

Portland Community College Microelectronics Technology Program

Program Review 2006-2007

Executive Summary

During the past year, the MT SAC performed a program review, in which we examined the achievement level of student learning outcomes, instructional quality, and responsiveness to student and community needs, and then articulated improvement recommendations. We found that the program has been greatly strengthened by successful recruitment of staff with strong industrial expertise, and by acquisition of more updated lab equipment and facilities. The program has also significantly improved its curriculum. As a result, our students develop successfully the technical skills that enable them to excel in the industry more so than ever. The program continues to serve our students well by providing them the education background that leads to well paid, highly skilled employment. A key to our success is our active and involved Advisory Committee, and the internship opportunities they provide which allow our adult students to receive an education and support their livelihood at the same time.

As a result of this review, we found that our program needs to improve its retention and recruitment of students. Most of our current students come to us as an avenue to specific jobs in the local semiconductor industry. This source is subject to the cyclical nature of the industry, and these students tend to lack the math/science background necessary to succeed. Additionally, students try attaining their AAS degree within two years, often while working full time. The excessive load can restrict their achievement. We need to find a better way for students to balance these needs. Finally, while we know our students meet the technical objectives we have set for them, we find it difficult to incorporate teaching and assessment of the softer skills such as teamwork and communication. We need access to professional development opportunities, and then we need to further develop our curriculum to address this shortcoming.

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History of the Program

In 1990, at the request of Intel Corporation, PCC resurrected the MT program and updated the curriculum to fit Intel's wafer fab technician requirements. At this time, construction had begun on two new wafer fabs at Intel's Aloha, OR, campus. Intel's motivation in establishing an AAS program in Microelectronics Technology was to help approximately 300 operators in Fab4, their 4-inch wafer factory, transition to technician jobs in the new factories. The MT program was offered at Intel's Aloha, OR, campus from 1990 to 1995 under a contract administered by CWT. All courses were offered at Intel with the exception of science laboratories in chemistry and physics which were held at PCC. At this time, the MT program was only available to full-time Intel employees. In August of 1995, the MT program was moved from Intel to PCC's Washington County Workforce Training Center (CAPITAL Center). The MT program was opened to the general public in addition to Intel employees. In terms of college organization, the MT program is part of the Rock Creek Campus. This is the campus where the program is currently located.

1) To improve the quality of teaching and learning by asking faculty and staff, to reflect upon and examine teaching methodologies, learning outcomes, and curriculum.

A) Evaluate the curriculum using national and professional discipline/program guidelines where available.

Few specific national or professional discipline/program guidelines exist for two-year microelectronics technology programs at this point in time. In 1995, SEMATECH's Technician Training Task Force published curriculum recommendations for two-year programs in semiconductor manufacturing technology.

A.1) SEMATECH

Originally created to reinvigorate the U.S. semiconductor industry, International SEMATECH has evolved into the world's premiere research consortium. Member companies cooperate pre-competitively in key areas of semiconductor technology, sharing expenses and risk. SEMATECH includes thirteen member companies: AMD, Conexant, Hewlett-Packard, Hyundai, Infineon Technologies, IBM, Intel, Lucent Technologies, Motorola, Philips, ST Microelectronics, TSMC, and Texas Instruments.

In 1995, SEMATECH Technician Training Task Force developed guidelines for two-year programs in semiconductor manufacturing technology. These guidelines were based to a great extent on the two-year microelectronics technology curriculum jointly developed by Intel Corporation and Portland Community College in 1990.

Subsequent efforts by the Technician Training Task Force further defined the skill requirements for process technicians and equipment technicians. The requirements for process technicians have been compiled by the Maricopa Advanced Technology Center (MATEC) while the Technician Training Task Force commissioned an effort coordinated by Richland College (TX) to define equipment technician skill requirements for the semiconductor industry.

Both efforts to define skill standards for process and equipment technicians were based on a DACUM methodology. The list of competencies provides useful information in PCC's transition to an outcomes-based curriculum development and implementation process (<http://www.sematech.org/public/resources/stds/stdorgs.htm>).

SEMATECH guidelines for process technicians match PCC's Microelectronics Technology curriculum in terms of credit distribution by subject area. Unfortunately, the SEMATECH guidelines are not comprehensive guidelines addressing faculty, laboratory facilities, student body, administration, satisfactory employment, industrial advisory committee, financial support and facilities. A more comprehensive set of criteria is presented in the TAC of ABET criteria for engineering technology programs.

A.2) ABET Accreditation

In the United States, accreditation is a non-governmental, peer review process that ensures educational quality. Educational institutions or programs voluntarily undergo this review to determine if minimum criteria are being met.

ABET began in 1932 as the Engineer's Council for Professional Development (ECPD). In 1980, the ECPD became the Accreditation Board for Engineering and Technology, focusing its efforts on the accreditation of educational programs. ABET now accredits some 2,300 engineering, engineering technology, and engineering-related educational programs at over 500 colleges and universities in the U.S. ABET is recognized by the U.S. Department of Education and the Council for Higher Education Accreditation (CHEA) for its responsibility in these areas.

Criteria for Accrediting Engineering Technology Programs are developed and used to accredit engineering technology programs by the Technology Accreditation Commission (TAC) of ABET. These criteria address the following areas: program content and orientation, program level and course requirements, curriculum elements, technical currency, faculty, student body, administration, satisfactory employment, industrial advisory committee, and financial support and facilities.

Under the "Criteria for Accrediting Engineering Technology Programs" that are in effect for evaluations during the 2006-2007 accreditation cycle, the MT program does meet the credit distribution requirements set forth by TAC of ABET. Specifically, 34 quarter credits of technical courses are required by TAC of ABET requirements while the MT program has 43 quarter credits. On the other hand,

TAC of ABET requirements call for a minimum of 24 quarter credits of basic sciences and mathematics while the MT program requires 35 quarter credits in mathematics, chemistry, and physics.

B) Review of the learning outcomes for MT program, and of the sequence of courses within our program.

The department has decided to change our learning outcome concerning process equipment maintenance and trouble-shooting. The original version of the program outcomes is as follows:

- maintain manufacturing and testing systems and equipment, troubleshoot circuit and systems
- monitor and maintain semiconductor manufacturing process
- work effectively in teams
- communicate effectively with colleagues and vendors

The revised version is as the following:

- Be able to understand how process equipment function at a component level and at a system level. Have a good foundation in process equipment maintenance and trouble-shooting.
- Be able to troubleshoot circuits.
- Monitor and maintain semiconductor manufacturing process
- Work effectively in teams.
- Communicate effectively with colleagues and vendors.

The revised outcomes incorporate requirements for understanding of process equipment in addition to the original requirement on process equipment maintenance and trouble-shooting.

The reason for the above change is as follows: Currently we spend the majority of time in the classes MT224, MT227 and MT228 helping students to understand process equipment. MT224 helps them to understand process equipment at a component level (such as motors, sensors, controllers, etc.) MT227 and 228 help them to understand process equipment from a systems level. This is absolutely necessary since no one can learn how to maintain and trouble-shoot process equipment without first having a good understanding of it. While we do teach maintenance and trouble-shooting, they together consume only about 30% of our process equipment class time. Within that amount of time, we can only help students to form a good foundation in maintenance and trouble-shooting, a good starting point. More coverage of these topics is not possible since it takes the equivalent of half of a term to learn just one maintenance procedure in the fab, and it takes years to accumulate trouble-shooting experience. Such extensive training in maintenance and trouble-shooting is also not so necessary since students will be taught more about maintenance and trouble-shooting once they work in the industry. Our philosophy is that once they understand process equipment well and have a good foundation in maintenance and trouble-shooting,

they can advance much faster later on in their careers in maintenance and trouble-shooting.

The department also spent time developing assessment methodology for the above learning outcomes during this program review. The department completed the transition from a competency based curriculum to an outcome based curriculum during the previous 2000 program review. The outcomes were worked out clearly. On the other hand, no attempts have been made to develop the methodology to assess these outcomes. It turns out that many of the outcomes involve “soft skills” such as communication skills or trouble-shooting skills. They are much harder to assess than the traditional competency goals. The department decided to develop an assessment method for the outcome “communication skills” during this review.

