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1. Program/Discipline Overview:
   
   A. What are the educational goals or objectives of this program/discipline, and how do they compare with national or professional program/discipline trends or guidelines? Have they changed since the last review, or are they expected to change in the next five years?

Microelectronics Technology is proud to serve a number of high technology companies that are pillars to Oregon’s economic engine. We strive to endow our students with equipment maintenance and trouble-shooting skills and an understanding of the high technology manufacturing process to qualify them as technicians in the industry. The high technology industry presents a unique challenge to the Career and Technical education community as it requires a mix of traditional “wrench turning” mechanical skills and much more technology intense understanding of electronics and electro-mechanics in its technician workforce. It also requires understanding of sophisticated processing technologies which entails the grasp of the basic sciences such as physics and chemistry. Since its inception, Microelectronics Technology curriculum was designed to meet this challenge. The core of our program is the Microelectronics Technology AAS degree. Its learning outcomes state: MT graduates should be able to:

   - Operate, maintain and troubleshoot manufacturing and testing equipment;
   - Troubleshoot circuits and systems;
   - Monitor and maintain semiconductor manufacturing processes;
   - Work effectively in teams;
   - Communicate effectively with colleagues and vendors.

This set of learning outcomes is mainly designed to target the needs of the semiconductor industry. Few specific national or professional discipline/program guidelines exist for two-year microelectronics technology programs due to its specialized nature. In 1995, SEMATECH’s Technician Training Task Force published curriculum recommendations for two-year programs in semiconductor manufacturing technology. SEMATECH is the world’s premiere semiconductor industry collaborative research consortium. 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. Maricopa Advanced Technology Center (MATEC) later inherited these guidelines and refined them in 2000 to be the MATEC Semiconductor Manufacturing Technician Skill Standards. PCC MT curriculum and program outcomes match closely to the above mentioned standards.

After the last program review in 2007, in the year of 2007, we were excited to welcome the solar voltaic manufacturing industry to Oregon. We reached out to and were warmly received by companies in this sector. Since then, we have worked closely with their representatives to develop our new Solar Voltaic Manufacturing Technology AAS and COC. The Solar Voltaic Manufacturing Technology AAS learning outcome states: SVMT graduates should be able to:

   - Monitor and evaluate solar cells manufacturing process.
- Operate, perform maintenance and trouble-shooting on selected solar cells process equipment.
- Be able to troubleshoot electrical, mechanical and automated systems.
- Work effectively in teams.
- Communicate effectively with colleagues and vendors.

And the Solar Voltaic Manufacturing Technology COC learning outcome states: COC graduates should be able to:

- operate manufacturing and testing equipment after specific training.
- monitor semiconductor manufacturing processes.
- communicate effectively with colleagues, supervisors and vendors.

The semiconductor and solar voltaic manufacturing process has become highly automated. It involves automation within process equipment as well as a highly automated complex system used to shuttle materials in between process equipment. To meet this new trend in the industry, in consultation with our industrial partners, the MT program has developed a new Automated Manufacturing Technology AAS. Its learning outcomes state AMT graduates should be able to:

- operate, maintain and troubleshoot automated equipment used in the high volume manufacturing environment.
- maintain automated systems used in work flows and for material and supply handling.
- work effectively in teams.
- communicate effectively with colleagues and vendors.

The new developments in our program are consistent with national trends in high technology sector technician education. With the trend of off-shoring of manufacturing, many of our counterparts around the nation have to adapt to serve a diverse field of industries: such as nano-technology, Micro Electro-mechanics, renewable energy, medical equipment, transportation equipment, etc. We see a continuing trend of program migration to these diverse fields but most of them share the commonality of electro-mechanical equipment or devices. Because of the nascent nature and diversity of the fields, there has been no national standard in these fields.

As the industry we serve constantly changes, it is almost certain that our program will need to evolve as well. The automation option is new, it is very possible that as we obtain more industrial feedback, we will have to tune the outcomes of this option. We also need to monitor emerging industries that utilize similar skills we train our students to have and possibly offer new options or certificates in those areas. Examples of this may include the biotechnology manufacturing industry and the transportation industry.

B. What changes have been made as a result of the last program review?

One of the main weaknesses of the program identified in the last program review was low enrollment and retention rate. The most important motivation for students to enroll in our program is the prospect of employment in the industry. The down cycle of the semiconductor industry from 2007 to 2010 saw the success of our department’s effort to identify the solar manufacturing industry
as an industry that employs similar skills to the core competence of our students. This effort and the subsequent adaptation of our curriculum to serve this industry were instrumental to maintaining a sustainable enrollment in those years.

In addition to this development, the department also implemented two main thrusts in recruiting strategy. In 2008 and 2009, we expanded our effort to recruit high school students. Our high school recruiting activity fell into two areas. In the first area, we found out about a program by the Beaverton School District that sent students to take college courses, with tuition paid for by the district. We promoted our department to high school CTE and science teachers who are responsible for advising students about this program. We collaborated with WestView High School under this program. Some of their students came to take various classes from us. We also contacted Sunset and Aloha high school. They did not have such an active program like WestView. When we were trying to establish a similar arrangement with them, the high school budget crisis started. And thus the schools became reluctant to send students with tuition dollars out. This outreach activity effectively stalled.

In the second area of our effort, we tried to raise awareness about the MT program and career path to high school students through high school counselors, career counselors, science teachers, CTE teachers, high school career fairs and PCC Preview Days. A substantial portion of the high school graduates pursue CTE careers instead of four year colleges. And through our conversations with both the teachers and counselors and with students, we discovered that a large percentage of this population, especially the boys, is interested in our program and is a potentially good fit for our program. However, awareness of the MT program and career path is virtually non-existent amongst this population. We therefore identified this population as a huge potential recruiting market. We tried to reach out to high school students through high school career days and PCC preview days. Ten to twenty students would express that they would like to pursue a MT career at each event. We obtained their contact information to follow up. But because faculty members are too preoccupied with so many tasks, no one did the follow up work. (The initial research on high school recruiting was sanctioned under release time given to a faculty member. When the release expired very little work continued on.) As a result, we saw very few high school students entering the program.

In summary, we researched the possibility of recruiting students from high schools. We discovered that a very large portion of the high school students are interested in our program and are potential good fits. We found some ways to reach out to them effectively. But lack of time prevented us from follow-up efforts that are necessary to produce recruits from this population.

Being aware of the lack of manpower for recruiting, the division stepped in and hired our adjunct instructor, an Intel employee and industry veteran Mr. Wohr, as a part time recruiter for the program. He brings a great enthusiasm for the program and the industry. He has been able to identify and attend events with potential for yielding successful students. The following is a report by Mr. Wohr on his recruiting effort.
“We began in earnest during winter term 2011 to recruit, targeting adults into the MT program. We contacted students that had previously dropped out of the program, and with the assistance of the group in Willow Grove we were able to coordinate returning students with a scholarship program to encourage completion. We also reached out at a few of the large conventions in the Portland Expo center to try and reach adults interested in technology.

During the spring term 2011 we targeted advertising. We were able to capitalize on President Obama’s visit to Intel and the early interviewing and hiring of our June 2011 graduates to capture the attention of KGW television and the Oregonian, providing articles on the MT program and the job opportunities available to our graduates.

The summer term 2011 was targeted to unemployed and under employed people in our local communities. We met with local church groups and exhibited at job fairs on campus and at community centers in Beaverton.

Fall term 2011 was dedicated towards improving visibility within the PCC community. We have met with the woman’s resource center, Military support and international student groups to create opportunities to present our program.

Overall this has been a very successful year in recruiting. We have seen the enrollment double and yet we still have open seats in many of our classes and there is still a lack of understanding in the community of what the Microelectronics Technology degree is and what opportunities it offers. For future plans, during the winter term 2012, we hope to effectively offer scheduled “Open House” dates where we can present the program to interested individuals. We are also contacting the Oregon department of employment and labor to determine what we can do to direct adults interested and capable of completing our program to enroll and complete the MT AAS degree program. We are also planning on renewing efforts to reach out to our military veterans and other people demonstrating a genuine interest in the MT program.”

