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ABSTRACT

In June 1985, a survey was sent by the Industrial Technology Institute to 397 Michigan automobile supplier firms concerning their industrial training in modern manufacturing technologies. The purposes of this survey were to investigate the training needs of Michigan automobile suppliers, with particular emphasis on how they met their training requirements in computer numerical control (CNC), computer-aided design (CAD), and statistical process control (SPC); to determine the future training needs of these companies; and to assess the general health of the automobile supplier industry in Michigan. Study findings, based on responses from 202 firms, included the following: (1) of the three technologies, SPC was the most commonly used by Michigan automobile suppliers, followed by CNC and CAD; (2) 44% of the firms that utilized CNC equipment used it for only 10% of their machining operations, and 88% used it for less than 40% of their operations; (3) 47% of the firms that utilized SPC used it for 70% or more of their activities; (4) there was a tendency in all three technologies to use training provided by vendors and private training companies; (5) most workers in all technologies received less than 40 hours of formal training; and (6) the fact that the system of vendor training in advanced technologies was dependent upon the skills brought to the training by the workers may be related to the respondents' desire for schools to emphasize the basic skills that would give employees the ability to learn the specific tasks associated with each technology. (EJV)

THE TRAINING NEEDS OF MICHIGAN AUTOMOBILE SUPPLIERS
Initial Report

July 1986

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Introduction:

In June 1985, a survey was sent to almost 400 Michigan automobile supplier firms concerning their industrial training in modern manufacturing technologies. This survey was part of a research project funded by the Governor's Office on Jobs and Economic Development. There were three major research questions motivating the study:

1. One purpose of this survey was to investigate the training needs of Michigan automobile suppliers as they begin to introduce modern industrial technology.[1] The primary assumption in the construction of the survey was the belief that training is technology specific and thus each technology must be evaluated separately. The survey was constructed to examine how automobile supplier firms met their training requirements in three technologies: Computer Numerical Control(CNC), Computer Aided Design(CAD), and Statistical Process Control(SPC).[2] The survey attempted to determine 1) the extent of training in these technologies, both in terms of who receives the training as well as for how many hours, 2) the present sources of the training, 3) factors influencing the selection of specific training, and 4) the outcomes as the result of this training. By asking specific questions concerning each of the three technologies separately, it was anticipated that some more detailed information on the training process would be collected on specific technologies to complement the more general

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[1]For the purposes of this study we understand modern industrial technologies to mean the applications of the computer to product design, planning for manufacturing, and the manufacturing process itself. For a good overview of this subject see: editors of American Machinist,Computers In Manufacturing,{New York: McGraw Hill, 1983.}

[2]These three technologies were selected as the result of site visits to Michigan automobile suppliers. For two months extensive interviews were conducted at 25 automobile supplier firms in the State of Michigan. Sources in the automobile industry identified these firms as involved in the deployment of modern manufacturing technologies. In these shops the three technologies that were most likely to be deployed were Computer Numerical Control, Computer Aided Design, and Statistical Process Control. For our purposes we have defined these three technologies in the following manner:

Computerized Numerical Control involves the use of a computer to provide automatic control of the machining sequence of a machine tool.

Computer Aided Design is the creating or altering of a graphic design through the use of a computer.

Statistical Process Control is a system to measure variations in the process output.

SPC was selected for detailed examination because of its present significance to the automobile supplier industry. While SPC is hardly a "new" technology, and in practice does not involve the use of computers, it is the initial step in a process of quality control and communications between OEM and auto supplier that will include bar coding, computer networking, and CAD-CAM production. In a sense SPC may be the first step to more advanced technologies relationship. See: James Jacobs, "Report on Computer Based Technologies In 25 Michigan Auto Supplier Firms", Industrial Technology Institute, October 1985.

national studies completed on training in the advanced manufacturing technologies.[3]

2. A second goal of the survey was to determine the future training needs of these companies. One assumption made by most observers has been that the deployment of the new manufacturing technologies would significantly increase the training needs of firms.[4] Yet, there has been very little empirical evidence to support or reject this assumption. Our survey attempted to find out 1) if firms involved in the deployment of modern manufacturing technologies anticipated training increases, 2) in what job classifications and in what technology they anticipated training increases, and 3) what training delivery system they were likely to utilize in these new training activities. Because the training decisions made by firms are relatively short-term, respondents were asked only questions that dealt with their roles in the near future.

3. A final goal of the study was to gather some information concerning the general health of the automobile supplier industry in Michigan. These firms play a vital role in the economy of the state. The automobile suppliers have been targeted by Michigan authorities as a key industry for long-term survival of the state's economy.[5] Moreover, most observers believe this industry faces a very critical period as it adapts to new relationships with the OEMs as well as the threat of off-shore competition.[6] In large part the survival of the firms is dependent on how successfully they adapt to the new manufacturing technologies. The survey tried to ascertain: 1) their employment projections in Michigan, 2) their perceptions of what barriers existed to prevent them from meeting their training requirements, and 3) their suggestions on how Michigan educational institutions can aid in the process of training a work force able to handle the new manufacturing technologies.

