



2014-NIST-SSCD-01 EVALUATION REPORT



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INTRODUCTION AND METHODOLOGY

The Washington State Center of Excellence for Aerospace and Advanced Manufacturing (CoE) and Everett Community College received a one-year award from NIST in July, 2014, with the grant ending June 30, 2015. The project was granted a no-cost extension to November 30, 2015 in order to prepare a presentation for the NIST Academic Partnerships Conference: NIST Construction Awardees and their Scientific Research Facilities, November 12-13, 2015.

The CoE Metrology Curriculum Development Project is a project whose mission is to increase the number of community college students that are qualified to fill job openings in measurement science/precision measurement/metrology within local companies.

Project Goals

- Develop course curriculum with industry subject matter experts' input that can be embedded into advanced manufacturing/aerospace programs
- Develop a series of courses that can be included in a short term certificate that can be adopted at any of the state's community and technical colleges
- Create curriculum that will be easily recognizable (common certificate with course titles/objectives) so that industry hiring managers are able to clearly identify the training when it appears on resumes
- Increase the number of community and technical college students that are qualified to fill job openings in measurement science/precision measurement/metrology within local companies
- Provide professional development opportunities for Design Team faculty to attend industry-led conferences and seminars for exposure to workplace best practices

Core Evaluation Questions

The following questions guided the evaluation plan and activities.

1. To what extent was the curriculum development plan implemented?
2. To what extent were timelines met?
3. Is progress sufficient to meet project goals?
4. What challenges were encountered and how were they addressed?
5. To what extent was the curriculum adopted in the colleges selected by the project?
6. To what extent was the 19-credit Certificate Program adopted by colleges selected by the project?
7. What was the impact on the Washington State community college system?

Theoretical Foundation

The evaluation is primarily based on adaption of the Context-Input-Process-Product evaluation model developed by the Evaluation Center at Western Michigan University, under the direction of Arlen Gulickson, PhD and Daniel Stufflebeam PhD. The year's activities were evaluated following Gulickson's four essential elements:

1. The degree to which the project is achieving its goals.
2. The level of impact, and the degree to which the project is reaching intended individuals or groups.
3. The effectiveness of the products and services delivered to constituents.
4. Ways in which the project can be significantly improved.

The investigative approaches recommended by the Evaluation Center at Western Michigan University were utilized to produce a theoretically based, complete and comprehensive review of the Center:

- Objective Orientation: How closely the products and services met the stated goals and objectives as stated in the grant proposal.
- Teaching/Learning Process Orientation: Based on the perspective of teachers, how the project activities assisted or facilitated teaching and learning.
- Faculty and Institutional Support: The degree to which the project efforts were integrated and accepted, and the positive changes resulting from the efforts.
- Business and Industry Support: The level of acceptance and support for the project efforts by business and industry, especially those which hire graduates and utilize the technician workforce.

Each item in the evaluation plan was considered from one or more of the approaches listed above. The following methods were used to develop the data necessary to cover the topics in the evaluation plan:

- Interviews with Principal Investigator, Co-Principal Investigators, project staff, partners and faculty.
- Determination of impacts and influences on technician level education.
- Analysis of project documentation.
- Analysis of applicable survey and other data gathered to date.

Project data-gathering activities and subsequent data analysis were guided by standards developed by the Joint committee on Educational Standards and Evaluation. The evaluation which follows covers findings and recommendations, discussions with PI and staff combined with findings of the data gathered through surveys, interviews and data analysis.

Participants were representatives from industry and faculty members from community colleges across the region. Faculty members participated in the Curriculum Design Team (CDT) and industry representatives were on the Oversight Industry Partners Group (OIPG). The CDT met 5 times and the OIPG met 4 times between February and June 2015. Attendance at the meetings was excellent, with the CDT meetings averaging 75% and the OIPG averaging 90%.

Participants were surveyed at the conclusion of the grant period. Surveys included questions on the quality and utility of the curriculum, the effectiveness of the process and the potential impact on institutions, students and the manufacturing workforce. Surveys were both qualitative and quantitative in nature, utilizing Likert scales, multiple choice responses and open-ended questions. Representative comments were selected and are in the report narrative.

SURVEY RESPONSES

Total participants equaled five from education and five from industry. The survey was sent to all participants, and four out of five from each category of participant responded, for a combined response rate of 80%.