Table 1: Encouraging statistics showing an average 70.4% increase in enrollment over the past year.

<table>
<thead>
<tr>
<th>Term:</th>
<th>Enrollment:</th>
<th>Term:</th>
<th>Enrollment:</th>
<th>% Increase:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spring 2010</td>
<td>158</td>
<td>Spring 2011</td>
<td>283</td>
<td>79.1</td>
</tr>
<tr>
<td>Summer 2010</td>
<td>67</td>
<td>Summer 2011</td>
<td>154</td>
<td>129.8</td>
</tr>
<tr>
<td>Fall 2010</td>
<td>219</td>
<td>Fall 2011</td>
<td>351</td>
<td>60.2</td>
</tr>
<tr>
<td>Winter 2011</td>
<td>255</td>
<td>Winter 2012</td>
<td>287</td>
<td>12.5</td>
</tr>
</tbody>
</table>

Another area of weakness identified by the last program review was retention rate. According to that review, a major factor in the reduction of retention rate is the following: “… 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.” Some of the second year courses required excessive work and received complaints from students. We were able to rework most of the 2nd year courses to reduce their load. For example, in the MT223 Vacuum course, many homework problems were too challenging to the average students. The reworked assignments had these problems clearly labeled as extra credit or reduced the amount of
credit students lose if they choose to skip these problems. We have received many fewer complaints afterwards. We also started to provide tutors for first year courses.

SECTION 2

2. Curriculum: reflect on learning outcomes and assessment, teaching methodologies, and content in order to improve the quality of teaching, learning and student success.

   A. Addressing Course-Level Outcomes: Identify and give examples of assessment-driven changes made to improve attainment of course-level student learning outcomes. Where sequences exist, also include assessment-driven changes to those sequences. (CTE programs may address this in section 6).

   See section 6.

   B. Addressing College Core Outcomes

   i. Describe how the College Core Outcomes are addressed in courses, and/or aligned with program and/or course outcomes.

   The department did a self study to comply with the college accreditation in 2004, addressing this exact question. The following is a rating of how well each course addresses the college core outcomes resulting from the study with a few updates from this review cycle concerning newly created courses. The numbers in the table indicate student proficiency level for each outcome after taking each course as rated by faculty impressions 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.

   ii. Please revisit the Core Outcomes Mapping Matrix for your SAC and update as appropriate. [http://www.pcc.edu/resources/academic/core-outcomes/mapping-index.html](http://www.pcc.edu/resources/academic/core-outcomes/mapping-index.html)

Table 2: Core Outcomes Mapping

<table>
<thead>
<tr>
<th>Mapping Level Indicators:</th>
<th>Core Outcomes:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not Applicable</td>
<td>CO1- Communication</td>
</tr>
<tr>
<td>Limited demonstration or application of knowledge and skills.</td>
<td>CO2- Community and Environmental Responsibility</td>
</tr>
<tr>
<td>Basic demonstration and application of knowledge and skills.</td>
<td>CO3- Critical Thinking and Problem Solving</td>
</tr>
</tbody>
</table>

Table 2: Core Outcomes Mapping
Demonstrated comprehension and is able to apply essential knowledge and skills.
Demonstrates thorough, effective and/or sophisticated application of knowledge and skills.

<table>
<thead>
<tr>
<th>Course #</th>
<th>Course Name</th>
<th>CO1</th>
<th>CO2</th>
<th>CO3</th>
<th>CO4</th>
<th>CO5</th>
<th>CO6</th>
</tr>
</thead>
<tbody>
<tr>
<td>MT100</td>
<td>Intro to Microelectronics</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>MT180*</td>
<td>High Tech Employment Strategies</td>
<td>4</td>
<td>0</td>
<td>3</td>
<td>3</td>
<td></td>
<td>4</td>
</tr>
<tr>
<td>MT109*</td>
<td>Basic Electronics and Instrumentation</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>MT111</td>
<td>Elec circuits &amp; Devices I</td>
<td>2</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>MT112</td>
<td>Elec circuits &amp; Devices II</td>
<td>2</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>MT113</td>
<td>Elec circuits &amp; Devices III</td>
<td>2</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>MT121</td>
<td>Digital Systems I</td>
<td>2</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>MT122</td>
<td>Digital Systems II</td>
<td>3</td>
<td>3</td>
<td>4</td>
<td>0</td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>MT200</td>
<td>Semiconductor Processing</td>
<td>3</td>
<td>2</td>
<td>4</td>
<td>1</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>MT222</td>
<td>Quality Control</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>MT223</td>
<td>Vacuum Technology</td>
<td>2</td>
<td>0</td>
<td>3</td>
<td>0</td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>MT224</td>
<td>Process Equipment I</td>
<td>2</td>
<td>0</td>
<td>3</td>
<td>0</td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>MT227</td>
<td>Process Equipment II</td>
<td>2</td>
<td>0</td>
<td>3</td>
<td>0</td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>MT228</td>
<td>Process Equipment III</td>
<td>2</td>
<td>0</td>
<td>3</td>
<td>0</td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>MT240</td>
<td>RF Plasma Systems</td>
<td>3</td>
<td>1</td>
<td>3</td>
<td>0</td>
<td></td>
<td>1</td>
</tr>
</tbody>
</table>

- New courses created in this program review cycle.

C. **Assessment of College Core Outcomes** *(Note: for Career and Technical Education (CTE) programs, assessment of Core Outcomes that have been mapped into the Degree and Certificate outcomes may be addressed in that section 6B instead).* This section may refer to, include or summarize the results of annual Core Outcomes assessments carried out over the last 5 years.

i. **Describe** the strategies that are used to determine how well students are meeting the College Core outcomes

ii. **Summarize** the results of assessments of these outcomes (SACs may refer and/or link to the Annual Reports, but work should be summarized here.)

iii. **Identify and give examples** of assessment-driven changes that have been made to improve students’ attainment of the Core Outcomes.

See section 6B.
D. To what degree are courses offered in a Distance modality? Have any significant revelations, concerns or questions arisen in the area of DL delivery?

The department currently offers five courses via Desire2Learn: the introductory set of one credit classes (MT101, MT102, MT103, MT104) and the three credit Quality Methods class (MT222). MT222 is offered only in the distance learning mode. We also offer versions of all five of our first year electronics classes as hybrid distance classes with the lecture offered online and the lab meeting on campus.

There has been no significant change in our online offerings, other than the development to accommodate the breakup of MT100 into MT101, MT102 and MT103, and the addition of MT104 to meet the solar voltaic demand.

In general we find that our students prefer campus based classes, though the flexibility of web classes helps many with scheduling challenges. There is a higher failure and dropout rate in distance classes associated with the additional student responsibility regarding time management and motivation.

Instructors continue to note that distance demands more work per student as compared to campus based classes as there is a greater tendency for one-on-one interactions as opposed to the group learning opportunities in a scheduled class. Likewise, group/team learning exercises are much more difficult to coordinate and in general less effective. Also assessment evaluation is less flexible as the instructor is tied to a work station.

Another concern arises due to PCC twice changing learning system software. Each change requires retraining, adapting learning materials and adapting teaching and learning styles. This places significant additional burdens on faculty, which means less time is available for students and effective teaching.

A final concern arose with the division of the three credit course, MT100, into three one credit classes, MT101, MT102 and MT103. This division was done to allow greater flexibility to students, and to explore more effective learning methods. For the web versions of these courses this means a student must pay an additional $40 for the distance learning fee, even though they are getting the same amount of content and credit as those students that took MT100. This fee should be credit based at best, and really the administration should consider removing it as a distance student requires no expenditures for heat, classroom space, parking, restroom cleaning, etc.

E. Has the SAC made any curricular changes as a result of exploring/adopting educational initiatives (e.g., Service Learning, Internationalization of the Curriculum, Inquiry-Based Learning, Honors, etc)? If so, please describe.

None.

F. Identify and explain any other significant changes that have been made to course content and/or course outcomes since the last review.

