APPLICATION COVER PAGE
(Please Print or Type – All Fields Must Be Completed)

Project Name: Digital Design and Fabrication: Collaborative FabLab Training Facility with a Mobile STEM FabLab (FabLab)
Amount Requested: $494,510

Project Director: John Niebergall		
District, School or ESD: Sherwood High School		
Address: 16956 SW Meinecke Rd		
City: Sherwood	State: OR	Zip: 97140
Phone: (503) 825-5500	Email: jniebergall@sherwood.k12.or.us	

Grant Fiscal Agent Contact: Phil Johanson		
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Superintendent: Dr. Heather H. Cordie		
District or ESD: Sherwood School District		
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City: Sherwood	State: OR	Zip: 97140
Phone: (503) 825-5000	Email: hcordie@sherwood.k12.or.us	

	Participating High School or Middle School Name (add additional rows as needed)	Lead Contact Name	Grade Levels	Student Enrollment
1.	Sherwood High School	John Niebergall	9-12	1477
2.	Laurel Ridge Middle School	Ryann Reedy	6-8	514
3.	Sherwood Middle School	Ryann Reedy	6-8	553
4.				
5.				

Please check all that apply:

___ This project directly involves Career and Technical Student Organizations
Please note page of proposal that describes this relationship. Page: _____

__X_ This project has a clear connection to STEM
Please note page of proposal that describes this relationship. Page: 4-8 and throughout document

Purpose and Scope of Project (1 page)

The *Digital Design and Fabrication: Collaborative FabLab Training Facility with a Mobile STEM FabLab (FabLab)* project is being proposed by the Sherwood School District, building on their proven model, and collaborating with Portland Community College, local employers and schools throughout Oregon. The FabLab project's purpose is to:

Create strong partnerships between education and employers to build a revitalized CTE ecosystem in Oregon, in which students engage in collaborative design and fabrication projects, using industry-standard equipment and processes including distance collaboration, to gain academic, STEM, and technical skills that allow them to participate in fabrication and design as globally-interconnected ventures.

The FabLab project's scope incorporates two main elements:

(1) Sherwood High School's Digital Design and Fabrication Lab (FabLab) and a Mobile FabLab provide professional development and offsite fabrication for schools throughout Oregon. Sherwood High School will act as a central training location, and as the hub for digital communication among schools that are working on shared fabrication projects. The project will provide professional development and student training to **at least 96 teachers at 30 Oregon schools**, supporting implementation/expansion of digital design and fabrication programs.

(2) Sherwood High School's onsite and mobile FabLab have industry-standard equipment, for use as the training hub, and provides revitalized CTE **instruction for 400 Sherwood High School students annually**. Sherwood Middle School and Laurel Ridge Middle School will implement new FabLab activities, reaching an estimated **1,015 middle school students per year**.

Supporting the Overall Revitalization Effort - Innovation in the delivery of CTE

In Sherwood High School's FabLab students engage in an engineering and technology pathway, using digital design and fabrication tools. Students take courses aligned with Oregon Skill Sets, and eight of 10 classes offer dual-credit from Portland Community College. The FabLab will both improve the status quo and offer new trainings that will bring the existing CTE program to scale across Oregon. Innovation occurs though:

- *Professional development*. The Sherwood High School CTE teacher, John Niebergall, has helped schools in several states implement FabLab programs, and will use the Sherwood High School Lab and the mobile FabLab to provide professional development for partnering schools throughout Oregon. Please see *Expansion and Growth of CTE in the State*. This will allow many more Oregon students to engage in Industrial and Engineering Systems programs of study.
- *Curriculum development*. Curriculum has been developed and replicated, and partnering schools can use it, or adapt it to design new/enhanced curriculum.
- *Problem-based teaching*. The FabLab instruction is designed around problem solving activities, many of which are posed by local industry partners. Also, in the FabLab model, students engage in collaborative projects, communicating and working with students in other schools and businesses. This innovative model overcomes traditional school and geographic boundaries, preparing students to work in a globally interconnected manufacturing environment.
- *Facility upgrades*. Industry-standard equipment at the Sherwood High School FabLab and mobile lab, as well as CNC vinyl cutters for partnering schools will allow CTE programs to align with current industry practices, skill sets and standards.

Integration of required and bonus elements into a coherent project

In the FabLab, students problem solve through fabrication & design, based on current industry practices of digital design, distributed project implementation with multiple geographic locations, and evolving technologies such as 3D printing and rapid prototyping. Students learn interrelated skills – from STEM technology skills like CAD and CAM, and math used in measuring and design, to communication skills using Skype with off-site team members – that lead to high wage, high demand careers in engineering and manufacturing.

The project replicates a successful program of study and professional development, bringing curriculum and activities to the middle school level and to additional Oregon high schools. The program of study incorporates strong industry involvement. These lead to outcomes including increasing the number of students, making program delivery more relevant by using industry standard equipment, and teacher professional development.

The FabLab model integrates core academic content and community resources. All ten courses have Industry Validated Technical and Academic Skill Standards based on Oregon Skill Sets; eight qualify for dual credit with Portland Community College. Core academics are integrated throughout, with a Technical Skills Assessment (TSA), and industry validated performance based skill assessment. The academic content connects the FabLab program with diploma requirements, academic achievement, college and career readiness. Community resources are integrated through local business involvement. Businesses help design projects engaged in by students and may contribute equipment, manufacturing parts, mentoring students, material or printing, worksite tours or student internships. Having projects with a tangible end product, relevant to local industry, conveys the value of the program to both students and parents.

