd.)

Its purpose is to train technicians to high skill levels to compete in the advanced technology of future factory systems.

Training on AUTOCAD and use of SMARTCAM to operate lathe and milling operations. Extensive use of laboratory exercises to show how the students can apply the theoretical knowledge in an industrial atmosphere.

- Title II grant has provided state-of-the-art labs for mechanical, electrical, and fluid power systems--(five year grants totalling $1.5 million).
- Small classes with intensely student-oriented faculty.

Our program is in an evolutionary phase, building A +2 degree program on top of our associate of technology degree. We concentrate on the automated manufacturing process in our curriculum, and are working with local industry to bring real projects into our new four-thousand square foot robot lab.

- Small class size
- Placement rate
- Instructor qualifications

General comment: NVCC does not have a manufacturing technology program. AAS degrees are awarded for Mechanical Engineering Technology, Civil Engineering Technology, and Electronics.

Competency based curriculum, distance learning, consortium sponsored-statewide.

- lab equipment
- associate with Northeast Manufacturing Technology Center
- industry interaction

In-depth CAD to CNC to assembly line using industrial equipment. All computers are networked and program has a strong computer base. The full scale automated assembly line provides live lab for many manufacturing courses.

- stay current with industry needs
- 95% graduate placement rate

A state-of-the-art CIM cell with industry sized robots--a Vision system and a coordinate measuring machine.

Practicality.

Utilization of machine shop and AUTOCAD labs in course work.

Question 14: **Do you have any opinions you wish to express about the project described in the proposal; namely developing specifications for an associate degree in manufacturing with employer organizations such as the National Association of Manufacturers?**

Yes! This sounds like a very exciting program. I definitely want to be advised of progress.

The project is a positive thing. We have been working in this direction by listening to our advisory committees, responding to industry needs, working our articulation agreements with area high schools and with two universities in our state for BS degrees.

Consideration: my experience with employers, industrial advisors, SME, ASQE & ABET indicates this type of coursework is a science--AS or AAS. Why are you proposing the A.A. degree?

You might want to include the: American Design Drafting Association and Data Processing Management Association.

Worth a try.

The project appears to be well developed and planned. As I proceed with my PhD dissertation, I appreciate your efforts. I would also like to be considered as a member of your educators' panel. I would appreciate the opportunity to visit with you about it. Good luck!

We have been doing most of items in your proposal.

No comments at this time. (2)

Local unions and manufacturers have realized that the traditional apprentice to journeyman is no longer valid. Journeymen will be required to engage in lifelong learning to master the new technologies. Associate Mfg. Tech. degrees and submodules of these degrees will be required for the technical upgrade of journeymen.

Unless there are jobs available for graduates of these programs, it will not be possible to attract sufficient students into the programs.

It is extremely important to make the program viable and provide employable students.

I think that if standards can be set it will help American industries become more competitive. Especially it will help if the work-based standards can be established.

Strive for performance-based outcomes. Design adequate time on task. Integrate general education/applied academics.

With the process an excellent program should be developed.

Question 14 (cont'd.)

At the present time our program is in limbo due to reorganization and enrollment limits. However, we expect to have our program in Manufacturing Technology back on line this spring.

This program was developed 2 to 3 years ago with an industry advisory committee with input from SME's local chapter.

Degree would be an associate in applied science degree in the Virginia system (as opposed to the arts).

This should make a real contribution to manufacturing education.

I am in full agreement.

Sounds good. Keep me informed.

Candidates need lots of actual shop experience along with academic training.

We would be very interested in participating in the project, and we feel that employers must "buy in" to the concept of national skill standards or certification before the degree programs are finalized.

This should be an AS or AAS degree.

There should be uniformity in the associate degree programs from one school to another.

Project sounds great, wish I could be involved in a more meaningful way.

Many community colleges already have good programs. I would be glad to help you "benchmark" best programs and spread coursework.

Yes. Why an AA degree instead of an AAS? I feel that we should teach practice, not theory. The curriculum should not include calculus, since it is a barrier to many potential students, and very few will use it.

More emphasis should be given on hands-on training. One of the areas students lack in is metrology. Students need more exposure in this area because some of the inspection, gauging, and testing methods have changed considerably in recent years. We also need to make them aware of environmental impacts of technology.

Do not understand initial reference to AA degree and subsequent reference to "Associate" degree. Are we really talking AS? In Florida, the AA is predefined and has very little room for technical courses.

Question 14 (cont'd.)

This very closely follows my sabbatical leave interest. I would like to volunteer my services should you need them.

I endorse the idea of working with NAM wholeheartedly. We have to emphasize more lab work (hands-on) in our two year manufacturing programs than what we are doing now. It is time that manufacturing industries are thinking of working with the educational community. Please keep me informed about this project.

Sounds very interesting! How can I help?

Sounds like an exciting adventure!

I would like to be involved in the process if possible. As author of the "Craftsmanship 2000" curriculum youth apprenticeship program in Tulsa, I feel I have valuable input to offer. Please advise.