Responding to the recently developed trends in the semiconductor industry (the solar technology), our program has made significant changes in the curriculum in the last four years. These changes are summarized next.
Table 3: New degree options and certificates

<table>
<thead>
<tr>
<th>Associate of Applied Science Degree</th>
</tr>
</thead>
<tbody>
<tr>
<td>* Automated Manufacturing Technology Option</td>
</tr>
<tr>
<td>* Solar Voltaic Manufacturing Technology Option</td>
</tr>
<tr>
<td>Less than One Year Certificates:</td>
</tr>
<tr>
<td>* Career Pathway Solar Voltaic Manufacturing Technology</td>
</tr>
</tbody>
</table>

Table 4: New courses approved after 2008

<table>
<thead>
<tr>
<th>MT 101 Intro to Semiconductor Manuf.</th>
<th>Required by the AAS in MT and career pathway in Solar Voltaic Manufacturing Technology.</th>
</tr>
</thead>
<tbody>
<tr>
<td>MT 102 Intro to Semiconductor Dev</td>
<td></td>
</tr>
<tr>
<td>MT 103 Intro to Micro and Nano Proc.</td>
<td></td>
</tr>
<tr>
<td>MT 104 Intro to Solar Voltaic Process -1 cr. each</td>
<td></td>
</tr>
<tr>
<td>MT 109 Intro to Elec. and Instr -3cr.</td>
<td>Required by the career pathway in Solar Voltaic Manufacturing Technology.</td>
</tr>
<tr>
<td>MT 180 High Tech Employment Strategies -2cr.</td>
<td>Required by all three AAS degrees.</td>
</tr>
<tr>
<td>MT 131 PLC-3 cr.</td>
<td>Required by all AAS degrees.</td>
</tr>
</tbody>
</table>

The original MT100 Introduction to Microelectronics Technology was divided into three one credit classes. As part of this process the outcomes were divided among the courses, and revised to meet current PCC standards. The content was also divided, but some adjustments were made to accommodate the addition of solar voltaic manufacturing to the curriculum. Note that we easily added this topic as the manufacturing of solar cells shares much in common with that of manufacturing integrated circuits. Thus, the new course in semiconductor devices gained content on the photovoltaic device, as well as additional time for these unfamiliar topics. Time was reduced introducing the actual processes used to manufacture the microelectronic circuits so as to accommodate the devices. This means we cover the processes faster and in less depth. The course still meets its objective of introducing the concepts, and is backed up by a second year course in semiconductor processes. The MT Advisory Committee has continually emphasized their desire for us to focus on process equipment and not on actually processes.

MT104 Introduction to Solar Voltaic Processing was added to support the new degree option. This course parallels and complements MT103 which is specific to the processing of micro and nano scale devices.

The original MT90 course title was changed to MT109 to qualify it as a college level course. This was done in order to maintain the “career pathway” format we need to align the Solar COC course list to the Solar Degree course list. To qualify for career pathway, the Solar COC has to contain certain number of college level courses (at or above 100 level).

MT180 covers strategies for: researching, preparing for, and acquiring a job in the MT associated industries of solar, microelectronics and automated manufacturing. The MT department has
identified with our Advisory Committee members deficiencies in our graduates hiring process attitudes and techniques. This course is designed to address these as they specifically pertain to High Tech Manufacturing hiring practices.

MT131 introduces Programmable Logic Controller programming. Includes PLC components, architecture, execution cycle, data file type and management, variable monitoring, and basic programming instructions. A major trend of advanced manufacturing is the increasing degree of automation. Both of our major industrial partners Intel and SolarWorld built fully automated production lines in which products are handled from the beginning to the end by robots only. Many of these robots are controlled by PLCs (programmable logic controllers). To work in this environment, it is desirable or required that technicians should have PLC skills. MT131 was developed to address this requirement.

SECTION 3

3. Needs of Students and the Community: are they changing?

A. What is the effect of student demographics on instruction, and have there been any notable changes since the last review?

The instruction in this technical program is driven by the needs of the industry and the abilities of the students to achieve those needs. Graduates need to meet industry needs regardless of their demographic group. Data from Institutional Effectiveness indicate few changes in MT demographics except for a reduction in younger students. Students entering the MT program are expected to meet prerequisites for the program. These prerequisites are expected to be indiscriminant of demographic. Any actual difference in ability based on demographic is handled on an individual basis by individual instructors. Instruction in MT is in no way designed to discriminate based on demographic.
Age distribution of MT students for the years preceding current and previous years. Earlier data towards the back of the chart exhibits two modes while current data shows the 31-40 age group mode continues yet the 21-25 age group has abated.

B. Describe current and projected demand and enrollment pattern. Include discussion of any impact this will have on the program/discipline.

Current demand for Microelectronics Technology is extremely high. Our second year courses are over full, and our first year courses are nearly full. Demand for the program has always been cyclic, and we expect that to continue. The largest factor determining demand is Intel. Intel is the largest private employer in the region, and locally is larger than any other microelectronics employer by a factor of 10. Recently Intel announced and began the construction of a new fab for which they will need to hire many technicians. It is worth noting that this impact is much greater than the impact of the greater economy that is driving general enrollment trends at PCC. While PCC’s enrollment recently boomed, the MT enrollment remained steady at a relatively low level, even though MT graduates were getting jobs in the challenging hiring environment, and even though leading economists were predicting and publishing that high tech would (and is) leading us out of the recession.

Our current demand is exceeding the capacity of our classes. We could offer more classes by hiring more faculty, but we are reluctant to do this. Even though the public perceives a great employment opportunity, we recognize there are still limits to the number of inexperienced technicians the industry will hire in any one year. Hiring new faculty would require significant effort on our part due to the extensive training required to learn the specialized equipment we use in instruction. This
effort would yield minimal benefit as we expect the current demand to tail off over the next few years while consumer markets gradually expand enough to demand further manufacturing construction.

C. What strategies are used within the program/discipline to facilitate access and diversity?

The simplest and most direct way to facilitate access to a considerable diversity of students is to be a very divers department. Other instrumental tools in attracting minorities into the program are the NSF-STEM grant based on which we are awarding every year at least three substantial scholarships primarily to minority students.

Table 5: Mini photo gallery of diverse student body of the MT department.

Isaac Sunday – currently an MT student, procured a $3,450 grant from the Ndong Awing Cultural and Development Association through his summer grant-writing class at the Rock Creek Campus to fund 50 benches, six-month salaries for four teachers and a table for a school back home in his village of Awing in the Northwest region of Cameroon.

The picture above represents a sample of our student population. From left to right Chris Nguyen-born in Vietnam, Amir Alayan born in Iran, Farhad born and recently emigrated from Iran, Dorina Cornea-instructor born in Romania, Nia Tureck born in USA, and Varuny born and recently emigrated from Sri Lanka. All five graduates from this picture (taken in 2008) are currently working at Intel as fab technicians.
Damani Proctor-MT student, was accepted to the Oregon Space Grants Program and was an intern at the Goddard Space Flight Center in Maryland in 2010. He was later selected as one of the 105 students nationwide for the NASA Student Ambassador Program. Currently Damani works as technician for Intel Corporation.

D. Has feedback from students, community groups, transfer institutions, business, industry or government been used to make curriculum or instructional changes (not been addressed elsewhere in this document)? If so, describe.

SECTION 4

4. Faculty: reflect on the composition, qualifications and development of the faculty

A. Provide information on

i. Quantity and quality of the faculty needed to meet the needs of the program/discipline.

ii. Extent of faculty turnover and changes anticipated for the future.

iii. Extent of the reliance upon adjunct faculty and how they compare with full-time faculty in terms of educational and experiential backgrounds.

iv. How the faculty composition reflects the diversity and cultural competency goals of the institution.

Quantity and Quality: There are three full time faculty members in the department. This number allows all of our second year classes to be taught by full time faculty, and maintain appropriate contact with the first year courses (with only two full time members some first year classes would never be taught by department members.) Each member has an advanced engineering degree and has experience working in manufacturing. Two members have worked for semiconductor manufacturers with a local presence.
The department also has a technician who has extensive experience working as a technician in the microelectronics technology field. This is the position that we are training our students for. His experience is invaluable in maintaining the highly complex manufacturing equipment (donated by Intel) utilized in our labs. Also, he provides an important reference for our students, presenting a perspective of the job that we instructors cannot.

