# ROBOTICS NEEDS ASSESSMENT

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## EXECUTIVE SUMMARY

- Locally as well as nationally, the robotics industry outlook is promising. The Bureau of Labor Statistics, the Robotic Industries Association, and southeast Michigan employers agree that employment prospects for the future are bright. While the automotive industry continues to dominate the field of robot use, there are indications that the market is becoming more diverse.

- Machine vision is expected to experience exceptional growth in coming years. Among the southeast Michigan employers contacted, however, very few are significantly involved with machine vision, suggesting that this trend may not yet be fully realized in the local area.

- Women and minorities continue to be underrepresented in robotics careers. While OCC's Robotics program enrolls minority students in numbers proportionate to college-wide enrollments, there are very few women in the program. This is not a problem unique to OCC, as evidenced by the growing number of programs at both two and four year institutions designed to attract and retain women and minorities in science and math-based programs.

- The education required for a career in robotics varies substantially depending on the particular needs of the employer. In many cases, employers reported that previous work experience in the field was at least as important as formal training. Analysis by employer type indicates that systems integrator employers tend to emphasize previous experience, while robot user employers are more likely to require an associate degree for employment.

- Employers' ratings of the robotics skills important for employment indicate that safety skills, interfacing, and troubleshooting are very important. GMAW, joint design, and weld positions are considered the least important skills for employment in the robotics field.

- Student ratings of the robotics skills important for employment are consistent with employer ratings, indicating a student awareness of employer requirements and the skills necessary for employment.

- Employers find that most new hires in the robotics field are well trained in interpretation of schematics and robotic safety procedures. Many report that training is not adequate in end effector nomenclature and installation.

- Approximately half of employers contacted are currently hiring new employees, primarily due to company expansion. However, many employers also cited a need for employees with up-to-date technology training and employee turnover within the organization as reasons for hiring.

- Tuition assistance and on-the-job training are both common practices among the employers contacted. Employers in southeast Michigan appear confident that the robotics market will continue to grow over the next ten years.

# Robotics/Automated Systems Technology

*Needs Assessment*

*Oakland Community College*

## INTRODUCTION

The following report summarizes the findings of a needs assessment implemented by OCC's Office of Planning & Analysis. Designed to evaluate declining enrollments in the Robotics program in light of current employer needs and industry trends, the report incorporates information from the Occupational Outlook Handbook, the Michigan Employment Security Commission, and the Michigan Occupational Information System with data collected through student and employer surveys and interviews with industry experts. Where appropriate, faculty members and program coordinators at peer institutions were consulted.

### *Description of Existing Program*

The current Robotics program at OCC is an Extended Associate Program leading to an associate degree in Applied Science. Designed to prepare students for careers in robotics and automation, the program covers robotic programming and welding, mechanical drives and linkages, sensor technology, robotic controllers, and CIM applications. Robotics courses are designed to provide students with the technician-level skills required for employment in field service or systems building. Robotics faculty believe that many students in the Robotics program are currently employed in the field and are enrolled at OCC in order to improve their chances for career advancement. OCC's Robotics program recently received five FANUC robots through the College's Major Gifts Campaign, an addition the faculty feel may make the program more attractive to potential students who are already employed in the field. While the program has additional equipment which has been donated over the years from plant closings, faculty feel much of it is outdated.

Currently, the Robotics program offers the following core courses:

| | |
|---|---|
| ROB 150 | Introduction to Robotics Technology |
| ROB 152 | Robot Manipulator Drives and Linkages |
| ROB 162 | Industrial Robotic Applications |
| ROB 164 | Interpolated/Welding Robotic Applications |
| ROB 166 | Sensor Technology |
| ROB 204 | Programmable Controller Systems |
| ROB 240 | Automated Systems Applications |
| ROB 250 | Automated Controller Maintenance |

Students are also required to complete the following non-core courses:

| | |
|---|---|
| CAD 100 | Fundamentals of Engineering Graphics |
| EEC 102 | DC Fundamentals |

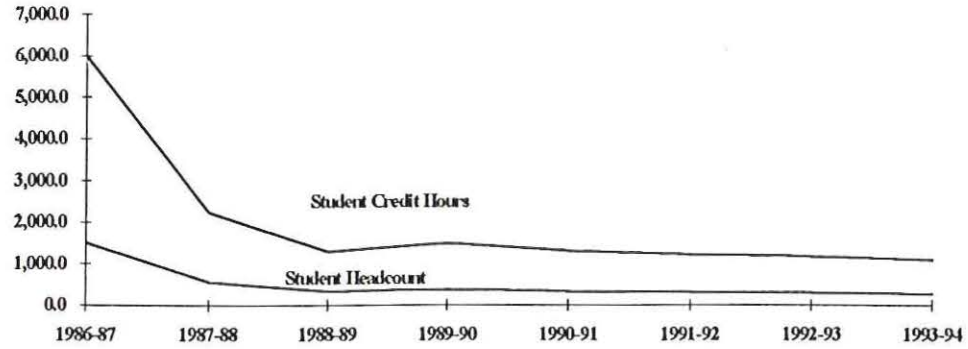
| | |
|---|---|
| EEC 104 | AC Fundamentals |
| ETT 270 | Machines and Process Controls |
| ECT 208 | Introduction to Microprocessors |
| ATF 140 | Introduction to Hydraulics |
| ATF 147 | Fundamentals of Pneumatics |
| ENG 135 | Business Communications |
| MAT 154 | College Algebra |
| MAT 156 | Trigonometry |

Student headcount and credit hour enrollments in the Robotics program have been on the decline since 1986, although this decline has been minimal for the past four years. Available data reveals that enrollments for the past three years have been concentrated in the introductory course (ROB 150). In the 1993-94 academic year, for example, 36% of all students who took a Robotics course were enrolled in ROB 150. Data for 1992-93 and 1991-92 reveal similar trends. Enrollment data also reveal that ROB 166 (Introduction to Sensor Technology) and ROB 204 (Programmable Controller Systems) have also had relatively high enrollments. These enrollments may be due in part to the fact that the ROB 150 course is a core requirement for several other programs, including Computer Integrated Manufacturing, Manufacturing Technology, and Technical/Management Development Technology.

The following table represents overall enrollment trends:

**Table 1**
**Annual Student Credit Hours and Duplicated Headcount**
**(1986-87 Through 1993-94)**

| | 1986-87 | 1987-88 | 1988-89 | 1989-90 | 1990-91 | 1991-92 | 1992-93 | 1993-94 | Percent Change 5- Year | Percent Change 8- Year |
|---|---|---|---|---|---|---|---|---|---|---|
| Student Credit Hours | 6,002.0 | 2,234.0 | 1,292.0 | 1,482.0 | 1,304.0 | 1,216.0 | 1,164.0 | 1,084.0 | -26.9 | -74.3 |
| Student Headcount | 1,504 | 559 | 327 | 372 | 326 | 304 | 291 | 271 | -27.2 | -74.5 |




## METHODOLOGY

In order to obtain background information on the robotics industry, a literature search was conducted and representatives of various professional organizations were contacted. Relevant information was used in both the writing of this report and in the employer survey design process.