With this last research issue, the survey focused upon the role of the community colleges of Michigan in the process of industrial training. This study assumes that one key aspect of the maintenance of a strong Michigan based auto supplier network is the vocational technical training offered by the 29 community colleges of Michigan. A large part of the mission of these institutions has been to train the industrial work force. Yet, the establishment of the linkages between community colleges and business has been considerably sporadic because of a great deal of both organizational and programmatic

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[3]Studies on technology and training have been completed by Office of Technology Assessment, Computerized Manufacturing Automation: Employment, Education and Training and the Work Place, April 1984; for the survey of firms upon which the OTA study was based see: Nieva, Veronica, Ann Majchrzak and Mary Jane Huneycutt, Education and Training In Computer-Automated Manufacturing, Vol. I, October, 1982.

[4]See OTA, Report, pp. 221-225.

[5]See Path To Prosperity, Michigan Department of Commerce, 1984, ch 5.

[6]For a discussion of the problems faced by auto supplier firms see Michael S. Flynn and Daniel D. Luria, The Post-VRA U. S. Automotive Market, ITI, June 1985.

barriers within the educational institution.[7] In addition, employers have often not been aware of the recent changes in community college programs and the commitment made to pursue closer relationships with business. In the last few years, there has been a sustained state wide effort to develop the community college relationships with business.[8] Part of the survey was an attempt to gather information on what automobile suppliers wanted from the local education institutions, both in terms of the specific technologies of SPC, CNC, and CAD, as well as what suggestions auto supplier firms would make to community colleges on general program directions.

Methodology

From June 17-July 1st there were 397 surveys mailed to Michigan automobile suppliers. Our survey defined auto suppliers as any firm that produces and/or designs parts that ultimately are used by the original equipment manufacturers. This sample of automobile suppliers was drawn from firms that were likely to have introduced some of the modern manufacturing technologies. The term modern manufacturing technologies includes machine tools (NC, CNC, DNC, automatic tool changing), material handling (industrial robots, automatic storage and retrieval systems, computer controlled transport systems), inspection/gauging (vision systems, SPC), control technology (programmable controller), and software (CAD, group technology, CAPP).

The names of these firms were gathered from four separate sources:

1. Michigan firms that in their response to a survey conducted by the Industrial Technology Institute in August 1984 stated they had installed at least one aspect of the above list.[9]

2. Michigan auto supplier firms that indicated they made investments in modern manufacturing techniques in the University of Michigan Automobile

[7] For a discussion of the problems of community colleges relating to business see: Catharine P. Warmbrod, Retraining and Upgrading Workers (National Center For Research In Vocational Education, 1983.)

[8] The major recession of 1979-1982 sparked a rethinking on the part of many Michigan community colleges on the need to relate more closely with employers and in general with state efforts at economic development. This motivated the formation of the Michigan Community Colleges Economic Development and Job Training Network, a group specifically designed to promote cooperative arrangements between business and community colleges. In addition in 1984 the State of Michigan initiated a program in the training of SPC coordinators throughout the community college system. This included specific monies to community colleges that were willing to send their instructors to training sessions coordinated by Jackson Community College.

[9] For a report on that study see: Kitty Bridges, ITI Automotive Supplier Survey: Executive Summary, April 1985.

Supplier Survey completed in 1982.[10]

3. Firms that were identified by Michigan community college vocational deans as being firms that have been deploying some of the modern manufacturing technologies.[11]

4. Firms that have been identified by equipment vendors as those in the process of purchasing some of the modern manufacturing technologies.

Based on these four sources, 397 questionnaires were sent out to individual firms or one

[10]For a report on that study see: Robert E. Cole, Michael S. Flynn, and Rajan R. Kamath, Participants' Report On A Survey of the North American Automotive Supplier Industry, Industrial Technology Institute, February, 1985.

[11]In February 1985, members of the Michigan Occupational Deans Administrative Council were surveyed for names of firms in their area that were actively involved in the deployment of modern manufacturing technology.

plant of larger corporations. By August 20th, 202 responses were returned.[12]

General Data On Firms

Size: The distribution of the firms sampled is found in Table No. 1. Approximately two-thirds of our sample are firms with less than 100 employees. This is a bit less than the national percentage of manufacturing establishments in the United States with 100 or

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[12]The survey was completed in the following manner: From June 15th-June 30th surveys were mailed to the chief executive office of the company. Before each survey was mailed phone calls were made to determine if the addresses were correct and to alert the CEO of the significance of the completion of the project.

On July 8th all respondents were sent a postcard to remind them to send in their returns.

On July 15th call backs began with new survey forms sent to those firms that either had lost them or had said they would fill them out. The calls were not completed until the end of July.

Those firms that indicated at the second phone call they would complete the survey were called again during the week of August 12-16th to remind them of the importance of getting their surveys completed as soon as possible.

On August 20th the survey data entry was completed; after this date no returns were entered into the data set.

As of September 15th-the following results were recorded:

- 202 surveys completed
- 63 refusals
- 132 non-returns
- rate of return 50.88%
- 8 surveys returned after the closing date

Of the 63 refusals, the following reasons were given:

- 17-not an auto supplier, only a sales office, shop too small
- 13- hostile to survey,"state should stay out of auto business; surveys do little good"
- 12- survey too long, little time
- 3- on vacation
- 17- no reason given

fewer employees (83%)[13] The variance is not surprising because our sample was initially drawn from firms that have been in the process of implementing new technology and these would normally be larger with more access to capital.[14] About 20% of these firms were subsidiaries of larger companies (Table No. 2).

Location: The zip code breakdown of the mailing addresses of the firms indicates that auto suppliers are heavily concentrated around the major industrial centers of Michigan (Table No. 3). As expected, the Detroit Metropolitan area contains half of the respondents, suggesting the significance of that industry to southeast Michigan.