**Turnover:** There have been no changes in the department faculty since our last program review. No impending changes are expected.

**Adjunct:** Part time faculty typically work in the industry and look to PCC to contribute to the community and broaden their experience in the field. They bring with them a current perspective of what is going on in the industry. They include engineers and technicians, and typically have more industry experience than the full time faculty.

**Diversity and Culture:** The full time faculty are one third female, one third non-Caucasian, two thirds use English as their second language. Current part time faculty are 40% female and at least 20% non-Caucasian.

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**B. Report any changes the SAC has made to instructor qualifications and the reason for the changes.**  
[http://www.pcc.edu/resources/academic/instructor-qualifications.pdf](http://www.pcc.edu/resources/academic/instructor-qualifications.pdf)

Only minor changes have been made to accommodate new courses including: the breakup of the introductory course, MT100, into MT101, MT102, MT103, the addition of new courses: MT90 (which is now MT109) and MT180

**C. How have professional development activities of the faculty contributed to the strength of the program? If such activities have resulted in instructional or curricular changes, please describe.**

The solar voltaic manufacturers utilize a somewhat different type of controllers called programmable logic controllers (PLC) from the controllers used by their semiconductor counterpart. To best serve this industry, our department decided to develop new courses on PLCs. One faculty member spent two summers reading through PLC textbooks and lab manuals and wrote PLC programs to prepare for the development of the new courses. To make sure that the most suitable equipment was purchased for our PLC curriculum, he also studied various product manuals. He also attended a workshop offered by the manufacturer of our PLC system in the summer of 2010. All of these activities helped us to design the new PLC courses.

Quality Matters (QM) is a faculty-centered, peer review process that is designed to certify the quality of online and hybrid courses. QM is a leader in quality assurance for online education and has received national recognition for its peer-based approach and continuous improvement in online education and student learning. In the last 5 month, Dorina Cornea who is teaching a large number of hybrid DL courses joined the QM movement and attended the Applying the QM Rubric and Peer Reviewer Courses. As a result, principals and standards (one of them being the alignment between the course outcomes and teaching activities within a course) of an improved on line teaching and student learning will be adopted and instilled within the next year or so in her 5 DL courses.
While similar professional development activities have been available during this program review cycle (as compared to the previous cycle), there has been less and less available time to incorporate learned concepts and ideas into the classroom. Time spent on developing assessment, evaluating it, and reporting it all take away from time on teaching and curriculum development. As an example, one instructor took classes in web page authoring and Flash. The time spent in these classes does not really fit into the expected contract instruction requirements. After such a term ends effort is spent catching up on duties, and the opportunity to implement is lost as the knowledge dissipates.

One final note regards the previous program review’s recommendation to incorporate professional development in teamwork instruction and assessment. Administration was also unable to follow through on this.

SECTION 5

5. Facilities and Support

A. Describe how classroom space, computers/technology and library/media, laboratory space and equipment impact student success.

There is definitely a clear correlation between the instructional space available and students’ success. Currently the teaching and learning activities of the MT program take place in three different labs that belong to the department, located in building 7 and a few lecture rooms for general use, usually all available in the same building. The lecture rooms mentioned are well equipped with podiums, white boards, and appropriate furniture and number of seats, offering a comfortable atmosphere for both students and instructors. The three MT labs where more than 50% of the technical teaching takes place are generally equipped with adequate lab or industrial equipment acquired in time, through either industry donations or significant grants. The department was recently facing serious challenges due to equipment failure in our equipment lab (MT 227 and MT 228 classes). In moments like these, the presence and involvement of technical support becomes crucial. Our department finds that in our technician, Robert Beadle, who, with well fitting experience and incredible patience, always finds the best possible and most economical solution to any technical problem. Such problems tend to occur unexpectedly and lately quite often, as the cleanroom equipment used for teaching becomes old.

B. Provide information on clerical, technical, administrative and/or tutoring support.

The MT technician’s permanent presence in the labs is much appreciated by the MT students who usually spend many, many hours in there doing homework or analyzing the equipment. The needs of extended open lab hours lead us to the idea of having a second year student hired as “lab assistant”. The position is funded through a federal internship-grant. In addition, we also have a second year student-tutor available for our students every year, funded through a STEM federal grant.

Our division admin has also been extremely helpful in providing us with good support through her knowledge and understanding of PCC’s inner workings. Our previous division dean was instrumental in building and maintaining the department. She always encouraged us and provided us
with strong support. Her background in the semiconductor industry uniquely qualified her to offer insight and guidance for our department.

C. Provide information on how Advising, the Office for Students with Disabilities and other student services impact students.

Perkins funds provide for a Learning Skills Specialist (LSS)-Jessie Levine and a Student Employment and Cooperative Education Specialist -Donna Drayer. Both, Donna and Jessie support the MT program in a myriad of ways, with the dedication and passion typical for an employee that is easily exceeding any work expectations.

Jessie is providing our students with academic advising, class planning, degree audits, tutoring, study skills, campus and community referrals, and assistance in filling out scholarship applications. Students entering the MT program, similar to PCC students overall, are often new to the culture, policies, and procedures of an academic environment and become easily overwhelmed. The initial processes of admissions, testing, transcript evaluation, and class registration can be overwhelming and confusing for new students. By offering support in all these areas, Jessie- the MT LSS provides a “one-stop shop”, helping students alleviate unnecessary sources of stress. We consider it very important that students receive support even before they begin attending classes. That is why we appreciate so much Jessie’s support. Once they begin their classes, some students face difficult barriers such as financial troubles, lack of academic preparation, and poor study skills. Our LSS often meets with students one-on-one to help assess their struggles and provide them with appropriate resources. Jessie would practice communication skills with students that may not have English as their first language, and thus find it hard to understand the instructor, textbook, and classmates, or would patiently work on time management skills with students that struggle to balance a full time job, a family and schoolwork, helping them understand the amount of time needed to be successful academically.

In addition to the student struggles mentioned above, some students face the challenge of having a disability which might interrupt their academic success. Disability Services works with these students by testing and assessing the students’ specific needs, and providing necessary accommodations. For students who utilize this service, it works pretty seamlessly judging from our experience.

The second student services person whose work achievements in the last five years have greatly and positively impacted MT students’ success is Donna Drayer. As Employment and Cooperative Education Specialist, working part time for PCC, Donna’s efforts are often underestimated and translated in endless unpaid hours of work for our MT students, who openly praise the continuous support and well known motherly affection that she is showing them every day. From developing and maintaining ongoing partnerships in such a fast-paced industry like ours to advocating for the MT program and our graduates, from developing and coordinating several popular internship programs for the MT students (FEI, Siltronic, Maxim) to having the MT graduates hired one by one, from gracefully preparing the students for job interviews to taking them on field trips just to help them better understand the industry, Donna has done it all, with first class professionalism. In order to optimize the limited time she is spending on campus and maximize the number of students who get to talk to potential employers, she designed and teaches a special MT class: MT 180 High Tech Employment Strategies. The class that is targeted toward confidence and skill building in the
job search process, resume writing, job application, specific job duties, industry information and interview skills preparation. The class was from the beginning an attractive forum where MT students can go through mock interviews offered by industry personnel and network with key people from the semiconductor and solar industry. To exemplify the impact of Donna’s efforts in our MT students’ success, we should mention a recent event that took place on our campus: As a result of her industry outreach, and partnership, 16 personnel from Intel came to the Rock Creek campus in November to interview the June 2012 AAS Microelectronics/Solar Voltaic graduates. Intel also included upcoming graduates of two other PCC programs, EET and CME, in the interview, totaling 43 PCC student participants. She coordinated and organized the event and instructed all 20 MT student applicants in resume preparation/writing and interview preparation workshops.

Although there have been many challenges with the economy lately, Donna strives tirelessly to foster and maintain contacts with the right people in industry, with the ultimate goal of employment for our students and graduates. Besides working so closely with, instructing and supporting the MT students, her role as industry liaison for the MT department has been essential for the program, is fully recognized and much appreciated.