In April 1995, telephone interviewers in OCC's Office of Planning & Analysis contacted 68 employers in southeast Michigan to answer survey questions regarding employment opportunities and skill requirements. Employers were selected through the 1994 Harris Industrial Directory from manufacturing categories which employ large numbers of people in the local area. These employers, many of whom are involved in automotive-related manufacturing, are categorized as follows:

| SIC Code: | Name: |
|---|---|
| 3462 | Iron & Steel Forgings |
| 3455 | Automotive Stampings |
| 3471 | Electroplating & Plating |
| 3479 | Coating & Engraving |
| 3544 | Dies, Tools, Jigs & Fixtures |
| 3711 | Motor Vehicles & Car Bodies |
| 3714 | Motor Vehicles Parts & Accessories |
| 3715 | Truck Trailers |

Respondents were asked to comment on the level of training of most job applicants as well as their own current employer needs. A similar survey designed to gauge student opinion of the Robotics program was also carried out in April 1995. Telephone interviewers contacted 78 of the 180 students (43%) who were enrolled in one or more Robotics courses between Spring 1994 and Winter 1995 were contacted. Survey instruments appear in Appendices A and B. Frequency distributions, crosstabulations and correlations were used in the analysis of the survey data.

## ANALYSIS

### *Occupational Outlook*

The Occupational Outlook Handbook (1994) indicates that the long-term outlook for the robotics industry in North America is promising. The Bureau of Labor Statistics predicts a need for more than 800,000 employees to design, maintain, and operate robotic equipment by the year 2000. While the majority of the robotic equipment installed in North American businesses were once manufactured overseas, domestic robot manufacturers reported record sales in 1993. According to the Robotic Industries Association in Ann Arbor, Michigan, "the 31% increase in new orders in 1993 followed a 21.5% gain in 1992, resulting in the industry's healthiest year-end backlog since 1984. The US robot population now tops 50,000, ranking the US second only to Japan in robotics use" (Managing Automation, June 1994). While the automotive industry continues to lead the way in robot use, non-automotive manufacturers are increasingly turning to robots in the face of corporate right-sizing, lower capital, affordably-priced robotic equipment, and the need to remain flexible and adaptable.

According to the Robotic Industries Association in Ann Arbor, one area of robotics which may well experience growth in coming years is machine vision. Used for inspection, gauging, measurement, and character recognition, machine vision systems continue to play an important part in quality assurance by allowing industries to increase productivity while improving defect identification. Since their inception in the early 1980's machine vision systems have been

prohibitively difficult to use. Recently, however, manufacturers have directed their efforts at creating systems which will be easier to use. Of the southeast Michigan employers responding to the survey, just two indicated current involvement with machine vision, suggesting that the trend may not yet have fully impacted the local market. Tracking this trend among local employers over the next few years could prove beneficial to the OCC Robotics program, as it is likely that these employers will have additional training needs.

### *Salary and Employee Benefits*

Salaries in the field of robotics vary widely depending on position and level of education. According to Opportunities in Robotics Careers, graduates of a two-year robotics program can earn anywhere between $12,000 and $22,000 a year, depending on level of experience and employer. Those with a bachelor's or graduate degree in engineering earn between $25,000 and $52,000, depending on level of experience and education. Benefits also vary widely, although college-educated robotics workers typically received paid holidays and vacations, health insurance and pension plans. The responses of employers in southeast Michigan indicate a similarly wide salary range, from hourly wages beginning at $6.00 to yearly salaries of $35,000 and up. Many employers declined to answer this question, stating that salary is too dependent on individual experience to estimate a range.

### *Opportunities for Women and Minorities in Robotics*

According to Jan Bone, author of Opportunities in Robotics Careers, women and minorities are often underrepresented in robotics careers. Citing the Women's Educational Equity Program at Purdue University, the author states that "too often, women interested in entering engineering have had no encouragement to develop manual skills, and are unused to handling tools or technical equipment." A report issued by the National Science Foundation in 1986 reveals that while the number of women and minorities employed in engineering fields has grown since the mid-70's, underemployment among degree-holders is higher among women than men. The same study reported that employment of African and Asian-Americans has risen more rapidly than that of whites, although engineering careers are still dominated by whites.

Analysis of data from OCC's Robotics program indicates a consistency with the trend noted above. Of the students who have taken an ROB course between Spring 1994 and Winter 1995, just 15.7% were female. For those students declaring Robotics as their major field of study, this figure was even lower (8.9%). Minorities are better represented in OCC's Robotics program, comprising 17.5% of those who have taken an ROB course over the last year.

### *Currently Available Training*

Several other community colleges in southeast Michigan offer an associate degree in Robotics. Washtenaw Community College in Ann Arbor offers a Robotic Technology associate degree

program, as does Henry Ford Community College in Dearborn and Macomb Community College in Warren.

### *Macomb Community College*

Macomb students interested in pursuing a career in robotics have several educational options. The college offers a one-year certificate program in Robotics, a two-year associate degree program in Industrial Technology (Robotics specialty), and a four-year degree in Mechanical Technology (Robotics specialty) through the college's University Center. Several years ago, the college did a needs assessment for the Industrial Technology program, and found that employers want employees with a high degree of specialization in a variety of areas. This is consistent with the findings of OCC's survey in which employers indicated that the majority of the skills and competencies covered in the program are "very important." In response, Macomb faculty and administrators developed seven specialty areas within Industrial Technology, one of which is Robotics. Al Manore, a faculty member in Industrial Technology who advises students in the Robotics specialty, says that the college recognizes the importance of providing students with quality instruction which will allow them to move forward in the field. This is particularly true of the basic courses which students take early in the program. Currently, he says, the Mechanical Technology program with a Robotics focus is one of the College's few growing programs.

### *Henry Ford Community College*

Henry Ford Community College offers a Automation/Robotics option within their Electrical/Electronics Technology program. Students choosing the robotics option receive focused instruction in four technical areas: electrical/electronic power and controls, hydraulic/pneumatic power and controls, computer circuitry and programming, and industrial instrumentation and electronic calibration. One half of class time is devoted to hands-on laboratory experiments involving simulated automated machines. Courses are designed to prepare students for employment as support technicians in research and development, assembly and testing, field service, and equipment sales.

### *Washtenaw Community College*

Washtenaw Community College's program in Robotic Technology prepares students for employment as automated equipment technicians in assembly, installation, and maintenance of electrical and electronic, electro-mechanical, pneumatic and hydraulic components. Students receive instruction in the use of hand tools, electronic testing instruments, diagrams, and prints, and are qualified for entry-level employment in the field upon completion of the program.

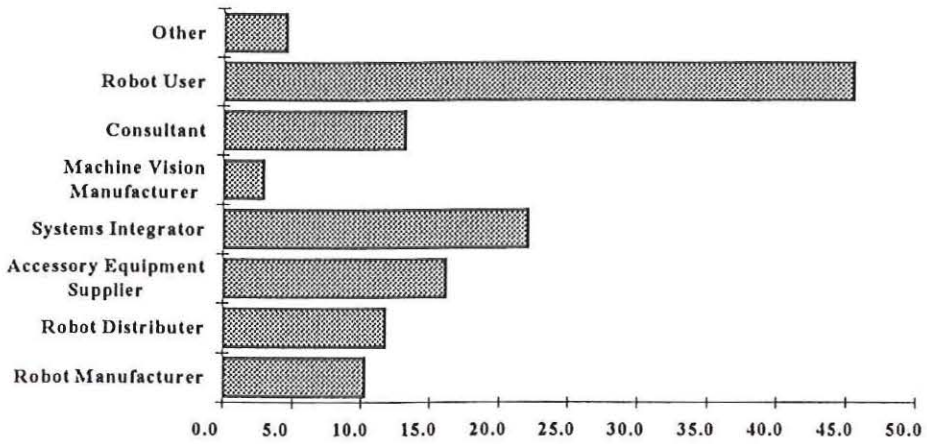
### *Employment Opportunities*

In April 1995, telephone interviewers in the Office of Planning & Analysis contacted 68 employers in southeastern Michigan. At the start of the interview, employers were asked whether they build, service, or use robotic equipment. Those with no involvement with robotics were not questioned further. The 68 employers completing the survey represent a mix of manufacturers, distributors, suppliers, and users. It should be noted that some employers are represented in more than one category. The breakdown by category is as follows:

