2013 Session
Joint Committee on
Ways and Means
Trans/Econ Dev Subcommittee
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Exhibit #: 3

A Partnership for Innovation and Competitive
A Proposal from Oregon's Research Universities

Overview

Oregon realizes substantial returns on modest investments by linking its four research universities (Oregon State, University of Oregon, Portland State, and Oregon Health and Science University) with established industries and new businesses. Over the past eight years, the Oregon Innovation Council (Oregon InC) and its three Signature Research Centers (SRCs) focusing on nanoscience (ONAMI), biotechnology (OTRADI), and environmental technology (BEST), have worked with the universities to achieve a return of seven dollars for every dollar invested by the Oregon Legislature, through research grants, new startup companies, and venture capital.[i] In addition, an increasing share of the universities' $800M of annual research expenditures come from major collaborative, interdisciplinary grants, over $10M each, involving two or more of the schools.

When Oregon InC was launched, few other states had comparable programs, and federal funding was more readily available. Oregon's economic success is now threatened by competition from other states building similar but larger strategic initiatives linking economic development with research and innovation. Washington,[ii], Arizona,[iii], Ohio,[iv], and others have out-invested Oregon in the past decade, buffering their economies from the latest recession, and increasing their success rates for federal grants. However, by upgrading our telecommunications infrastructure, strengthening collaboration, expanding business incubation capabilities outside Portland, and taking advantage of Oregon-based computing expertise from companies like Intel and IBM, we can leapfrog these other states and recapture a leadership position in innovation.

Objective

Oregon's research universities, Oregon InC, and Oregon-based companies propose a "Partnership for Innovation and Competitiveness" that will position Oregon to more effectively use scientific and technological discovery to grow new businesses, preserve the competitiveness of our existing manufacturing base, and participate in the shaping of entirely new industries. This initiative includes five components:

- *Networking*: Enhance high-speed computer networking capacity and associated expertise across the state to allow unprecedented sharing and analysis of huge data sets ("Big Data"), which are transforming industries ranging from drug development to energy generation to resource management.
- *Incubation*: Add business incubation facilities in Corvallis and Eugene to those near PSU and OHSU, thus launching a distributed network that can increase the success of startup companies derived from university-based research statewide.
- *Competitiveness*: Make Oregon's extensive metals industry more competitive through stronger research and training ties to university faculty and students.
- *Efficiency*: Use the IT industry's latest analytics techniques to help manufacturing companies design more efficient and cost-effective processes and supply chains.
- *Partnerships*: Better support private sector partners and job creation by connecting the five Regional Solution Centers to each other and the universities.

[i] http://www.oregon4biz.com/ assets/docs/13-15InnoPlan.pdf
[ii] http://www.pnwgp.net/
[iii] http://www.flinn.org/file/a_bridge_crossed.pdf
[iv] http://www.sri.com/sites/default/files/brochures/final_oh_impact_exec_sum_sri.pdf

SPREADSHEET FOR OMI PROJECTS FOR THE LAST SIX YEARS

COMPANY	PROJECT	INDUSTRY FUNDS
American Bridge	Application of electroslag welding for the Oakland ...anchor	$ 63,500.00
American Bridge	Electroslag welding technology application development	24,900.00
American Bridge	Analysis of electroslag weldments	11,721.00
American Bridge	Electroslag welding technology application development	137,107.00
American Bridge	Electroslag welding technology application development	90,000.00
American Bridge	Prior Year	45,000.00
ATI Wah Chang	Simulation of metal extrusion facility	7,500.00
ATI Wah Chang	Effect of temperature and strain rate on the flow stability of... materials	4,500.00
ATI Wah Chang	Bicriteria forge scheduling of jobs	34,422.00
ATI Wah Chang	Nitrate removal optimization for treatment in constructed wetlands	70,000.00
Benchmade Knives	Optimum blade characteristics for sharpness	6,000.00
Benchmade Knives	Development of a knife testing device	10,000.00
Benchmade Knives	Development and application of a testing ... blade steels	15,000.00
Benchmade Knives	Development and application of a metal cutting tool selection procedure	15,000.00
Benchmade Knives	Blade steel alloy formulation	25,503.00
Blount	Self-contained cutting-fluid system for concrete-.....chain saws	40,000.00
Blount	Kickback censor and brake systems for a chain saw, part II	40,000.00
Blount	Self-contained system for concrete-and-metal-cutting chainsaws, part II	40,000.00
Blount	Optimum garden-pruner blade-edge geometry	40,000.00
Blount	Characterization of hard thin wear resistant coatings	56,000.00
Blount	Kickback sensor and brake systems for a chain saw	39,000.00
Boeing	Analysis of dimension change	18,325.00
Boeing	Finite element analysis of induction heat treating...gear	15,000.00
Boeing	Materials properties for computational modeling of machining process	17,500.00
Boeing	Computer simulation of rockman hardness test	11,847.00
Boeing	Development of a sustainability assessment ... components	51,000.00
Boeing	Spur/Bevel gear flow line scheduling	34,529.00
Bount	Hard chromium coating alternatives technology evaluation	84,000.00
Cascade Steel	Operations characterization..... steel production system	9,250.00
Cascade Steel	Development of an implementation strategy...and training	10,209.00
Cascade Steel	Deployment and implementation...tools and training	7,289.00
Cascade Steel	Deployment and implementation...tools and training	7,000.00
Cascade Steel (2009 adj)	Deployment and implementation...tools and training	620.00
Clear Edge Power	Characterization of damage at a steel/composite interface	5,000.00
Coast Distributions	Welding procedure specification and qualification development	8,000.00
Columbia Steel	Best practices for dissimilar metals joining	25,000.00
Daimler Trucks North America	Effective composites to replace metals	15,000.00
Daimler Trucks North America	Effective composites to replace metals II	18,250.00
Daimler Trucks North America	Effective composites to replace metals III	25,000.00
Daimler Trucks North America	Intelligent optimization of super truck routing...operation	45,000.00
Daimler Trucks North America	Effective composites to replace metals IV	25,000.00
Daimler Trucks North America	Robust commercial vehicle control, routing and operation	20,451.00
Davis Tool	Bicriteria job scheduling with dual resource constraints	15,000.00
DeMarini Sports Inc.	Aluminum bat performance	20,000.00
DeMarini Sports Inc.	Aluminum bat performance (Phase VII)	20,000.00
DeMarini Sports Inc.	Aluminum bat performance (Phase VIII)	20,000.00
DeMarini Sports Inc.	Aluminum bat performance	20,000.00
DeMarini Sports Inc.	Aluminum bat performance	20,000.00
ESCO	Thermophysical and mechanical properties of cast steel	25,000.00
ESCO	Abrasive wear behavior of weld overlayed steel	25,000.00
ESCO	Microstructural and wear property evaluation of cast alloys	25,000.00
ESCO	Influence of fracture test methods on the evaluation ... practices	25,000.00
ESCO	Toughness, wear and microstructural relationships in steel	25,000.00
ESCO	OSU Validation Study with FE SafeTM/VerityTM Software	29,999.00
EST & D	Analysis of electroslag weldments with complex geometries	10,000.00
EST & D	Modeling of electroslag welding	10,000.00
EST & D	Electroslag welding advanced technology development	8,000.00
EST & D	Heavy section ESW application for elevated temperature	5,000.00
EST & D	Microstructural Analysis of elecgtroslag weldments..geometries	8,000.00
EST & D	Novel methods of evaluating electroslag welds	8,000.00
EST & D	Development of electroslag weld preheating procedures	8,000.00
FEI	Materials selection and process optimization...sources	8,000.00
FEI	Lifetime and reliability improvements of novel ion sources	8,000.00
FEI	Investigation of materials for lithium liquid metal ion sources	9,000.00
FEI	Investigation of materials and processing for electron optic elements	9,000.00
FEI	Investigation of materials for liquid metal ion sources	9,000.00
Gunderson	Extension of 2005-06 Project (Rail Car Deck Tests)	15,000.00
Hewlett Packard	Development of lead-free piezoelectric materials and devices	75,000.00
Hewlett Packard	Materials for high performance actuator applications	100,000.00
Hewlett-Packard	High performance piezoelectric materials.....applications	75,000.00
Intel Corporation	Fracture toughness of various printed circuit board ...lead free solder	1,948.00