Survey Completion

The number of responses to each question is found in the tables below. The total possible number of responses is five, for both industry and education. Overall, questions had a 69% response rate. As is typical of adult survey respondents, the open-ended questions had the lowest response rates.

Survey Completion		
Questions to Both Industry and Education	# of Education Respondents	# of Industry Respondents
Please describe the primary impact you believe the grant will have on colleges, students and/or the workforce.	4	5
Please rate the overall quality of the courses developed by the grant project.	5	4
Please indicate the degree to which the curriculum developed by the project meets criteria	5	5
What improvements could be made to the Measurement Science 101 course?	2	2
What improvements could be made to the Measurement Science 102 course?	2	2
What improvements could be made to the Measurement Science 103 course?	2	2
Please rate aspects of the facilitation.	5	5
Overall, what went well?	4	3
Overall, what did not go as well?	2	2
Other comments?	2	0
Questions to Education Only		
Please rate the quality of the curriculum development process overall	5	n/a
How might the process for developing the curriculum have been improved?	2	n/a
Please rate the quality of the professional development opportunities of the grant.	5	n/a
Please indicate your level of confidence that the Measurement Science 101, 102 and 103 will be implemented at your college by Winter Quarter 2016.	5	n/a
Please indicate your level of confidence that the project will result in an easily recognizable naming protocol for all colleges.	5	n/a
Questions to Industry Only		
Please provide feedback on the curriculum development aspect of the project.	n/a	5

CURRICULUM

Quality of the Curriculum

Participants were asked to rate the overall quality of the courses developed by the grant project. A four- point Likert scale was used and ratings were assigned a numerical value as follows:

- Excellent = 4
- Good = 3
- Fair = 2
- Poor = 1

The mean ratings were calculated for each statement as shown in the table below.

Average responses, Overall Quality of the Curriculum			
	N=5 Educators	N=4 Industry	N=19 Both
Measurement Science 101	3.60	3.75	3.67
Measurement Science 102	3.60	3.75	3.67
Measurement Science 103	3.60	3.75	3.67

Interestingly, industry rated the overall quality of the curriculum more highly than did educators. However, both groups of participants rated the curriculum very highly, with an average of 3.67, out of a possible of 4.0.

Participants were also asked about their perceptions of the quality of the curriculum with respect to specific criteria established in the grant proposal. Respondents reported their level of agreement with a series of statements, using a four-point Likert scale. Ratings were assigned a numerical value as follows:

- Completely meets the criteria = 4
- Somewhat meets the criteria = 3
- Does not meet the criteria very well = 2
- Does not meet the criteria at all = 1

The mean ratings were calculated for each statement.

Average Responses, Quality of the Curriculum			
STATEMENT	N=5 Educators	N=5 Industry	N=10 Both
Includes knowledge of the principles and concepts of measurement science, including various levels of measurement science terminology, definitions of common metrology terms and units of measure.	3.80	3.80	3.80
Includes basic knowledge of measurement and uncertainty concepts.	3.80	3.80	3.80
Provides students with the ability to make accurate, precise and repeatable measurements with general purpose electrical test and measurement equipment.	3.80	3.40	3.60
Contains appropriate hands-on projects for each level of training.	3.40	3.75	3.56

100% of respondents found that the curriculum completely or somewhat met the criteria. A higher score indicates greater agreement with the statement. With the lowest rating at 3.40, both educator and industry participants found that the curriculum meets the criteria.

Participants were also surveyed regarding any improvements they would recommend for Measurement Science 101, 102 or 103 using an open-ended question format. Four individuals provided ideas for continuing improvement as follows:

Educators:

Faculty need to identify and share their local hands-on activities that will support the theory portions of the curriculum. Although the labs need not be identical, they faculty should be comfortable enough with their colleagues lab work to accept their students' grades without question.

Industry:

Increased focus on understanding specifications and their relationship to the requirements of a measurement to be made.

I think that the Lecture/Lab split for "Fundamentals of Test Equipment including selection, use and operating principles" could be improved upon - more lecture is needed in order to inform the decisions necessary.

Some kind of introduction to the key physical/mechanical parameters: Mass, Temperature, Length, Pressure, Force, Torque, etc.....