**Table 2**

**Employer Type**

| Type | Number Responding | Percent |
|---|---|---|
| Robot Manufacturer | 7 | 10.3 |
| Robot Distributer | 8 | 11.8 |
| Accessory Equipment Supplier | 11 | 16.2 |
| Systems Integrator | 15 | 22.1 |
| Machine Vision Manufacturer | 2 | 2.9 |
| Consultant | 9 | 13.2 |
| Robot User | 31 | 45.6 |
| Other | 3 | 4.5 |



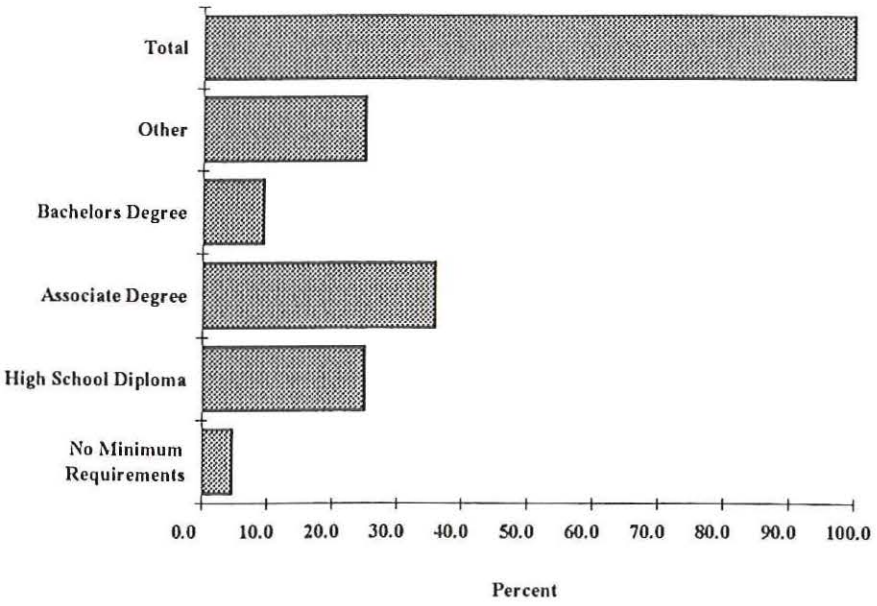

The majority (91%) of employers responding to the survey indicated that their companies employ people—either on staff or on a consulting basis—to maintain their robotic equipment. Most (63%) have employees on staff in this capacity, while the remainder bring consultants or manufacturers' representatives in to service equipment.

The minimum level of education required for employment in robotics varied significantly among the employers contacted. Over one-third (35%) said that employees must have an associate degree, while one-quarter (25%) reported that a high school diploma is their minimum requirement. However, an additional 25% said that their minimum educational requirement varies depending on the amount of work experience. In many cases, an associate degree is preferred, but a skilled background and technical training is an acceptable substitute. Several employers commented that "experience counts more than education."

**Table 3**

**Minimum Education Required**

| Education Level | Number Responding | Percent |
|---|---|---|
| No Minimum Requirements | 3 | 4.7 |
| High School Diploma | 16 | 25.0 |
| Associate Degree | 23 | 35.9 |
| Bachelors Degree | 6 | 9.4 |
| Other | 16 | 25.0 |
| Total | 64 | 100.0 |




Crosstabulations of minimum education required by type of employer indicate that the two largest employer groups surveyed—robot users and systems integrators—have different educational requirements than the group as a whole. Robot user responses reveal that 36% require a high school diploma and another 36% require an associate degree. Systems integrator responses

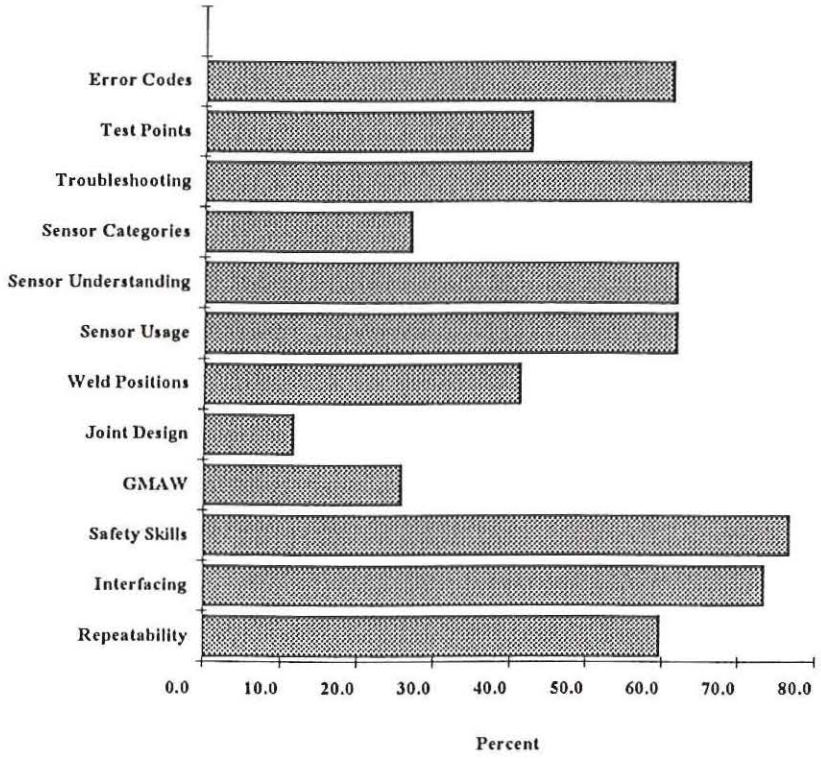
indicate that while the associate degree (27%) and the high school diploma (20%) are common educational requirements, others—such as previous employment and on-the-job experience—are also important. Twenty percent of systems integrator employers reported that their educational requirements fall into this category, and analysis of narrative responses indicate that many look for previous work experience.

Employers were also asked to comment on the importance of various skills to the tasks and duties of their robotics employees. These skills were identified by faculty members as the competencies which students should possess at the completion of each course. Employers were asked to state whether each competency is not at all important, somewhat important, or very important when hiring new employees in the robotics area. The following graph displays responses.

**Table 4**

**Employers Rating Skills "Very Important"**

| Skill | Number Responding | Percent |
|---|---|---|
| Repeatability | 37 | 59.7 |
| Interfacing | 47 | 73.4 |
| Safety Skills | 49 | 76.6 |
| GMAW | 16 | 25.8 |
| Joint Design | 7 | 11.5 |
| Weld Positions | 26 | 41.3 |
| Sensor Usage | 39 | 61.9 |
| Sensor Understanding | 39 | 61.9 |
| Sensor Categories | 17 | 27.0 |
| Troubleshooting | 45 | 71.4 |
| Test Points | 26 | 42.6 |
| Error Codes | 38 | 61.3 |



As the chart indicates, employers feel that safety skills, as well as an understanding of interfacing and the safety skills involved in troubleshooting, are the most important. Understanding GMAW (gas metal arc welding), the use of proper joint design, and an understanding of weld positions with reference to correct weld parameters are considered the least important skills when hiring new employees.