Intel Corporation	Project to study imaging of embedded metal interconnects II	13,700.00
Intel Corporation	Phase III AE Monitoring of Solder Joint (SJ) Failure	15,000.00
Intel Corporation	Fracture toughness of various...with a lead free solder	3,508.00
Intel Corporation	Fracture toughness of various...with a lead free solder Part 2	11,235.00
Intel Corporation	Sputtering of metal films for microelectronics processing	50,000.00
Marks Metal	Implementation of electroslag welding technology	14,000.00
Northwest Pipe	Adhesion mechanism of liquid polymer coatings to steel pipe	25,000.00
Northwest Pipe	Materials and process evaluation for API products at NW Pipe	20,000.00
Northwest Pipe	Comparison of materials used in pressure pipe applications	25,000.00
Northwest Pipe	Identify and quantify key variables influencing ...connections	25,000.00
Northwest Pipe	R & D of prototype restraint system for small ....gasketed joints	25,000.00
Northwest Pipe	Scheduling and Rescheduling of Metal Pipes	31,764.00
Northwest Pipe	Development and testing of modified ...for steel pipe	20,000.00
Northwest Pipe	Comparison of materials used in pressure pipe applications	25,000.00
Octavian	Gold Aluminum contact assessment, Phase 2	35,000.00
Octavian	Phase III gold aluminum gold copper assessment...test	8,750.00
Oregon Cutting	Assessment of alternative manufacturing..development R/D	30,000.00
Oregon Cutting	Property characterization of hard thin wear resistant coatings	81,000.00
Oregon Iron Works	Linked column system analysis and component tests	27,000.00
Oregon Iron Works	Linked column system analysis and component tests Phase II	30,000.00
Oregon Steel Mills	Simulation of rolling mill processing	20,000.00
Oregon Steel Mills	Assessment of the impact of process parameters... practice	25,000.00
PCC Structurals	Thermophysical Properties of FSX 414	2,500.00
PCC Structurals	Casting alloys and Process Design	96,922.26
PCC Structurals	Physical and mechanical properties of material	98,020.00
PCC Structurals	Test apparatus for abrasive grinding, part 2	20,000.00
PCC Structurals	Part handling system	20,000.00
PCC Structurals	Fractographic and Microstructural Analysis of Ni-based Alloy Test Bars	10,000.00
PCC Structurals	Thermophysical properties of ceramic shells	50,000.00
PCC Structurals	Modeling gamma prime precipitation in nickel alloys	22,872.50
PCC Structurals	Unified hot tear/crack modeling	22,872.50
PCC Structurals	Design tools for investment casting	93,851.50
PCC Structurals	Operations assessment and scheduling decision..SSBO production	11,022.50
PCC Structurals	Test apparatus for abrasive grinding	10,000.00
PCC Structurals	Identification of vulnerabilities to human error...inspection process	27,107.50
PCC Structurals	Scheduling and rescheduling of castings	34,544.00
PCC Structurals	Self-cleaning systems for caustic tanks	15,000.00
PCC Structurals	Reducing visual inspector error	14,840.00
PCC Structurals	Test apparatus for abrasive grinding - budget amendment	11,141.00
PCC Structurals	Swing grinder operator interface	13,073.00
PCC Structurals	Metallurgy and properties of advanced nickel alloys	45,000.00
PCC Structurals	Welding of cast nickel alloys	45,000.00
PCC Structurals	Welding of cast nickel alloys (Revision of 1st project)	15,000.00
PCC Structurals	Material properties of forming materials and cast Alloys	90,000.00
PGE	Finite element and physical...structures and components	18,000.00
Sheldon Manufacturing	Humidity and temperature control of thermal chambers	25,000.00
Sheldon Manufacturing	Design and fabrication plan for a slide-out platform	8,975.00
Sheldon Manufacturing	Peltier cooling of an incubator	9,500.00
United Street Car	Street Car Boogie Monotonic and Fatigue Test	31,000.00
Wah Chang	Process simulation/characterization	5,000.00
Wah Chang	Electron microscopy analysis of titanium and hafnium alloys	10,000.00
Wah Chang	Processing Effects on Electrical Properties of High Purity Niobium	7,000.00
Xerox	Materials properties for brazing simulation	3,000.00
	Total Projects Funded	$ 3,352,568.76

OREGON METALS INITIATIVE

2011 - 2012
Annual Report

Oregon Metals Initiative
2011 - 2012
Annual Report

MISSION AND GOALS:

The Oregon Metals Initiative, Inc. (OMI) is a consortium of metals industry companies and research institutions that pursue research to improve the long-term competitiveness of the metals industry and the research infrastructure in Oregon. Metals industry firms are involved in a diverse range of activities including primary metal production, manufacturing of fabricated components, designing and building a wide range of specialized machinery and transportation products including trucks, railcars, ships, and aircraft components. In addition to the direct economic impact provided by payrolls, metals firms play an important role in providing demand for products and services produced by other Oregon businesses such as intra-industry sales of metals industry products, business services, energy, and transportation.