We developed a two-step process to design the assessment methodology of soft-skill learning outcomes. The first step is to develop a set of standards to better measure the level of our students against. The second step is to develop ways to measure student performance against the standards. A standard should define the skills our students should have and the level at which they should have them. We think that the appropriate skill list needs to reflect the immediate skill requirements of the future work places of our students. It should also take into consideration skills which prove to be valuable to the lives of our students over the long run. To determine the work place requirements on communication skills, we decided to survey the typical communication tasks our graduates perform in their future work place. We also referenced requirements on communication skills from a national standard microelectronics curriculum: the MATEC standard. For a list of skills that are valuable to the lives of students in the long term, we simply used the PCC communication learning outcome as a guide. To determine the level at which our students should have the skills, we came up with communication task examples with varied complexity. If a student is able to perform the most complex one, the student is then determined to be at the A level in communication skills. If a student is able to perform the minimum task, the student is then determined to pass the minimum requirement on communication skills and so on. Now that we have developed a standard for communication skills, we should proceed to define ways to measure student performance against the standards. We ran out of time to complete this task. This will become a future project for the SAC.

One additional future change to assessment methods of soft skills such as communication is to require each MT course to specify required learning outcomes in this skill area. For example: MT228 needs to list ‘being able to read and understand industrial standard PM specs’ as an outcome in the communication skill area. Also, we may require all courses to align their soft skill learning outcomes to the program standard defined above. Also we may require higher level courses to build upon students’ learning in earlier courses, so

that upon completion of the whole MT curriculum students would have built up their skills to the program standard (i.e. course skills standards would be incremental and progressive).

C) Evidence that the MT program learning outcomes are being met by students.

C.1) Communication Skills:

The department relies primarily on a series of Gen Ed courses to help our students to develop communication skills. The courses are WR121 English composition, WR122 English composition, WR227 Technical writing I, SP130 Business and Professional Speech Communication and SP215 Small Group Communication. The English composition courses train students in basic written communication. Speech 130 addresses professional and technical written and oral communication. Small Group communication is intended to cover group dynamics in a teamwork environment. The following table shows grade distributions of MT students in their speech classes in four school terms from fall 2004 to winter 2006. The tables show that our students are passing the basic requirements of these courses.

Grade category	# of Students	%
A	6	25
B	13	54
C	3	13
W, I	2	8
Total	24	100

Speech 130

Grade category	# of Students	%
A	9	45
B	8	40
C	3	15
W, I	0	0
Total	20	100

Speech 215

Students also practice their communication skills throughout their curriculum within the MT department. Such training covers three main areas: written technical reports, mixed media technical presentations, and small group technical or interpersonal oral communication.

Students are required to write brief lab reports in almost all of their first year courses once a week or once every other week. They learn to write brief reports to communicate the purpose and results of their experiments. They often have to utilize graphs and tables. At the end of the year, the absolute majority of our students receives lab report grades that indicate they can describe their experiments in a clear and structured fashion. Students who are not native speakers will sometimes make mistakes in grammar and sentence structure, but readers can still understand the ideas conveyed.

At the beginning of the second year, students learn to adopt the standard scientific report format of stating the purpose, procedure, results, analysis and conclusion. They learn to place information in the correct sections. The absolute majority of them can accomplish these basics tasks successfully. Instructors very often ask students to perform even more complex tasks that are more typically learned in a four year engineering school. Students learn to format graphs and tables to

accentuate trends and features within their data. They learn to discern and describe the trends and features within their data in words item by item. They learn to draw pertinent insights from trends and features of their data. Judging from their lab reports, roughly one third of the students successfully learn to do this. Another third can do so with varying degrees of success. A final third fails to demonstrate this ability. In the second and third terms of their second year, students learn to compose research reports and presentations. They learn to gather information and organize it into written reports and mixed-media presentation. Quite often they have to incorporate complex and in-depth technical ideas in their reports. The absolute majority of our students can communicate relatively simple subjects, subjects that are comparable to the minimum tasks required of them in their future jobs in the industry. But some experience difficulty when the subject becomes more complex. Roughly a third of them can successfully communicate to their readers quite intricate technical ideas with effective usage of graphs, tables, diagrams, and images. Another third can do so with varying degrees of success. A final third can only convey relatively simple ideas. Besides having some difficulty handling more complex subjects, our students also need to demonstrate more awareness of their audience in their communications, especially during presentations.

It is worth noting that as our student body is becoming increasingly diverse, we do occasionally see a few non-natively speakers not able to communicate clearly verbally to instructors and peers at the end of their second year.

C.2) Teamwork skills:

Most of the MT courses require students to participate in teamwork in the labs. In first year circuit labs, students are divided into two to three person groups. In the second year process equipment classes, students are required to work in four to five person groups. Currently, the department only puts students in an environment where teamwork is important to the success of their learning. On the other hand, no attempts have been made to coach students on their teamwork skills in our classes. Students do learn about group dynamics theory in their Small Groups Communication class from the Speech department. In some MT courses, the grade an individual gets at the end is based on his/her own performance and the performance of others in the group. This is done to stress the importance of teamwork. The department currently does not assess student teamwork skills in a formal way.

C.3) Trouble shooting circuits:

Training in trouble-shooting in the MT curriculum was not so strong in the past. Recent development has helped to address this issue. Our circuit courses consist of three analog circuit courses and two digital circuit courses. Students typically take analog circuits first. Due to their less-than-solid science education in the past, students at this stage are still struggling with basic circuit concepts. The department has thus decided to incorporate only limited training in circuit trouble-shooting in these analog circuit courses, although more basic trouble-shooting

exercises will be incorporated into these courses in the future. Students learn and practice a basic systematic trouble-shooting methodology in our current digital circuit courses. Whereas at the beginning of the digital series, students are still used to asking instructors for help whenever they encounter problems in their circuits, at the end of the series most students can solve most of the problems on their own. Students encounter more complex circuitry in Process Equipment I in their second year. Currently students are required to do their own trouble-shooting should problems occur. More reinforcement of the teaching of basic trouble-shooting methodology is missing right now in this course and is definitely needed in the future. As it is now, most students tend to either forget what they have learned about trouble-shooting in their first year classes or can not relate it to the more complex circuits involved in this course. We also need to train students more in the usage of oscilloscopes as a diagnostic tool.

C.4) Understanding of process equipment:

Component level: Our students' grasp of the components that make up process equipment, such as sensors and motors, is average at the present time, as assessed through written exams. Many students lack quantitative analytical skills, especially with more complex topics. Students also show weakness in conceptual learning. Retention of the knowledge taught is also a problem. More repetition is needed to reinforce the concepts. The course that covers this material still needs some adjustment. More emphasis should be placed on the fundamentals so that students can understand and retain them better. On the other hand, students seem to be able to fit this knowledge better into an overall context and be able to apply this knowledge better in a laboratory setting than before. This is due to two recent improvements of the course. A detailed discussion of controller to sensor/actuator interface has been added to this course. This better prepares our students for the understanding of how individual components are connected together at a systems level later on. Labs developed for this topic also greatly enhance our students' ability to build actual automated control systems in a laboratory setting.

Systems level: Our curriculum on systems level understanding of process equipment has seen great improvement since 2003. New process equipment was donated, which replaced the old grossly out-of-date equipment. There are also multiple units, which provides more time for hands-on practice. The department also hired a new faculty member with process equipment background from the industry to take charge of developing this curriculum. The curriculum that is now in place is much more solid and much more relevant to industry application. The department also lengthened the coverage of this material by adding a 4-credit course to the existing 3-credit course. An expert technician also joined the department, which enables us to maintain our process equipment in operational condition at all times. After these changes in the curriculum, student proficiency in this area has seen a large jump. Prior to these changes, students received very little training in the understanding of process equipment from a systems perspective. Now students' understanding in this area is much higher than most entry-level technicians in the industry. In fact, it is higher than many technicians with four years of experience in the industry. Our students have good

understanding of controller-to-components interface and signal path. They also have good understanding of the functions of pneumatic, wafer transfer, vacuum, and RF systems. Furthermore, they are trained to be able to independently investigate and figure out how process equipment works. This is a skill that is typical only among experienced technicians in the industry.