Auto Sales: Over half of the firms surveyed indicated that auto sales accounted for from 76-100% of their business. About one fifth of the firms responded that auto sales accounted for less than 25% of their business. These figures correspond to the findings of another ITI auto supplier study.[15]

Implementation of Technology

Of the three technologies, SPC is the most commonly used by Michigan automobile suppliers. This is followed by Computer Numerical Control (CNC) and Computer Aided Design (CAD) (Table No. 5). It is somewhat significant that while CAD is the least used of the technologies at present, there is a greater number of firms who are "considering" using this technology. This suggests that its implementation will become more widespread. Still, the data indicate that the deployment of these technologies has been pursued at a relatively slow speed. Of the entire survey respondents, 19 firms indicated that they had no plans for the deployment of either CNC, SPC, or CAD.

Perhaps a better indication of the deployment of the technology is the percentage of work performed in the shop by these technologies (Table No. 6). Almost half of all firms that utilize CNC equipment use it for only 10% of their machining operations. Eighty-eight percent of the firms used CNC for less than 40% of their operations. In contrast, almost half of the firms that utilized SPC use it for 70 percent or better of their activities. The distribution of work performed by CAD is bi-modal. Thirty-eight percent of the firms who utilize CAD use it for less than 10% of their activities, and another quarter used CAD for 70% or better of their operations.

This evidence indicates that, despite the claims of many trade publications, the concept

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[13]Bridges, p.4.

[14]In May 1985 a survey of auto suppliers in Michigan was undertaken by the Auto In Michigan Project. According to interim figures obtained from survey director Allan Baum, 76% of its sampled firms were under 100 employees. The original Dun and Bradstreet list from which the sample was drawn indicated 77% auto related companies with 57% below 20 employers in size. The probability is that many of the smaller manufacturers not only do not possess modern manufacturing technology, but they are also unwilling to respond to questionnaires concerning their business. This is somewhat reflected in the amount of refusals to our survey from smaller firms.

[15]Bridges, p. 6.

of computerized, "paperless" OEM-supplier relationships may be still far off.[16] At least in the production areas, Michigan automobile supply companies are proceeding very cautiously. Only in the deployment of SPC, which appears largely generated by the direct demands from the OEMs, have auto makers implemented new technologies to a great extent. Despite the many advantages to a CAD-CAM production system, it appears from our data that this goal is still in the distant future for most of the Michigan auto supplier firms.[17]

Training

The majority of training performed in these technologies is performed informally, directly on the job[18] (Table No. 7). Even in the area of CNC, the level of apprentice training was very slight. Formal training was conducted most in SPC and least in CNC. What these overall figures suggest is that in most firms the informal training mechanisms center around the work process. In this process, usually one of the more advanced workers or a line supervisor is selected to attend formal training in a particular technology. Then, that individual is expected to train the others on the job. Perhaps the unfamiliarity of the auto supplier firms with the statistical process control, and the specific demands made by the OEMs for documentation of the training, have motivated these firms to seek some formal training.

Information concerning the number of people in each firm that have responsibility for training confirms that lack of an organized approach to on the job training (Table No. 8). Despite the fact that respondents in the survey used the informal on the job training as the dominant form, forty percent of the firms listed no formal training coordinator at all. Only one third had between 2-6 individuals associated with training. The presence of a training coordinator was not associated with plant size. Some of the smaller facilities had training coordinators, while plants as large as 300 were without any formal training coordinators.

Training Sources

In order to understand what sort of formal training was used, each of the respondents were then asked to list the sources of training that were used in each of the technologies (Table No. 9). There is a tendency in all three of the technologies to use the vendor training(or in these case of SPC, the OEMs themselves) and private training companies. Community colleges are utilized for training most in SPC, and least in CAD training.

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16 For an overly optimistic discussion of the trends see: Drew Winter, "Networking promises to smooth out the pipeline," in Wards Automotive News, August 1985, pp. 40-42.

17 For a discussion of the problems of implementing CAD see: James F. Lardner, Implementing CAD/CAM Technology In Industry, AUTOFACT III Proceedings, 1982 pp.17 A-H.

18 The survey instrument attempted to distinguish between informal or on-the-job training (training that was received informally from co-workers and supervisors during the production process), apprentice training, and formal training (training separate from the production process).

In-house instruction is particularly prevalent in SPC training. Both governmental training and university programs appear less utilized by the respondents.

The amount of training received by various segments of the work force also varies by technology. In the case of CNC, about one-quarter of the skilled employees, engineers, and management people received formal training (Table No. 10). The formal training received by workers in SPC was considerably broader, with almost half of all production workers having some training in SPC. Also significant is the considerable amount of training in SPC received by management. This suggests the technology is considered more of a business strategy than a tool of statistical tests. Finally, CAD training is heavily concentrated in two categories: designers and engineers. The lack of management training in CAD may account for the relatively low rate of adoption among our sample respondents.

The amount of formal training received by most of the groups is less than 40 hours (Table No. 11). The training received by CNC operators appears to be the most limited. This may be associated with the fact that previous machining skills would be held by skilled workers and engineers. Much of the CNC technology builds upon the metal working tradition. CAD is a more unknown technology and thus the amount of training received by the workers is far greater. Half the designers and almost half the engineering staff of these firms received over one week's worth of training. Again, in contrast to this amount of training, management received very little formal training in CAD. For SPC, a good deal of the training received by production and maintenance workers is under ten hours. However, management and engineers receive more hours of training, reinforcing the belief that training in SPC among auto suppliers is viewed as a management awareness of the need for quality.