Expansion and growth of CTE in the district, region and state (1 page)

The *FabLab* project directly supports the growth of CTE both in the Sherwood School District and in the State of Oregon using a proven model. The Sherwood High School FabLab CTE Teacher, John Niebergall, has assisted multiple schools in Oregon, Washington, and Alaska to replicate the FabLab.

The project includes several strategies to expand CTE programs in Oregon, thereby creating a "healthy ecosystem" of digital design and fabrication within the state:

Professional development through the mobile FabLab and Sherwood High School Fab Lab. The mobile lab will travel to locations throughout Oregon to provide training at the regional, district or school level. Training will be based on local needs, including understanding of high and low priced equipment (from $1,500 to $30,000), so that schools can customize their programs based on available budgets. The distance student-collaboration model means that students without a specialized lab will be able to participate in a design and manufacturing process; this may be of particular interest for schools with fewer resources to dedicate to creation of a lab. The mobile lab can also be used to provide summer workshops for students. Target: 30 schools with 96 teachers, who in turn provide education to at least 2,100 students (100 students per 21 schools during grant).

The FabLab at Sherwood High School will expand to provide additional learning opportunities for Sherwood High School Students (as well as providing fabrication for students at other schools). Target: 400 Sherwood High School students annually.

The two Sherwood Middle Schools will create completely new opportunities for students at those schools, thereby growing CTE programs. Target: New Digital Design and Fabrication units integrated into three courses, reaching 1,015 students annually.

Experiential Learning (1 page)

Bilkstein (2013) finds that the Digital FabLab approach makes education more experiential and connected to real-world objects. An estimated 95% of activities in the Sherwood High School FabLab classes are hands-on. In the FabLab, students learn by doing, designing creations on a computer, often after several types of measurements and calculations. For example, in 3D modeling, to make an iPhone holder, students measure the dimensions needed and create a design using CAD software, applying STEM skills. The student sends the design to the 3D printer, creating a real, rapidly prototyped model that can quickly and accurately be adjusted to meet customer needs.

The FabLab model is inherently problem based. Students work on projects identified as part of the curriculum, or on new problems that are suggested by industry partners. The attachment, *Door Check Design*, shows a door latch design problem provided by Daimler.

Students work with high levels of autonomy. Individual students are trained in a specific area, and then teach their peers. As a result, students take lead roles in project administration, programming, quality control, or OEM (original equipment manufacturer). Students work together to solve problems, with teacher coaching. The Program of Study includes capstone projects in which students take charge of bringing a project through from launch to completion.

The model simulates 21st century global manufacturing methods through remote student teams using CAD/CAM software and telephones/internet to design, model, and manufacture products using rapid prototype tooling. Industry partners are particularly supportive of students learning to work across multiple sites, and using peer-based problem solving.

Project Description (20 pages)

A. Project Outcomes and Progress Markers

The *Digital Design and Fabrication: Collaborative FabLab Training Facility with a Mobile STEM FabLab (FabLab)* project will build strong partnerships between education and employers that will engage students in collaborative design and fabrication projects, using industry-standard equipment and processes including distance collaboration, in order to provide a revitalized, relevant CTE program accessible to schools and students throughout Oregon. Students will gain the academic and technical skills (STEM) that allow them to understand and participate in fabrication and design as globally-interconnected ventures. Outcomes and progress measures are as follows. (*student numbers count class enrollments; students may be counted more than once if they take more than one class)*.

1. Outcome: Partnerships focused on multiple FabLabs throughout Oregon are improved and sustained with business, industry, labor, and education, through professional development focused on helping schools implement or improve FabLab CTE programs that incorporate multi-school collaborative student projects, industry support, and dual credit.

Progress Markers (observable within grant period):

1.1. The SHS FabLab provides **training to 96 teachers from at least 30 schools** throughout Oregon. Teachers and schools participating in training are required to engage in collaborative partnerships around student projects, thereby creating a healthy "digital fabrication CTE ecosystem." **At least 70% of schools (21 schools) implement FabLab CTE instruction including multi-school collaborative student projects** during the grant.

1.2. Each school will identify local industry partners to collaborate with their FabLab, posing industry relevant problems for students, and otherwise engaging with the project. **All 21 implementing schools connect with at least 2 industry partners (42 total**).

1.3. At least **15 schools will develop or expand dual-credit options, in partnership with a community college** (PCC or a local college).

2. Outcome: Student access to Industrial and Engineering Systems CTE programs of study will be improved, as teachers learn to implement/expand digital design and fabrication programs and have appropriate equipment and software available.

Progress Markers (observable within grant period):

2.1. All 30 schools (100%) will receive a vinyl cutter that can be used to teach digital design and fabrication skills.

2.2. At least **70% of schools (21 schools) will implement FabLab activities** during the grant period, reaching approximately 100 students per school, so that **2,100 Oregon students are able to engage in education related to a Industrial and Engineering Systems program of study**. (The remaining schools implement later).

2.3. Sherwood High School students will have access to a FabLab, with industry standard equipment, providing access to improved education for **400 students per year**.

2.3. Two Sherwood Middle Schools implement 3 new digital design and fabrication units in existing classes, reaching **1,015 middle school students per year**, building interest and excitement for those students to enter a CTE program of study in high school.

3. Outcome: Increased rigor in technical and academic content aligned to diploma requirements, industry recognized technical standards and employability skills. This occurs as the professional development focuses on the Sherwood FabLab model which uses an approved Program of Study incorporating **10 courses with Industry Validated Technical and Academic Skill Standards based on Oregon Skill Sets**, and eight qualify for dual credit with Portland Community College.