OMI was established in 1990 as a mechanism to both support and enhance the competitive position and contribution of the metals industry to Oregon's economy and, more generally, to the national economy. The organization is managed by a 10-member board of directors which includes both industry and research (university) representatives. Mark Nelson, Public Affairs Counsel, currently serves as OMI's Executive Director. The following are OMI's objectives:

- Develop new technologies and new applications of existing technologies;
- Increase metals research capacity, accessibility and infrastructure;
- Encourage collaboration on research between the metals industry and Oregon's scientific research institutions; and
- Improve the competitive position of Oregon's metals industry.

The objectives are met through joint industry-academic research projects. Interested companies work with one of two research institutions, currently Portland State University and Oregon State University, to develop project proposals. Every July, the OMI Board meets for its annual meeting. At this meeting, the Board reviews the proposals to ensure they meet the criteria established in the by-laws. The Board then determines which projects will be funded up to the level of available matching funds. The Oregon University System provides the matching funds to the industry funds on a 1:1 basis. It is the availability of the matching dollars that renders OMI feasible. With the matching support, the industry has been able to undertake research that would not have been pursued at all or at this time, and research institutions have benefited from the invaluable experience of conducting this research and working with industry.

All funds go to the research institution, with none being earmarked for administrative costs. The Oregon State Board of Higher Education states, "Since 1990, the Oregon Metals Initiative has exemplified the concept of successful private-public partnerships... OMI is the model the Chancellor's Office hopes other industries will emulate in the next biennium." (OSBHE Docket 4/17/98).

PARTNER ORGANIZATIONS:

- Oregon State University
- Portland State University

PARTNER COMPANIES:

- ATI Wah Chang (2 Projects)
- American Bridge (1 Project)
- Benchmade Knife Company (1 Project)
- Blount International (3 Projects)
- Daimler Trucks North America (1 Project)
- DeMarini Sports, Inc (1 Project)
- EST&D (1 Project)
- ESCO (1 Project)
- PCC Structurals (4 Projects)

INVESTMENT:

During fiscal year 2011 – 2012, $440,338 from the industry was matched by $440,337 in state funds to conduct research projects.

TABLE OF CONTENTS:

Blade Steel Alloy Formulation

Participating Company: Benchmade Knives
Company Contact: Dave Maxey
Participating University: Oregon State University
OSU Principal Investigator: David Kim & David Porter

PROJECT SUMMARY:

This project was to conduct blade steel characterization tests and fit empirical models of alloy elements to blade performance and to conduct a test to quantify the effect of edge angle on sharpness.

The project has been completed. This project provided the ability to apply a more systematic and scientific procedure to understand blade steel performance.

It is difficult to quantify the cost savings, but a more focused future product development is what the true savings would be. No new jobs were created directly, although a technician was used to help conduct testing. The possibility exists of developing a new product, but there is a requirement for more development. No new patent applications or patents were filed.

The team involved was able to learn more about steel alloys and additional types of statistical analysis while creating a strong working relationship between OSU and Benchmade Knives.

BUSINESS SUMMARY:

The goal of the project was to reach an understanding of the effects on the steel performance from each alloying element in the base material. This would in turn provide the data to create unique steels for our application to optimize and differentiate the product performance. The project has been completed.

Process development costs would decrease because the specific material properties would be understood. We estimated this would reduce the development costs by 25% for the specific blade component using the unique material. The improved performance would allow increased product value and therefore increased product. Estimate 10% increased margin potential. This project focused on US made materials only. The objective is to utilize only US materials on future products to promote local sources and minimize lead times.

No new jobs were created by this project, but the job responsibilities of the lab technicians increased to meet the necessary materials testing. New markets will be created due to the understanding of the materials and possible new applications. No patents have been created at this time. As previously

mentioned, the goal was to create unique material with possible proprietary properties.

Testing methodologies and data analysis are new to the test lab.

The project was a follow-on project based on the initial project outcome and the knowledge base of the academic staff. There is an expectation or goal for an ongoing relationship between the company and academics for mutual research and growth.

KICKBACK SENSOR AND BRAKE SYSTEMS FOR A CHAIN SAW, PART II

Participating Company: Blount
Company Contact: Jamie Munn
Participating University: Oregon State University
OSU Principal Investigator: John Parmigiani

PROJECT SUMMARY:

The goal of this project was to develop a safety system for gasoline powered chainsaws that would electronically detect kickback and actuate a brake mechanism. Kickback occurs when the tip of the chainsaw gets lodged in a work-piece, causing the saw to accelerate back toward the operator very rapidly. Current chainsaws have mechanical braking systems that can be unreliable, sluggish to actuate, difficult to design and are prone to wearing out over time. This project aimed to replace some of the impreciseness of a mechanical brake with an electronic safety system. This new system could potentially reduce the dangers of kickback by sensing kickback earlier, stopping the chain faster in the event of a kickback and providing a more repeatable and reliable safety system.

The project has been completed. Two capstone design groups designed two separate proof-of-concept brake mechanisms, and a state of the art detection method was developed by a graduate student. The information has been presented to the sponsor company and will be implemented as they see fit.

Chainsaws are very dangerous tools for untrained operators to use. Even with the current safety devices as mandated by the US Consumer Product Safety Commission thousands of people are injured by them each year. Implementing a new safety system will benefit the company by providing them with a marketable safety advantage to consumers that are aware of the inherent dangers of chainsaw use.