Selection Process

The factors that were significant in the selection of training also differed among the technologies (Table No. 12). In both CNC and CAD, the management of the company played the critical role, with customers playing some role in the selection of training for CAD. In SPC, however, the process of selection was influenced by the customers, which in this context are the OEMs themselves. It is also apparent that the line supervisors in the selection of SPC training have less control over the process.

The selection criteria of formal training reflect some of the differences in the technology (Table No. 13). The fact that for CNC respondents the ability to customize the training was the most significant determinate confirms observations made in 25 Michigan auto supplier firms. These observations indicated that where vendor training was conducted with CNC equipment, normally it was done at the work place with the specific piece of equipment purchased by the firm. However, for CAD users, the desire to have some follow-up assistance is most important for the users. This suggests that the newness of the technology and management's relative unfamiliarity with the technology has prompted this concern. Finally, because the SPC training appears to be directed at work groups involving larger numbers of people, the location and the scheduling of the training appear to be the most significant factor influencing the choice of training.

The selection of employees for training also appears to vary with the specific technology (Table No. 14). Skill level is far more important to the firms that have deployed CNC and CAD technologies, while firms implementing SPC target all those employees within a specific job classification. Employee interest and past performance are also used as criteria for training. It is also somewhat significant that seniority played little role in the decisions of employers on whom to select for training. This conflicts with much of the traditional view of union-management relations which accords seniority as a major determining factor in many aspects of labor relations.

Skills Learned

Ultimately the success or failure of any training hinges of what specifically was learned. Each of the firms were asked to rate a series of skills on a scale from "no increase in ability" to "substantial increase in ability." The skills for each technology were developed separately, but some comparisons can be made. For CNC, the major "pay-off" in skill development appears to be that training permitted the workers to operate the equipment with greater efficiency and with confidence (Table No. 15). This suggests that the training is primarily built upon the already pre-existing skills of the machinists. The one new skill cited was computer programming. Some of the basic skills (i.e. reading comprehending instructions etc.) did not appear to be substantially increased by the training.

In contrast, the CAD training appears to have developed some specific skills of the workers (Table No. 16). The ability to perform 2-D drafting and workers' abilities to adapt CAD software were both substantially increased by the training. The ability to operate the equipment confidentially was not substantially increased in the training. This again underscores the relative "recent" development of the technology. It requires first the learning of the skills and the need to practice these skills on the job before an individual becomes proficient in the process.

For companies who have trained in SPC, the clear "skill" learned is a greater concern for quality (Table No. 17). This general skill is even more important than knowledge of statistics, or the use of simple math concepts. Indeed, SPC appears to have the effect of a general management strategy to improve the production, as opposed to a specific technology that has specific use during a phase in the process.

Future Training Needs

As important as the past training experiences of these firms are the future trends. If these firms are considered more likely to have some of the modern manufacturing technologies, they may be interested in considerable amounts of training in the future. Because training is often a management decision that is made in the short term, our respondents were asked to identify their future training needs only over the next year.

The first question asked of the respondents was their training projections for their different occupational groups (Table No. 18). There is a clear increase in the amount of training that will be directed to the skilled employees, engineers and management. There is little sign of a decrease in training. This suggests that the implementation of technology continues to provide a demand for more educational development and formal training needs in the future.[19]

When asked to indicate the sources they believed to be the most significant suppliers of future training, there was willingness to use more vendor training, more in-house instructors and more community college training. There was little support for future ties with universities and government sponsored training programs (Table No. 19). There was also a decrease in the demand for any training from private companies.

What will be some of the technical areas of this future training? All respondents were asked about a series of technologies that are normally considered part of the "computer integrated manufacturing" technologies.[20] There was a clear interest in training in programmable controllers, group technology, bar coding, and computer aided manufacturing. There was less of a concern for robotics, automated storage and retrieval systems and automated guided vehicles, and machine vision. The technologies in which firms appear most likely to want training are those which will aid auto suppliers in continuing their service to the OEMs. Bar coding, for example, is one of the new technologies demanded by the OEM of their suppliers. It does not appear that the auto suppliers will develop their technologies to serve different markets. The technologies like machine vision and automated guided vehicles are extremely expensive and at this point are often financially beyond the reach of the smaller firms. Computer assisted product planning is also an unfamiliar area for Michigan automobile suppliers firms (Table No. 20). It will be interesting to speculate on how the lowering of cost for these technologies will affect their deployment and consequent training needs.

It is significant to know whether the future training will be directed primarily at entry level workers or upgrading workers (Table No. 21). The emphasis appears to be in training to upgrade employees as opposed to training new workers. For example 31 firms indicated they would spend between 0-20 percent of their budgets on the training of new workers. In contrast, 72 of the firms sampled will spend between 80-100% of their training budgets on the upgrading of their work force. There is little support for the thesis that the introduction of the new machinery will "de-skill" the present work force.[21] Indeed it appears firms are ready to spend substantial amounts of money to retrain their existing work force.

[19] See the OTA report, p. 221-225.

[20] The list and the definitions were derived from two other surveys: the ITI auto supplier study completed by Kitty Bridges in August 1984, and the survey of auto supplier firms undertaken by the Auto In Michigan Project in June 1985. Each of the technologies listed in Table No. 20 included a brief one sentence definition of the technology in order that respondents could have a common frame of reference.