PROJECT PROCESSES

Facilitation

OIPG facilitation was conducted by Susan Bradshaw and Mary Kaye Bredeson, grant project leadership and by Dave Cunningham, who provided project management consultation to the project. CDT facilitation was conducted by Bob Monroig, who provided consultation on curriculum development.

Both the education and the industry participants were asked about the quality of the facilitation they experienced. Because the nature of the work of the CDT and OIPG were different, the educators and industry representatives were asked different questions. However, both sets of questions used the same five-point Likert scale as follows:

- Strongly Agree = 4
- Agree = 3
- Disagree = 2
- Strongly Disagree = 1

Means were calculated for each aspect of facilitation and are shown in the following table.

Educators ratings of the CDT Facilitation	
STATEMENT	n=5
The Curriculum Design Team met frequently enough to meet objectives.	3.20
Communications about meetings, deadlines and deliverables were clear and timely.	3.20
I was clear about my role in the project.	3.20
The curriculum design deliverables and deadlines were clearly communicated.	3.20
The agendas were well thought out in advance.	3.40
Actions steps from last meeting were reviewed and status noted.	3.20
We avoided getting into administrative and management details.	3.25
Different opinions were encouraged. Communication was open and successful.	3.60
The facilitator guided the meeting effectively by allowing and encouraging discussion but staying on agenda.	3.60
Members participated responsibly.	3.75
Decisions were reached after sufficient deliberation.	3.40
Next steps were identified and responsibilities assigned.	3.40
The meetings began and ended on time.	3.40
A written record was made of the action steps.	3.20
The meetings were collegial and collaborative in tone.	3.60
The Curriculum Design Team met frequently enough to meet objectives.	3.20
Communications about meetings, deadlines and deliverables were clear and timely.	3.20
I was clear about my role in the project.	3.20
The curriculum design deliverables and deadlines were clearly communicated.	3.20
The agendas were well thought out in advance.	3.40
Actions steps from last meeting were reviewed and status noted.	3.20
We avoided getting into administrative and management details.	3.25
Different opinions were encouraged. Communication was open and successful.	3.60

Industry ratings of the OIPG Facilitation	
STATEMENT	n=5
My input was valued.	4.00
The meetings were a good use of my time.	3.80
The intentions of the meetings were clear.	3.80
The purpose of the project was clear.	4.00
Communications and updates were sufficient.	3.80

The average across all aspects for the CDT was 3.37 and the average across all aspects for the OIPG was 3.88, a nearly unanimous rating of *excellent*. The combined average was 3.60, which is very high, out of a possible 4.0.

“The facilitators inspired thought to bring out knowledge that each member had to offer.” Educator Participant

Curriculum Development Process

Both educator and industry participants found the curriculum development process to be effective, as indicated in their responses to the following survey items.

Educators were asked to rate the quality of the curriculum development process used by the grant project. A four- point Likert scale was used and ratings were assigned a numerical value as follows:

Excellent = 4
 Good = 3
 Fair = 2
 Poor = 1

The mean rating by educator respondents was 3.4, with all participants rating the curriculum development process as excellent or good. In open-ended questions education respondents indicated that including the industry participants in the process worked well. One educator provided a comment about the curriculum development process:

“A strong team of faculty from diverse measurement science related fields was gathered, facilitation was made available, the time-frame was challenging but reasonable, and the goals were reasonably clear.”

Industry participants were also asked about the quality of the curriculum development process. 100% of industry respondents agreed or strongly agreed that the OIPG was sufficiently involved in the curriculum development process; however two of the five industry respondents indicated that they would have liked to have been included in the faculty working sessions. Respondents also indicated that communication and collaboration were good and that the organization and scheduling of meetings went well. Following are comments from industry participants regarding the curriculum development process.

“Although it would have been interesting to see how the faculty worked together my input at that level would not have been of much value, my expertise is in engineering theirs is teaching.”

“Although it would have been interesting to see a faculty working session it would not be necessary. Educators are the subject matter experts on how to teach they are the best to come up with a curriculum based on my input of what knowledge I would like new hires to have.”

PROJECT OVERALL

Broadly speaking, the project plan worked in that the meetings set up by the CoE were carried out as planned. Additionally, the two face-to-face meetings held in Seattle with the NIST team were very supportive of the project's success.