This project could result in a new product or a new product feature that would expand the company's presence in certain markets. This research did not lead to a new patent or a new patent application.

For the graduate student, the project involved developing experimental data collection methods and exploring several types of data analysis methods to develop a kickback detection algorithm. The graduate student was also responsible for managing and mentoring the capstone design students working on the braking system. The capstone design students gained experience with developing fast-acting brake mechanisms, working as a team, developing testing targets and procedures, and documenting research and project results.

The connection made during this partnership has allowed for continued collaboration between Oregon State and Blount International. Several research projects of various sizes have been initiated as a result of the partnership, and Blount has hired the graduate student working on the kickback project as a full time employee.

BUSINESS SUMMARY:

To research if kickback in a chainsaw could be repeatedly detected using modern electronics, and could a safety braking device be actuated quickly enough by the detecting electronics to reduce to potential occurrence of injury from misuse.

This project has been completed. Documentation and prototypes have been produced to our requirements.

The problem that we were addressing is that chainsaws are very dangerous tools for untrained operators to use. Even with current safety devices as mandated by the US Consumer Product Safety Commission thousands of people are injured by them each year. Implementing a new safety system would benefit the company by providing them with a marketable safety advantage to consumers that are aware of the inherent dangers of chainsaw use.

The cost savings would be potential years of internal research reduced due to the mass creativity of the students and the guidance provided by the supervising and consulted professors. Due to this project, we have created one internal Research & Development Engineering position to hire the graduate student who led the research. There is high potential for new features within an existing product category that may be developed. There have been no new patents or patent applications relating to this research.

This project has allowed the engineering students an opportunity to learn and exercise:

- Project management skills
- Teamwork
- Machinery design
- Drawing and dimensioning and GD&T tolerances...to real life producible results
- An understanding of validating testing to theory
- Applied research
- Digital signal and filtering theory
- Application of theoretical calculations and CAE modeling to actual results
- Presentation skills

The connection made during this partnership has allowed for continued collaboration between Oregon State and Blount International. Several research projects of various sizes have been initiated as a result of the partnership. Blount has hired the graduate student working on the kickback project as a full time employee.

SELF-CONTAINED SYSTEM FOR CONCRETE-AND-METAL-CUTTING CHAINSAWS, PART II

Participating Company: Blount
Company Contact: Todd Gerlach
Participating University: Oregon State University
OSU Principal Investigator: John Parmigiani

PROJECT SUMMARY:

Concrete and metal cutting chainsaws utilize abrasive chains and continuous water supplies. Current saws use 1-2gpm of water flow during cutting operations. These high flow systems meet most

industrial needs, but there is a desire to reduce the water input to make the system more time efficient and portable. If the water flow can be reduced by 90% then the required water quantity for a job can be carried by the operator. This will allow access to sites that do not have continuous water supplies. Further, using less water reduces work stoppages. When using 1-2gpm the work site can become flooded and will need to be pumped out periodically before work can continue. A low flow system will not require these work stoppages. However, the water used in concrete cutting has many tasks to accomplish. It cools, lubricates, and clears the chainsaw of debris. It also suppresses dust. Reaching the

benefits of a low flow system requires the understanding of how to maximize the effectiveness of the water supplied, so that these performance critical functions are maintained.

This project has had much progress towards its goals and is nearing completion. Proof-of-concept prototypes of self-contained, portable fluid delivery systems have been successfully designed, built, and tested. Further, a solution has been found to suppress dust emissions below OSHA regulations at 0.1gpm using a high performance additive mixed with water. The wear characteristics of the saw during cutting still need to be addressed, but once a solution for wear and the new found solution for dust suppression can be combined, a low flow concrete and metal cutting chainsaws can be started down the path of marketability.

It is not possible to determine the cost savings. The new product developed is a low flow concrete and metal cutting chainsaw. It will remain in the construction market, but it can be used on job sites that are not currently considered because a continuous water source is not available.

Many skills were required to progress this project closer to its goals. The students gained experience in project management and task allocation as they designed, built, and tested prototypes. In order to meet OSHA standards a knowledge base of applicable regulation procedures and air sampling techniques were required. The students employed a third party lab to analyze these dust samples, but in certain instances performed the analyses themselves. Further, SEM EDS imaging analyses were conducted on the air samples to determine the composition of the dust particles. Dynamic flow modeling was learned for designing flow passages in the internal passages of the chainsaw's guide bar. A test test-bench flow system for controlling the fluid input to the concrete cutting chainsaw was designed, built, and tested. Thus designing this device required knowledge of fluid mechanics and sensor, pump, and piping component selection. Lastly, the students researched high performance additives for use as mixing agents in water to be used in concrete cutting.

A student used Finite Element Analyses and Energy Balance Methods to determine the thermal input to a wear location on the chain/bar interface.

BUSINESS SUMMARY:

As defined above, the goal of the project was to substantially reduce the water needed in using diamond chain concrete-cutting products. This project is nearing completion.