Progress Markers (observable within grant period):

3.1. **At least 70% of schools (21 schools) increase their rigor,** using curriculum aligned with the state approved program of study and industry validated skill standards.

3.2. At least **15 schools will implement a dual-credit class** within the grant period.

4. Outcome: Increased career opportunities for students.

Progress Markers (observable within grant period):

4.1. **100% of high school students (2,100 students) will learn industry-demanded skills** by engaging in Digital Design and Fabrication CTE education, leading to increased career opportunities. As described below, FabLab skills prepare students to enter careers in high demand, high wage careers, such as Engineering Technician, Engineer, CAD Technician, Machinist or Entrepreneur.

4.2. At least **4 students at Sherwood High School will launch businesses** using FabLab skills (from sign manufacturing to design and printing of logo materials).

4.3. At least **2 industry partners at each of the 21 implementing schools (42 total)** play an active role in local program implementation, and will provide career related learning experiences for students, such as speakers, tours, and project opportunities.

5. Outcome: Improved ability to meet workforce needs in Oregon.

Progress Markers (observable within grant period):

5.1. **100% of high school students (2,100 students) have access to industry standard software and equipment** (directly and through shared fabrication projects), and learn skills that Oregon industry has identified as needed in their workforce (through the industry validated skill standards), including areas such as visualization skills, collaborative project work at multiple sites, and independent work.

5.2. Of the 400 Sherwood High School Students, 95% will learn skills that meet industry workforce needs, demonstrated by class projects.

5.3. At least 1,015 middle school students have FabLab experiences, thereby building excitement for high school programs and building the CTE pipeline of students, thereby increasing the number of students likely to gain skills that meet workforce needs.

B. Career and Technical Education Program of Study Design

The FabLab program is based on Sherwood School District's State approved Industrial and Engineering Systems program of study (please see attachment). In this engineering and technology career pathway that incorporates STEM skills, students use digital design and fabrication tools: Industry Standard CAD and CAM design software; laser systems for cutting, engraving, and marking; 3D printers; CNC routers; 3D Scanning, and vinyl cutters.

Students at Sherwood High School will have access to this program of study. In addition, the professional development for teachers in other schools will help those teachers implement and/or adopt this program of study for use within their school or district. As such it will develop new or enhanced CTE programs of study at participating schools.

Each of the 10 courses in the Program of Study are listed below, along with alignment with Oregon Skill Sets, demonstrating connection to state academic content standards including STEM, industry-recognized technical standards and employability skills.

<table>
<tr><th colspan="2">Sherwood High School Engineering and Industrial Systems CTE Program of Study</th></tr>
<tr><td colspan="2"><u>Architecture 1, 2, 3 and 4</u>: Four separate courses, 0.5 credits each. Students explore the software package of their choice, and use industry standard programs such as Chief Architect. Career exploration is included as a class component.</td></tr>
<tr><td>Dual Credit

PCC

ARCH 111 Working Drawings, 3 credits

ARCH 140 Chief Architect, 3 credits</td><td>Industry Validated Technical Skills
DESIGN AND PRE-CONSTRUCTION
COPA10.01 Develop technical drawings drafted by hand or computer-generated plans to design structures.
COPA10.02 Employ appropriate representational media to communicate concepts and design.
COPA10.04 Apply basic organizational, spatial, structural and constructional principles to the design of interior and exterior space so that design plans are effective.
COPA10.05 Interpret schematics, blueprints, and technical drawings.
COPA10.07 Create technical sketches using technical sketching techniques and procedures.
COPA10.08 Use a CADD system and procedures.
COPA10.09 Detail projection views/components.
COPA10.10 Explore architectural drafting and design concepts and problems.
COPA10.11 Demonstrate drafting and design concepts as related to architectural design using CADD systems.
COPA10.12 Create drawings of structural sections and details using CADD systems.
COPA10.13 Create pictorial drawings and models.</td></tr>
<tr><td colspan="2"><u>Engineering 1:</u> one course, 0.5 credit. Introductory course in Computer-Aided Design (CAD) with an emphasis on engineering & design. Students use state of the art computer equipment along with the latest version Rhino3D, learn and improve sketching skills found in engineering fields, learn to draw technically precise images with a computer to industry standards, and create custom products.</td></tr>
<tr><td>Dual Credit

PCC
Two 2-credit classes will start Winter 2013</td><td>Industry Validated Technical Skills
MECHANICAL CAD/DRAFTING
MNPJ10.01 Apply measurement and scale concepts in drafting and design.
MNPJ10.03 Create technical sketches using drafting procedures.
MNPJ10.04 Use a CADD system and procedures.
MNPJ10.05 Detail projection views/components.
MNPJ10.06 Explore mechanical drafting/design concepts and problems.</td></tr>
</table>