The project unfolded according to the plan and both the industry and the education participants stayed involved with full participation and for the full term of the project through the final deliverable. The industry participants were very knowledgeable subject matter experts (SMEs) and represented major manufacturing employers in the Puget Sound Region (Boeing, Fluke Corporation, Lockheed Martin, Puget Sound Naval Shipyard, Greysam Industrial Services, CimTech, and Hexcel Corporation). The number of educational institutions involved with the project grew from four to five, and the project had active involvement with a very committed and motivated group of faculty, who met on a regular basis which was not easy for them because of the traveling involved.

The quarterly meetings with industry SMEs were largely effective in the sense that the outcomes for each meeting were met, and drafts of the curriculum were reviewed and feedback obtained. Additionally, the project was successful in meeting with the deans of the participating educational institutions, and plans were discussed for implementing the curriculum and certificate program at each individual college.

Interviews were conducted with CDT Facilitator Monroig and with Project Consultant Cunningham to obtain feedback about the project. Both indicated that, overall, the project was well managed and that it was able to deliver the curriculum required by the grant. Facilitator Monroig was particularly appreciative of Consultant Cunningham for the pre-project DACUM and the coordination of the industry participants, obtaining their input on the drafts of the curriculum and keeping all the participants on the same track. Consultant Cunningham developed the project plan, which is found in Appendix 1.

Both Facilitator Monroig and Consultant Cunningham indicated that it was challenging to pull the full-time faculty out of their institutions for frequent meetings of significant length, which put stress on the faculty members and the project. One suggestion was, in the case of a future similar project, to hold one or two full-day sessions rather than a series of shorter meetings for the curriculum development.

Both also agreed that the project's start date was later than optimal for producing the deliverables and meeting the timeline. However, they also agreed that the organization and recruiting of education and industry participants performed by the project leadership did a lot to overcome the late start. The project completed the curriculum development for the certificate program. However, had the project's kickoff meeting taken place earlier in the timeline, the project would have been able to also gotten farther down the track in implementing the common certificate across partner colleges to include the common course numbering desired by the industry partners.

The community college system in Washington State has three councils at each college, all of which are involved in common course numbering: instructional council, academic transfer council, and professional-technical council. The course numbering is complex and it proved to be a challenge to produce a rapid response to industry, and will require more time than allowed by the grant timeline.

The industry engagement could have been stronger with more time, which would have allowed the project to directly engage the industry advisory committees at the individual colleges to attempt to obtain their support for the project outcomes. This would produce greater sustainability and traction for implementation, as these committees are influential with college Presidents.

Education and industry participants were asked, in open-ended questions, to describe the primary impact they believed the grant will have on colleges, students and/or the workforce. Industry and education responses were affirmative in nature and expressed confidence in the curriculum as follows:

Industry:

“I think this grant will help develop students and a future workforce that have a clearer understanding of measurements.”

“This grant will give students a practical knowledge that can be used by any manufacturing, engineering or construction trade.”

“The primary impact to the workforce will be an immediate improvement of the measurement skills of associates seeking employment. In order to make an impact on students, it will be necessary to follow up with employers to notify and ensure that they specifically seek this form of training now that it is available. This will motivate the students to take the classes, and college benefits by both increased enrollment and meeting its mission of providing relevant education to the community.”

“Measurement science is the fabric of manufacturing and technology. Without a pipeline of qualified entry-level candidates to fill positions in industry, we are at risk of reduced quality products, lower efficiencies, and increased safety risks. By providing our future technical workforce with the necessary skills related to measurement science, we are arming them with the tools they need to be successful.”

“I see this curriculum being very useful in all forms of engineering studies. Giving students in technical and manufacturing curriculums a useful knowledge base in test and measurement will help them secure careers.”

Education:

“Assuming schools can move forward with providing instruction to the curriculum generated, the grant will have come a long way to providing industry with a better skilled workforce, and with providing workers with skills to get better jobs.”

“This new curriculum will help students gain a deep understanding of metrology. We may run some of the class material.”

“Manufacturing programs students will have a better idea of how crucial measurement science is to all of these disciplines. Additionally, the measurement science courses might well serve as a “Intro to Manufacturing” career exploration opportunity for high school students.”