[21] The major proponent for this view, with specific reference to CNC, has been David Noble. See: Forces of Production (New York: Alfred Knopf, 1984).

Barriers To Training and Future Options

One of the significant factors influencing the deployment of the technology by firms is the obstacles or barriers they perceive in the training process (Table No. 22). Firms were given a list of factors with the goal of determining which of them were significant "barriers" to the process. The three most cited by firms as "a good deal" of a barrier were costs, lack of relevant expertise, and the shortage of personnel to provide the training. It is significant that few firms cited "resistance from the work force" as a major barrier to the ability of the firm to train for the new technology. This finding disputes the conventional belief that workers are resistant to the new technology. There also appears to be little concern for the lack of internal support, suggesting that at least among the firms in the sample there is a commitment to the issue of training for the new technology.

How will this training take place in the near future? Our survey attempts to reveal some of the options being considered by the firms (Table No. 23). The most significant from their perspective was the linkage to the local community college, and technical training for management and engineering. The firms were less interested in establishing their own training centers or the development of a technology consortium with other companies. There was also some support for the internal testing of employees.

Finally, what was the general employment future for these firms? (Table No. 24) There appear to be two trends. First was the increase in the need for skilled employees and engineers. The deployment of the new technology does appear to raise the skill levels at least in terms of the future hiring practices of these firms. However, this finding should not be interpreted to mean that there will be an employment increase in work force of auto supplier firms. While there appears to be an increase in hiring of skilled personal, there are indications that auto supplier firms expect a decrease in the amount of production workers. Thus, in absolute terms, a small firm may increase its engineering staff 100% (from 2 to 4 people), and decrease its production employees only 10% (from 500 to 450), resulting in net job loss of 48. In other words this table should not be interpreted to mean that employment in the manufacturing industries will rise in the near future. Rather, it suggests that as the new technology is introduced, skill levels rise.[22] The issue is how well the educational institutions will adapt to that change.

Training Philosophy and Education

The survey attempted not only to reveal the empirical practice of the automobile supply firms, but some of their own perceptions on what educational institutions should be doing to promote a better trained work force. The purpose of the following series of questions was to lead to a better understanding of what sort of educational system might be constructed as Michigan firms adopt the new manufacturing technologies.

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[22] Contrary to the argument of Noble, concrete detailed examinations of implementation practices indicate the raising of skill levels. See: Kan Chen, et. al. Human Resource Development and New Technology In The Automobile Industry: A Case Study of the Ford Motor Company's Dearborn Engine Plant, Center For Educational Research and Innovation Organization for Economic Cooperation and Development, Paris 1984.

The respondents were asked a question concerning the specificity of training (Table No. 25). By almost two to one majority, firms were interested in having their workers obtain training in general areas that enable them to perform a number of tasks. This confirms the general impressions of many observers that the demand of the computer based technologies is for more flexible employees who can easily adapt to new job situations. It suggests that training programs need to be broad, as opposed to specific, in their orientation.

The issue of job skills was related to the role of community colleges (Table No. 26). Here the attempt was made to depict training as a choice between two large general areas--basic skills, and "hands-on" specific training. It is important to note that firms were not asked who they would hire, rather what role they thought community colleges should play. Nonetheless, the majority of firms were interested in a mixture of hands-on training and basic skills, with the emphasis on basic skills. Less than one third of the survey respondents believed that hands-on training would be more significant than basic skills. This finding confirms again the general observation that as firms deploy the new technology, there is a greater tendency to see the need for basic comprehension skills as vital. Furthermore this evidence, taken with some of the findings in the previous sections, indicates that firms will pursue vendor training for much of the specifics and that they want from the educational institutions individuals who in a sense "know how to learn."

What were the skills that Michigan auto suppliers thought important for the future industrial work force? (Table No. 27) In this open-ended question the concern for basic skills("ability to read", "need to do basic math") was most pressing to employers. There was also some strong emphasis on learning computer skills, with far less emphasis on specific skills of electronics and machinery.

The concern for basic skills was also evident in the recommendations that respondents made to educators (Table No. 28). Almost 60% of the respondents urged educators to increase the basic skills levels of the students. Almost one-quarter believed that public educators should improve ties with business, suggesting cooperative education programs and more business input into curriculum. Again it is significant how little emphasis was placed upon the learning of more vocational skills.

Conclusion

There are three major trends that emerge from the responses to the questionnaire. The first is the slow deployment of the computer based technologies, and as a consequence, the relative absence of formal training undertaken by the companies. If the commitment to new manufacturing technologies is one way by which the original equipment manufacturers will be able to survive the challenge of international competition, there appear to be significant obstacles among auto suppliers in the development of the same strategy.

Perhaps one aspect of the problem emerges out of our survey evidence. Not only is there little formal training undertaken by firms, but the majority of it is primarily an orientation course to the specific groups who will implement the technology, as opposed to training of the management of the firm in the capabilities of the technologies. This is particularly true in the case of CAD, where the potential power of the technology is only beginning to be understood, both in terms of the development of CAD-CNC direct linkage, as well as computer assisted engineering and computer assisted product planning. Even in a more immediate context, it may be difficult for managers of CAD operations to know the potential productivity of their operators, if they do not understand the functioning of the technology. In other words, if computer based technologies are going to be implemented, management needs far more understanding in how they work, and their future potential. In one sense, some of the future training plans of companies to increase their training of management and engineers suggests a beginning recognition of the tasks ahead.