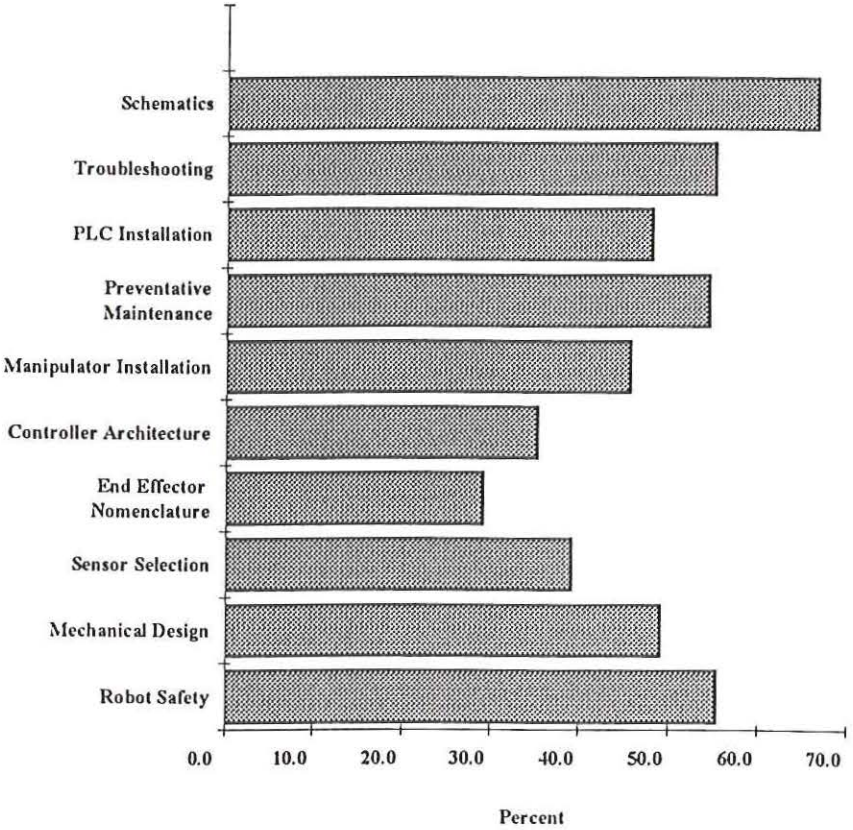
Further analysis indicates that the importance of certain skills varies by employer type. Crosstabulations reveal that skills involving interfacing, sensors, and troubleshooting are considered more important to systems integrators, while reapeatabilty, safety, GMAW, and error codes are more important to robot users.

In addition to commenting on the detailed course competencies developed by Robotics faculty members, employers were also asked how well-trained job candidates are. Responses, which are displayed graphically below, indicate that employers are most satisfied with candidates' training in interpretation of schematics, and least satisfied with training in end effector nomenclature and installation.

**Table 5**

**Employers Rating Training Level "Adequate"**

| Training Area | Number Responding | Percent |
|---|---|---|
| Robot Safety | 31 | 55.4 |
| Mechanical Design | 27 | 49.1 |
| Sensor Selection | 20 | 39.2 |
| End Effector Nomenclature | 14 | 29.2 |
| Controller Architecture | 18 | 35.3 |
| Manipulator Installation | 21 | 45.7 |
| Preventative Maintenance | 30 | 54.5 |
| PLC Installation | 26 | 48.1 |
| Troubleshooting | 32 | 55.2 |
| Schematics | 38 | 66.7 |

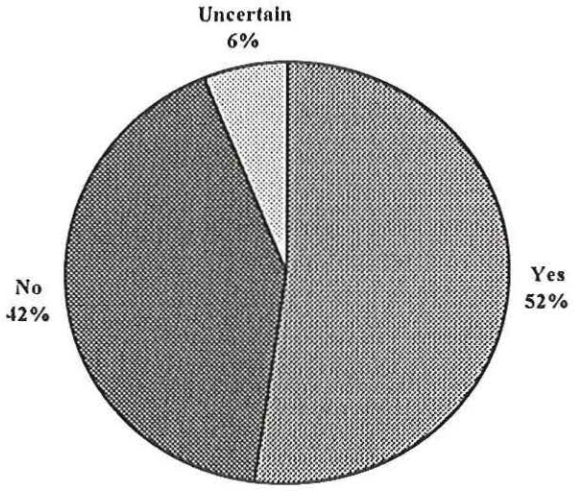


About one half of the employers contacted report that they are currently hiring new employees. Of those that are hiring, the most common reason cited was expansion of the company (89%). Other reasons included employee turnover (52%) and a need for people trained in new technology (64%).

**Table 6**

**Employers Currently Hiring**

| Response | Number Responding | Percent of Total |
|---|---|---|
| Yes | 34 | 52.3 |
| No | 27 | 41.5 |
| Uncertain | 4 | 6.2 |
| Total | 61 | 100.0 |




Nearly half (47%) said that if an employee were to obtain robotics training through a community college program, his/her income would be likely to increase slightly. Roughly the same number (48%) said that participation in a community college robotics program would also increase an employee's chance for career advancement. Over three-quarters (77%) reported that their organization provides employees in educational training programs with tuition assistance. An

even greater number (89%) said that their organization routinely provides employees with on the job training.

Employer comments confirm the literature predicting growth and diversification in the robotics field. The vast majority (92%) said they believe that employment opportunities in robotics will increase in the next five to ten years. Just 5% feel that employment in this area will decrease during this time period. Over half (60%) stated an interest in working with OCC to develop the college's robotics program. (Names and phone numbers of these employers are listed in Appendix C.)

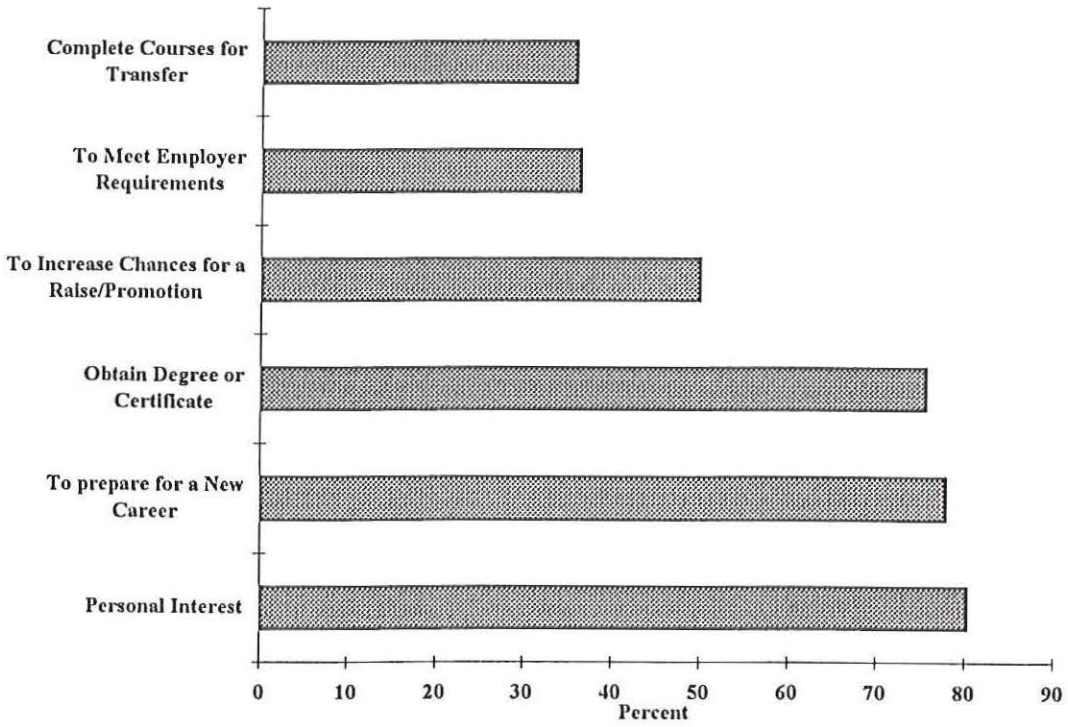
### *Profile of OCC Robotics Students*

In early April 1995, 78 OCC students were contacted by telephone interviewers in the Office of Planning & Analysis. Students responding to the survey were asked about employment, their use of various robotics skills in the workplace, and the degree to which their OCC Robotics coursework prepared them for their current jobs. Just over half (50.6%) declared Robotics as their major field of study at OCC, while the remainder have taken at least one ROB course over the past year.