Sherwood High School Engineering and Industrial Systems CTE Program of Study	
	MNPJ10.09 Depict assemblies of components.
Engineering 2: *one course, 0.5 credits.* Intermediate level engineering course. Students learn Solid Works, the industry standard, to communicate graphical information. Students expand knowledge in problem solving, visualization and design, explore advanced sketching techniques related to engineering. Students produce prototypes (such as: Lego bricks, animations and CNC projects) using the Fab Lab equipment.	
Dual Credit PCC DRF 117: Drafting Fundamentals, 4 credits; DRF 270: SolidWorks Fundamentals, 3 credits	**Industry Validated Technical Skills** MECHANICAL CAD/DRAFTING MNPJ10.01 Apply measurement and scale concepts in drafting and design. MNPJ10.02 Interpret engineering documents and control documents. MNPJ10.03 Create technical sketches using drafting procedures. MNPJ10.04 Use a CADD system and procedures. MNPJ10.05 Detail projection views/components. MNPJ10.06 Explore mechanical drafting/design concepts and problems. MNPJ10.07 Demonstrate drafting/design concepts as related to basic manufacturing processes. MNPJ10.09 Depict assemblies of components. MNPA02.01 Communicate with others to ensure that the manufacturing production process meets requirements.
Engineering 3: *one course, 0.5 credits*. Students engage in problem solving, fabricating and design activities. Dimension Printings 3D Re-Design Challenge, 2D to 3D laser projects, CNC vinyl, 3D printing of personal jump drives, Lego part design and the possible exploration of Arduino projects, silicon mold making, CNC PlasmaCAM and CNC ShopBot projects. These are all industry standard machines that many university programs do not yet have.	
Dual Credit PCC CAS 216A: Beginning Word, 1 credit MCH 291: Laser Cutting and Engraving Fundamentals, 1 credit MCH 292: FDM Additive Manufact.	**Industry Validated Technical Skills** MECHANICAL CAD/DRAFTING MNPJ10.01 Apply measurement and scale concepts in drafting and design. MNPJ10.02 Interpret engineering documents and control documents. MNPJ10.03 Create technical sketches using drafting procedures. MNPJ10.04 Use a CADD system and procedures. MNPJ10.05 Detail projection views/components. MNPJ10.06 Explore mechanical drafting/design concepts and problems. MNPJ10.07 Demonstrate drafting/design concepts as related to basic manufacturing processes. MNPJ10.09 Depict assemblies of components. MNPA02.01 Communicate with others to ensure that the manufacturing production process meets requirements. MANUFACTURING PRODUCTION PROCESS DEVELOPMENT MNPA10.01 Produce a product that demonstrates the relationship between production processes and meeting customer needs.

<table>
<tr><th colspan="2">Sherwood High School Engineering and Industrial Systems CTE Program of Study</th></tr>
<tr><td>Fundamentals, 1.5 credits</td><td>MNPA10.02 Implement manufacturing processes to manage production of new and/or improved products.
MNPA06.01 Monitor, promote and maintain a safe and productive workplace using a variety of techniques and solutions to ensure safe production of products.</td></tr>
<tr><td colspan="2"><u>Engineering 4 & 5</u>: two courses, 0.5 credits each. Students immersed in hands-on problem solving activities with access to all Fab Lab technologies. Class is for the advanced student who wants individualized instruction and in-depth study. Possible areas of study that carry PCC credit include: Rhino 3D, SolidWorks, Product Design, 3D Printing, Laser Cutting and Etching, CNC Routing, 3D scanning, ShopBot, PlasmaCAM & MasterCAM. All students use the state approved Technical Skills Assessment (TSA).</td></tr>
<tr><td>Dual Credit
• CAS 216A Beginning Word, 1 credits
• MCH 291 Laser Cutting and Engraving Fundamentals, 1 credit
• MCH 292 FDM Additive Manufacturing Fundamentals, 1.5 credits
• MCH 229 Rapid Prototyping, 5 credits
• MCH 290 MasterCAM Fundamentals Orientation, 1.5 credits
• MCH 294 3 Dimensional Digital Laser Scanning Fundamentals, 1.5 credits</td><td>Industry Validated Technical Skills
MNPA10.02 Implement manufacturing processes to manage production of new and/or improved products.
MNPA10.06 Improve production processes in order to achieve manufacturing goals and meet customer and product standards.
MNPJ10.01 Apply measurement and scale concepts in drafting and design.
MNPJ10.03 Create technical sketches using drafting procedures.
MNPJ10.04 Use a CADD system and procedures.
MNPJ10.05 Detail projection views/components.
MNPA06.01 Monitor, promote and maintain a safe and productive workplace using a variety of techniques and solutions to ensure safe production of products.
MNPA10.02 Implement manufacturing processes to manage production of new and/or improved products.
MNPA10.01 Produce a product that demonstrates the relationship between production processes and meeting customer needs.
MNPA10.01.05.09 Inspect the product to verify that it meets specifications.
MNPA02.01 Communicate with others to ensure that the manufacturing production process meets requirements.
MNPA02.01.03.01 Communicate safety, training, and job-specific needs using speaking and presentation skills.</td></tr>
<tr><td colspan="2"><u>Imagine*Design*Build It – No Boyz Allowed</u>. 0.5 computer credits. In addition to the Program of Study, Sherwood High School offers an all girl's class that requires no previous experience in Computer Aided Design (CAD). Various projects include using modeling software and woodshop equipment to transform ideas into 3D objects.</td></tr>
</table>

All classes prepare students technically and academically for further education beyond high school. Eight are dual credit, leading into the Portland Community College career and technical pathways in areas including Manufacturing Technician and Engineering Technician. PCC credits can also be applied to similar programs at Oregon Tech or state universities. Students can earn 29 credits, which fits with state 40/40/20 goals.

The educational pathway leads to high wage and high demand careers. The following table lists careers associated with the pathway, as well as average Oregon wages and projected job growth (all data from the Oregon Employment Department, www.qualityinfo.org). All targeted jobs pay close to or higher than Oregon's average hourly wage which is $22.36 per hour for Oregon's private-sector payroll employees (9/17/13, Oregon Employment Department, http://www.olmis.org/pubs/pressrel/0913.pdf).