CONCLUSIONS

Based on review of project documentation, observation, interviews with staff and surveys of stakeholders, the NIST SSCD 01 grant was successful in meeting its goals. Highlights of the accomplishments are below:

- The final curriculum received high ratings from both education and industry participants.
- Both education participants and industry SMEs rated the project process very highly.
- Curriculum was developed that leads to a certificate of completion in measurement science.
- Major manufacturing employers and five colleges were involved with the project.
- Relationships between industry and colleges were strengthened.

The project team is to be commended for its perseverance and commitment to manufacturing and measurement science education and training.

Recommendations

The success of the CoE NIST project lays the foundation for additional efforts in the area of measurement science education in the Pacific Northwest. First, the certificate program and associated curriculum will be posted as open-source on the CoE website. This could be used to scale-up the measurement science training and education across multiple community colleges in the region.

Additionally, the CoE could build on the current success to work with industry to develop a set of standards for entry level employees in metrology and endorsed by employers. If employers would agree to interview students who pass the courses, colleges would have a clear map on how to proceed and could leverage the interview commitment for recruiting new students to the programs.

The results of this grant, and the evidence of success gathered by the project positions the CoE well to pursue future funding for follow-on and scale up projects.

APPENDIX ONE

PROJECT WORK PLAN

	Item	Fall Qtr 2014-15		Winter Qtr 2014-15			Spring Qtr 2014-15			Fall Qtr 2015-16
		Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Sept/Oct
1	Project Start	x								
2	DACUM/Course/program Assessment	x	x							
3	C - Design Team Formation			x						
4	CD Team mtgs			x	x	x	x	x	x	
5	OIPG e-communications		x	x	x	x	x	x	x	
6	OIPG F2F mtgs	x		x		x		x	x	
7	Reporting (NIST, OIPG, SBCTC)		x			x			x	
8	Evaluation					x			x	
9	Refinement of Courses & Certs			x	x	x	x			
10	Minutes of CD mtgs to Evaluator & OIPG		x	x	x	x	x	x	x	
11	Instr Council Approvals				x	x	x	x		
12	Program Implementation									x
13	Labor Market Tracking	x		x			x			
14	All contracts & Agreements signed		x							
15	Course and program development			x	x	x				
16	Final Approval of courses/programs by each college							x		
17	Internship Opportunities set-up						x	x		
18	Course and program review and approval					x	x	x		
19	SBCTC Approval					x				
20	Program, Promotion (at all colleges				x	x	x	x	x	

Contracts & Agreements Between CoEx and Stakeholders		Stakeholders _ their roles & responsibilities		NIST Deliverables
				Project Goals
Party	Agreement/Contract	C of Ex	Overall project and budget administration	1. Develop course curriculum with industry subject matter experts' input that can be embedded into advanced manufacturing/aerospace programs.
NIST	Grant Approval and Deliverables	OIPG	1. Technical and overall project oversight 2. Define standards to be met 3. Assist with program promotion 4. Help find internship opportunities 5. Provide student mentoring support 6. Sharing job opportunities with team 7. Providing equipment when possible 8. Helping to find and support new faculty 9. Helping with Goal # 4	
Partner Colleges	Agreements on course numbering, sharing curriculum, recognizing credits, project deliverable dates; fiscal support for development	Curriculum Design Team	1. Leadership on curriculum design 2. Identification of stackable certificates 3. Support of each college's program development 4. Troubleshooting development blocks 5. Monitoring and enabling program approval process in each college and with SB 6. Honoring DACUM in final design 7. Receive and act on feedback from OIPG	2. Develop a series of courses that can be included in a short-term certificate that can be adopted at any of the state's colleges
Contractors	Assignments, fees, expenses, deliverables and project timeline requirements	SBCTC	1. Ensuring all new program, development aligns with PAR process 2. Supporting each college's development efforts	3. Create curriculum that will be easily recognizable (common certificate with course titles/objectives) so that industry hiring managers are able to clearly identify the training when it appears on resumes
State Board	Program requirements as per PAR guidelines; SB support to participating colleges; support with promotion	Participating Colleges	1. Assign a dean and faculty to the Curriculum Design team 2. Finalize an agreement with other colleges, SB and C of Ex on course numbering, Learning outcomes, sharing curriculum, meeting deadlines and providing faculty support	4. Increase the number of community college students that are qualified to fill job openings in measurement science/precision measurement/metrology within local companies
				5. Provide Professional Development opportunities for Design Team faculty to attend industry-led conferences and seminars for exposure to workplace best practices.