C.5) Trouble-shooting process equipment systems:

Students learn and practice basic systems trouble-shooting methodology in their process equipment II and III courses. This trouble-shooting methodology is consistent with the methodology they learned about circuit trouble-shooting in earlier courses, except the emphasis now is on more complex, multiple module systems such as the pneumatic system, wafer transfer system, or vacuum system of an etcher. Our training emphasizes the application of basic trouble-shooting methodology on complex systems with realistic scenarios. Our methodology requires skills in the following areas: 1. Forming a clear mental picture of all sub-systems involved in the problem, 2. isolate the problem to a sub-system, 3. list possible causes of the problem within a subsystem and design tests to verify the true cause, 4. observe and use clues effectively to discern the nature of the problem. The first two skills are deemed to be basic skills. The third one is more advanced. The fourth one, though discussed and encouraged, is beyond the scope of our current training. Below is a table showing an assessment of student skills in the above areas during trouble-shooting exercises in spring 2006.

Category	Clear Mental Picture	Isolation to Sub-System	Design Tests of Causes	Effective Use of Clues	#of students (23 total)	% in the category
Excellent	Yes	Yes	Can design efficient and definitive tests	Somewhat	4	17
Good	Yes	Yes	Can design tests but not necessarily efficient or definitive tests	some guesses	9	39
Sufficient	Yes	Yes	Can design some tests with help	some guesses	3	13
Pass	Yes	Somewhat	Experience difficulty	few ideas	5	22
Below standard	Yes	No	Can not	no idea	2	9

The Pass level is set by the instructor to be somewhat above average expectation of entry-level technicians by the industry. This data clearly shows that the absolute majority of our students graduate with superior trouble-shooting skills than what is expected of entry-level technicians by the industry.

C.6) Maintain process equipment:

The goal of our maintenance training is to help students develop a good foundation for preventive maintenance (PM) training later on. Students do so by forming a habit of implementing good PM practices. We also emphasize the mentality of “exactness” in whatever is done in a PM and the mentality of gaining

maximum control of the actions, strokes, steps and outcomes of a PM. By the end of their training, students should also be able to perform major parts of a typical basic industry standard PM (such as a wet clean), but not necessarily the entire PM (for example electrode replacement in a wet clean but not the whole wet clean). (The whole wet clean is too long a process to train in class) The goal of our maintenance training is limited in scope given the limited practice time available to our student trainees as compared to maintenance training in the industry. The table below shows how well our students did in their PM tests.

Category	Style and Form	Quality and Speed	Damages in PM results	% of students
Near perfect	Minor imperfection	No mistakes	No damage	44
fab pass	Substantial imperfection	Minor mistakes	No damage	37
fab fail			Damage	19

(Data from the average of 3 PMs done in spring 2006 term, pass/fail criteria same as in an industrial fab) Given the limited scope and objectives of our PM training, the above data demonstrate that most of our students have formed a good foundation in performing maintenance, although we still have a significant number of students failing the fab PM standards. This needs to be improved in the future.

C.7) Monitor and maintain semiconductor manufacturing process:

There are three courses in the curriculum that pertain to manufacturing processes:

- MT100 Introduction to Microelectronics Technology
- MT200 Semiconductor Processing
- MT222 Quality Control Methods in Manufacturing.

MT100 introduces the entire AAS program and spends much time explaining the processes and sequence followed to manufacture integrated circuits. This is a complex procedure that most students are not familiar with. This foundation leads to their education in the equipment used to manufacture these devices, which is the focus of the program. Assessment in this class is done by homework and examination, along with observation of classroom participation. At this point we are trying to develop in the student the framework upon which to build the rest of the curriculum. Generally, students who complete the exercises develop this framework and can succeed in the program.

MT200 is taught in the final term of the program. It again covers the sequence and processes used to make semiconductors, but the objective in this class is for the student to develop the ability to learn about a process and convey key information to their peers. Assessment focuses on student presentations. Each student chooses a particular process, learns about it, condenses key information about it into a presentation, and presents that to their classmates. The presentation is evaluated based on content and effectiveness of conveying that content; and the

students are also quizzed on the content presented. Students have a very high success rate at collecting and assembling information, though the conveyance is a challenge that only goes away with experience. The students demonstrate that these experiences are steps on that journey.

MT222 introduces the quality control methods/systems universally used in the semiconductor industry to monitor the product and processes, with particular emphasis on quality improvement and control charts. This is an on-line course. Assessment is based on homework submissions that include written descriptions, data analysis, and assembled charts and graphs. Short quizzes are also used to assess fundamental concepts, and for self-assessment. Again, students that complete the work in a timely manner show excellent success of understanding and utilizing the quality tools covered in actual process monitoring and analysis. Given the above analysis, we can see that through these courses, our students are given all the tools necessary to maintain processes as technicians.

D) Do the MT courses address the College Core Outcomes?

The department did a self study to comply with the college accreditation three years ago, addressing this exact question. The following is a rating of how well each course addresses the college core outcomes. The numbers in the table indicate student proficiency level for each outcome after taking each course as rated by faculty impression at the time of self study. Outcome 5 (professional competence) is not rated here because every course in this technical program addresses professional competence. The table below shows that our curriculum helps students to achieve communication, problem solving and professional competence very well by enhancing their skills in these areas to at least level 3 by the time they graduate. Our curriculum does not address Community and Environmental Responsibility, Cultural Awareness and Self-Reflection, although some of the other courses we require students to complete from other departments such as general education courses in the social sciences and humanities may address them.

CORE OUTCOMES MAPPING
___Microelectronics Technology___

SAC

<p>Mapping Level Indicators: Not Applicable Limited demonstration or application of knowledge and skills. Basic demonstration and application of knowledge and skills. Demonstrated comprehension and is able to apply essential knowledge and skills Demonstrates thorough, effective and/or sophisticated application of knowledge and skills.</p>	<p>Core Outcomes: CO1- Communication CO2- Community and Environmental Responsibility CO3- Critical Thinking and Problem Solving CO4- Cultural Awareness CO5- Professional Competence CO6- Self-Reflection</p>
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Course #	Course Name	CO1	CO2	CO3	CO4	CO5	CO6
MT110	Intro to Microelectronics	1	0	1	0		0
MT111	Elec circuits & Devices I	2	0	1	0		0
MT112	Elec circuits & Devices II	2	0	1	0		0
MT113	Elec circuits & Devices III	2	0	1	0		0
MT121	Digital Systems I	2	0	2	0		0
MT122	Digital Systems II	3	3	4	0		0
MT200	Semiconductor Processing	3	2	4	1		3
MT222	Quality Control	3	2	3	1		2
MT223	Vacuum Technology	2	0	3	0		0
MT224	Process Equipment I	2	0	3	0		0
MT227	Process Equipment II	2	0	3	0		0
MT228	Process Equipment III	2	0	3	0		0
MT240	RF Plasma Systems	3	1	3	0		1

2) To maintain instructional quality consistent with standards of excellence within the MT program.