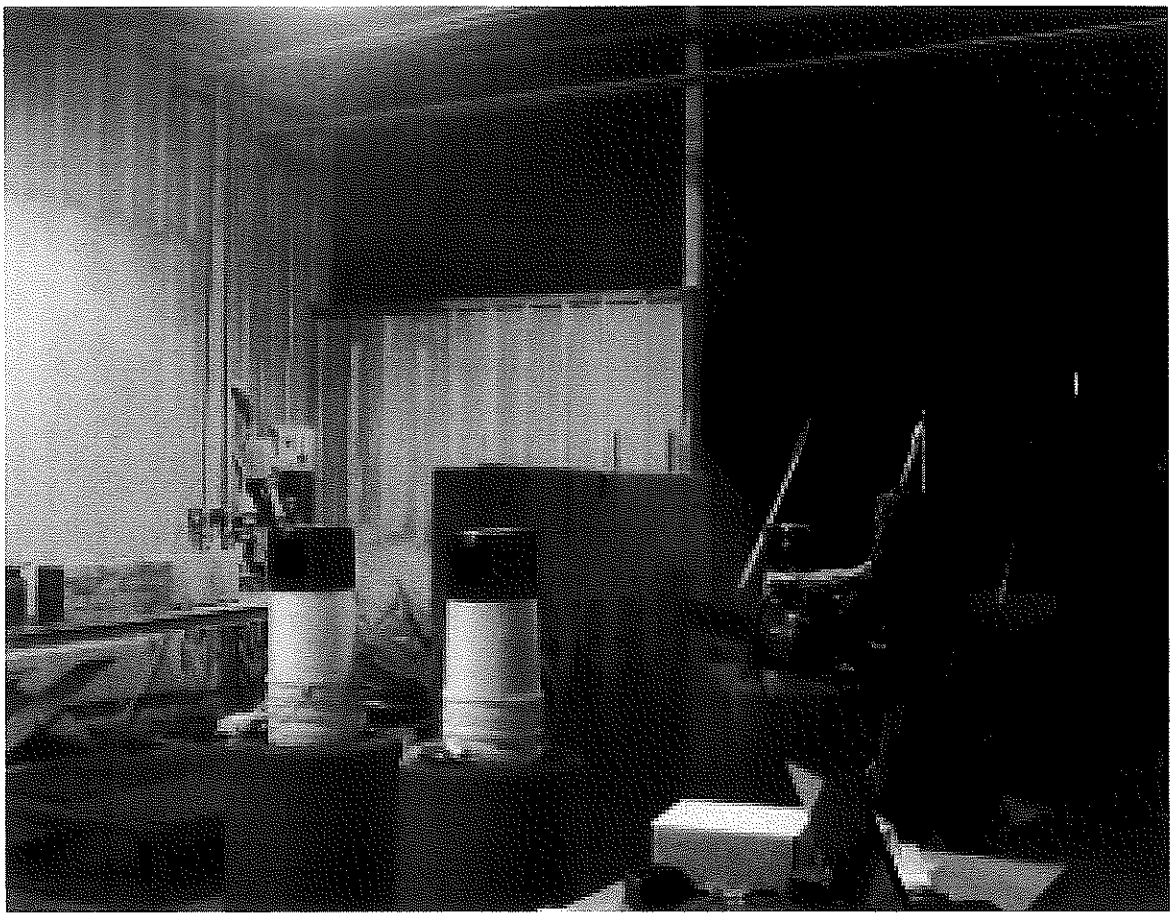
Estimated saving for the company is valued in saving years of internal engineer's time and thousands of dollars in testing to reach the conclusion as discovered by the research team. Due to the knowledge of OSHA dust measurement instrumentation gained by us we have hired one test technician and two engineers.

There is a moderate to high likelihood for several product improvements to be made to incorporate this new technology once more deeply understood and validated. At this time, no patents or applications have been applied for.

This project has allowed the engineering students an opportunity to learn and exercise:

- Project management skills

- Teamwork
- Machinery design
- Drawing and dimensioning and GD&T tolerances...to real life producible results
- An understanding of validating testing to theory



- Government regulations and their impact on product design or performance
- Application of theoretical calculations and CAE modeling to actual results.
- That mechanical engineering can encompass a wide array of technologies, such as thermal dynamics, fluid mechanics, chemistry, metrology, machinery design, and CAE to name a few.
- Presentation skills

In other research projects in this partnership certain team individuals that have been sponsored for research have ended up being hired by our company as they have demonstrated excellent engineering skills.

OPTIMUM GARDEN-PRUNER BLADE-EDGE GEOMETRY

Participating Company: Blount
Company Contact: Jamie Munn
Participating University: Oregon State University
OSU Principal Investigator: John Parmigiani

PROJECT SUMMARY:

The shape of a cutting blade determines which application it should be used for. Large thick blades are used for cleaving and small thin blades are used for filleting. Blount wishes to improve on their prototype powered garden pruner by gaining a deeper understanding of the effects of different blade geometries such as straight, curved, smooth, or serrated. The goal of the project was to investigate the effects of different blade geometries on cutting force by using experimental and analytical methods.

The project is ongoing. A device for performing experiments on cutting blades has been created. A review into what theories and experiments have been conducted in this area has been performed. Using a theory created by another researcher, an analytical model has been created. A numerical model for blade cutting is being developed through the use of finite element analysis to extend on the information gained from the analytical model.

The prototype-powered garden pruner created by Blount was capable of cutting small twigs. Blount wished to have a device that could cut up to a three inch diameter branch. They also wanted to maximize the battery life of the pruner. This required a deeper understanding of how exactly their pruner cuts wood. This project solves the problem by looking at different blade geometries and seeing which geometry minimizes the amount of energy needed to cut a wooden rod.

The product created from this project will allow for the creation of a device that cuts wooden rods up to three inches and runs off a battery. This allows the user to take it anywhere without having to bring along a power cord and also reduces hand fatigue from excessive pruning.

A new product will be developed based off the findings from this project. A small market already exists for such a project. This project allowed a team of students to gain experience in the mechanical engineering field before entering the work force. Each team member learned how to better research technical aspects of a project and how to apply what they learned in class to real life situations.

BUSINESS SUMMARY:

The objective of the project is to gain an analytical understanding of the ratio between the fore/aft motion and the vertical motion in a slicing blade when cutting a green branch or wooden object. To see if within a parameter ranges an optimal ratio may be analytically defined or calculated and proven. The project is ongoing. A device for performing experiments on cutting blades has been created. A review into what theories and experiments have been conducted in this area has been performed. Using a theory created by another researcher, an analytical model has been initiated.

To find an optimal slicing angle that consumes the least amount of energy in slicing through a branch we may develop a cordless battery operated pruner that produces a very clean cut and by using the least amount of energy that would maximize the run-time of the product on a single charge.

The iterative process to fabricate, test, and measure the energy consumptive values of various slicer blade geometries could possibly take years to hit upon an optimal geometry. With the analytical model the cost of prototypes, resources involved in designing, fabricating, and testing can be significantly reduced.

A rough estimate of material and resource savings may be in the $100k range. There may be several hundred hours in labor and/or resource saved should we decide to commission the university team to build a duplicate testing rig that we could use for our development purposes. There were no additional jobs created. A new product is intended to be developed using the theory that comes from this research. But, as of yet, there have been no new patents or patent applications.

