

## An Outreach Program To Promote Manufacturing Careers To Underrepresented Students

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### Abstract

The Puget Sound Consortium for Manufacturing Excellence (PSCME), funded by the National Science Foundation, and the Mathematics, Engineering, and Science Achievement (MESA) Program co-sponsored two student field trips; one to Renton Technical College, and another to Edmonds Community College and Dillon Works, a manufacturing company. The primary purpose was to build an interaction between middle schools, high schools, community and technical colleges, and industry while promoting manufacturing careers to students. The first field trip concentrated on machine technology, computer-aided drafting, electronics, and surveying. The second included a materials lab and manufacturing plant tour. The format included hands-on experiences, interaction with college faculty and students, and involvement of manufacturing industry innovators. This paper presents details of organizing and managing such an outreach activity for manufacturing technology programs. Overall student experience and lessons learned in organizing such an outreach event are also discussed.

### 1. Introduction

Despite a steady increase in the number of minorities receiving undergraduate degrees in engineering and science fields, enrollment figures of non-white students in science and engineering majors is still very low. This figure is considerably small compared to the enrollment figures for the same category in non-science and engineering majors[1-3]. One approach to increasing the population of underrepresented students in science and engineering is to encourage minority students to learn about careers in these fields. An outreach program that incorporates relevant field trips can be an effective tool in promoting careers to underrepresented students[5-7]. Many inner-city schools do not have the means to provide needed courses, lab exposure, motivation, and career counseling in science and engineering[4].

Established in 2001, the Puget Sound Consortium for Manufacturing Excellence (PSCME) is a regional education-industry partnership aimed at enhancing the connection between manufacturing technology education, student career goals, and private sector demand. The PSCME, a three year project funded through the National Science Foundation (NSF), is interested in promoting science and engineering careers to K-12 students. In particular, the PSCME works with local educational partners to promote manufacturing career opportunities to students. Toward this end, the PSCME is developing recruitment and retention strategies to encourage a diverse workforce. Of particular interest is the recruitment and retention of people from diverse ethnic backgrounds who are underrepresented in manufacturing careers. Consequently, the PSCME and the Mathematics, Engineering, and Science Achievement (MESA) Program co-sponsored two field trips for Washington State students -- one to Renton Technical College, and another to Edmonds Community College and Dillon Works, a manufacturing company, as part of an outreach program. The MESA program supports disadvantaged and underrepresented students to succeed in math, science and engineering and to attain math-based degrees. The outreach program was funded by the PSCME. Renton Technical College Foundation and Edmonds Community College Foundation provided the students lunch. Working very closely with PSCME staff, the colleges also provided facilities, faculty and staff time for this activity.

This outreach program was designed to introduce students to educational opportunities, expose them to college curriculum and the manufacturing industry, involve them in hands-on activities, and encourage them to pursue careers in manufacturing engineering technology. In addition, one of the major objectives of the program is to begin building interaction between middle schools, high schools, community and technical colleges, and industry while promoting manufacturing as a viable career path.

This paper presents details and experiences involved in the organization and management of such an outreach activity for manufacturing technology programs. The overall student experience and lessons learned in organizing such an outreach event will be discussed.

## 2. Outreach Program Planning

The PSCME organized the outreach program, choosing several technology disciplines in manufacturing areas: materials processing, machining technology, computer-aided drafting (CAD), and electronics. In order to introduce these manufacturing technology disciplines to underrepresented students, the PSCME first contacted Seattle MESA leaders to plan the events and to recruit program participants. The MESA leaders identified students in their programs at two Seattle schools: the African American Academy (Middle school) and Rainier Beach High School. Two local community colleges (Renton Technical College and Edmonds Community College) were involved and agreed to host the workshops. Because the two colleges are geographically separated, two field trips were planned. Field trip 1 was hosted by Renton Technical College. On field trip 2, Edmonds Community College and local industry partner, Dillon Works,

joined the program. Dillon Works designs and manufactures dimensional, sculptural and architectural elements for retail/themed environments, restaurants, amusement parks, casinos, signage, and exhibits for national and international clients. The activities at the company were designed to capture the program participants' interests.

As shown in Figure 1, the organization of the outreach program brings together PSCME staff, MESA students, teachers, and staff, faculty at two community colleges, and local industry partners. The schedules of the field trips are shown in Table 1.