SME has a hangup on ABET accreditation--many Associate Degree granting institutions (such as ours) are offering programs which provide flexibility for the student wishing to take higher level math (calculus based) instruction. This is unfair to those institutions wishing to compete for grants, if ABET institutions are given preferential treatment.

The proposal is similar to the direction we are taking for our manufacturing and quality programs.

We have very little high school manufacturing left in our high schools--especially in the areas of CAD/CAM CNC--or general machine shop! Tech Prep has been a challenge. Good luck with this project. It's long over due!

We need programs or grants that give strong academic programs unrestricted funds annually to upgrade equipment.

Perhaps the National Association of Industrial Technology should be involved with the project as well. Also, I would very much like to participate in this project, if possible.

You are to be applauded in development standards in partnership with the private sector.

Employers must keep a realistic view of what is possible for an education institution to do.

This must be done in order to establish a meaningful program that leads to employment and advancement.

None.

Question 14 (cont'd.)

None at this point.

The MET program is a design oriented program, but we are considering a manufacturing engineering technology program including some course work from our industrial engineering technology and some advanced manufacturing.

I think it would be an excellent idea to have a standard and program that would be accepted by local industry.

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Please send any information.

Good idea.

While I have a BS degree and am within three credit hours of an MS, it is my opinion that work experience as a craftsman is far more important in the selection of faculty than academic credentials. A combination of the two is ideal, but there aren't a lot of those people around.

This is a necessary effort to enhance quality manufacturing in the United States and the rest of the Americas.

We always ask the question--What should we be teaching? Of course different areas of the country require different courses.

Seems okey.

Any linkage that can lead to a mutually beneficial program of study and subsequent employment for students has my full support.

Why is it an AA degree as opposed to an AAS?

I would be interested in discussing this project with you or a committee and providing input. Please advise.

I believe this AA program is a very good idea if it prepares the students for a two plus two type of program in manufacturing engineering.

I would be interested in the results of your survey.

No comments.

We are very encouraged about this program. Please keep us posted with new developments.

Question 14 (cont'd.)

See SME curricula 2000 workshop notes from 1987.

We have been awarded the two year curriculum improvement project for the State of North Carolina for manufacturing-industrial-mechanical engineering technologies for the community college system. Our project is similar to yours.

It sounds good. Most of the topics of item 11 are covered in our four year program. It is difficult to see h ow all those topics could be covered in two years along with the basics, i.e. math, physics, English, etc. I firmly believe that until this nation gets back to an economy that is based on the wealth or value adding industries, i.e., manufacturing, agriculture and extracting minerals, we will not be able to sustain a high wage/salary economy. Our two year feeds a four year BS in Manufacturing Engineering Technology. Would like to be informed of the results!

Sounds great. Go for it! Keep us informed.

I think the concept has merit and would like to be kept informed of its developments.

With industry's support and input I feel that it would be very beneficial and would welcome the opportunity for our college to participate in the development of this degree program.

I agree with this approach as we need business and industry representatives to define the outcomes needed in graduates of our programs. We are using this approach in our Tech Prep Youth Apprenticeship Program. I would appreciate a copy of your report on this survey.

More training must be done at the job site due to the wide variety of equipment. Most manufacturing sites have unique equipment.

Definitely a good idea and necessary, meaningful goal.

None at this time.

- The term "youngster" is inappropriate.
- SME should be a major player.
- Proposal focuses too much on "negotiating contracts" which is only <u>one</u> small part of manufacturing.
- I'm not sure what the real outcome of the proposal is??--why not SME???

We do need to enhance the manufacturing focus, and perhaps this proposal seeks to do so, but real results not clear.

Why develop an AA degree rather than an AS degree?

Question 14 (cont'd.)

An exemplary mission. One area to concentrate on is developing continuous, frank communication from employers on the skills they need from grads---- > feed this through organization and into curricula.

I would be very disappointed if this turns into another certification body.

- Interested in the outcome(s) as to curricula commonality.
- Why an AA instead of AS or AAS? (The "arts" is normally associated with a "liberal" or general education.)

Excellent idea.

Note: At the time the original concept was proposed by Dr. Arnold Packer, Maryland offered only the Associate of Arts degree. All subsequent efforts are title Associate Degree to address the level rather than identify a specific degree designation.

The Johns Hopkins University
Institute for Policy Studies

SCANS/2000 PROGRAM
Arnold H. Packer, *Chairman*
(410) 516-4535

Shriver Hall, Baltimore, Maryland 21218
(410) 516-7174

August 5, 1993

Dear Manufacturing Program Director:

RE: Participation in a National Focus on a High-Performance Manufacturing Associate Degree Program

As an economist who began his career as an engineer, a former Assistant Secretary of Labor, a coauthor of *Workforce 2000*, and former Executive Director of the Labor Department's study of the Secretary's Commission on Achieving Necessary Skills (SCANS), I have an interest in bridging industry and education in the manufacturing sector.

The Sloan Foundation has funded the Institute for Policy Studies, at the Johns Hopkins University, to bring together top-level industry and community college representatives. The goal is to develop specifications for an associate degree in manufacturing that has nation-wide "buy-in" by manufacturing employers. Enclosed is a copy of the proposal for your review.