A second major conclusion of the study is that when formal training occurs, auto supplier firms increasingly turn to the equipment vendors to supply the specific training. This appears to be true for the future as well. The lack of generic training for particular technologies (i.e. programmable controllers), coupled with the substantial monetary investment in new machinery, motivates firms to seek out training with the individual equipment vendors. It appears the training paradigm for firms is for the vendor to train the most advanced workers on the equipment purchased. In turn, it is expected that these workers will informally teach their co-workers and any new hires the new technology.

Obviously from the perspective of the firm, this training strategy makes for considerable short-term sense. The vendors know their equipment the best, and since training is normally part of the sales package, the firms use it extensively. Second, as the survey respondents indicate, in more unfamiliar technologies such as CAD, the ability of the vendor to provide follow-up assistance is considered a significant criteria by the auto supplier in their selection of a particular system. Finally, vendors have a vested interest in getting their products to work well, which will lead to greater sales in the future. Thus they have a vested interest in successful training.

Yet, the system of vendor training is only useful as an initial part of the training experience. Most vendor training is directed at orienting workers to the basic functioning of the equipment, and with little emphasis upon understanding the new human relations skills, or a general understanding of how the technology fits within the structure of the firm.[23] As a result workers are trained to run the machine, but it may be a year or more before the firm masters the technology and its implications upon the work force and the company perspective.

Second, vendor training is normally provided for new machine purchases only. Many of the auto supplier firms, particularly the smaller ones, purchase used equipment. Often

[23]National research into CAD/CAM training confirms this view: see Ann Majchrzak,"Education and Training For CAD/CAM," Krannert Institute Paper Series, Krannert Graduate School of Management, Purdue University, April, 1985, p. 17.

these firms are in the position of learning about their machines through a "trial and error" approach, which means it can be six months to a year before the machine becomes operable. The demand of these firms for training is often not met by the types of vendor training offered at present.

Finally, the system of vendor training, particularly in the advanced technologies, is dependent upon the skills brought to the training by the workers. In the case of CNC, the skilled machinist can build upon their experiences to understand the functioning of the system. Indeed, many firms use their CNC machines by giving wide latitude to the operator to decide the correct program route, and utilize programmers only for very detailed operations. However CAD and SPC are newer technologies which require skills that are often not present among the industrial work force. Part of the difficulty in learning CAD, for example, is getting used to the conceptualization of dimensions on a computer screen.[24] For workers already familiar with computer screens and some menu driven programs, CAD is not as difficult to understand. In other words, what backgrounds individuals bring to the training appear to be even more critical to the success of vendor training than in the past.

This is perhaps why, in questions concerning the educational systems, the survey respondents were clear in their desire for schools to emphasize basic skill preparation. In a number of instances in our survey, the Michigan auto suppliers were convinced that newly hired workers should have general backgrounds, with the ability to be trained in the specific areas. Indeed, it appears that our respondents were articulating a "mesh" between educational institutions and vendor training. The purpose of educational institutions would be to create individuals with a basic skills background that would give them the ability to learn the specific tasks associated with each technology that will be taught by the vendors or some form of in-house delivery systems.[25]

[24]There is an interesting debate among small shop owners over what makes a good CAD operator. For some shops, CAD is seen as basically a faster means by which design can take place. Thus CAD operators are required to already have extensive backgrounds on the drafting boards. For others, in particular shops that emphasize more design of unique products (i.e. large machine tools), work on a drafting board was considered irrelevant to training of CAD operators. In one instance a shop owner trained his mold makers to become CAD operators. See James Jacobs, "Report on Computer Based Technologies in 25 Michigan Auto Supplier Firms, Industrial Technology Institute, October 1985.

[25]If the behavior of the OEMs is significant as a precursor for the future behavior of automobile supplier firms, two recent news stories concerning GM lend confirmation to the employer concerns about basic skills. One of the decisive reasons for the selection of Tennessee as the site for the Saturn plant facilities was the "basic skills first" program instituted in the educational system. See: "Tennessee program to upgrade schools was persuasive," Detroit Free Press, July 31, 1985: Inside the corporation, GM is spending over $35 million dollars simply to improve the communications skills of its workers. According to Chevrolet-Pontiac-Canada group executive, Lloyd Reuss, "While Technology is important, it's not the answer...We're looking at improved communication with assemblers, suppliers and dealers too, not just with the final customer. All human beings have to be able to understand where we are going and what we want to do." See: "GM VP stresses communications skills," State Journal, May 1985.

Still, there are many unanswered questions within this suggestion to emphasize basic skills. Do auto suppliers believe that these should be taught solely to entry level workers, or would they be interested in upgrading their present work force in basic skills? Which institutions would undertake this type of training? It appears the community colleges with their vast experience in adult education and their commitment to program flexibility and delivery would be a logical choice. Finally, how much would the basic skills approach lead to a generally mobile, more educated work force that would demand far more participation in work place decisions alter the present organizational and decision making process? Recent research suggests a relationship between implementation of technology and administrative innovation.[26] Michigan auto suppliers may not be aware of the implications of their concern for basic skills upon their own organizational structure. Despite these issues, however, the concerns for basic skills delivery by Michigan auto suppliers is clear. Now the vocational educational system must meet the challenge.

Indeed, the demands on the part of Michigan auto suppliers for an orientation towards basic skills teaching may contribute to a more realistic assessment of the interrelationship between the "liberal arts" and vocational technical programs at community colleges. Too often Michigan community colleges are divided along these artificial lines; institutional debates rage between faculty, administrators and staff of these two hostile camps which each regard the efforts of the other with great suspicion. Michigan employees appear to be urging that "both sides" should recognize the mutual interrelationships and jointly proceed with the business of training a Michigan industrial work force for the present and future.