Occupation	**Average Wage**	**Projected Job Growth: 2010 - 2020 job openings / % change in employment**	
Architectural/Civil Drafter (CAD Tech)	$22.81	+307 jobs	+23.6%
Civil Engineering Technician	$28.22	+118 jobs	+11.8%
Electrical Engineering Technician	$27.84	+ 434 jobs	+ 14.8%
Mechanical Engineering Technician	$24.88	+ 91 jobs	+ 21.4%
Civil Engineer	$38.64	+563 jobs	+ 17.7%
Electrical Engineer	$45.49	+ 256 jobs	+ 16.4%
Mechanical Engineer	$40.07	+ 483 jobs	+ 19.1%
Machinist	$22.07	+ 666 jobs	+ 23.1%
Model makers – metal and plastic	$22.60	+ 5 jobs	+20.8%
Commercial and Industrial Designers	$28.25	+ 71 jobs	+ 29.2%

Please note that in addition to the above listed occupations, students are able to become entrepreneurs. Entry costs to opening a business are relatively low, because much of the work can be done on a computer, with items manufactured either on a low cost machine (starting at $1,200 for a vinyl cutter) or sent out to a manufacturer (similar to the model used

between high school programs). Sherwood High School students have started successful businesses designing and making metal signs, vinyl for motorcycles, and jewelry.

C. Underserved Students

The Sherwood School District's FabLab program encourages all students to succeed. Mr. Niebergall has been an innovator in creating opportunities for underrepresented students. After noticing the lack of non-traditional students in the CTE classes, he co-developed a program in 2009-2010, for girls only, in which girls design, develop, and produce a product following the FabLab model. The response was overwhelming. In 2011 John and three students were recognized by the National Center for Women & Information Technology (NCWIT) with the Award for Aspirations in Computing.

Overall, the FabLab model is particularly suited to reaching underserved students.

Students who are economically disadvantaged or first generation college going are often well served by the FabLab model. Bilkstein, P. (2013), finds that "Especially in low-income schools, students would often tell me that they used to 'make' and build things with their parents and friends, and often had jobs in garages, construction companies, or carpentry shops. However that experience was disconnected from their school life ….In the lab, students … were still constructing, building, and using their hands, but all the work was permeated with two socially valued practices: computation and mathematics.…. By building onto students' familiar practices and adding a layer of expressive technologies, a digital fabrication lab, which merges computation, tinkering and engineering, has the potential to augment rather than replace familiar and powerful practices that students already possess, therefore they can recognize their own previous expertise in what they accomplish."

Students who are English Language Learners can access CAD training manuals in 16 different languages.

For many students with disabilities, the computer aided nature of the process eliminates manual dexterity requirements, thus allowing many students to engage in a broader level of design and production than was possible in the past. In addition, students with disabilities can use a modified curriculum, and often can work side by side with other students on the same projects, contributing to the group project as part of a team – designing a logo, burnishing, or applying transfer tape – and thus make a valuable and real contribution to the end product.

In addition, the *Imagine*Design*Build It – No Boyz Allowed* class recruits and supports girls in the CTE program. This is important in that women are underrepresented in engineering and manufacturing careers and preparatory educational programs. National statistics illustrate that girls are less likely than boys to be exposed to computing in middle or high school. Although girls represent 47 percent of Advanced Placement (AP) Calculus test-takers and more than half of AP test-takers overall, only 18 percent of Computer Science AP test-takers are girls. Having a safe space, for young women to learn new skills together, helps to overcome gender biases, and help these students learn and practice new skills. The class has a hugely successful history, documented both in local news media and nationally on the CBS Evening News (5/6/12).

Professional development activities will include strategies for teachers to recruit underserved students, emphasizing the benefits and special characteristics of the FabLab, and the connections with local industries and jobs likely to be familiar to the students. Strategies to ensure the success and participation by underserved students will also be

included. The project will support communication among teachers to share best practices, including for recruiting and supporting underserved students.

D. Diploma Connections

The FabLab project will help students meet the requirements of the Oregon Diploma. Students engage in career related learning experiences that support Essential Skills:

- Read and comprehend a variety of text. This includes written instruction manuals for using software and equipment, as well as written orders from collaborating schools which use the Sherwood FabLab to manufacture items.
- Write clearly and accurately. Students must write up projects, including both for the class instructor, and for collaborating students at other schools and industry partners.
- Apply mathematics in a variety of settings. Students measure and use mathematical concepts to design items, and use graphs and other data to develop solutions to design and fabrication problems.
- Listen actively and speak clearly and coherently, and think critically and analytically. Students use and develop these skills as they problem solve, working together in teams both in the classroom and with offsite collaborators, to jointly solve problems.
- Use technology to learn, live, and work. The FabLab is highly technology based, with computers, software and machines used to generate ideas, products and processes, and to participate in broader industry and community service projects.
- Demonstrate personal management and teamwork skills. Again, the collaborative nature of projects leads to students developing these skills as they must plan out and execute a project, working with their fellow students.

The Sherwood High School's Achievement Compact with the state set a goal of 39% of students graduating with 9 or more college credits, and Sherwood has set an internal goal of 45% of students. Other school districts have similar goals. Implementing FabLab programs with dual credit options helps schools meet these goals, leading schools to implementing the Governor's 40/40/20 plan as a realistic, attainable goal.

Students are also able to personalize their educational experience by choosing the number of classes taken that focus on CAD technical skills, architecture and engineering, as well as working on capstone projects focused on their individual interests.

E. Sustainability and Communication

The FabLab project has been designed to be sustainable. It replicates a model of CTE delivery that has been sustainable in Sherwood High School, using district CTE and Carl Perkins federal funds as well as generating significant new cash and product donations from business and community partners.