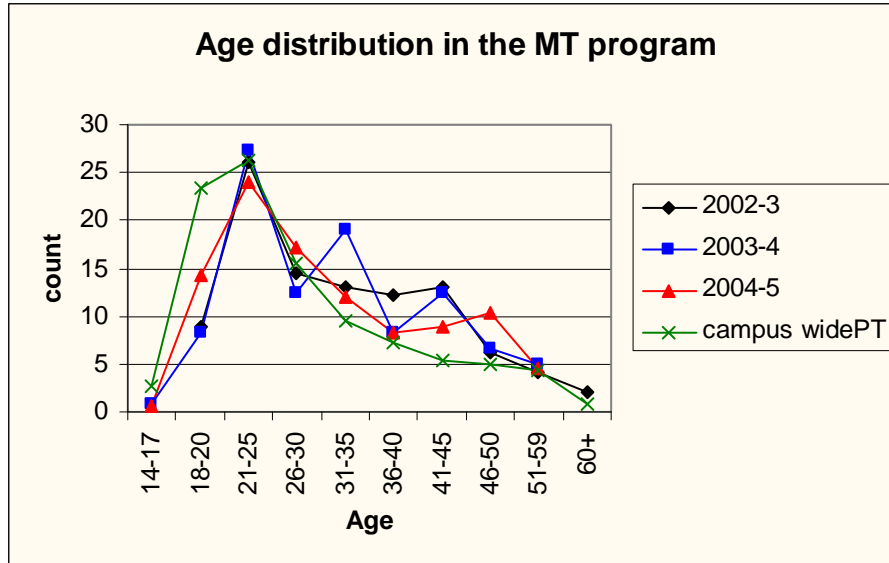
A) Is the MT program contributing to the College mission?

Mission

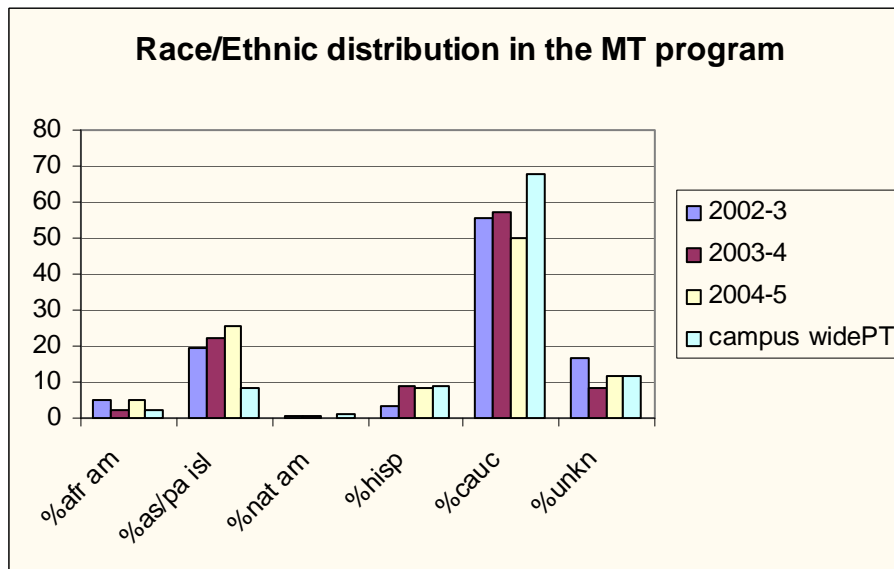
Policy B 101

Portland Community College provides **quality education** in an atmosphere that **encourages the full realization of each individual's potential**. The College **offers students of all ages, races, cultures, economic levels, and previous educational experience** opportunities for personal growth and attainment of their goals. To achieve its mission Portland Community College **offers accessible and affordable education** to the residents of its 1500 square mile district and to the residents of its service districts. As a public, comprehensive, post-secondary institution, this multi-campus college offers lower division college transfer programs, **occupational and technical programs**, basic skills education, and community education programs. **Partnerships with business, industry, labor, educational institutions and public sector agencies** provide **training opportunities for the local workforce** and **promote economic development**. Through **effective teaching** and **supportive student**

- A.1) **Quality education** – The education offered by the MT department is consistently considered to be of a high level by the students and our industry partners. All of the faculty members have advanced degrees in related fields; all have experience working in a manufacturing environment, and two thirds of the faculty members have worked in the microelectronics industry, along with our technician, and our division dean.
- A.2) **Encourages the full realization of each individual's potential** – The MT department contributes its small part to this college wide mission. For those students with a technical bent, and those looking for new career opportunities, we offer an outstanding path. The MT program develops a strong grounding in basic sciences and math, and emphasizes the communication skills required for success in any technical related field. Our industry partners continually request that we produce more graduates for them to hire. The absolute majority of our graduates easily get employment in the field.
- A.3) **Offers students of all ages, races, cultures, economic levels, and previous educational experience** –



This first figure shows the age distribution of the students in the department over the past three years, and compares them to the most recent distribution amongst all PCC professional/technical programs. The data shows much similarity. There are notably fewer students just out of high school in the MT program, but significantly more middle age students in the program. This distribution is as we would expect: students with the technical inclination are much more likely to enter a four-year program than start the MT AAS, and are better options at PCC for them if they intend to continue on for a four-year degree (EET for example.) And, the employment opportunities available are very attractive to citizens past the traditional college age.



This second figure shows the racial/ethnic distribution of students in the MT program over the past three years along with the most recent distribution for professional/technical programs. The results suggest we are doing as well as

or better than other programs in providing opportunities for all groups in the community.

- A.4) **Offers accessible and affordable education** – While affordability is predominantly determined by PCC policy, the education we offer has great value. The combination of PCC’s support of the technical community, the major support from industry in equipment donations and tuition assistance, and the high caliber of the faculty produce an opportunity not available elsewhere in the region and perhaps the country.

Currently there are a few accessibility issues entering the program. The program is limited in space due to lab size and available equipment; however our enrollment levels are not currently high enough for that to have an impact. We do hope to approach those levels within the next five years though. One real issue is the high prerequisite standards for the program as compared to those of PCC. We need students to be starting at a college entry level in both math and English in order to achieve the outcomes of the program. We rely on PCC to provide any necessary remedial education to prepare students to start the MT AAS. A final access issue relates to the time available to students. Our typical student must work 40 hours per week in order to sustain their lifestyle and often that of their family. Unfortunately, many of the financial aid opportunities also require them to be full time students. For many this is too much to juggle, and leads to excessive stress and burnout.

- A.5) **Occupational and technical programs** – This is a technical program specifically designed to prepare students for an occupation in microelectronics manufacturing.

- A.6) **Partnerships with business, industry, labor, educational institutions and public sector agencies** – We have a very strong relationship with our industry partners who participate on our advisory committee. All of our curriculum and program development is done in concert with their input. They are major contributors to the program of equipment and student financial assistance. Their participation is a major draw of students to our program, and likewise they see us as a vital part of the community providing them with well trained employees without which they would not be able to do business in the region.

Likewise, we partner with other educational institutions. We try to maintain articulation with OIT, providing our students the opportunity to continue on towards a four year degree in manufacturing engineering. Through PACTEC we also provide the opportunity for high school students to earn college credit while taking classes at their own high school, towards their high school diploma. This opens up opportunities to these students, and provides an avenue for them towards a promising career in microelectronics through us.

We also participate on the Semiconductor Workforce Consortium, a regional group consisting of semiconductor manufacturers, colleges, and state agencies working to promote the industry through workforce development and economic opportunity.

- A.7) **promote economic development** – The local microelectronics manufacturing industry is a major employer in the region. They are highly dependent on having an educated workforce.
- A.8) **effective teaching** – All full time faculty have advanced degrees in related fields, experience in manufacturing, with two of three working in the microelectronics industry. All are motivated to promote an effective learning experience, and have contributed significant curriculum development towards that end. We have incorporated new equipment into several courses, and made several courses available though the internet.
- A.9) **prepares students for success as individuals** – While providing the students the education needed to work as technicians in the microelectronics industry, we particularly promote problem solving, critical thinking and self evaluation. The curriculum is designed to give them a strong base in science and math, with a strong emphasis on communication skills. These are abilities that suit them well in the microelectronics field, but would suit them well in any technical field they choose to explore.
- A.10) **citizens of a rapidly changing world** – There are few things in life that change faster than the microelectronics industry. The field is susceptible to wildly varying economic fluctuations. This education makes them highly desirable employees, making them much less exposed to those fluctuations. Their breadth and depth of knowledge gives them greater flexibility when they do have to or want to reach beyond their degree focus.

B) Changes the MT SACC has made to instructor qualifications and the reasons for the changes.