D. Describe how students are using the library or other outside-the-classroom information resources.

Because the MT curriculum is such a “hands on” curriculum, there is little time left and little need for our students to spend it in the library. Most of their study time is spent in the labs, and it is because of that reason that we are trying to maximize the open lab hours. Occasionally students are checking out calculators and text books from the library, and also attempting to do research when presented with assignments of that nature. However, the predominant and favorite source of info during class/lab time and outside-the-classroom remains the internet. All the MT labs are equipped with an adequate number of computers with internet access. It is common to see students attending the lecture and, while the instructor is talking about a certain subject, searching the internet on their personal laptop for related explanations or details.

MT101, 102, 103, 104 – students search journal/news articles for current issues affecting the microelectronics industry and related effects on society.

MT200 – students research holdings and reserve material 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.

MT111, 112, 113 – students use reserve books

MT240 – students reference databases for standard published technical information on properties of materials studied in class.
**E. Describe current patterns of scheduling (such as class size, duration, times, location, or other) address the pedagogy of the program/discipline and the needs of students.**

We are trying to maintain the traditional schedule that mimics the compressed work week schedule - a characteristic for the semiconductor and solar industries. That means, normally we are offering the same class twice per week, first on Monday and Tuesday and second on Thursday and Friday, allowing in this way students to potentially work in the industry the days when they are not in school. With some fluctuation in the enrollment, we have adjusted this typical schedule to either just one section on one half of the week or, as of this term, three sections per week, adding an extra section on Wednesdays, in order to satisfy the high student demand. In addition, evening, Saturday, and DL classes are offered, especially for first year courses. A limited number of MT classes are also offered every summer in order to allow first year students to have the prerequisites for second year classes satisfied prior to their start in fall term. An average class size for our program is about 13 students, and lower enrollment numbers are common for certain classes (Process Equipment II and III) because of the limitations imposed by the access to the lab equipment. With very few exceptions, the classes we are offering have a lecture, followed by a lab, the two sections usually being offered on two consecutive days.

<table>
<thead>
<tr>
<th>Course Numbers</th>
<th>Availability</th>
</tr>
</thead>
<tbody>
<tr>
<td>MT 101, 102, 103, 104, 111, 112, 113, 121, 122</td>
<td>Offered in DL format and campus based. Offered as day and evenings classes.</td>
</tr>
<tr>
<td>MT 222</td>
<td>Offered only in DL format.</td>
</tr>
<tr>
<td>MT 111, 112, 113, 121, 122</td>
<td>Offered on campus and in a hybrid DL format</td>
</tr>
<tr>
<td>MT 111, 112, 113, 121</td>
<td>Offered as Saturday classes.</td>
</tr>
<tr>
<td>MT 101, 102, 104, MT 113, MT 122, MT 109</td>
<td>Offered as summer classes.</td>
</tr>
</tbody>
</table>

**SECTION 6**

6. **For Career and Technical Education (CTE) Programs only**: to ensure that the curriculum keeps pace with changing employer needs and continues to successfully prepare students to enter a career field.

   A. Evaluate the impact of the Advisory Committee on curriculum and instructional content methods, and/or outcomes.

The MT advisory committee meets once every term. It is composed of representatives from all prominent local companies in the industry, such as Intel, SolarWorld, Maxim, FEI, Microchip, Applied Materials, Aerotek, On-Semiconductor, Triquint, etc. Our advisory committee serves the following critical functions:

1. Fosters relationship between the department and the industry, upon which all manners of communication and collaboration develop.
2. Updates the department of employment trends in the industry

3. Informs us of the skill sets required of workers in the industry. These skill sets are in turn reflected in the MT program outcomes.

4. Recommends, evaluates and approves major changes in curriculum.

5. Advises us on issues such as recruiting methods, training methodology, assessment methodology, etc.

6. Advocates for the MT program in the community, industry, professional groups, and other educational institutions.

7. Provides feedback on the performance of our graduates on the job.

As often as the committee meets, more work is done behind the scenes in sub-committee meetings, company visits, and one-on-one discussions, made possible through the human connections made during the committee meetings.

One example of the impact of the advisory committee is the creation of the Solar Voltaic Manufacturing degree. As soon as the MT department learned the news of the coming of SolarWorld to Hillsboro, we realized its potential impact on our local industry due to its size and its emergent nature. We contacted the company before it set up its local offices. We soon invited them to be on our advisory committee. In the course of the next several meetings, the MT department and SolarWorld representatives mapped out skill sets required of their technicians and operators. Feedback and suggestions from SolarWorld helped the MT department to create a new curriculum customized to meet these needs. As a result a Solar Voltaic Manufacturing AAS degree was born to meet the needs of entry level technician positions and a separate certificate was developed to meet the needs of operator positions. This is an example of how our advisory committee actively guides the program and how the MT department proactively ensures that our curriculum keeps pace with changing employer needs and continues to successfully prepare students to enter a career field.

Another example of the impact of our advisory committee is how it is helping us in the development of learning outcome assessment plans required by Perkins Fund and separately by the PCC accreditation process. This was the focus of the advisory committee meetings for the last two years. We involved our advisory committee from the very beginning of the process when we tried to decide what skills need to be assessed. This is to ensure that the skills we equip our students with in our curriculum are relevant to the needs of our local industry. We then asked our advisory committee to help us further identify specific aspects of a skill category that are most relevant to them. For example, for equipment trouble-shooting skills, we started with a list of about forty aspects of equipment trouble-shooting in the Oregon Skill Sets published by the Oregon Department of Education. We interviewed technical representatives from various companies to prioritize the
various aspects according to their importance to the needs of their company. We then chose the sub-
categories that are identified by all companies as the aspects of trouble-shooting skill that we want to
assess. This process really helped us to sharpen our focus on the skills that are most relevant to the
needs of the local industry. We also performed similar work to develop methodologies to assess
these skills and to define proficiency levels of student mastery of these skills, each with close
involvement from the advisory committee.

Based on our experience working with our advisory committee, we can envision several ways to
make the advisory process even more effective:

1. Some companies only send representatives with human resources background but not
representatives with technical background. Some companies do the opposite. While representatives
with human resources background can provide us with the most comprehensive and accurate
information on the hiring needs of their company and offer the most direct help for our students in
job applications, technical representatives give us the most insightful inputs concerning our
curriculum. In the future, it would be nice to ask both types of representatives to be present if
possible.

2. Sometimes items discussed in the committee meetings require follow up. It may make sense to
assign specific persons to be responsible for the follow up tasks during the meeting and review the
status of completion in the next meeting.

3. Even though most companies in the industry are represented in the committee, some potential
employers of our students are not. For example, we may try to recruit more semiconductor
equipment makers to the advisory board in the future.

4. Some of the companies on our advisory board are very large. This requires that we cultivate long
term relation with relevant branches within these companies, not just the representatives on the
board.

B. Degree and Certificate Outcomes [From the 2010 Interim Accreditation
report: the college must show “progress in demonstrating, through regular and
systematic assessment, that student who complete their programs have achieved
the intended learning outcomes of degrees and certificates.”]

This section may refer to, include or summarize the results of annual
assessments carried out over the last 5 years.

i. List your degree and certificate student learning outcomes, and identify the
strategies that are in place to assess them.

ii. Summarize the results of the assessments of these outcomes.
iii. Identify and give examples of assessment-driven changes that have been made to improve students’ attainment of degree and certificate outcomes.

Note:
1) Our answer to section 6B i, ii is divided into several sections. Each section addresses B i and ii for one program outcome.
2) According to PCC assessment council requirement, we have been focusing on the main AAS degree learning outcomes only, not its off-shoot options or certificate of completion outcomes. Also it was expected that assessment is to be completed by the end of 2012 Spring term. Thus we have not completed the assessment of certain outcomes at this point in time.