For the FabLab project, all equipment will continue to be used beyond the life of the grant, thereby sustaining existing and new FabLab programs, which can be taught by existing CTE staff or other relevant teachers at each school. Further, the professional development activities will build the knowledge base at each school, and this knowledge will continue into the future. Mr. Niebergall will use rhino3du.ning.com and Edmodo to connect teachers and industry partners, and provide a means for ongoing communication. These connections between programs support continued learning and partnership. In addition, he is working with McNeel and Associates to develop webinars that can be used

on an ongoing basis for training. Further, the mobile FabLab can continue to provide professional development Oregon, using existing professional development funds.

Ultimately, however, the goal of the FabLab project is to create a systems change in which Oregon has a self-sustaining ecosystem of knowledge and programs regarding digital design and fabrication. The project seeks to create the critical mass that will allow programs and teachers to work together, sharing knowledge as well as physical resources like specific types of printers. Teachers, industry, and students can work together, across conventional boundaries, to create and make projects. Sharing knowledge of successful programs helps to celebrate successful actions and leadership. The kinesthetic nature of the products created in the FabLab also helps to use the media to share the effectiveness of the program. Sherwood School District will continue to use the full complement of district communication strategies to inform parents, students, partners and the community, including press releases, email newsletters, websites and social media, and will encourage partnering schools to do the same. As part of the collaborations, teachers will be encouraged to share their successful communication plans.

F. Activities and Timeline

The FabLab project will accomplish the following activities, tied to project outcomes:

Outcomes	Activities	Timeline
Outcome 1.: Partnerships Improved and Sustained *Rationale:*	1.1. SHS FabLab professional development a. purchase equipment, set up labs, including mobile lab, adapt existing teacher training b. identify & schedule schools c. provide training	a. Spring 2014 b. Spring and Summer 2014 c. Summer, Fall & Winter 2014/15

Teachers and schools participating in training are required to engage in collaborative partnerships around student projects, thereby creating a healthy "digital fabrication CTE ecosystem."	1.2. Professional development helps new programs build connection with Industry Partners. Each school identifies 2+ industry partners	As professional development provided (1.1.c.)
	1.3. Professional development helps new programs develop Dual Credit options with PCC using already developed model, or programs may develop with another community college	As professional development provided (1.1.c.)
	1.4. Evaluate partner satisfaction with FabLab project, compile into final evaluation report	Spring 2015
Outcome 2: Student access improved *Rationale:* Teachers learn to implement CTE programs, have appropriate equipment available, and more programs available to students.	2.1.1 Professional development delivered; schools/ teachers completing training receive vinyl cutter	Summer, Fall and Winter 2014/15
	2.1.2 Schools implement or improve FabLab Activities, including collaborating on projects with SHS for use of equipment in fabrication	Summer, Fall and Winter 2014/15
	2.2. Sherwood High School students access fully equipped FabLab, learning industry standard skills	Summer 2014 and ongoing
	2.3. Two Sherwood middle schools implement new units covering digital design & fabrication activities in 3 courses.	Fall 2014 launch, classes in 2014/15
Outcome 3: Increased Rigor *Rationale:* Programs use the Sherwood FabLab model which has demonstrated rigor	3.1 Schools implement curriculum aligned with state approved POS and industry validated skill standards, based on Sherwood HS program.	School year 2014/15
	3.2 At least 15 schools implement dual-credit class(es), and students earn both high school and college credit.	Fall and Winter 2014/15
Outcome 4: Increased career opportunities *Rationale:* FabLab skills prepare students to enter careers in high demand, high wage careers.	4.1. 2,100 students learn industry-demand skills through full participation in FabLab CTE classes and programs of study.	School year 2014/15
	4.2 4 SHS students launch businesses using Fab Lab skills learned in CTE program	School year 2014/15
	4.3. 42 industry partners provide career related learning experiences	School year 2014/15
Outcome 5: Improved ability to meet workforce needs	100% of high school students (2,100 students) fully participate in CTE education with access to industry standard software and equipment Sherwood High School.	School year 2014/15

Rationale: Students learn industry standard procedures, problem solving, other business skill needs	Of the 400 Sherwood High School students, 95% will earn skills that meet workforce needs, demonstrated in class projects.	Fall and Winter 2014/15
	At least 1,015 middle school students have FabLab experiences, leading to their increased participation in the high school level programs.	Fall and Winter 2014/15

The professional development workshops will be delivered by the Sherwood High School CTE Instructor, John Niebergall, in partnership with other teachers and industry contacts. Workshop content includes using CAD/CAM/Software; using fabrication equipment (vinyl cutter, 3D printer, etc.); technical vocabulary used in digital design and fabrication; how to identify and implement projects that engage students; working collaboratively; identifying Dual Credit opportunities, implementation strategies, and CCSS opportunities to add into project design and reporting. **Mr. Niebergall is highly experienced in helping teachers and schools launch FabLab programs, and has worked closely with educators in Oregon schools**, including Gaston, North Marion, Century, Hillsboro, Forest Grove, Glencoe, Crook County, Corvallis, St. Helens, Aloha, West View, Benson, and Meek Tech**.** Over the course of Mr. Niebergall's 29-year career in public education he has taught Engineering, Architecture, CAD/CAM, Math, and more. In all of these classes, he provides his students with hands-on, contextual, real-world learning experiences. He has coached his students in robotics where they were national champions. His state of the art prototyping lab CTE program has led to a student-run enterprises, in which students design and manufacture products used in the community.

Professional development workshops will be delivered throughout Oregon. The workshops may be delivered via the mobile lab or at the Sherwood High School lab. To the

extent possible, workshops will be scheduled to reach several schools within a geographic area. Similarly, consecutive workshops may be held in an area to meet local interest.