The instructor qualifications shown below were developed by the MT SAC in 2004. They replaced some generic qualifications that did not suit our needs well. These new guidelines are designed to specifically meet the outcomes of the specified courses, while utilizing the abilities of the range of experienced personnel associated with the industry.

1. **MT100, MT111, MT112, MT113, MT121, MT122** - Fundamentals in electronic and ability to teach concepts to students lacking relatable background
 - a. **MASTERS OF SCIENCE** in physics or engineering
 - i. 3 years industry experience preferred
 - ii. Teaching experience is preferred
 - iii. Demonstration of teaching competency in the subject
 - b. **BACHELORS OF SCIENCE** in physics or engineering
 - i. Industry experience preferred
 - ii. Teaching experience is preferred
 - iii. Demonstration of teaching competency in related subject
 - iv. Two quarters upper division coursework in the subject
 - c. **ASSOCIATES OF APPLIED SCIENCE** degree required for employment in the semiconductor industry as an equipment technician
 - i. Demonstration of teaching competency in the subject:
 - ii. Able to demonstrate teaching competence in all CCOG topics
2. **MT222** - Quality systems used in the semiconductor industry. Instructors need experience in quality systems as used in the semiconductor manufacturing area.
 - a. **BACHELORS OF SCIENCE** in physics, chemistry or engineering
 - i. Two years recent industry experience in manufacturing process control
 - ii. Demonstration of teaching competency in the subject
3. **MT110, MT200** - Processes and procedures used in the semiconductor manufacturing industry. Instructors need experience in those processes and procedures.
 - a. **MASTERS OF SCIENCE** in physics, chemistry or engineering
 - i. Two years recent industry experience in semiconductor manufacturing process engineering
 - ii. Demonstration of teaching competency in the subject
 - b. **BACHELORS OF SCIENCE** in physics, chemistry or engineering
 - i. Three years recent industry experience in semiconductor manufacturing process engineering
 - ii. Demonstration of teaching competency in the subject

C) Using the library and other outside-the-classroom information resources.

MT100 – students search journal/news articles for current issues affecting the microelectronics industry and related effects on society.

MT200 – students research holdings and reserve material, and also interview industry experts for project topics presented in class.

MT222 – students find published data describing a process for examination with quality control methods. Data can be found through the library, the internet, or other sources.

MT223 – students use reserve books

MT240 – students reference databases for standard published technical information on properties of materials studied in class.

3) Responding to the changing needs of students and the community.

A) Professional development activities of the MT faculty over the last three years; instructional or curricular changes made as a result of those activities.

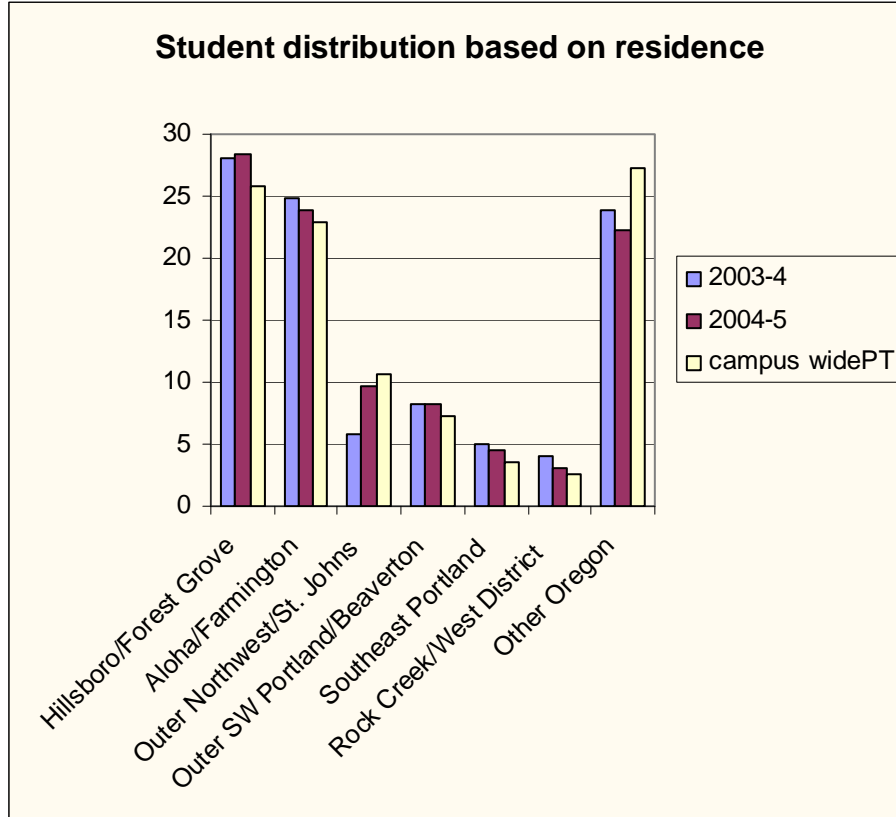
- MATEC Conferences (EJK 2003, 2006)(SF 2004)
- Nanotechnology workshop (EJK 2004)
- TLC discussion groups, including:
- "Improving Writing Across the Curriculum" (DC November 2004)
- "Improving Writing Across the Curriculum II" (DC May 2005)
- Portland Area Semiconductor Seminar Series (PSU and OGI)
- IDT Job Shadow: --IDT offered me the opportunity to do job shadowing focused on test and failure analysis. The time spent there on the test floor along with the IDT engineers and technicians was a great experience that provided me the chance of learning new and advanced testing techniques and exposed me to the use of a totally sophisticated equipment (DC July 2004)
- NI technical symposium at Tektronix-focused on data acquisition. (DC October 2004)
- Presenter at the High Technical University organized by SEMI and Intel –hosting a group of 30 Latino HS students. (DC January 2005)
- On line distinguished lecturer series organized by IEEE: "Defining and Teaching Engineering Ethics" presented by Billy Koen. (DC February 2005)
- Presenter at the 10th Annual Math, Science & Technology Conference for Middle School Girls -Rock Creek PCC. (DC April 2005)
- "NI Developer Education Day" Beaverton, OR. (DC May 2005)
- Project: "Remotely Controlled Labs". Inspired by a successful similar project started by OIT, and sponsored by an Intel grant, the project is supposed to design many of the electronics labs on line, allowing students to do some of these experiments occasionally on line, operating the equipment in the lab remotely. January 2005 to present
- Project: learned Labview programming language for the purpose of setting up on-line electronics lab (SF August 2005)

No significant curricular changes have been made based on the technical activities attended. We have found the best input for our technical content comes from working with our industrial partners. We do see a need to explore professional development opportunities relating to "softer" skills/outcomes, such as teamwork and conflict resolution, and hope to explore such opportunities in the future.

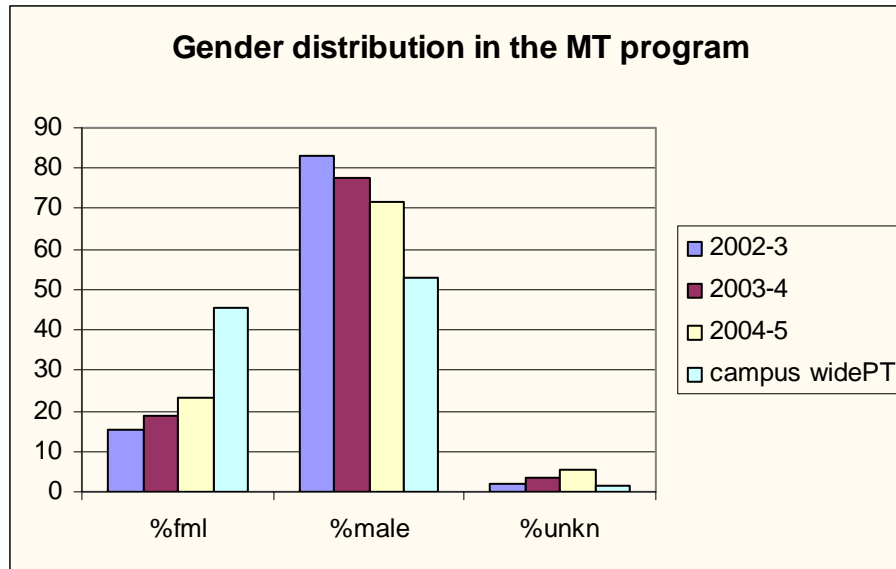
B) Demographics within MT program.