This project allowed the engineering students an opportunity to learn and exercise:

- Project management skills
- Teamwork
- Machinery design
- Drawing and dimensioning and GD&T tolerances...to real life producible results
- An understanding of validating testing to theory
- Applied research
- Application of theoretical calculations and CAE modeling to actual results
- Presentation skills

In this partnership certain team individuals that have been sponsored for research have been hired by our company as they have demonstrated excellent skills.

EFFECTIVE COMPOSITES TO REPLACE METALS IV

Participating Company: Daimler Trucks North America
Company Contact: Justin Yee
Participating University: Oregon State University
OSU Principal Investigator: John Parmigiani

PROJECT SUMMARY:

Trucks are typically constructed using a ladder frame. These frames are typically fabricated from steel and are relatively quite heavy. The overall goal of this project (parts I, II, III, and IV) was to explore light-weight alternatives to steel in the fabrication of truck frames, specifically frame rails and cross-members. The project began with considering various candidate materials resulting in the selection of carbon-fiber composite material. Next, engineering analysis and design work was conducted to create a computer model of a carbon-fiber frame rail and, later, a carbon-fiber cross-member. The frame rail was fabricated and tested at the sponsors' Portland facility.

The project is complete and a final report has been submitted to the sponsor, DTNA in Portland.

The problem for industry, DTNA in this case, was that their product (trucks) needed to be made lighter in weight in order to have better fuel economy and/or to allow more freight to be carried for the same amount of fuel.

Estimated cost savings (capital, labor or resources used): No cost savings for DTNA. Carbon-fiber frame components are more expensive than steel. If implemented as a product option, purchasers of trucks with carbon-fiber frames would realize cost savings from greater fuel efficiency or greater freight efficiency (more freight for same fuel cost). If implemented, DTNA would offer a more fuel efficient vehicle which may lead to greater sales.

The research skills of students were greatly enhanced. This project funded the education of two graduate students. The project topics provided not only subject matter for their thesis and project reports, but also gave them an in-depth education in composite materials application, design, and testing. Due to the positive outcome of this project, subsequent projects are likely.

BUSINESS SUMMARY:

The major thrust of this project was validation of design for a composite beam. The project has been completed.

Weight can be a critical component to freight hauling, especially in those cases in which trucks are maxed out on weight. Every pound reduced on a tractor means another pound of freight that they could haul. This project tried to reduce weight on one of the heaviest components on a tractor, the frame rails. No real measurable cost savings have occurred, however weight limited customers are willing to pay for weight reduction.

The skill level was raised for the students involved in the project. The students learned about how to analyze composite structures, and the pitfalls of performance versus idealized design.

It was determined that at this time the end product is still too expensive, so no patents or patent applications have been sought.

A continued working relationship has been developed between Daimler and Oregon State University.

SELF-CLEANING SYSTEMS FOR CAUSTIC TANKS

Participating Company: PCC
Company Contact: Jim Barrett
Participating University: Oregon State University
OSU Principal Investigator: John Parmigiani

PROJECT SUMMARY:

Two teams were to design, build, and test prototype devices to remove dissolved casting material from a hot caustic tank at PCC used to remove mold debris from castings.

The project is completed. Both designs were submitted to the project sponsor for evaluation and determination of the best solution to pursue.

Dissolved casting material was building up and hardening on the bottom of PCC's hot caustic casting removal tanks. The current method was not able to capture enough dissolved casting material and was therefore ineffective. This would require periodic cleaning of the tanks, causing down time and reducing productivity.

Two teams designed improved material capturing and removal devices. Team one designed a mesh line cage to capture dissolving material as it came off the castings. Team two designed a pumping filtration system to remove the material after it settled on the tank floor. The devices will be used either in process or after a casting has been cleaned in the caustic tanks. The devices will capture and then remove the dissolved casting material before it has the chance to harden on the bottom of the tanks.

Time savings is the best estimate of overall savings. Initial down time to clean a tank was approximately 24 hours, or two shifts. The new devices could potentially operate within an hour. The new devices would no longer require the use of manual labor to remove the dissolved and hardened casting material. The devices would use only available resources near the tanks. No new jobs were created. The tanks' operators were the target users of these devices, and will gain skills in their use and function. Approximately two or three operators will use the new devices. These devices were built around the current PCC tank dimensions that limit the market potential since they are designed to work specifically with PCC equipment. No new potentially marketable products were designed and there were no new patents submitted for these devices.

Both teams gained skills using the House of Quality (HoQ) design approach and in defining customer requirements and translating them into engineering requirements. Both teams also gained skills in negotiation of project scope and budgeting. All students vastly improved their technical writing skills while developing their final reports. Lastly, they all gained skills in manufacturing and testing of concept prototypes.

Due to the success of this project, PCC has submitted new design projects for students to work on. This is beneficial to both the university and industry. Projects like these allow students to have interesting and challenging real-life projects, while helping industry develop new solutions to their design problems.

BUSINESS SUMMARY:

PCC casts parts into a ceramic mold. Following solidification the mold is removed from the part by chemical digestion in a tank. This project focused on how to more efficiently remove the digested shell from the cleaning tank. This project has been completed.

The benefit of this project was new ideas being brought to the table. The initial process was manually removing digested shell in the same way for the last 40 years. This project was given to students to help come up with a better solution; ideas that may not have been brought up by industry. Two teams of students developed very innovative ideas at solving a long-term problem.

Once this process is implemented the company will save the equivalent of 24 man days/year or ~$10,000. By improving an undesirable task, members of the cleaning department were impacted. No new markets or products were impacted and no new patents or patent applications have been sought.

Students had the opportunity to work on a real world problem without the bias of knowing what the solution should be.

REDUCING VISUAL INSPECTOR ERROR

Participating Company: PCC
Company Contact: Jim Barrett
Participating University: Oregon State University
OSU Principal Investigator: Ken Funk

PROJECT SUMMARY:

The purpose of this project was to understand why visual inspectors miss obvious defects on parts and, with that understanding, develop measures to reduce missed defects. A system to supplement PCC's current process for handling missed defects was designed to capture, compile, and analyze information on missed defects caught in later inspections. The graduate research assistant working on the project left OSU for an industry job and no qualified replacement was available until just recently, so the system has not been implemented. A no-cost extension has been requested so that the work can move forward.