Workshops will typically be 3 days in length, and can be attended by 12 teachers. The workshop will follow the curriculum which Mr. Niebergall has used previously with schools. Workshop information includes the curricula, technical skills, evidence-based strategies for developing a successful program, building community involvement, and proven strategies for implementation of dual credit opportunities for students.

When possible, Mr. Niebergall will incorporate a student from Sherwood High School in delivering the professional development. All participating teachers are asked to bring a student to the workshop, so they learn with the student and bring skills to the classroom together. This model has proven to be highly successful, is a best practice, both building student interest and providing additional expertise in the classroom.

Each school which has teachers completing the workshop will receive a CNC vinyl cutter, appropriate software with license, a roll of vinyl, a roll of mask, and a flash drive with projects. This will allow teachers to immediately begin to use the materials to teach digital design and fabrication skills to students; teachers and schools can then continue to add equipment over time, and can have access to collaborating schools' or partnering businesses' equipment for manufacturing items designed on in-classroom computers.

Each school that participates in the professional development and receives a CNC vinyl cutter will agree to two obligations: (1) contribute any new curriculum developed back to the project and other Oregon schools, including samples of work done in the classroom; and (2) join in collaborative projects in which students work with students from other schools and districts. It is expected that approximately 70% of schools will implement

FabLab activities in year 1, with the understanding that 100% of CAD teachers will be ready to implement, but that other interested teachers such as art or agriculture teachers, may implement an activity but will take longer to get an approved curriculum or to integrate FabLab activities into a program of study in a new area.

Following the professional development workshop, Mr. Niebergall will spend an additional one to three days in the community, to meet with community leaders and parents, help build business connections , and potentially to assist teachers with setting up classrooms. During the school year, as teachers implement FabLab activities, they will be connected with one another though the rhino3du.ning.com and Edmodo to provide peer-to-peer support; Mr. Niebergall is also available to answer questions.

G. Evaluation

The evaluation of the FabLab project will be measured against the following numeric progress marker outcomes (also in Section A: Project Outcomes and Progress Markers):

- Sherwood High School Lab upgraded & Mobile FabLab created.
- Professional development delivered to 96 teachers in 30 Oregon schools; schools receive a vinyl cutter and other materials allowing rapid implementation of new FabLabs.
- 21 high schools implement Digital Design and Fabrication activities with students.
    - 21 high schools provide rigorous instruction using curriculum that aligns with industry validated skill standards and ties to a state approved program of study.
    - 15 high schools provide dual-credit offerings related to FabLab instruction.
    - 2,100 students engage in experiential learning of industry-demand skills; student counts gathered through teacher feedback using free Google forms.

- 42 industry partners are involved in Digital Design and Fabrication activities with schools (based on 2 partners per each school), playing an active role in their local program and providing career related learning experiences.
- Two Sherwood Middle Schools implement 3 new Digital Design and Fabrication units within classes in STEM, Engineering, and Family and Consumer Science (FACS) classes, reaching 1,015 students.
- Sherwood High School provides improved CTE instruction to 400 students; At least 95% will learn skills of value for industry.

The evaluation measures related to professional development will be collected by John Niebergall. On an ongoing basis, he will track trainings provided, and which schools/regions received training. During late-Spring 2015, he will survey all teachers and schools which received training to determine what activities were implemented and the number of students reached. He will also work with Sherwood Middle School teachers to collect information on the middle school programs.

Sherwood High School students in Engineering 4 - 6 will participate in an existing Technical Skills Assessment using a performance based skill assessment covering the following: CAD/CAM/Prototyping; Planning Skill Sets; Design Skill Sets; Production Skill Sets; and Communication Skill Sets. The TSA is included as an attachment, and is systematically collected by Sherwood School District and reported to Oregon Department of Education. The remaining students will demonstrate skills gained through completion of projects in class, which teach Industry Validated Technical Skills; this documentation is systematically collected as part of regular instructional activities.

Finally, the FabLab project is working to create a strong knowledge base and culture supporting digital design and fabrication in Oregon. This will fully occur after the grant period. However, Mr. Niebergall will collect qualitative data that he will include in the final grant report. This will be comprised of items such as descriptions of collaborative projects with multiple schools, student and teacher success stories, industry involvement, etc.

Partnerships

Partnerships with other schools, with industry, and with community colleges are one of the defining features of the FabLab proposal, and of the proposed CTE instruction. Please see the attached Partner letters. The initial idea for this proposal was generated by discussions among school and business partners. Mr. Niebergall has worked with many Oregon schools, both formally and informally, and has received requests for additional training. The following email from McLoughlin High School demonstrates the impact of partnerships:

John, I cannot begin to thank you enough. Last year we started our Manufacturing Tech classes that were modeled after your classes. Before I would get about 15 students who would sign up for CAD. I filled 2 periods with 20 each semester last year. This year I filled 3 period with 29 and could easily fill 1-2 more periods. ….

Regionally my program is being used as a model for other schools. Hermiston and Heppner are getting lasers this year. …Every district in our region with an Industrial and Engineering program now has 3d printers and we are all moving toward using Rhino.

It is making real dramatic changes in all of our programs. Hermiston and I have been going full speed toward digital fabrication … and the others are following. - James Polson, McLoughlin HS, Milton-Freewater

Similarly, industry partners are seeking students from the CTE program to hire. Expanding capacity of Oregon's educational system to produce students with these skills will respond to that industry demand.