As we discussed in section 2A, there has been no noticeable change in the age and race/ethnic demographics within our program. There are significantly more Asian/South Pacific students that we can associate as recent immigrants. These students do generally have greater challenges associated with the English language.

At this point we rely on them to get the support they need for success. To some extent we have tried to rely on more written material than verbal presentations to deliver lessons to the students in order to provide a method that better supports the pace that ENL students can follow.



The figure above shows there has been no significant change in the regional demographics attending the MT program at Rock Creek, and the demographics are similar to all PT programs.



This final figure suggests an increasing trend in the number of women enrolling in the program. We see this as desirable to better match the community demographic. We have also observed in general that women work and respond well in the cleanroom environment of the industry. We have not identified any way to change the curriculum to promote this trend.

C) Examples of how feedback from students, business and industry, community groups, or institutions our students transfer to, was used to make curriculum or instructional changes.

The MT department continually gets feedback from students through end of term course surveys which faculty members continually utilize to optimize their instruction. We also collaborate closely with our industry partners through our advisory committee. That committee includes the employers of basically all of our graduates.

Significant changes we have made based on industry input include: adding MT222, a course on quality control methods, adding MT228, a third course in the equipment sequence to increase the depth students can study systems and troubleshooting, and to further emphasize safe practices. The addition of these courses required us to eliminate one process class, MT225, which was acceptable as the industry feels they are better suited to teach their employees the specific processes used in their factories. Another major activity was the redevelopment/update of MT240 on plasma technology. Part of this development included a 2005 workshop with industry technicians and engineers evaluating the content. The mutual benefits of this activity lead us to develop a short course suitable for currently working technicians to update and enhance their skills in vacuum technology. The Semiconductor Workforce Consortium (a collaboration of regional companies, colleges and government agencies focused on enhancing

the local workforce) has expressed interest in expanding the scope of this concept.

Our impression based on student feedback is that the course load is too high. At some points in the past few years students were required to take as many as 108 credit hours to get the AAS degree, which is basically the maximum number of credit hours allowed by the state. The level got this high due to the addition of courses, and also due to Math and Chemistry increasing the credit hours of their courses. We decided to eliminate CH223 from the curriculum to reduce the load. This was acceptable as our shifting emphasis from process to equipment requires less chemistry background. We additionally considered eliminating CH222. As part of this process we surveyed graduates of the program to determine how their chemistry education was being used in their work. The predominant opinion was that CH222 should be kept in the program, though a MT specific chemistry course that contained the relevant concepts from CH221 and CH222 would be better option. Our decision was to keep the chemistry two course sequence in the curriculum. Currently the credit load for the AAS is 102 credits.

D) Strategies used within the MT program to increase enrollment, improve student retention and student success.

D.1) Internal growth strategies already used:

- Trailer courses starting in winter and offering summer courses in order to increase the number of students attending second year classes.
- Visiting periodically MTH, WR and Science classes on campus, as well as the councilors and carrier advisors at Rock Creek campus.
- Organizing “Open Hoses” and tours of the facilities for prospective students.
- Movie theaters ads and “Silicon Smile” campaign through SWC.
- Participation based on invitation to:
 - Industry job fairs (ex. Intel’s annual job fair)
 - Career fairs in Washington county and Portland
 - College fairs
 - High school “career fairs”

D.2) New initiatives for growth:

- Contact new companies that might have personnel interest in taking classes.
- Organizing “get together” activities on Saturday afternoons when students and their families would come over to PCC and bring a friend who might be interested in the program.
- Creating and maintaining personal contacts with industry and/or high schools personnel in charge with “career path”.
- Working consistently on retention, adopting new retention strategies.
- Seek grant opportunities for recruitment and retention.
- Maintain an active database of potential students.

- Contact potential students by phone, mail or email at the “key moments”, i.e. during the registration periods.
- Periodically distribute ads about the program on campus and outside campus.
- Have an “itinerary display board” advertising the technical program at the District level (various campuses of PCC).
- Write short articles about the technical program and have them published on PCC web sites and in “The Bridge”, “The Insider”, Campus News Letter, and occasionally on the “Oregonian” (which proved to be very effective back in 2000).

D.3) **Currently used Retention strategies:**

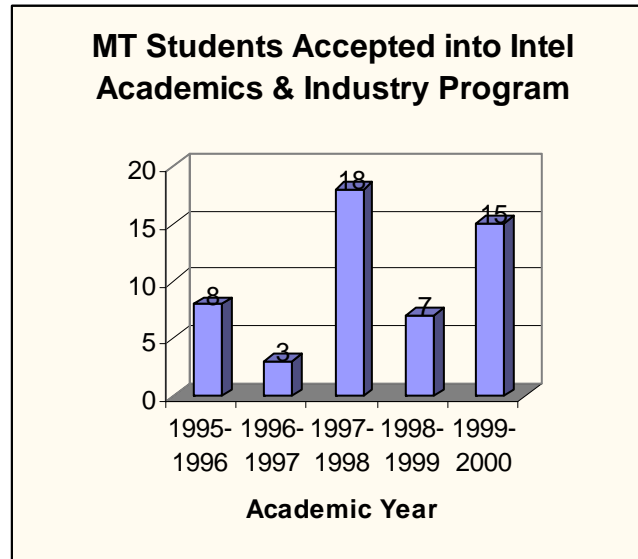
- Flexibility in schedule (compressed work week, on-line classes multiple sessions).
- Study groups. Early identification of slower learners and invitation for them to get help from office hours.
- Faculty advising: pairing up students with one faculty member for academic advising.

D.4) **Academics and Industry program** – our most effective growth and retention tool. One goal of the two-year Microelectronics Technology (MT) degree is employment in the microelectronics industry. The more exposure students have to the industry before graduating, the better choices they will be able to make upon graduation.

- In addition to making better-informed decisions, pre-graduation employment can help cement classroom ideas and skills with real-world problems.
- For these reasons the Microelectronics Technology program has concentrated on forming partnerships with industry that allow students to work part time and still pursue full-time schooling. The MT programs developed to mesh work with school are not co-operative education in the strictest sense of the word. None of our programs grant academic credit for work experience. Because no academic credit is granted, we call them Academics and Industry programs rather than co-ops.
- The basic model for Academics and Industry was developed in partnership with Intel Corp., during the program's transition from customized training within Intel to the general public.
- The basic features of the program are as follows:
 - Students must work 20 hrs/week, minimum,
 - Students must take at least 12 credits toward graduation every term except summer,
 - Students are employees of their companies; quitting school is equivalent to quitting work,
 - Companies pay a substantial fraction of tuition, fees, and books,

By far the largest industrial partner with the MT program, the **Intel Academics and Industry program** has some important features beyond the basic model. Intel pays for all tuition, books, and fees. In addition, students

receive some medical benefits and profit sharing, as well as some retirement benefits. Participants in the Intel program work in all areas of the factory, from implant to etch to lithography and test/sort. The Intel program has helped a substantial number of students pursue education at PCC. The chart below shows the number of new students accepted into the Industry and Academics program since its inception:



The Intel program is quite healthy and is expected to grow over the next several years.

D.5) **Coordination with neighboring Community Colleges** - In addition to its role as local educator, PCC provides a blanket of accreditation for two rural community colleges, Columbia Gorge Community College (CGCC) and Tillamook Bay Community College (TBCC). Such colleges want to offer students training for high-paying industrial jobs, but cannot afford or provide enough students to justify microelectronics programs of their own.