With the help of Mark Stratton, Education Department Manager for the Society of Manufacturing Engineers, a colleague and I are studying current associate degree programs that prepare employees for the manufacturing sector. Please take a few minutes to complete the survey form and return it to Dr. Elizabeth Mathias in the enclosed self-addressed envelope. We will be attempting to locate existing exemplary programs and the colleges that offer them as we work with the National Association of Manufacturers and the American Association of Community Colleges.

Thank you for your cooperation.

Sincerely,

Arnold H. Packer, Ph.D.

Enclosure

Fax (410) 516-8233 / Telex: 710 234 1090

SURVEY OF MANUFACTURING AND RELATED ASSOCIATE DEGREE PROGRAMS

NAME______________________________ PHONE______________________________

TITLE______________________________ ADDRESS______________________________

COLLEGE____

1. Number of students enrolled in your Manufacturing Technology program (or related) associate degree program.

   Full time ______ Part time ______ Program title(s)______________________________

   ______________________________ ______________________________

2. Number of faculty teaching in above named program(s): Full time ________ Part time ________

   What percentage of your Manufacturing Technology program faculty hold a master's degree but no doctorate? ____

   What percentage hold a doctorate? ____

3. Are you currently implementing Tech Prep pathways with:

   a) secondary education? YES _____ NO _____

   b) baccalaureate education? YES _____ NO _____

4. Does your program provide students with defined parallel industry experience? YES _____ NO _____

   If YES, for how many semesters? 1 2 3 4

   If YES, check applicable titles of defined industry experience:

   Cooperative Education ___ Apprenticeship ___ Internship ___ Other ______________________________

5. With how many local or regional employers (or employer groups) are you actively (meet with representatives at least twice a year) involved?

   a. 1-4 b. 5-7 c. 8-10 d. more than 10

6. Circle all activities that describe your level of interaction:

   a. advisory committee participation
   b. participate in activities such as DACUM chart development or other activities focused at revising curricula
   c. provide on-site learning experiences for students
   d. provide a paid parallel industry experience of a jointly planned and sequential nature (more complex experiences as the student progresses through the program)
   e. hire program graduates
   f. provide faculty industry experience
   g. industries use college academic manufacturing program faculty for upgrading existing employees
   h. applied research
   i. serve as a site for industry employee training
   j. other ______________________________

7. Describe efforts to integrate academic (general education or supportive coursework) and technical (work related theory and skills) courses within your program(s).

over

8. Are you teaching Total Quality Management or some variation of quality management? YES _____ NO _____

9. Have you examined the Secretary's Commission on Achieving Necessary Skills (SCANS) identified competencies?

YES _____ NO _____ If YES, has it had an impact on the curriculum? YES _____ NO _____

10. Do you offer manufacturing coursework using distance learning capabilities, eg. courses on cable TV, computer-based learning packages, videotape, extensive prepared notebooks, etc.? YES _____ NO _____

11. The Society of Manufacturing Engineers lists coursework using these categories. Please circle if you have courses or substantial coursework (more than 15 teaching hours) in the listed topic areas.

1) Artificial Intelligence
2) Assembly
3) Automation
4) CAD
5) CAM
6) CIM
7) Coating/Finishing
8) Composites/Plastics
9) Control System
10) Design, Machine Tools
11) Design, Product
12) Economics
13) Electronics Manufacturing
14) Engineering Materials
15) Expert Systems
16) Group Technology
17) Inspection
18) Machine Vision
19) Manufacturing Management
20) Manufacturing Systems
21) Materials
22) Material Forming Processes
23) Material Removal Processes
24) Material Handling
25) Microcomputers
26) Microprocessors
27) Modeling
28) Numerical Control
29) Probability and Statistics
30) Process Planning
31) Production Planning and Control
32) Productivity, Manufacturing
33) Programming, Dynamic
34) Quality Control
35) Reliability
36) Robotics/Automated Systems
37) Simulation
38) Technology Strategy
39) Welding

12. Using the list of coursework categories in #11 above, mark above with ↑ (increase content) or ↓ (decrease content) if there has been a significant change in a category in the past four years.

13. What is it about your manufacturing or related program that you feel makes it distinctive or exemplary?

14. Do you have any opinions you wish to express about the project described in the proposal; namely developing specifications for an associate degree in manufacturing with employer organizations such as the National Association of Manufacturers?

Thank you.

Please return to:

Dr. Elizabeth A. Mathias
Tech Prep Office
Student Center -- Room 26
Anne Arundel Community College
101 College Parkway
Arnold, MD 21012
Phone: 410-541-2777
FAX: 410-541-2245

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Signature: Elizabeth A Mathias	Position: College Tech Prep Director
Printed Name: ELIZABETH A. MATHIAS, Ed.D.	Organization: Anne Arundel Community College
Address: ADMIN 101 College Parkway ARNOLD, MARYLAND	Telephone Number: (410) 541-2328
	Date: Jan 11, 1994

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