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[26]A recent study of the introduction of flexible manufacturing systems indicates a majority of firms examined introduced specific administrative innovations specifically to facilitate the introduction of new technology. See: John Ettlie, Implementation Strategies For Discrete Parts Manufacturing Innovations: Interim Report, Industrial Technology Institute, August 1985.

TABLE 1

Size of Firms

Number of Employees	Percent
0-20	22%
21-100	44%
101-250	18%
251-500	9%
500+	7%
(n)	(201)

TABLE 2

Subsidiary of Larger Corporation

Yes	19%
No	81%
(n)	(201)

TABLE 3

Location of Firms

	Number	Percent
City of Detroit	23	11.4
Western Wayne County	20	10.0
Oakland, Macomb Counties	47	23.4
Flint Area	6	3.0
Saginaw Area	13	6.5
Lansing Area	7	3.5
Kalamazoo Area	28	13.9
Jackson Area	16	8.0
Grand Rapids Area	33	16.4
Traverse City Area	2	1.0
Gaylord Area	4	2.0
Western Upper Peninsula	2	1.0
(n)	(201)	

TABLE 4

Auto Sales As
A Percent of Total Sales

Percent of Auto Sales	Percent
0-25	18%
26-50	13%
51-75	17%
76-100	53%
(n)	(195)

TABLE 5

Implementation of
CNC, CAD, SPC

	CNC	CAD	SPC
Yes	49%	24%	57%
No	37%	55%	32%
Considering	14%	21%	11%
(n)	(197)	(196)	(197)

TABLE 6

Percentage of Work Performed in the Firm With These Technologies

Percent of Work Performed	CNC	CAD	SPC
0-10	44%	38%	18%
11-40	44%	23%	16%
40-70	7%	15%	8%
70+	6%	24%	47%
mean	22%	37%	62%
(n)	(89)	(34)	(114)

TABLE 7

Sources of Training

	CNC	CAD	SPC
% On-The-Job Training (n)	83 (90)	72 (43)	56 (109)
% Apprenticeship Training (n)	4 (57)	2 (27)	— (71)
% Formal Training (n)	20 (75)	29 (37)	52 (104)

TABLE 8

Amount of In-House Training Co-ordinators

Number of Coordinators	Percentage of Firms
0	40
1	17
2-6	33
7+	9
	(99)

TABLE 9

Sources of Present Training In CNC, CAD, SPC

	Percent of CNC Firms Who Used	Percent of CAD Firms Who Used	Percent of SPC Firms Who Used
Vendors (Customers)	86	75	64
Private Training Companies	68	61	78
In-House Instruction	18	27	42
Community Colleges	41	29	51
Universities	16	18	22
Government-Sponsored Training Programs	17	5	11
(n)	(82)	(40)	(101)

TABLE 10

Percent of Training
Received By Workforce Group

	CNC	CAD	SPC
Maintenance & Repair	20	—	33
(n)	(62)	(30)	(85)
Production	11	—	48
(n)	(63)	(34)	(88)
Skilled Employees	25	7	54
(n)	(82)	(34)	(92)
Engineers	28	41	70
(n)	(70)	(41)	(90)
Designers	—	45	—
(n)		(41)	
Management	23	11	70
(n)	(77)	(37)	(108)

TABLE 11

Formal Hours of Training In Work Force

CNC

	0-10 hours	11-40 hours	41+ hours	(n)
Maintenance workers	55	27	16	(49)
Production workers	59	20	20	(49)
Skilled workers	28	36	36	(72)
Engineers	41	28	32	(54)
Management	41	30	30	(61)

CAD

	0-10 hours	11-40 hours	41+ hours	(n)
Skilled workers	84	7	10	(31)
Designers	24	24	51	(37)
Engineers	27	27	46	(37)
Management	52	30	18	(33)

SPC

	0-10 hours	11-40 hours	41+ hours	(n)
Maintenance workers	68	24	8	(76)
Production workers	48	40	12	(85)
Skilled workers	44	41	16	(84)
Engineers	25	45	30	(84)
Management	19	55	26	(104)

TABLE 12

Groups That Influenced Training Decision
(% who stated "strongly influential")

	CNC	CAD	SPC
Corporate Management	67	61	53
Line Supervisors	20	23	5
Purchasing	1	3	2
Consultants	4	—	2
Customers	8	13	37
	(85)	(31)	(167)

TABLE 13

For Selection Criteria for Training
(% who stated "extremely important")

	CNC	CAD	SPC
Cost	21%	24%	17%
Location	26%	24%	31%
Scheduling	27%	24%	27%
Follow-up	32%	42%	14%
Customized	40%	61%	27%
Reputation in the Industry	18%	20%	25%
	(84)	(42)	(103)

TABLE 14

Criteria In Selection of
Employees for Training
(% who stated "extremely important")

	CNC	CAD	SPC
Skill Level	42%	36%	24%
Past Performance	34%	23%	18%
Seniority	3%	5%	4%
Employee Interest	48%	37%	23%
Job Assignment of Employee	19%	22%	47%
(n)	(92)	(41)	(95)