<table>
<thead>
<tr>
<th>MT PROGRAM Outcome</th>
<th>When will assessment take place?</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. A) Be able to understand how process equipment function at a component level and at a system level. B) Demonstrate a good foundation in process equipment maintenance. c) Demonstrate a good foundation in process equipment troubleshooting.</td>
<td>2011 Spring</td>
</tr>
<tr>
<td>2. Be able to troubleshoot electric circuits.</td>
<td>2011 Spring</td>
</tr>
<tr>
<td>3. Monitor and maintain semiconductor manufacturing process.</td>
<td>2012 Spring</td>
</tr>
<tr>
<td>4. Work effectively in teams.</td>
<td>2011 Spring</td>
</tr>
<tr>
<td>5. Communicate effectively with colleagues and vendors.</td>
<td>2012 Spring</td>
</tr>
</tbody>
</table>

1) a) Understanding of process equipment:
Assessment method: We assessed this in the 2nd year class MT224 where this knowledge was covered. There was only one session of 18 students that year. All participated in this assessment. We used a written final exam and a practical final exam to assess students. The exam was then graded against the following rubric.

To construct a rubric, understanding of process equipment at a component level is broken down into the following aspects:
1) Identify basic components of a modern control system such as controllers, various sensor types, DC motors, stepper motors, AC motors, etc.
2) Understand the proper functions of each component. And be able to measure to discern whether a component functions properly.
3) Understand how these components work (e.g. describe how a stepper motor take discrete steps)
4) Perform simple calculations on the functionalities of these components (tell what resolution a 12 bit A/D converter gives; given the torque-speed curve of a motor, tell what torque is available at what speed)
5) Build, in an laboratory setting, simple systems in which these components can perform their basic functions (be able to use a computer to instruct a stepper motor to go 10 steps clock wise and 2 steps counter clock wise.)

6) Build a simple system where the various components can work together to achieve automatic control (be able to build a close loop control system with sensors, controllers and actuators to perform desired control tasks.)

There is no curving in the scoring of the problems in the exams. The rubric is shown below together with assessment results for 2010 Fall term.

Results:

<table>
<thead>
<tr>
<th>Aspects</th>
<th>Average score of all students</th>
<th>Is this a problematic area? (Y if average &lt;75%)</th>
<th>% of students failed</th>
<th>What level students failed?*</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Component ID</td>
<td>84</td>
<td>N</td>
<td>17%</td>
<td>2F+1C</td>
</tr>
<tr>
<td>2 Understand Functions</td>
<td>82</td>
<td>N</td>
<td>17%</td>
<td>3F</td>
</tr>
<tr>
<td>3. Understand Mechanism</td>
<td>85</td>
<td>N</td>
<td>11%</td>
<td>2F</td>
</tr>
<tr>
<td>4. Simple Calculations</td>
<td>78</td>
<td>N</td>
<td>22%</td>
<td>3F+1C</td>
</tr>
<tr>
<td>5+6 Build systems**</td>
<td>77</td>
<td>N</td>
<td>22%</td>
<td>2F+1B+1C</td>
</tr>
</tbody>
</table>

- Level of a student is defined by her overall score in the written final. (2F+1C) means 2 students with an F and one student with a C in the overall written final exam failed this problem.
- 5+6 require more advanced problem solving skills.

From the above data, we can conclude:
1. Students did well in most areas as evident by the averages. There are no problematic areas.
2. The only area that is somewhat weak is the simple calculations area. (Here we exclude system building area because it requires more advanced problem solving skills). We have known this for a while that our students are not strong in quantitative analysis, even simple ones. This area, however, is not such an important qualification to help them to become good technicians in the industry.
3. The F students are the ones who tend to fail in all areas. This fact, combined with the high average scores, suggests that the greatest cause of failure may be problematic individuals. Of the three failed students, one had health problems and skipped many classes, one had a busy schedule outside of class so did not have enough time to study.

1 b) Equipment maintenance assessment: The goal of our maintenance training is to help students develop a good foundation for preventive maintenance (PM). Students do so by forming a habit of implementing good PM practices. We 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. Students receive training on, practice, and should be able to perform, major parts of typical
basic industry standard PMs, such as the electrode removal and replacement part of a wet clean. They are not required to perform entire PMs. Given the limited time available in class as compared to maintenance training in the industry, we think this limited scope in our maintenance training is appropriate.

At the end of their PM trainings, students were graded on their on-demand performance of a maintenance procedure—upper electrode replacement. The procedure is a major part of a basic industry standard maintenance procedure (a wet clean). All students in the MT228 course were assessed. They were from 2 sessions of the class totally 15 in number. Most students take this class at the end of their degree.

The assessment was evaluated by the single instructor who teaches this class. The instructor observes an individual student performing a representative part of this procedure (about 1/5 of the whole procedure), then grades him/her against the following rubric.

<table>
<thead>
<tr>
<th>Score</th>
<th>Level</th>
<th>Style and Form</th>
<th>Speed and Familiarity</th>
<th>Quality</th>
</tr>
</thead>
<tbody>
<tr>
<td>90</td>
<td>Good</td>
<td>Minor imperfection</td>
<td>&amp; fluent, no hesitation</td>
<td>&amp; No issue</td>
</tr>
<tr>
<td>80</td>
<td>Pass</td>
<td>Substantial imperfections</td>
<td>Or some hesitations</td>
<td>Or Minor issues but no damage</td>
</tr>
<tr>
<td>60</td>
<td>Fail</td>
<td>N/A</td>
<td>Can not complete the procedure without major help from the written procedure</td>
<td>Or Damage</td>
</tr>
</tbody>
</table>

Out of 15 students assessed, 13 passed, 2 failed. Both students who failed did not attend instructor’s demonstration on this procedure. Thus, they are not all that reflective of the student’s inability here. Of the 13 passed, 10 scored in the Good category. Based on this fact, we feel students learned very well in this area.

1 c) Equipment trouble-shooting assessment: We lengthened trouble-shooting training time in our curriculum significantly last year. This improved familiarity of our students to equipment trouble-shooting considerably. Students overall did well in the 2011 spring assessment. Out of the total of 15 students assessed, 1 was an outlier*. Out of the rest of the 14 students, 11 students were deemed proficient (79%), 3 were deemed non-proficient (21%). The assessment method and its proficiency standard were attested to by our advisory committee to meet or exceed their entry level technician requirement. Since this is the first time we have tested students’ equipment trouble-shooting skills with this proficiency standard, it for the first time demonstrated to us that the majority of our students are meeting or exceeding entry level technician requirement on equipment trouble-shooting skills by our local industry.

The assessment also revealed specific weak areas of instruction. For example, electrical system trouble-shooting was the weakest part of our student performance, as all non-proficient students
failed in that area. The three non-proficient students all showed deficiencies in system level electrical trouble-shooting (e.g. system interconnect schematic reading and wire tracing) as well as component level electrical trouble-shooting (such as how to probe if a transistor failed switching function).

To address the weakness in system level electrical trouble-shooting, we plan to offer more rounds of signal tracing and probing demonstrations in class as well as more student exercises in this area. We also need to address the weakness in component level electrical trouble-shooting. Right now as it is, our electronic circuit courses tend to emphasize more circuit analysis rather than trouble-shooting. We do need to insert more trouble-shooting labs throughout our circuit curriculum to reinforce various basic trouble-shooting methodologies in their minds. At a component level, as we introduce each new circuit component, we may consider adding a part about how to trouble-shoot the failure of that component, and about the common failure modes of that component. (For example, what are the most common failure modes of a capacitor or a motor?)

2. Circuit trouble-shooting assessment: This assessment was given at the end of spring term in MT113 Electronic Circuits and Devices III. The assessment is a one hour performance test in a lab setting. Students are required to design, build and test a circuit defined in the lab. The design requires use of skills learned in the course; building and testing the circuit requires skills developed in the lab over the three course sequence. This assessment involved one class of eight students.