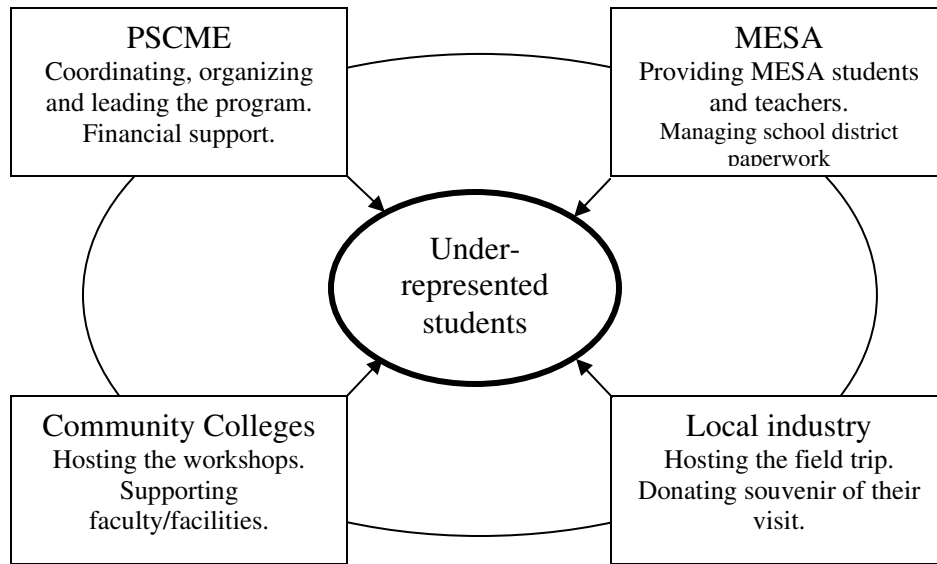


Figure 1. Four organizations and their roles.

Table 1. Program Schedule

PSCME Outreach Program			
Field trip 1		Field trip 2	
Morning	Afternoon	Morning	Afternoon
Renton Technical College		Edmonds Community College	Dillon Works Inc.

### 3. Field Trip 1 to Renton Technical College

#### 3.1 Field Trip 1 Organization

*A. Field Trip Participants:* The MESA-Seattle organization presently 1,400 Seattle Public School students representing high school, middle school and elementary school levels and were instrumental in identifying participants. Renton Technical College hosted the first field trip, thus the MESA students attending the African American Academy and Rainier Beach High School were chosen for Field Trip 1 due to their geographical

advantage. Finally, thirty-four students from the African American Academy (n =23) and Rainier Beach High School (n =11) attended a one-day field trip to Renton Technical College, Renton, WA.

*B. Field Trip Instructor(s) and Staff:* Instructors from four different actively participated in the planning. All 4 workshops were instructed by Renton Technical College faculty and focused on machining technology, electronics, computer-aided drafting (CAD), and surveying. MESA staff, PSCME staff and Renton Technical College administrators and instructors attended several meetings to organize the program and develop workshop curricula. During the field trip, the MESA teachers, PSCME staff and Renton Technical College students volunteered to help the workshops as chaperones.

*C. Field Trip Schedule:* Students left their respective schools at 9 am, and returned to school at 2:30pm. Each workshop lasted 70 minutes, and lunch time was 40 minutes. The field trip schedule is shown in Table 2.

Table 2. Field Trip 1 Schedule

Time	
9:00 – 10:00	Transport
10:00 – 10:15	Welcome and Introduction
10:30 – 11:40	1 <sup>st</sup> Workshop
11:50 – 12:30	Lunch
12:40 – 1:50	2 <sup>nd</sup> Workshop
1:50 – 2:00	Evaluation
2:00 – 2:30	Transport

### 3.2 Field Trip 1 Activities

There were four different workshops related to manufacturing technology and applied science, and they were machining technology, electronics, CAD, and surveying. Students selected, or were randomly assigned to attend two of four workshops during the field trip. They attended one in the morning and the one in the afternoon. The college instructors from each program led the workshops.