TABLE 15

CNC

Training and Abilities (% who stated "training substantially increased abilities in")	
Reading and comprehending manuals	12%
Use of fractions	9%
Communicating instructions	8%
Receiving instructions	4%
Simple computer programming	33%
Making adjustments to the machinery	29%
Troubleshooting	27%
Operating equipment efficiently	42%
Operating equipment confidently	38%
Operating equipment safely	36%
	(85)

TABLE 16

CAD

Training and Abilities (% who stated "training substantially increased abilities in")	
Reading and comprehending technicals manuals	9%
Using fractions and decimals, reading graphs and other simple math concepts	—
Communicating instructions to others	—
Receiving instructions from others	3%
Simple computer programming	17%
2-D drafting	40%
3-D drafting	34%
Troubleshooting	15%
Operating equipment efficiently	26%
Operating equipment confidentially	34%
Learn to adapt CAD software	35%

TABLE 17

SPC

Training and Abilities (% who stated "training substantially increased abilities in")	
Reading and comprehending technical manuals	3%
Using functions and decimals, reading graphs	21%
Communicating instructions clearly	12%
Simple computer programming	2%
Knowledge of statistics	44%
Operating test equipment efficiently	16%
Greater concern for quality	62%
	(109)

TABLE 18

Future Training Projections*

	Increase	Decrease	About the same	(n)
Maintenance employees	36	3	60	(164)
Production employees	49	6	45	(166)
Skilled employees	60	3	37	(182)
Engineers	48	2	48	(161)
Management	49	3	48	(174)

*(Question: In the next year, do you anticipate an increase, decrease, or about the same amount of training directed at the following groups?)

TABLE 19

Future Training Sources*

	Increase	Decrease	About the same	(n)
Equipment vendors	36	6	57	(171)
In-house instructors	42	4	54	(158)
Private training companies	16	11	74	(150)
Community colleges	39	9	77	(141)
Universities	13	9	77	(141)
Government-sponsored training program	10	10	81	(132)

*(Question: In the next year, do you anticipate an increase, decrease, or about the same types of formal training received from the following sources?)

TABLE 20

Future Technology Training Needs Over the Next Year

	% Increase	% Decrease	% About the same	(n)
Robotics	36	—	61	(188)
Automated storage and retrieval systems	12	7	82	(179)
Automated guided vehicle systems	8	5	87	(182)
Machine vision	28	4	67	(182)
Programmable controllers	47	16	38	(186)
Other CAM hardware/ software	45	12	43	(183)
Computer-assisted engineering (CAE)	40	10	50	(183)
Group technology bar coding	43	2	54	(183)
Computer-assisted Process Planning	29	9	63	(180)

TABLE 21

Number of Firms Who Are Directing Training at Entry Level, or Upgrading

Percent of Training Budget	# of Firms Directing Training at Entry Level	# of Firms Directing Training at Upgrading
0-20	31	8
21-40	70	23
41-60	43	41
61-80	17	40
81-100	18	72
	(179)	(184)

TABLE 22

Barriers to Training*

	%	(n)
Lack of funding	29	(183)
Lack of relevant	23	(180)
Resistance of work force	8	(181)
Lack of internal support	6	(181)
Technology changing too rapidly	7	(182)
New workers who cannot read and write	10	(182)
Shortage of personnel to provide training	24	(181)

*(Percentage of respondents who also said these barriers have been "a good deal" of an obstacle.)

TABLE 23

Future Training Option Considerations*

	% Responding yes	(n)
Establishment of training center	15	(201)
Employing in-house training coordinator	29	(201)
Technical training for management and engineering	45	(201)
Linkage with local community college for training	51	(201)
Technology consortium with with other companies	16	(201)
Apprenticeship program in program automated equipment	24	(201)
Internal testing of employee skills	35	(201)

*(Question: In the future do you see any of the following options as possible developments for your company?)

TABLE 24

Future Hiring Patterns of Firms*

	% Increase	% Decrease	% About the same	(n)
Hourly maintenance repair employees	36	3	61	(174)
Hourly production employees	48	17	36	(174)
Hourly skilled employees	67	3	30	(189)
Engineers	50	2	47	(173)
Management	22	5	73	(183)

*(Question: In the next year, do you anticipate a decrease or increase in employment of the following group at this facility?)

TABLE 25

Training Philosophy*

	% yes
Specific training on a machine	37
General training within an area	63
	(192)

*(Question: Some people see training as learning a specific job on a specific machine. Others view training as providing general skills in a particular area which enables the workers to perform a number of tasks. As an employer, which one makes more sense at your plant or facility?)

TABLE 26

Training and Community College Resources*

	% who identified
Basic skills	11
Emphasis upon basic skills, with some hands-on training	58
Emphasis upon hands-on training with some basic skills	28
Hands-on training	3
	(192)

*(Question: Community college staffs are debating over how much emphasis should be placed on, and scarce resources invested in, the learning of basic skills (i.e., reading, writing, mathematics, and general computer programming), and on providing more "hands-on experience" with the new machinery. What do you think community colleges should emphasize?)

TABLE 27

Skills Respondents Thought Significant for Michigan Workers*

	% responding
Basic skills	57
Computer skills	30
Ability to think	4
Willingness to learn	3
Electronics	2
Machinery	4
Other	1
	(130)

*(Question: What are the three most important skills that the Michigan industrial work force will need in the next five years?)

TABLE 28

Recommendations for Educators*

More basic skills	56%
More vocational skills	7%
Better ties with business	24%
Improved attitudes of workers	6
Other	6
n	(111)

*(Question: As an employer, what recommendations would you make to public education authorities to train a better work force for your firm?)