Like many other technical programs involving advanced mathematics, OCC's Robotics program enrolls relatively small percentages of women. Minority student enrollments, however, are consistent with College-wide figures. Of the students responding to the survey, just 15.6% are women, while 19.2% are minorities. In the Fall 1994 term, however, College-wide figures indicate that 59.6% of students were women and 17.8% were minorities. While the problem of low female and minority enrollments in math/science-based courses is well-documented, it appears that within OCC's Robotics program, the issue is low female rather than low minority enrollments. The vast majority of students responding to the survey (90.9%) stated that OCC's Robotics course(s) met their expectations. Students' responds for enrolling in the course(s) are illustrated below. Personal interest, preparation for a new career, and obtaining an degree or certificate were commonly mentioned.

**Table7**
**Reasons for Enrolling in OCC Robotics**

| Reason | Number Responding | Percent |
|---|---|---|
| Personal Interest | 61 | 80.3 |
| To prepare for a New Career | 60 | 77.9 |
| Obtain Degree or Certificate | 59 | 75.6 |
| To Increase Chances for a Raise/Promotion | 39 | 50.0 |
| To Meet Employer Requirements | 28 | 36.4 |
| Complete Courses for Transfer | 28 | 35.9 |

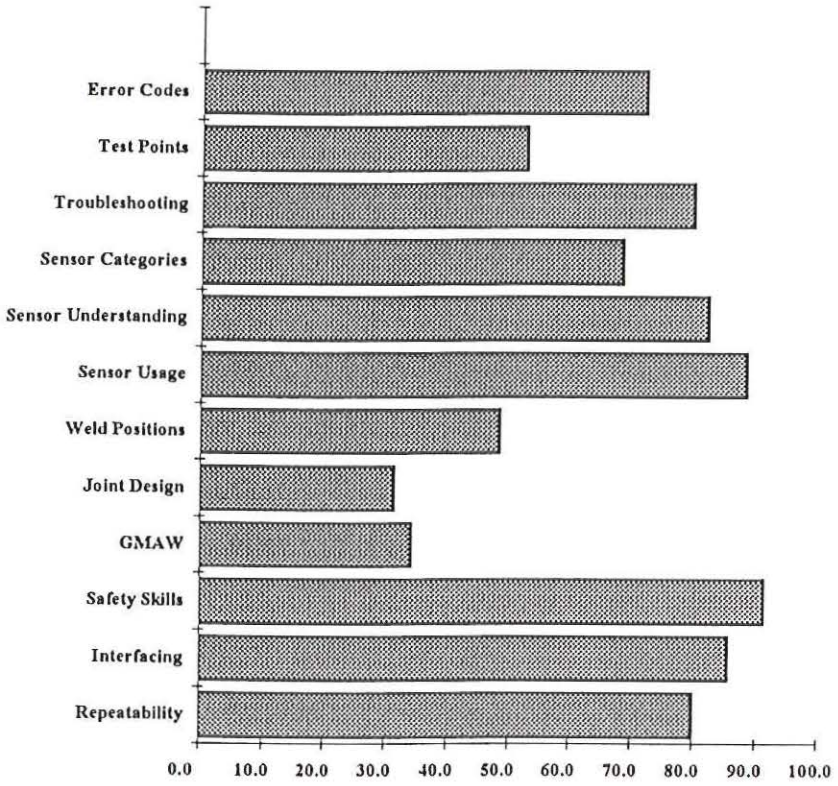


Although nearly all (88.3%) respondents are currently working either full or part-time, only 48% rate their work as five or higher on a one to ten scale of relatedness to their Robotics coursework. Students who are working in jobs related to their robotics coursework were asked to indicate the importance of various robotics skills in their current employment. Understanding repeatability, interfacing and safety skills were rated "very important" by at least 80% of respondents, as were the use and understanding of sensors and troubleshooting. Understanding GMAW and various weld positions were "not at all important" in the current employment of at least 20% of those working in related fields. The skill least important to respondents is use of proper joint design, considered "not at all important" by over one third (34.3%). Overall, over two thirds (69.4%) of those working in related fields stated that their current work has not required skills or training beyond what they learned in OCC's Robotics program.

**Table 8**

**Students Rating Skills "Very Important"**

| Skill | Number Responding | Percent |
|---|---|---|
| Repeatability | 28 | 80.0 |
| Interfacing | 30 | 85.7 |
| Safety Skills | 32 | 91.4 |
| GMAW | 12 | 34.3 |
| Joint Design | 11 | 31.4 |
| Weld Positions | 17 | 48.6 |
| Sensor Usage | 31 | 88.6 |
| Sensor Understanding | 28 | 82.4 |
| Sensor Categories | 24 | 68.6 |
| Troubleshooting | 28 | 80.0 |
| Test Points | 19 | 52.8 |
| Error Codes | 26 | 72.2 |



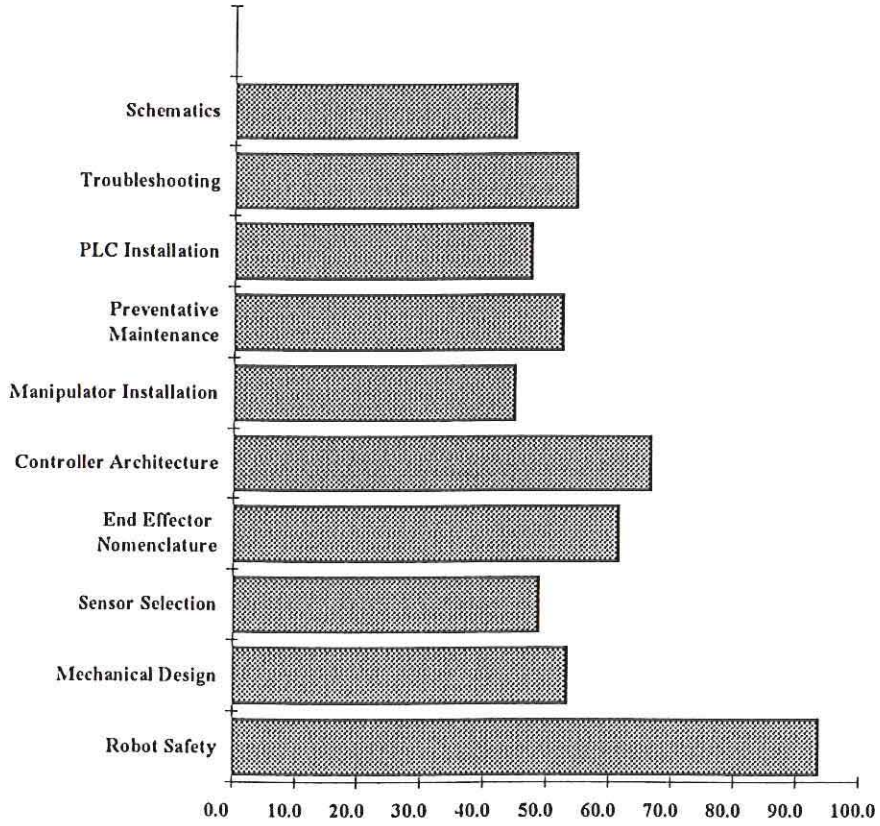
Further analysis of student and employer ratings of the skills which are important in the workplace show remarkable consistency between the responses of the two groups. Both students and employers feel that interfacing, safety skills, sensor usage and understanding and troubleshooting are the most important in the workplace, while GMAW, joint design, and weld positions are the least important. Only students who reported that they are currently working in a position related to their robotics coursework at OCC were asked to rate these skills.