D.6) **Distance Learning** – The MT department determined that a *distance learning program* could allow access for students in rural Oregon without draining the coffers of rural schools. Therefore, we developed a supplementary Internet teaching program. The goal of that program was to increase second year enrollments and reach populations of students not presently served by the MT program. Significant costs were incurred during course development and the costs were commensurate with the institution’s goals and budget.

An on-site lab instructor oversees laboratory sections of MT's distance learning courses. Success of these courses seems linked to high-quality teaching by the on-site lab instructor. Courses delivered by Internet are increasing the number of second year students in the PCC Microelectronics Technology program. While this mode of instruction has not been implemented long enough to derive reasonable statistics, there is every reason

to suspect the number of students it attracts to at least hold steady and probably increase.

E) Changes made in the last three years to increase student access and diversity.

Although not adopted in the last three years but very unique for the MT program is the particular scheduling done, imitating the compressed work week.

Also new in the last three years is the development of two new classes on line, MT100 Introduction to Microelectronics Technology, and MT222 Quality Control Methods in Manufacturing. They both are offered and taught every year, and based on the enrollment in these classes, they are very popular. MT100 is the first course in the MT degree, and it introduces the student to the program. This is our opportunity to connect with students with the aptitude and/or inclination to pursue a career in this field. Having a web based course opens up the program to a wider variety of student, in particular those searching for a career/education path while maintaining the flexibility they need for their time, travel or learning style needs.

MT222 is a required course in the degree program. It also covers a subject that most people in advanced manufacturing pursue education in. We hope to attract students in these related fields, providing additional service to the industry, and broadening our exposure.

For students who are not yet at the necessary level of math and/or writing when they try to start the associate degree program, we developed and implemented a certificate program (Employment Skill Certificate), an 18 credit program. The pre-requisite for the MT EST program is placement in MATH 65 and WR 115, as opposed to MATH 95 and WR 121 for the associate degree in Microelectronics.

F) Identify any operational issues faced by the SACC that impact student learning.

Three years ago, the department moved to Rock Creek campus, where new, larger and better facilities were waiting for us. Currently we run our classes in three lab rooms which are used intensively all year round, except for summers. We also have enough office space for the three full time faculty and the part timers who are working for us. The problem we face is rather finding experienced part time faculty who can teach effectively the MT curriculum.

If the enrollment will expand at the desired rate, the MT program will also have problems with limited student access to equipment in MT227 and MT228 classes.

Maintaining and fixing the equipment that we use is a continuous task for the technician of the program, and his position in the department is more than justified and needed.

4) Developing recommendations for improvement in the program.

A) Strengths and areas in need of improvement in the MT program.

Among the strengths of our program, we identified:

- (1) Strategic location in Washington county
- (2) Good job placement and job market for our graduates
- (3) Strong emphasis on science and technology
- (4) Qualification/background of the instructors and of the technician
- (5) A&I =the internship with Intel
- (6) Excellent new facilities, labs fully equipped with all the equipment needed
- (7) Very dynamic and supportive advisory committee

Among the weaknesses of the program we identified:

- (1) Low enrollment and low number of graduates.
- (2) Too many credit hours (101)
- (3) Just 56% of our credits(?) are transferable to a four year institution
- (4) Articulation program just with OIT
- (5) Overloading the students with school work.
- (6) Retention in the program is very low for the beginning classes.
- (7) Not much support for students (no tutors).
- (8) Students required to be full time to receive scholarship or Academic and Industry support.

B) Recommendations :

- Mandatory math/writing placement: for the first two years, test result data will only be used to help faculty better assess student strengths and weaknesses. Eventually the tests may be used as screening tests for program enrollment. We will consider reading placement in the next SAC meetings. The SAC is studying the possibility of administering screening tests of incoming students to our program in physics and chemistry.
- A survey of the MT graduates will be designed and administered in the near future, with the hope that our graduates' reflections and suggestions will help us with improving the way we teach the MT curriculum.
- For better student accessibility to academic advising, the MT student body was divided into three groups, one group per faculty. In this way each of the instructors can afford to spend more time with students who need advising.

- For better retention with the program, starting fall of 2006 a very detailed orientation will be done with all the MT students. The orientation will be organized by the MT faculty and will take place in the middle of the second week of class. Hints about how to balance life, work, family, how to live through a jam of limited time, how to obtain financial aid will be given during the orientation.
- The importance of good and consistent study skills/habits and better time management will be emphasized during the first year in the program. Homework assignments and pre labs will be required and expected to be finished by the time a new meeting with the instructor will occur.
- The SAC and faculty will revise the CCOG of certain courses (i.e. MT 240, MT 224) and the work load that they imply. A work load survey in every class was suggested and probably will be done during the next academic year.
- Lowering A&I credits per term requirements (as of now students are required to take 12 cr. per term and work at least 20 hours at Intel) is also something that stays in the attention of the MT SAC.
- In the last two years, the “study groups” organized for students by the instructors of first year classes seem to be very helpful with preparing the students for midterms and final examinations. Therefore, more of such activities will be organized and offered more consistently throughout the entire academic year and for all classes.
- Adult education support: how to balance life, work and family; how to live through a jam of limited time and financial resources. Orientation training is planned for this purpose.
- In terms of better and more effective recruitment, the plan is to contact new companies that might have personnel interest in taking classes, and to create and maintain more contacts with industry, and also with high school personnel directing student “career paths”. The department has on its agenda to maintain an active data base of potential students and contact them periodically at the “key moments”, i.e. during the registration periods. We will periodically distribute ads about the program on campus and outside campus, and also have an “itinerary display board” advertising the technical program at the District level (various campuses of PCC). We will write and publish short articles about the MT program and have them published in “The Bridge”, “The Insider”, Campus News Letter, and occasionally in the “Oregonian” (which proved to be very effective back in 2000).

5) Ensuring curriculum keeps pace with changing industry demands, and continues to successfully prepare students to enter into a career field.

A) The impact the MT advisory committee has on the MT curriculum and instructional methods.

Like any other technical program at PCC, Microelectronics has its own industry advisory committee that meets once every term. The companies represented in this committee are Intel Corporation, Siltronic, IDT, NI, Maxim, AMGI, Microchip, Cascade Microtech, and Tigrard HS. The MT advisory committee continuously provides advice and recommendations in matters relevant to the curriculum. As a result, three new classes have been created, MT 222 -Quality Control in SMT, MT 70-Vacuum technology practices, and MT 80-Safety and Clean room protocol. Also one class, CH 223, was removed from the list of mandatory classes, leaving the total number of credits at 101. Continuous adjustments to the already existing curriculum were done also based on the committee's advice in the areas of communication and troubleshooting skills. The board members help us through their input to provide our graduates with skills that meet their employment needs.

Periodically members of the advisory committee help the department to do a realistic assessment of labor market needs. Often grant writing opportunities, faculty internships, and student internships are offered by the advisory committee members to us. All of the above have a clear impact on the way the curriculum is taught, and on the instructional methods we are using.

The members of the advisory board constantly serve as a communication link and advocate for the MT program in the community, industry, professional groups, and other educational institutions.

Despite the strong and continuous support the MT program receives from its advisory committee as a group, we should mention the fact that the appointment of each member (industry representative) in the committee is rather short, mainly due to work related changes.

B) Job placement statistics of students in our program over the last five years:

This is the graduate hiring information we have for the students who did register with the student employment services at PCC, for the following years:

2001 Number of Graduate:	34
Total known working in semiconductor field	23
Continuing higher education in the electronics field	2
Working, by choice, in a different employment field	1
Unknown	8

2002 Number of Graduates : 33	
Total known working in semiconductor field	28
Continuing higher education in the electronics field	1
Working, by choice, in a different employment field	2
Not Working	1
Unknown	1

2003 Number of Graduates: 19	
Total known employed in semiconductor field	14
Working, by choice, in a different employment field	2
Unknown	3

2004 Number of Graduates: 21	
Total known working in semiconductor field	19
Working, by choice, in a different employment field	1
Unknown	1

2005 Number of Graduates: 16	
Total known working in semiconductor field	16

2006 Number of Graduates: 16
 Employment data not available at this time.

C) Analysis of the MT program learning outcomes, competencies, and skills as compared to the business and industry needs today and in the immediate future.