<table>
<thead>
<tr>
<th>Assessed Outcome</th>
<th>Description</th>
<th>Evaluation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Build the circuit</td>
<td>Given a circuit schematic and the necessary parts the student should be able to connect the parts and necessary power supplies.</td>
<td>Two points each for successful completion, one point if successful with assistance, no points otherwise. Maximum 8 points possible.</td>
</tr>
<tr>
<td>Design the circuit/calculate specified test values</td>
<td>Utilize circuit analysis techniques covered in the classes the student should determine voltages and currents within the circuit</td>
<td></td>
</tr>
<tr>
<td>Test the circuit</td>
<td>Using the available test equipment the student should be able to measure current and voltage at various points within the circuit.</td>
<td></td>
</tr>
<tr>
<td>Troubleshoot the circuit</td>
<td>Given a description of improper operation of the circuit the student should be able to design and implement a set of tests to determine and explain what is wrong with the circuit.</td>
<td></td>
</tr>
</tbody>
</table>
The first figure shows the score for each student, organized by tested category. The weakest scores were in the design/calculation skills, the strongest in troubleshooting skills.

The second figure shows scores organizes by student. The area of each skill reaffirms the strong/weak relationship mentioned above, but this figure emphasizes how the scores also depend on the student.

As we can see, 7 out of the 8 successfully trouble-shot the circuits. These students are trained to use a variety of tools to solve problems, specifically to examine a circuit to understand how it works, to theoretically calculate how it should work, and to test/measure how it should work. A student should be able to draw on their own strengths to solve the problem, and seven of these eight students were able to do this. One student failed, but is a transfer student who completed the first two courses of the tested sequence of 3 courses at another school. While that student demonstrates deficiencies in the tested outcome, the source of that deficiency is not in the MT program.

3. Monitor and maintain manufacturing process: According to PCC assessment council requirement, assessment is to be completed by the end of 2012 Spring term. The assessment method for this outcome has been developed, but it will not be implemented until the end of Spring 2012 term.

4. Work effectively in teams: Currently the MT department includes no specific training or assessment of teamwork. We rely on the stated outcomes of specific general education courses required for the degrees, such as WR227 and SP215. We use term grades from these courses as assessment of student achievement of this outcome, since these courses list the following teamwork skills as their course learning outcomes:
WR227 Technical/Professional Writing: Work and problem solve effectively with others to achieve a common communication goal, using collaborative techniques, respecting the work of colleagues, and meeting deadlines; listen and speak reflectively.

SP215 Small Group Communication: Process and Theory
   1. Continue to adjust communicative behavior in order to improve the quality of small group interactions within various settings
   2. Manage projects, presentations, and small groups through learned communication strategies.
   3. Manage conflict through learned communication strategies within the small group setting.
   4. Use learned active listening skills in order to analyze and explain others’ communicative behaviors within the small group

The figure above shows the course grades earned by MT students in 2011 (fall and winter terms.) It is expected that a student earning an A would have exhibited well all of the outcomes of the courses as defined in the CCOGs. This data shows that 84% of MT students are earning A’s in these courses, so it is expected that MT graduates are meeting the outcome for working in teams.

5. Communicate effectively with colleagues and vendors: This assessment has been designed but will not be implemented till 2012 spring.

   iii. **Identify and give examples of assessment-driven changes that have been made to improve students’ attainment of degree and certificate outcomes.**

While our program is always implementing changes to improve student achievement in outcomes, and we feel that our student performance does improve over time, we only have limited examples of measurable improvement of student attainment because we only recently started to implement documented outcome based assessments.

We are reporting here one such example. Even though equipment trouble-shooting skill has always been listed as the most important outcome of this program, very little time was dedicated for its training. Most of our equipment curriculum focused on teaching students to understand how equipment works. This is necessary, as understanding of how equipment works is crucial in
equipment trouble-shooting. And this understanding does take time to develop. After implementing formal assessments of our stated program outcome, we determined that more time is needed to address trouble-shooting skills in our curriculum. Otherwise, it would be impossible to meet the skill level desired by some potential employers of our students. After this realization, we effectively doubled the length of our equipment trouble-shooting curriculum. This expansion of our equipment trouble-shooting curriculum definitely helped our students to become significantly more familiar with trouble-shooting as shown in our equipment trouble-shooting assessment test.

We had a trial run of this assessment in 2010 and then implemented the test formally in 2011. Both runs are comparable to each other. We noticed that qualitatively, more students are able to handle the test better. Given a problem with identical or comparable difficulty, a higher percentage of students is able to successfully solve the problem in 2011 than 2010. This is especially true with the most challenging part of the test, the design of isolation tests. Many more students are able to design tests for systems that are complex in nature. We also analyzed the performance of the students quantitatively. We factored in student level (A, B, C, D, F grade levels), the difficulty level of the problem assigned (0~10), and student trouble-shooting performance score (0~100). We arrived at a performance index relative to student level = Performance score * Problem difficulty level / student level. Quite often if we get a year in which the general quality of the students is better, the average performance of the students in a test increases without any improvement in the curriculum. The student level is in the denominator to try to remove this as a factor. So a higher performance score on more difficult problems, performed by lower average competency students, results in a higher index. The following chart shows a histogram comparison of the % of students in each year achieving each level of performance index.

![Relative Performance Index Distribution Histogram](image)

One can see that the 2011 curve shifted to the right to higher index values. Also, from the table below, one can see that the simple average values of both the raw performance score and the relative index value improved in 2011.

<table>
<thead>
<tr>
<th>Year</th>
<th>Raw performance score average</th>
<th>Index average</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>76</td>
<td>6.6</td>
</tr>
<tr>
<td>2011</td>
<td>82</td>
<td>7.8</td>
</tr>
</tbody>
</table>
C. Review job placement data for students over the last five years, including salary information where available. Forecast future employment opportunities for students.

The following chart shows MT graduates employment rate statistics from 2001 to 2011. This data includes students who obtained employment in MT or related fields or who went on to 4 year engineering programs. Currently we obtain this information by asking students personally one at a time towards the end of their second year. Some students do not graduate by then and we may lose track of them. So, some of them are not counted in this statistic.

As we can see MT graduate employment and continuing education track record is very strong. Even in the recent few years when the nation is going through the worst economic crisis in many decades, a large percentage of our graduates found employment, when so many of their counterpart parts from four year colleges could not. Furthermore, our entry level jobs generally pay in excess of $40,000 per year. For an associate degree holder with no industrial experience, this is indeed a very decent wage, given many bachelor degree holders cannot compete with this. Technicians with several years of experience can easily earn more than $60k to $70k per year.

Historically, Intel has been the largest and sometimes exclusive source of employment of our graduates. Our program has greatly benefited from Intel’s strong performance as the leader in this industry and its large presence in Oregon. The Oregon Intel site focuses primarily on Research and Development (R&D). Because they are highly technology intensive and also geo-politically sensitive, research and development facilities like Intel’s are much less likely to be off-shored than manufacturing. That is why the large scale lay-offs affecting other Intel sites largely spared Oregon. Our program and our graduates benefited from this stability. Whereas prior to 2007 most of our graduates were hired by Intel Fab20, a manufacturing facility, since the 2007 shut down of F20 Intel’s development division has picked up the slack. The recent announcement of Intel’s newest and largest ever R&D fab in Hillsboro demonstrates its continuing commitment to the Oregon economy, and has fueled the recent explosion in MT enrollment.
The homogeneity of the employment source for our graduates is not always desirable. The semiconductor industry is highly cyclical. The employment rate of our students reflects that almost perfectly from year to year. For this reason, the program has been trying to diversify ourselves in the past several years. We have been trying to broaden our student employment base by both diversifying ourselves within the semiconductor industry and reaching out to other industries. We were able to reach out to companies such as Cascade Microtech, Maxim, Triquint, On-semiconductor, and IDT. In recent years, we have also been able to establish beach heads in other technology sectors, such as nano tech equipment makes like FEI, and solar voltaic manufacturers like SolarWorld. These companies have very different customer bases and cycles and thus complement and augment the semiconductor based demands for our graduates. We also attempted to draw partnership from the food industry, the pharmaceutical industry (Genentech), and the renewable energy industry (ClearEdge Power) with less impact so far.

Our outreach effort to Cascade Microtech, Maxim, FEI and SolarWorld have been successful in that these companies showed great interest in our program and are actively involved in our advisory committee. We have placed a number of graduates at Cascade Microtech and FEI. These graduates have proven to be great assets to them. That is why they are quite enthusiastic about our program. On the other hand, we have placed very few graduates with associate degrees in Maxim and SolarWorld. This is why a significant amount of work remains to be done before these potential venues of student employment can be fully developed.