When asked to consider the quality of the training they received at OCC, most Robotics students appear satisfied. Seventy percent of students feel that the training they received in robot safety was "excellent". Not one of the ten training areas received an "unsatisfactory" rating from more than 10% of those responding.

**Table 9**

**Students Rating Training Level "Excellent or Satisfactory"**

| Training Area | Number Responding | Percent |
|---|---|---|
| Robot Safety | 73 | 93.6 |
| Mechanical Design | 41 | 53.3 |
| Sensor Selection | 38 | 48.8 |
| End Effector Nomenclature | 48 | 61.5 |
| Controller Architecture | 52 | 66.7 |
| Manipulator Installation | 35 | 44.8 |
| Preventative Maintenance | 41 | 52.5 |
| PLC Installation | 37 | 47.4 |
| Troubleshooting | 42 | 54.6 |
| Schematics | 35 | 44.8 |



# CONCLUSION

## *Summary*

Southeast Michigan robotics employers are for the most part in agreement with the national organizations' predictions of a bright future for robotics. Most employers support the educational and career goals of their employees, as evidenced by the high percentage offering tuition assistance. Additionally, there is some evidence that successful completion of a community college training program may enhance career advancement and salary potential. Opportunities for immediate employment in robotics are also promising, as slightly more than half of responding employers report that they are currently hiring.

## *Issues*

If the predictions of the national robotics organizations prove true, machine vision will, within a few years, become a significant element in robotics careers. While this trend has not fully impacted robotics employers in southeast Michigan, it is likely that it will do so in coming years. As a provider of training, the OCC Robotic program will need to be prepared to meet new and different needs.

While a substantial number of employers reported that an associate degree is a minimum educational requirement, responses indicated that "other" experience, such as previous employment, is often at least as important as formal education. If this trend continues, community college robotics programs may be challenged to find ways to provide more practical experience as part of the degree program. Additionally, as the emphasis continues to shift from the formal degree to the skill level of the individual employee, institutions like OCC may find an increased demand for non-credit offerings in technical areas like robotics.

The problem of low numbers of women taking courses in technical areas is not a problem unique to OCC. Other institutions are taking steps to address this issue, including mentoring programs for women and/or minority students. While minority enrollments do not appear to be a problem for OCC's Robotics program, steps could be taken to improve the numbers of women taking ROB courses.

Student and employer agreement on the importance of various robotic skills indicates that students are up to speed on employer requirements, and are aware of the skills necessary in the workplace. This is consistent with the faculty statement that many Robotics students are working and attending classes concurrently. Further exploration of employer support for training—whether in the form of tuition assistance, salary incentives, career advancement, or OCC/employer partnerships—may prove beneficial to the program.

## REFERENCES


Bone, Jan. Opportunities in Robotics Careers (1987). Lincolnwood, Illinois: VGM.

Career Information Center (1990). New York: Macmillan.

Harris Michigan Industrial Directory (1994). Twinsburg, OH.

Henry Ford Community College Electrical/Electronics Faculty. Personal Interview.

"Machine Vision: Models for Success" (June 1994). Managing Automation. Robotics Industries Association: Ann Arbor, MI.

Manore, Al. Macomb Community College Robotics Faculty. Personal Interview.

McGregor, Elizabeth (1990). "Emerging Careers". Occupational Outlook Quarterly. 22-25.

"New Competitiveness Spurs Record Robot Sales"(June 1994). Managing Automation. Robotics Industries Association: Ann Arbor, MI.

Occupational Outlook Handbook (1994). Washington, DC: Bureau of Labor Statistics.

Office of Don Vincent, Executive Vice President, Robotic Industries Association.

"Robotics Education and Employment"(1993). Technology Teacher, 53, 7-11.

Robotics World (Winter 1993). Argus Business, Inc: Atlanta, GA.

# APPENDIX A
# ROBOTICS NEEDS ASSESSMENT
# STUDENT SURVEY

Oakland Community College
Robotics Needs Assessment
Student Survey

1. I'm going to read you a list of common reasons why students enroll in Robotics courses. Please tell me whether or not these reasons apply to your decision to enroll in a Robotics course(s) at OCC:

| | *Yes* | *No* |
|---|---|---|
| a. To obtain a degree or certificate | 1 | 0 |
| b. To complete courses necessary for transfer to another college | 1 | 0 |
| c. To prepare for a new career | 1 | 0 |
| d. To increase chances for a raise and/or a promotion | 1 | 0 |
| e. To comply with current employer's requirements | 1 | 0 |
| f. Personal interest | 1 | 0 |

g. Other, please explain: _____

2. Given the reasons you just mentioned, do you feel that the Robotics course(s) you took at OCC met your expectations?

*1* _____ Yes
*0* _____ No, please explain: _____

3. What is/was your major program of study at OCC?

_____

4. Currently, are you employed, or are you out of the workforce?

*If employed, ask:* Is this full-time or part-time work?
*If unemployed, ask:* Are you currently seeking employment?

*1* _____ Full-time
*2* _____ Part-time
*3* _____ Unemployed, seeking work *(skip to 10)*
*4* _____ Unemployed, not seeking work *(skip to 10)*
*9* _____ No response

5. On a scale of one to ten, with one being not at all related and ten being highly related, to what extent would you say your OCC Robotics courses relate to your current employment? *(If response is 4 or lower, skip to 10)*

*Not at all related* 1 2 3 4 5 6 7 8 9 10 *Highly related*

6. Please tell me which of the following categories most accurately describes your current position:

*1* _____ Technician/serviceman (employed by company)
*2* _____ Technician/serviceman (employed by manufacturer)
*3* _____ Systems builder
*4* _____ Other (please explain): _____
*9* _____ No response

7. Have you found that your current job has required robotics skills or knowledge beyond what OCC offers?

*1* _____ Yes, my current job requires skills beyond what OCC offers
*2* _____ No, my current job does not require skills beyond what OCC offers
*9* _____ No response