The teaching we are performing in the MT program is outcome based. The outcomes of the program were established by the MT SAC under the guidance of the advisory board and based on strong input from the semiconductor industry representatives. The program outcomes were distilled down at the level of each class, and they are under constant change. We believe that the program and course outcomes are responding in a large measure to the industry needs. If we look at the job placement statistics for our graduates (see above), the high percentage of people hired in industry every year reflects a good alignment of our program outcomes to the semiconductor industry needs in Washington County. The fact that the equipment used in the lab for teaching purposes is also real and current fab equipment (donated by Intel) is also proof that our curriculum is strongly oriented towards industry needs. The skills our students are developing by taking these classes and doing the labs are the kind of working skills that a good cleanroom technician has to have.

Based on the continuous input from the industry, the program and the course outcomes are evolving; such changes are done almost every time we teach a class. Our hope is that these outcomes will cover the needs of the semiconductor industry not only today but in the immediate future too.

D) Forecast of future employment opportunities for students in the MT program.

It is well known that the employment opportunities in the semiconductor industry are cyclic, showing significant ups and downs every two years. The encouraging fact for our students and graduates is that the cycle that one company is following is not necessarily synchronized with the cycles of all the other semiconductor companies. For instance while IDT and Intel are currently going through a job reduction, Maxim and Cascade Microtech are hiring many technicians. The hiring data presented above in this report reflects good and constant job placement during the years, regardless of the direction in which the state economy was going. This is promising for the future generations of graduates.

To date we have not had a lot of success establishing internship programs (such as A&I with Intel) with other companies. Our goal is to encourage more internship-type jobs this year. This is, of course, always dependent upon the economy and therefore the needs of the individual companies. We have the same companies we have always had to work with; we will be working to enhance relations with them and are hoping to bring in more internships for our students.

Oregon State Employment Department has the following to say about the future employment opportunities:

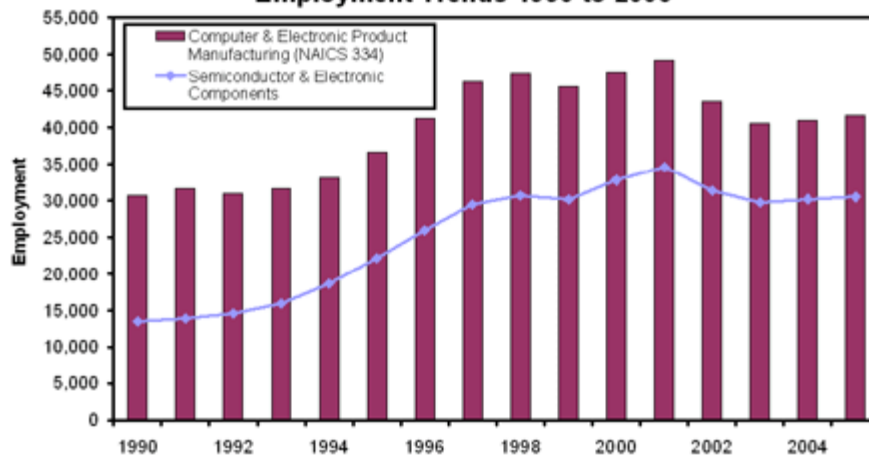
“The computer and electronic product manufacturing industry is clearly Oregon's largest high-tech employment sector. In 2005, computer and electronic product manufacturing accounted for 71 percent or 41,600 jobs of Oregon's high-tech employment. This industry sector's employment was still down by 7,700 (-16%) jobs in 2005 compared to 2001. Its turnaround came at a slower pace than the other high-tech sectors – it added a net of 600 jobs for 1.5 percent growth in 2005

In Oregon, the manufacture of semiconductors dominates the computer and electronic product industry. More than two-thirds of its employment consists of jobs in semiconductor manufacturing (see graph below). In February 2006, the industry employed 31,200 people.

Semiconductors – also known as integrated circuits or computer chips – are tiny electronic circuits etched on silicon. Their purpose is to electronically process, store, and move information. From the microprocessors that control our car engines to the chips in our digital watches, semiconductors are the heart of the modern technology we take for granted.

Despite its considerable job losses over the past few years, the semiconductor industry is not an industry to be ignored as it still has a huge economic impact on the state. In 2004, its total covered payroll to Oregon workers was more than \$2.4 billion. It has become more vulnerable as investment in chip manufacturing has shifted overseas. However, not all is gloom in this sector. A recent article in *The Oregonian* indicated Intel added at least 1,100 to its Oregon workforce in 2005. The article said Intel's current Oregon workforce is almost up to 17,000.

**Oregon: All Computer and Electronic Product
Manufacturing Versus
the Impact of Semiconductor Manufacturing
Employment Trends 1990 to 2005**



The Oregon Employment Department forecasts modest growth of 6.1 percent for computer and electronic product manufacturing over the 10 years from 2004 to 2014. This compares to overall employment growth projected at 15 percent. However, Oregon is one of only a few states nationwide to continue to add manufacturing jobs including high-tech jobs.

No one knows for sure what the future holds for this dynamic industry. Early in the recession, many believed this was a typical downturn in the business cycle. However, since the official recovery started in June 2003, economists wonder if it signals a major structural change in Oregon's manufacturing industry. Regardless, high tech is a key industry for Oregon's economy. Its rapid growth during the 1990s enhanced Oregon's ability to compete in the global high-tech economy. High tech continues to be one of the state's largest exporters, along with agriculture and wood products.” (source Oregon Employment Department , at http://www.qualityinfo.org/olmisj/ArticleReader?itemid=00004893&segmentid=0003&tour=0&p_date=111111111111&p_search=, on April 2006)

E) Analysis of barriers to degree or certificate completion that MT students face; main reasons why students leave the program before program completion.

There are many reasons one would not be able to finish the program once enrolled in it. These are different from case to case, but the most common one is the conflict between the rigorousness of the program and the lack of background knowledge, strong study skills and student support. In other words, sometimes students would start the program being attracted by the career opportunities opened, but without being prepared or ready to make any sacrifices in their personal lives for the duration of the program. There is not much time in the faculty work schedule for advising, help or encouragement to be offered to needy students outside the class time and office hours. In such cases their initial

enthusiasm fades away easily, discouragement occurs rapidly and the easy way out would be to “start something else”. Thus the initial retention rate is rather low in the MT program.

As faculty members, we recognize that our students need more of our attention, and the communication process between faculty and students needs to be improved. Also, more support from the campus level will be provided to our students, a new learning specialist has been assigned to our department. She will be introduced to our students in the beginning of the fall term, during an orientation done specifically for the MT students.

Another major barrier is the lack of study time on the side of the students. Most of our students need to work to support their study and their families. This deprives them of adequate time for studying.

Conclusions:

The last decade has been a time of remarkable growth for the high technology industries in the Portland-Metro area. Also remarkable was the growth the MT program went through: new and larger facilities, new and better equipment, new and highly qualified instructors and staff, positive and consistent changes in the curriculum, very supportive administration, and stronger industry endorsement.

In our review of the MT program we have found our students successfully develop the technical skills that enable them to excel in the industry more so than ever. The program continues to serve our students well by providing them the education background that leads to well paid, highly skilled employment. A key to our success is our active and involved Advisory Committee, and the internship opportunities they provide which allow our adult students to receive an education and support their livelihood at the same time.

As a result of this review, we found that our program needs to improve its retention and recruitment of students. Most of our current students come to us as an avenue to specific jobs in the local semiconductor industry. This source is subject to the cyclical nature of the industry, and these students tend to lack the math/science background necessary to succeed. Additionally, students try attaining their AAS degree within two years, often while working full time. The excessive load can restrict their achievement. We need to find a better way for students to balance these needs. Finally, while we know our students meet the technical objectives we have set for them, we find it difficult to incorporate teaching and assessment of the softer skills such as teamwork and communication. We need access to professional development opportunities, and then we need to further develop our curriculum to address this shortcoming.