Visual inspectors sometimes miss defects that are later found in subsequent re-inspections. This results in additional rework and inspection, which increases production costs and delays orders. Findings from this study may lead to changes to inspection processes, procedures, equipment, and training to reduce the rate of missed defects.

The cost savings as a result of this project are substantial but difficult to pinpoint precisely. Reducing missed defects will result in better utilization of workers and equipment and reduced production cost and time.

OSU had not conducted a visual inspection study before, so we gained expertise and learned to apply existing knowledge, skills, and tools in a new and important research area. Manufacturing is a new research domain for OSU and this project has given us a better understanding of the special problems that arise in this industry.

BUSINESS SUMMARY:

Missed indications by inspectors can result in potential quality misses - costly and sometimes dangerous shipments to customers of non-conforming product.

SWING GRINDER OPERATOR INTERFACE

Participating Company: PCC Structurals
Company Contact: Jim Barrett
Participating University: Oregon State University
OSU Principal Investigator: Ken Funk

PROJECT SUMMARY:

The purpose of this project was to develop a novel operator interface for belt grinders to help operators prolong belt life.

The first prototype interface for a mockup grinder was developed by a team of senior Capstone Design students between September 2011 and March 2012. Their design was accepted to the Student Design Competition at the Society of Manufacturing Engineers Annual Conference in Cleveland in June 2012. A fully functional second prototype interface for a real production grinder is nearing completion and will likely be demonstrated at PCC in late December 2012. A no-cost extension has been requested so that the project may proceed to completion officially.

When a part has been cast, gating (solidified metal in channels that carried the molten metal to the casting) is cut off with torches or saws, leaving protrusions that must be removed with belt grinders. Current operator practice is ad hoc and belts are changed more frequently than necessary, increasing production costs. Another PCC/OMI project is researching the effects of grinding force, belt temperature, and other factors on belt life and, when these are known, the parameters may be displayed in real-time to the operator, giving him or her feedback on performance, as well as guidance to optimize belt life and reduce costs.

The cost savings for this project are unknown but substantial. We are lowering costs to the optimization of belts, grinders and operators. No additional jobs were created, but installation of interfaces will give operators feedback on their performance to increase their grinding skill. The research has not, as of yet, lead to a new patent application or patent, but could in the future.

Previous OSU experience with operator interface design has been in the context of aviation, medicine, and other relatively "clean" environments. Belt grinding is a very dirty, noisy job and the new experience in such a domain has been valuable. Manufacturing is a new domain and the shop floor is an area with much potential for optimizing human-machine interaction.

BUSINESS SUMMARY:

This project is an extension of the previous work done to design a data-collection system for manufacturing grinding machines. An initial prototype for a computer operator interface with an industrial robotic machine was completed as a senior design project in March 2012. This initial project designed prototype components aimed at meeting data collection needs. A second prototype was subsequently designed for this project to be completely functional on a production swing grinder and

testing was completed in December 2012. The current no-cost extension has been requested to allow for further testing of the interface with specific production swing grinders. Project is on-going.

Belt grinding is a human-factor driven process with a vast amount of variability and a large amount of capital investment in consumables. A previous project designed a more controlled robotic grinding method. This current project aims to apply feedback to grinding operators based on the data generated by the robotic grinding apparatus so as to maximize process efficiencies in production.

Initial assessments project a cost savings of up to 20%, which translates to a $1.2M impact for PCC business. Potential for increased abrasive life will lead to increased operator efficiency. Less time will be required per part and operators will be able to spend more time grinding and less time changing out abrasive belts. The end goal of this project is to increase the efficiency of the 80-100 grinders currently employed at PCC. No new products or markets were developed and no new patents or patent applications have been submitted.

OSU students were exposed to designing and building a computer interface for a manufacturing setting as well as appreciating some of the challenges in a real-world production manufacturing atmosphere. PCC benefits from the many capabilities at OSU including data acquisition and feedback systems, and students gain real-world experience in the manufacturing industry.

BICRITERIA FORGE SCHEDULING OF JOBS

Participating Company: Wah Chang
Company Contact: Gary Micheau
Participating University: Oregon State University
OSU Principal Investigator: R. Logen Logendran

PROJECT SUMMARY:

The focus of this project was to develop and implement a scheduling algorithm for the parts (jobs) manufactured at ATI Wah Chang (ATI-WC). The scheduling algorithm so implemented is a user-friendly software that can be used by ATI-WC staff to schedule a variety of jobs to be released within a planning horizon of their choice. The planning horizon could range from a week to several weeks.

The project has been completed.

ATI-WC didn't have a formal, algorithm-driven methodology to schedule the various jobs received from customers in an effective yet efficient manner. This project enabled them to do so.

The scheduling algorithm developed was implemented in the form of user-friendly software. ATI-WC staff can use this software to schedule a variety of jobs to be released within a planning horizon of their choice. This effort significantly eliminated the effort previously required to *manually* develop the schedules. This would amount to a significant savings in human-hours. Also, when the manual approach was used there was no guarantee that a solution chosen to be implemented was of high quality. The algorithm-driven approach, as developed in this project, ensures that the solutions implemented on the shop floor are indeed high quality.

This project enabled a PhD student to work as a graduate research assistant (GRA) for a period of one year. Although the student's PhD dissertation research problem was different from the one investigated for ATI-WC, the insights and findings from the ATI-WC research problem helped the student not only learn about industry-relevant scheduling problems, but also with the methods used to solve the dissertation research problem as that too was on scheduling.

The problem attempted was very complex. That which has typically worked in scheduling problems by way of algorithm development based on tabu search, although was very effective, was computationally inefficient in this problem because of its inherent complexity. This required us to explore the development of a new algorithm based on genetic algorithm, which falls into the class of evolutionary algorithms.

The PI regularly teaches an undergraduate course (IE 363) and a graduate course (IE 563) in Production Planning and Control in which industrially relevant scheduling is an integral part. The experience and findings from this research would be used to enrich the content of both courses.

BUSINESS SUMMARY:

The project was designed to provide us with a scheduling program that would choose the most efficient schedule based on current product mix input. This outcome would improve the efficiency of our process as well as improve equipment utilization.