8. Please tell me whether the following skills are very important, somewhat important, or not at all important in performing your current job:

| | VI | SI | NI |
|---|---|---|---|
| Understanding of repeatability and its importance | 3 | 2 | 1 |
| Understanding of interfacing between robot controller & peripheral components | 3 | 2 | 1 |
| Safety skills when working in close proximity to robot and teaching a program | 3 | 2 | 1 |
| Understanding of GAS METAL ARC WELDING (GMAW) | 3 | 2 | 1 |
| Use of proper joint design | 3 | 2 | 1 |
| Understanding of weld positions w/ reference to correct weld parameters | 3 | 2 | 1 |
| Understanding of sensor usage to prevent entry into an active robot work cell | 3 | 2 | 1 |
| Understanding of various reasons why sensors are used in automation | 3 | 2 | 1 |
| Knowledge of the three categories of sensors used in manufacturing systems | 3 | 2 | 1 |
| Safety procedures involved in troubleshooting automation controllers | 3 | 2 | 1 |
| Proper use of multi-meter & record values at test points on AC input board | 3 | 2 | 1 |
| Use of error codes and diagnostics in troubleshooting procedures | 3 | 2 | 1 |

9. What additional training or knowledge would be helpful to you in performing your current job?

_____

_____

10. Thinking about the training you received at OCC, please tell me if the instruction you received in the following areas was excellent, satisfactory, or unsatisfactory, or whether you believe that the course(s) you took did not cover this material:

| | Excellent | Satisfactory | Unsatisfactory | Did not cover |
|---|---|---|---|---|
| a. Robotics safety | 3 | 2 | 1 | 8 |
| b. Mechanical design/adjustments | 3 | 2 | 1 | 8 |
| c. Sensor selection/installation | 3 | 2 | 1 | 8 |
| d. End effector nomenclature/installation | 3 | 2 | 1 | 8 |
| e. Controller architecture | 3 | 2 | 1 | 8 |
| f. Controller/manipulator installation | 3 | 2 | 1 | 8 |
| g. Preventative maintenance | 3 | 2 | 1 | 8 |
| h. PLC installation/diagnostics | 3 | 2 | 1 | 8 |
| i. Troubleshooting/diagnostics | 3 | 2 | 1 | 8 |
| j. Interpretation of schematics | 3 | 2 | 1 | 8 |

11. Of the skills and knowledge you learned while enrolled in an OCC Robotics course or courses, which would you say have been the most useful to you professionally? (please be as specific as possible.)

_____

_____

_____

12. Are there any other comments you would like to make about your experience in Robotics courses at OCC?

_____

_____

_____

# APPENDIX B
# ROBOTICS NEEDS ASSESSMENT
# EMPLOYER SURVEY

Oakland Community College
Robotics Needs Assessment
Employer Survey

We at OCC are currently contacting southeast Michigan businesses which build, service or use robotic equipment. Do you have a moment to answer a few questions for us?

1. Please tell me which of the following categories best describes your organization *(read all choices; circle one response)*:

   a. Robot manufacturer *(skip to 4)*
   b. Robot distributor *(skip to 4)*
   c. Robot accessory equipment supplier *(skip to 4)*
   d. Systems integrator *(skip to 4)*
   e. Robotic safety equipment supplier *(skip to 4)*
   f. Machine vision manufacturer *(skip to 4)*
   g. Machine vision distributor *(skip to 4)*
   h. Machine vision accessory equipment supplier *(skip to 4)*
   i. Consultant *(skip to 4)*
   j. Robot user

2. Does your organization employ robotics technicians and/or service people to maintain robotic equipment?
   *(If yes:* Are these technicians/service people on staff, or are they outside consultants/manufacturer's representatives?)

   *1* _____ Yes, we have technicians/service people on staff *(Skip to #4)*
   *2* _____ Yes, we employ outside consultants or manufacturer's representatives to address equipment problems
   *3* _____ No, we do not employ any technicians or service people (discontinue survey)

3. Which firm or organization do you use to solve equipment problems?

   *(write in name)*_____

4. What is the total number of people employed at your facility?

   _____ (write in number)

5. When your organization hires people in the robotics area, what is the minimum level of education required?

   *1* _____*No specific educational requirement*
   *2* _____*High school diploma or equivalent*
   *3* _____*Associate degree*
   *4* _____*Bachelor's degree*

5 _____*Master's degree or higher*
6 _____*Other (please specify:)* _____

6. We would like to find out which skills and competencies are important to you when hiring new employees in the robotics area. Please tell me whether the following skills are very important, somewhat important, or unimportant:

| | VI | SI | NI | No response |
|---|---|---|---|---|
| Understanding of repeatability and its importance | 3 | 2 | 1 | 9 |
| Understanding of interfacing between robot controller & peripheral components | 3 | 2 | 1 | 9 |
| Safety skills when working in close proximity to robot and teaching a program | 3 | 2 | 1 | 9 |
| Understanding of GAS METAL ARC WELDING (GMAW) | 3 | 2 | 1 | 9 |
| Use of proper joint design | 3 | 2 | 1 | 9 |
| Understanding of weld positions w/ reference to correct weld parameters | 3 | 2 | 1 | 9 |
| Understanding of sensor usage to prevent entry into a active robots work cell | 3 | 2 | 1 | 9 |
| Understanding of reasons why sensors are used in automation | 3 | 2 | 1 | 9 |
| Knowledge of the three categories of sensors used in manufacturing systems | 3 | 2 | 1 | 9 |
| Safety procedures involved in troubleshooting automation controllers | 3 | 2 | 1 | 9 |
| Proper use of multi-meter & record values at test points on AC input board | 3 | 2 | 1 | 9 |
| Use of error codes and diagnostics in troubleshooting procedures | 3 | 2 | 1 | 9 |

7. When hiring new employees in the robotics area, would you say that most candidates are adequately trained in the following areas, or do you find that the majority are inadequately trained:

| | *Inadequate* | *Adequate* | *No response* |
|---|---|---|---|
| a. Robot safety | 1 | 2 | 9 |
| b. Mechanical design/adjustments | 1 | 2 | 9 |
| c. Sensor selection/installation | 1 | 2 | 9 |
| d. End effector nomenclature/installation | 1 | 2 | 9 |
| e. Controller architecture | 1 | 2 | 9 |
| f. Controller/manipulator installation | 1 | 2 | 9 |
| g. Preventative maintenance | 1 | 2 | 9 |
| h. PLC installation/diagnostics | 1 | 2 | 9 |

| | | | |
|---|---|---|---|
| i. Troubleshooting/diagnostics | 1 | 2 | 9 |
| j. Interpretation of schematics | 1 | 2 | 9 |

8. Are there other skills or competencies which you look for when hiring new employees in the robotics area?

_____

_____

9. Are you currently hiring new employees in the robotics area?

*1* _____ Yes, currently hiring in robotics
*0* _____ No, not currently hiring in robotics *(skip to 11)*
*7* _____ Don't know *(skip to 11)*
*9* _____ No response *(skip to 11)*

10. What is the primary reason for hiring new employees in this area?

| | Yes | No |
|---|---|---|
| a. Expansion of the company | 1 | 0 |
| b. Employee turnover | 1 | 0 |
| c. Need people trained in new technologies | 1 | 0 |

d. Other: please specify:_____

11. What is the starting salary range in your organization for **entry-level** employees in the robotic area?

a. *From* _____ *to* _____ *per hour or*

b. *From* _____ *to* _____ *per year*

12. If one or more of your current employees in the robotic area were to obtain training in a community college robotics program, it is likely that their income would be affected substantially, slightly, or not all?

*1* _____ Substantial increase in income
*2* _____ Slight increase in income
*3* _____ No change in income

13. If one or more of your current employees in the robotics area were to participate in a community college robotics program, how might their potential for career advancement be affected?

*1* _____ Would not affect career advancement potential
*2* _____ Might increase career advancement potential
*3* _____ Would definitely increase career advancement potential

*7* _____ Don't know
*9* _____ No response

14. Does your organization provide any form of tuition assistance to employees in the robotics area who are interested in enrolling in outside training programs?