In the machine technology workshop, the instructors discussed the importance of machine technology and explained what machinists do. Students were introduced to CAD and computer aided manufacturing (CAM). Using computer software, students drew a block containing their name, holes, and special features. The instructors reviewed mathematical formulas and geometries during the workshop. Renton Technical College students volunteered to help the students with the software. Computer numerical control (CNC) machine tools were then demonstrated. Students had the opportunity to use these machine tools to make souvenir name medallions that were based on their block designs. Students also observed how machine tools can be used to make chess pieces and airplane frames from raw materials. Students took home several chess pieces and their souvenir name medallions.

The electronics workshop included a brief lecture on the history of electricity, a description of voltage, resistance, and current, and a presentation of mathematical formulas for calculating these concepts. Several handouts containing information about electricity were distributed. Discussion of existing career opportunities in electronics was also included. The lecture was followed by time in the electronics lab in which Renton Technical college students demonstrated the measurement of voltage, current, and resistance. Students had the opportunity to interact one-on-one with the college students to discuss the lab activities and the electronics program.

In the CAD workshop, students were stationed at computers with CAD software and were paired with a Renton college student. The CAD exercise had students follow instructions while participating in a hands-on activity to draft a house complete with doors, windows, and a roof. The products of this exercise were printed for students to take home. Students also had the opportunity to ask Renton college students questions regarding their own projects and the drafting program.

During the survey workshop students were provided a brief overview of surveying and a list of general questions about surveying was distributed. It was explained that surveyors make maps using their knowledge of mathematics and surveying equipment (total station, retro-reflector, Global Positioning System). Students were taken outdoors to experiment with the surveying equipment. After the demonstration, students returned to the classroom for a brief overview. The measurements taken outside were downloaded to a classroom computer and a map of the courtyard was projected onto a screen. The instructors concluded by commenting that surveying is a lucrative career.

#### 4. Field Trip 2 to Edmonds Community College and Dillon Works

##### 4.1 Field Trip 2 Organization

*A. Field Trip Participants:* For Field Trip 2, Dillon Works Inc. was incorporated into the program. Dillon Works is a manufacturing company that designs and builds dimensional, sculptural and architectural elements for retail/themed environments, restaurants, amusement parks, casinos, signage, and exhibits. Due to tourist maximum capacity at the company factory, the participant numbers were limited to fifteen students. Some middle school participants in the Field Trip 1 were chosen for the field trip 2. Finally, fifteen middle school students from the African American Academy (n =15) attended a one-day field trip to Edmonds Community College and Dillon Works Inc.

*B. Field Trip Instructor(s) and Staff:* The workshop at Edmonds Community College was instructed by engineering instructors who are members of the PSCME. The Director of Marketing and Sales, Mr. Brian Leonard led the workshop at the Dillon Works Inc. The MESA staff, PSCME staff, Edmonds Community College faculty, and Dillon Works Inc. staff had several meetings to organize the program and develop workshop curricula. The

MESA teachers, PSCME staff and Dillon Works Inc. staff volunteered to help the workshops as the chaperones.

*C. Field Trip Schedule:* Students were transported, by bus, from their school to Edmonds Community College then onto Dillon Works Inc., thus the workshop in the morning lasted 75 minutes, and lunch time was only 30 minutes. The field trip schedule is shown in Table 3.

Table 3. Field Trip 2 Schedule

Time	
9:00 – 10:00	Transport
10:00 – 10:15	Welcome
10:15 – 11:30	1 <sup>st</sup> Workshop- Materials Lab
11:30 – 12:00	Lunch
12:10 – 12:30	Board Bus & Travel to Dillon Works
12:40 – 12:50	Welcome and Introduction
12:50 – 1:40	Factory Tour
1:40 – 2:00	Team Exercise and Evaluation
2:00 – 2:30	Transport

#### 4.2 Field Trip 2 Activities

Fifteen students from the African American Academy attended a one-day field trip to Edmonds Community College and Dillon Works. At Edmonds Community College, the students participated in two activities in materials processing technology. The first activity, “What’s this?” was led by a PSCME staff member. In this activity, the four classifications of solid materials (e.g., metals, polymers, ceramics, and composites) were explained. Once the properties of each type of solid were described, students were invited to select an object from a table displaying approximately 25 objects. Each student was called upon to classify his or her selected object as either a metal, polymer, ceramic, or composite. Once the student had classified the object, a brief explanation of why the object belonged to the appropriate category followed.