Looking into the future, we see continuing demand for our students. After the building of Intel’s new R&D fab, we expect an initial surge of demand for our students. But even after that, the company still needs to replace workers it loses through regular attrition at a rate of 5~10% annually. Given the large base number of technicians Intel employs, this translates to a sizable demand for fresh workers each year. What is also encouraging is that Intel is building into the new fab much room for future expansion.

As our program broadens its employment base, we will also see demand from other technology companies, such as Maxim and SolarWorld. SolarWorld is the largest Solar Voltaic manufacturer in North America, and their main factory is right here in Hillsboro. Maxim plans to build a second fab in Beaverton, doubling their capacity. We therefore have reasons to hope that our graduates will see employment opportunities from these companies.

These new opportunities will not automatically translate into more hired students for our program without conscious effort by our department. These companies have a very different technician usage model as compared to our current primary customer of Intel. Technicians at Intel play a versatile role. They are expected to have skills in operations, maintenance, equipment trouble-shooting, process trouble-shooting, team building, and problem solving anything that affects manufacturing excellence. While Intel requires this high versatility, it is less demanding on specific technical skills such as advanced equipment maintenance and trouble-shooting. It relies more on vendor and engineering support for those tasks. Maxim and SolarWorld hire entry level technicians primarily for maintenance and trouble-shooting of equipment. Thus they demand more of these technical skills. To serve these companies, we need to ensure that our graduates meet and exceed
their requirement. That is why we have been strengthening our equipment trouble-shooting curriculum.

In general, we will also face pressure resulting from foreign competition of U.S. manufacturing. Asian companies have taken over a large share of semiconductor and solar voltaic manufacturing. This can lead to depressed wages at home and continuing pressure to off-shore manufacturing jobs. This can seriously affect our partners such as SolarWorld and Maxim.

This challenge also presents an opportunity for community colleges programs like ours. To meet this foreign competition, the U.S. has to be able to train highly skilled workers including technicians at a globally competitive wage. Many U.S. companies feel the need to upgrade the technical skills of their operator work force to manage the tasks previously handled by higher paid, experienced technicians. Community colleges can fulfill that training need to keep American manufacturers competitive. To upgrade the skills of the operators requires working around their full time work load. A two year full time degree can stretch into a decade long pursuit with no end in sight for a full time worker--part time student. Finding a solution to this problem can help us to serve the industry better.

D. Analyze any barriers to degree or certificate completion that your students face, and consider the reason that students may leave before completion.

We believe that reason number one why many of our beginning students are leaving the program, sometimes switching to different majors or simply dropping out of college all together, is the lack of academic preparation. They start the program with enthusiasm, usually after taking a long break from school, and when they are faced with the rigor of our MT curriculum, they get discouraged and before we, the instructors or student support staff are able to identify any issue and offer them help, they decide to change their majors. The second reason would be financial hardship: many of them are joining the program as unemployed people, with the hope that they will get hired sooner rather than later. When that happens while the student is still in the program, before graduation, the decision of dropping the program is immediate, yet completely understood. These are usually people living off unemployment or who ran out of benefits, most of the time the main bread winner of a family with many children, and are never blamed for choosing full time work over degree completion. Sometimes such students happen to return and work part time toward degree completion. Cases like these were on our mind when we designed the career pathway mentioned in Section 2F.

E. Describe and explain any additional changes (not already addressed above) that have been made to the program since the last program review.

7. Recommendations
A. Identify recommendations related to teaching and learning based on assessment of student learning outcomes (course, degree, certificate and/or College Core Outcomes)

We have discovered some weakness in circuit trouble-shooting skills of our students both at a system level and component level based on our equipment trouble-shooting skill assessment. To address the weakness in system level electrical trouble-shooting, we need to offer more rounds of signal tracing and probing demonstrations in class as well as more student exercises in this area. We also need to address the weakness in component level electrical trouble-shooting. Right now as it is, our electronic circuit courses tend to emphasize more circuit analysis rather than trouble-shooting. We do need to insert more trouble-shooting labs throughout our circuit curriculum to reinforce various basic trouble-shooting methodologies in their minds. At a component level, as we introduce each new circuit component, we may consider adding a part about how to trouble-shoot the failure of that component, and about the common failure modes of that component.

Our current assessment method of circuit skills also emphasizes more circuit analysis rather than circuit trouble-shooting. A more detailed circuit trouble-shooting assessment method needs to be developed to be able measure and diagnose what is lacking in our current circuit trouble-shooting curriculum.

In the future, we will experiment with the following. We will state clearly learning outcomes of all lectures and labs and other activities in a course and map them to the outcomes of the course and in turn the program outcomes.

In the past, some of the students may not have performed as well as they could in assessment tests because they were not familiar with the format of the tests or did not know what to expect. We should create a bank of questions accessible to all MT students to be used in preparation for these assessments.

The recent assessment mandated by the college and by its accreditation agency helps us to be accountable to the stated learning outcomes of our program. As it is currently practiced, it is not without its imperfections. The current drive to measure learning outcomes costs enormous amount of time to instructors. This year, our department faces not just assessment mandated by PCC accreditation agency, but also federal Perkins CTE assessment, and on top of that, this program review assessment. We feel buried by waves of assessment requirements. Our instructors were informally performing many of these actual assessments already prior to these requirements. The difference now is that we have to report it formally. This process of multiple assessments and formal report writing takes away so much valuable time from instructors that we do not have time to investigate further the findings of these assessments or implement any solutions suggested by the assessment. It is like a medical test that costs so much that the patient can no longer afford the treatment that the test requires afterwards.

It is our hope that the administration realizes that such assessment activity cannot be done without additional resources or reduction in other faculty responsibilities. For future assessment requirements, we wish that the administration will provide faculty with additional resources to fulfill
these requirements, or reduce other requirements of faculty. If possible, it may be beneficial for the college to offer feedback back to the accreditation agency concerning the additional burden and trade-offs these new demands entail. We also recommend that the college can waive or simplify program reviews for departments that are going through other assessments such as Perkins assessment.

B. Identify recommendations relevant to areas such as maintaining a current curriculum, professional development, access and success for students, obtaining needed resources, and being responsive to community needs. (For recommendations that require additional funding, please identify those that are of greatest importance to the SAC)

Even though we have made great progress in recruiting, we recognize that the industries we serve are cyclical. Thus we need to continue our recruiting effort. History shows that faculty members do not have the extra time required. We thus highly recommend that the funding for our current part-time recruiter position be implemented long term. We believe this will be critical to the long term health of the program. More assistance from the college on marketing will also be appreciated. Because of the success of our student tutors, we also recommend that a continuing funding source for MT specific tutors be identified. Our department realizes the essential role that Donna Drayer plays in the promotion of our program to industry partners, and the limited time and conflicting priorities that she has to struggle with, we therefore suggest to the college that her position be dedicated to the support of MT department alone if possible.

The process equipment we rely on to teach equipment maintenance and trouble-shooting are aging. Due to a massive failure in multiple pieces of equipment this year, for example, we almost could not offer our capstone course. The department needs to set finding replacement of these equipment as a high priority. Concerning MT department annual equipment budget, in many years, we do not need to spend the whole budget allowance. But in some years, when there are major issues with our equipment, we need to spend more than the budget. We recommend that the college finds a way to allow us to roll-over unspent budget from year to year as a “rainy day” fund for our equipment.

Our program succeeded in placing many graduates into companies such as Intel and FEI. We need to continue to work with SolarWorld and Maxim to ensure that we can demonstrate to them that our graduates have important skills that they desire. Also, as more and more of our students are hired by the research and development division of Intel instead of the high volume manufacturing division in the past, we need to understand their technician usage model to ensure the skills we train in students are most relevant to them.

We also have certain recommendations concerning PCC policies:
1. Financial aid should not be tied to full or part-time enrollment.
2. Math courses need to be tied to secondary education math levels.
3. Transfer students need to know which courses are equivalent and which are substitutions upon program entry.
4. Faculty department chairs need more release time. Any release time needs to be based on current enrollment, not on the previous year’s enrollment.