*1* _____ Yes
*0* _____ No
*7* _____ Don't know
*9* _____ No response

15. Does your organization provide any on-the-job training to employees in the robotics area?

*1* _____ Yes
*0* _____ No *(skip to 17)*
*7* _____ Don't know
*9* _____ No response

16. Could you describe the type of training you offer?

_____

_____

17. Thinking about the next five to ten years, do you predict that employment opportunities in the robotics area will increase, decrease, or remain about the same?

*3*_____ *Increase*
*2* _____ *Remain about the same*
*1* _____ *Decrease*
*7* _____ *Don't know*
*9* _____ *No response*

18. Would you be interested in working with OCC to develop the robotics program?

*1* _____ *Yes*
*0* _____ *No*
*7* _____ *Don't know*
*9* _____ *No response*

19. Are there any other comments you would like to make about your employment needs or the training available?

*1* _____ *Yes*
*0* _____ *No*
*9* _____ *No response*

# APPENDIX C
# ROBOTICS NEEDS ASSESSMENT
# EMPLOYER LIST

ACE Controls Inc
Farmington Hills, MI
810 476-0213
Contact: Dave Haslam

Motoman, Inc.
Waterford, MI
513 847-3204
Contact:Diandra Meyers

Carpenter Entrepreneurs
Fenton, MI
810 629-5891
Contact:Brian Pait

**Albar Industries**
**Lapeer, M**
**810 667-0150**
**Contact: Greg Rahn**

**Airflow Research and Manufacturing**
**Belleville, MI**
**313 397-1660**
**Contact: Rich Matsu**

Robotics Production Technology, Inc
Madison Heights, MI
810 583-2185

**Trellis Software and Controls**
**Rochester Hills, MI**
**810 853-0700**
**Contact: Tim Schiller**

**Therabotics /Dynamic Control**
**Warren, MI**
**810 759-2540**
**Contact: Bob Weins**

TL International
Madison Heights, MI
810 585-3140
Contact: Rob Cera

TEC Automation Inc
Wixom, MI
810 960-7575
Contact: Bob Todd

**Robotics Technology Inc**
**Clinton Twp., MI**
**810 469-0290**

Adept Technology, Inc
Novi, MI
810 348-5888
Contact: Jim Mathis

**Questech, Inc**
**810 615-0800**
**Contact: George Emanoil**

Nachi Robot Systems, Inc
810 305-6545
Contact: Susan Merritt

**Automation Products Corp.**
**810 294-9500**
**Contact: Mike Blean**

**FANUC Robotics Inc**
**810 377-7000**
**Contact: Mikki Prokach**

Ford Motor Company
Wayne, MI
313 467-0305
Contact: Sam Perron

**Control Devices Inc**
**810 239-3101**
**Contact: Mr. Windsor**

**International Star Corp.**
**810 949-2200**
**Contact: Dee Drott**

**Chrysler Corp.**
**Sterling Heights**
**810 978-6113**
**Contact: Phil Osmundson**

**Power Surge**
**Orion, MI**
**810 391-6133**
**Contact:**
**Harold Fitzpatrick**

**Robotic Concepts, Inc**
**Livonia, MI**
**313 425-5599**
**Contact: John Powell**

Wellington Industries Inc
Belleville, MI
810 942-1060
Contact: Mark Roggero

**Crescive Die and Tool**
**Saline, MI**
**313 944-1222**

Cordell Corp.
Rochester, MI
810 853-3494

**Blechert, Inc.**
**Sterling Heights, MI**
**810 726-8717**
**Contact: Mike O'Brien**

**AMP Industries**
**Harrison Twp, MI**
**810 469-4100**
**Contact: Larry Lambert**

Saturn Corp.
Troy, MI
810 524-6982
Contact: Rick Youngblood

Aeroquip, Inc.
Port Huron, MI
810 984-4446

**Plymouth-Wayne Welding Supplies Inc**
**Garden City, MI**
**313 425-8870**
**Contact: Dale Buhoski**

Milford Fabricating
313 372-8400
Contact: Walt Anderson

AEP Technologies
810 294-6000

Precision Tool
Farmington Hills
810 471-0360

**US Manufacturing**
**810 984-4145**
**Contact: Plant Manager**

**Textron Automotive Interiors**
**Westland, MI**
**313 721-1000**
**Contact: Bill Martin**

**Logic Systems**
**Oxford, MI**
**810 628-2878**
**Contact: Pam Knasinski**

Misui and Co USA
Southfield, MI
810 357-3300
Contact: Joe Carfora

**Flotronics**
**Clarkston, MI**
**810 625-8890**
**Contact: Lloyd Schamaltz**

**ABB Robotics**
**Auburn Hills, MI**
**810 391-8567**
**Contact: Charlie Miller**

**Pico Resources**
**Royal Oak, MI**
**810 435-4100**
**Contact: Mark Stroup**

**RPT Co**
**810 583-2185**
**Contact:Chuck Russo**

Aetna Industries Inc.
810 759-2200
Contact: Dan Done

**Letts Industries**
**313 579-1100**
**Contact: Jeff Bolton**

**Scandmac Inc**
**313 421-7540**
**Contact: David Miller**

**Servicon Co**
**Roseville, MI**
**810 294-1860**
**Contact: Tony Moceri**

Aerotek
Southfield, MI
810 575-9222
Contact: Curtis Heart

**Perceptron**
**Farmington Hills, MI**
**810 478-7710**
**Contact: Jill Smith**

Tokico USA Inc
Dearborn, MI
810 336-5280
Contact: James Bilski

Reis Machines Inc
Novi, MI
810 349-9220
Contact: Ryan Gilson

Creative Automation Inc
Plymouth, MI
313 455-4448
Contact: Brad Helm

Budd Co/Detroit Stamping
Detroit, MI
313 823-9100
Contact: Yvonne Snell

Watson Engineering
313 946-9856
Contact: George Jasowick

**General Motors**
**Orion, MI**
**810 377 5164**
**Contact: Shawn Davis**

**General Motors**
**Flint, MI**
**810 236-7272**
**Contact: Personnel Office**

**Chrysler Stamping**
**Warren, MI**
**810 497-3685**
**Contact: Tom Begeman**

Marubeni Corp.
810 355-6450
Contact: Steve Glouack

**Quasar Industries**
**Rochester Hills, MI**
**810 852-0300**
**Contact: Mark Bartoski**

**Hi-Tech Toll Industries Inc.**
**Troy, MI**
**810 649-0690**
**Contact: Dennis Dawes**

AGS Metal
810 939-3000
Contact: Mike Everett

Robotics Services
Grand Rapids, MI
616 954-0510
Contact: Randy French

**Ingersoll-Rand Water-jet**
**Division**
**810 471-0888**
**Contact: Chuck Andromales**

Draw-Tite
Canton, MI
810 722-7800
Contact: Jerry Brunette

**BCR Tool Co**
**Brighton, MI**
**810 229-2580**
**Contact: Mike Gow**

Dundee Research
Dundee, MI
313 529-2436
Contact: Danny King

**Tower Automotive**
**Romulus, MI**
**313 946-1300**
**Contact: Carl Van Wagoner**

**Kawasaki Robotics USA**
**Farmington Hills, MI**
**810 477 3900**
**Contact: Bruce Moyrend**

CD & A Industries
Huron Plastics Group Body
Systems
810 679-4887
Contact: Judy Vandewalker



**(Names in bold type are interested in working with OCC.)**