For project implementation and beyond, partners will play the following roles:

- **High Schools**: teachers attend professional development; provide digital design and fabrication instruction for students; engage in collaborative projects with other schools; actively engage industry in partnerships. In addition, programs can take on projects for industry, such as 3D printing, making displays, or having industry representatives and students engage in joint work.
- **Industry**: provide input into skill and workforce needs and how those needs change over time; share projects and challenges that students can solve; provide additional career related learning experiences such as internships, job shadows, etc. Donate materials and use of manufacturing equipment, such as specialized printers, etc. that the school labs may not have. The Sherwood High School program has a documented history of receiving several thousand dollars per year of donated materials. Last year, Multi-craft donated $22,000 worth of plastic (enough for several years of projects); Port Plastic also donated plastic; Lowe's donates a variety of items; Elite Granite and Marble donated tiles; The Joinery donated wood; and several other local businesses give cash donations.
- **PCC, other community colleges**: work with high schools to continue developing dual-credit opportunities for students in areas such as advanced 3D Modeling and rapid prototyping. Continue professional development for teachers. Continue to use industry advisory committee with regional schools.

Partners are correlated to high wage and high demand jobs. Community colleges help students continue their education. Industry partners are typically engineering firms which have engineer and engineering tech jobs, or are local manufacturers, all of which tend to pay above average wages. These industry partners may hire students. They also help assure that CTE programs are providing students with the right skills, in demand by industry, which leads to success in postsecondary education and in securing employment.

Bonus Sections

A. Career and Technical Student Organizations (CTSOs) (1 page)

n/a

B. Middle School Component (1 page)

Three courses—STEM, Engineering, and Family and Consumer Science (FACS)—at the two Sherwood middle schools will be vertically aligned with the high school's CTE courses. Students will learn about digital design, fabrication, and opportunities in high school and careers, while developing engineering and technology skills.

Students will have access to the Mobile Lab, computers for design work, a CNC vinyl cutter and associated supplies, and exposure to programs in electronics, robotics and software. Students will learn how to program for basic robotics, calculate and track results for units in rocketry and CO_2 cars, and design layouts for structures, including earthquake-proof buildings. CNC cutters can be used to produce materials from student-generated designs. The FACS classes will engage in projects such as planning and designing fabric layouts, now almost exclusively done in industry settings using lasers and CNC cutters.

Once per quarter, middle school students will work through the design cycle with student partners at Sherwood High School, using a blended teams approach. This will excite students into continuing exploration of CTE courses in high school, and give them an engaging application of the real-world fabrication process and its possible careers. Middle school CTE teachers will engage in professional development, learning how to use Rhino, the CNC cutter, design software, and technical vocabulary of digital design and fabrication.

During the 2014/15 school year, instruction will reach 1,015 students as follows:

- 35 students x 5 classes x 2 middle schools (SMS & LRMS) = 350 STEM Students
- 35 students x 5 classes x 1 school (SMS) = 175 Engineering Students
- 35 students x 14 classes (5 at SMS/ 9 at LRMS) = 490 FACS Students

Once developed, the program model and curriculum can be shared and replicated.

C. Out of School Time Programming (1 page)

Out of school time programming is a key component of the Digital FabLab.

Most directly, the professional development includes students both assisting to deliver the professional development, and attending the professional development with the aim of assisting teachers to implement programs in their schools. While not a large number of students or amount of time, this is a significant experience for students, allowing them to take on a more professional role, care for equipment, and feel ownership of their learning.

Students in Sherwood High School's Digital FabLab program have the opportunity to participate in multiple out of school opportunities. One of the primary ways is through robotics programs, in which students can engage in activities at the high school level, and can lead to participation in an after school club in which high school students teach robotics to elementary and middle school students, leading those activities.

The Sherwood "Summer Institute" provides a potential additional opportunity for students to take classes in the Industrial and Engineering Systems program of study. Many students each year choose to take additional classes that fit within their academic and career pathway.

The Digital FabLab program also has a component in which students are able to start their own businesses. Students have started successful businesses in everything from metal work to vinyl decorations to sign making to jewelry. Many of these business continue after the students graduate, and may even continue to be operated out of dorm rooms.

All after school time programming can be replicated in other school districts; should a school chose to replicate a program, additional advice and support will be provided in this area.

D. Focus on Regional, Statewide or System Changes (1 page)

The FabLab project is designed to add scalability to the successful Sherwood High School program. The overall focus is to help develop programs, strategies and approaches that will be implemented by multiple schools and districts in Oregon.

As described throughout the proposal, the intent is to reach at least 50 schools in Oregon and 96 teachers. Having this many schools engaged in delivering rigorous, proven digital design and fabrication instruction will have impacts throughout Oregon's CTE system.

One of the most exciting elements is the collaborative nature of the student work. With this broadscale implementation, students can problem solve like they do in industry, reaching out to peers in other schools, to ask for help with a problem or to access highly specialized software or equipment. For industry, typically design teams are not in the same building, so the distance collaboration piece gives students skills used in industry.

Further the broadscale nature of implementation creates systems change in that schools can share curriculum, having multiple schools, teachers and students contribute to the pool of knowledge, awareness of possible projects, and ways to include industry.

Developing these skills in Oregon students also helps revitalize the state in that local industry is able to hire Oregon youth, rather than searching outside the state or nation. This helps to keep our talent local, and provides good jobs for our Oregon graduates.

Now is the right time to do this project. Five years ago a 3D printer cost $20,000. Now one can be purchased for $1,600. This allows schools to provide a digital FabLab for a lower entry cost. Schools can add a vent to a traditional classroom, and have a state-of-the-

art FabLab to use. This makes it more possible to create a vigorous digital design and fabrication ecosystem in Oregon.