The second activity called, “Glue-Goo” was led by another PSCME staff member who is a faculty member at the University of Washington and his graduate student assistant. The instructor discussed basics of polymer processing. In this activity, students worked in teams to create four glue substances. In order to identify water contents on polymer, students put red food coloring on polymer with 50% white glue and 50% water and green food coloring with 75% white glue and 25% water. Students made two red putties that consisted of: 1) red polymer mixture and borax solution, or 2) red polymer mixture, borax solution, and 1 tsp of vegetable oil. Students also made two green putties that consisted of: 1) green polymer mixture and borax solution, or 2) green polymer mixture, borax solution, and 1 tsp of vegetable oil. The students formed the putties into balls and then examined them to judge, test and record the substances’ texture, consistency, fluidity, and

elasticity. Once the students' observations had been recorded, they discussed, as a group, reasons for variations in the putties' physical properties.

In the afternoon, the students were taken on a tour of the Dillon Works custom manufacturing facility by its Director of Marketing and Sales, Mr. Brian Leonard. Dillon Works designs and fabricates "almost anything." They utilize metal, foam, plastic, fiberglass, wood, fabric or any combination of the above in their creations. Students were led on a tour of the lobby and conference room; design area; molding/sculpting, wood, and metal shops; and the fabrication, soft goods, and painting areas. Students were able to observe the production of several pieces, and were exposed to diverse employees including several women, a typically underrepresented group in manufacturing environments. At the end of the tour, Mr. Leonard led the students through a production exercise. The students were split into three teams and each team was required to identify a spokesperson thereby cultivating teamwork. Each team was given the task of identifying the steps for producing 1500 holiday ornaments at a low cost. The teams brainstormed their production strategies, and the team spokesperson then communicated the plans to the larger group which incorporated public speaking. After listening to all three presentations, Mr. Leonard then conveyed Dillon Works' strategy for making this product for an actual client. The PSCME staff concluded the field trip by linking the morning activities in the Material Science Laboratory with the process that Dillon Works employees undertake when experimenting with ways to manufacture innovative products.

## 5. Program Assessment

All aspects of the workshop were evaluated by the students. At the end of each field trip, students were asked to complete an evaluation form. The questions inquired about demographic characteristics (e.g., grade, ethnicity), which workshops were attended, students' interest in the workshop area, and students' intent to pursue a career in that area. At the end of the program, the PSCME and MESA staff gathered the evaluations as well as recording student comments made during the program. This feedback and input will be used in the planning of future events.

According to the PSCME evaluation report [8], 95% of the students answered that they liked or really liked the outreach program. More than 75% of the students answered that they were interested in manufacturing technology area. In particular, approximately 25% of the students were definitely interested in researching career choices in this area. About half of the students described hands-on activities/being out of school learning and the industry field trip as the best opportunities of this outreach program. However, some students suggested integrating more hands-on/less talking/more exciting activities into the program.

Through the evaluation, it was evident that students gained knowledge about each of the manufacturing technology areas that they were exposed to during the workshops. In addition to content area knowledge, students gained knowledge about geometries and

computing, as well as general information about manufacturing careers and planning for the future. The CAD workshop and Dillon Works Inc. tour received the highest average ratings peaking students' current interests as well as their future interest in a career.

## 6. Conclusions

It is clear from the students' evaluations that they found both field trips to be stimulating and enjoyable. The two field trips not only allowed underrepresented students to learn the fundamental manufacturing technology disciplines, but also exposed them to career opportunities in manufacturing technology and application of manufacturing to their daily lives. They were favorably impressed with all aspects of the program, including the staff, the hands-on labs, the field tours, Dillon Works and the CAD workshop. During the CAD workshop, each student had a PC and worked with one college student to complete their drawing project. The students also drew a house, which they found to be a very simple and interesting task. The most frequent suggestion for improvement was the request for more hands-on learning activities. When the workshop topics met real-life experience, students were interested and participated in them thoroughly.

The most challenging part of this program was the collaboration with colleges, schools, and the local industry. Working with three or more organizations is an investment of time and energy; however, it was very important to have input from all participating organizations.

Overall, the PSCME Outreach Program was very successful and it contributed directly to underrepresented students' interests of a manufacturing technology career.

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