The program has been developed and delivered. We have had problems getting the program to run on the schedulers' PC (internal issue). That problem is being addressed. We have not used the program yet but have reviewed it and identified some aspects of the interface that are not as user friendly as we would like. We may look at some improvements after we get a chance to run it in practice.

We schedule product based on knowledge obtained through processing (trial and error, tribal knowledge), which isn't necessarily the most efficient way to schedule or optimize equipment. This algorithm program attempts to solve that problem by providing a more advanced methodology to schedule product. This program will be used to improve our scheduling ability by making it data driven and relying less on the scheduler's specific knowledge of each product process route.

By improving our ability to schedule, efficiency and equipment utilization will be improved, thereby reducing waste. Our major gain will be increased capacity. No additional jobs were created or raised in skill level. No employees were affected.

We have developed a relationship with Oregon State University and we have seen some of the possibilities of how computer programs may be developed to improve our specific process/product management.

ELECTROSLAG WELDING TECHNOLOGY APPLICATION DEVELOPMENT (extension of prior year project)

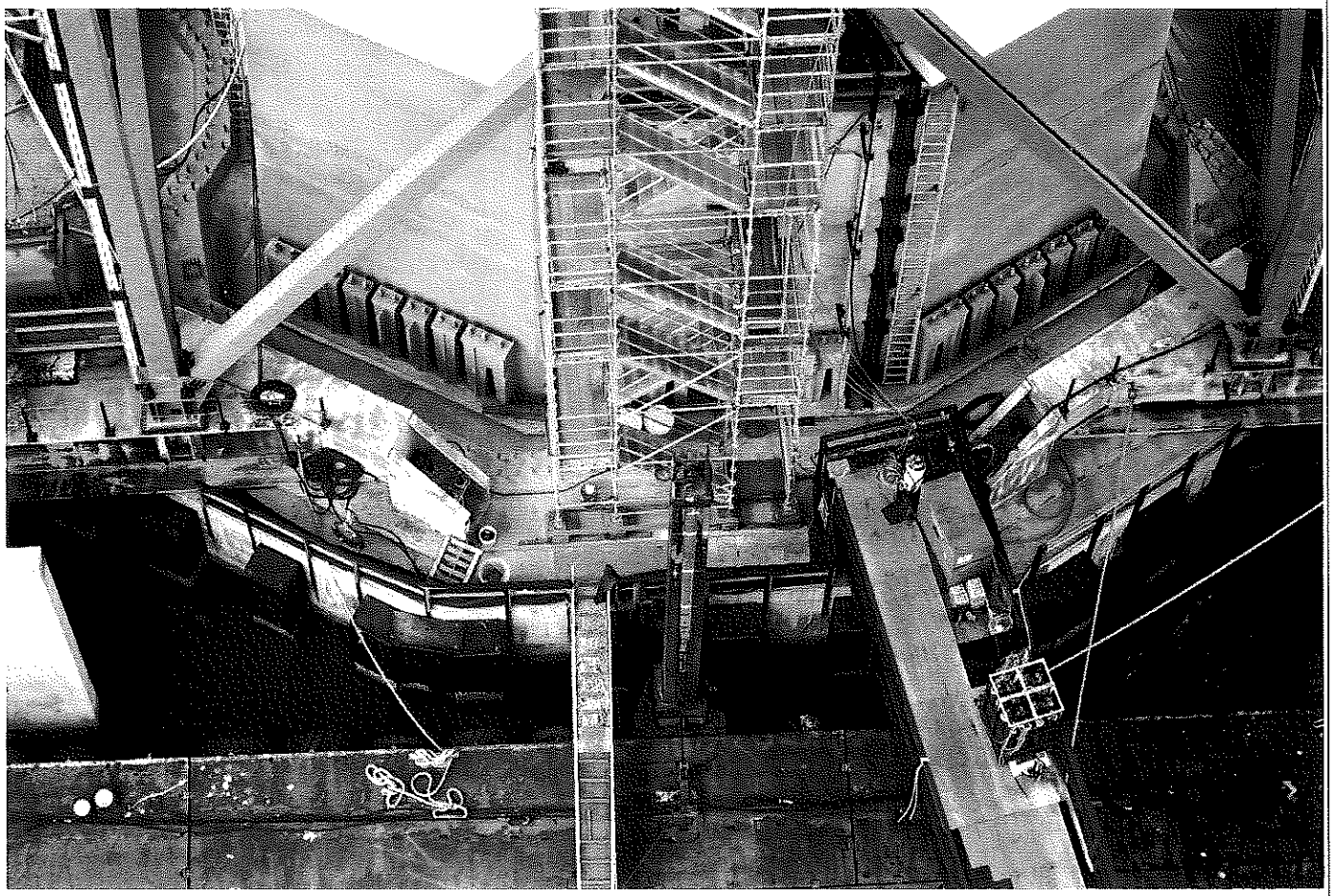
Participating Company: American Bridge
Company Contact: Michael Flowers
Participating University: Portland State University
PSU Principal Investigator: R. Turpin

PROJECT SUMMARY:

The most prominent feature of the new Oakland Bay Bridge is the single self- anchored suspension tower rising over 500 feet into the bay. Central to the tower fabrication by American Bridge is the requirement to join the four tower segments at the base of the tower. The multiyear PSU-OMI-American Bridge advanced research and technology development/insertion project has been completed during 2012. PSU successfully developed, demonstrated, as well as met all seismic requirements, trained, and ran the newly developed electroslag welding process that required more than 20 single pass 35 foot long vertical welds up to 4 inches thick to be completed on the bridge tower. Each weld required nearly 5 hours of continuous welding through very restricted work space. PSU made 15 of the welds for American Bridge and American Bridge personnel then made the remaining welds, completing the technology transfer to American Bridge.

This project started on a concept based on PSU's extensive long term Federal Highway Administration research and demonstration projects on bridge girder welding. This prior state of art technology position led American Bridge to approach PSU concerning joining the tower segments for the new bridge. American Bridge and the bridge owner, CalTrans, required PSU to (1) demonstrate proof of concept on a reduced height section, (2) develop instrumentation and control technology,(3) develop and demonstrate the final process on a full scale basis,(4) complete certified procedure qualification weldments,(5) train American Bridge iron workers, (6) transfer the process technology, and (7) make most of the actual welds on the bridge tower. Working jointly with PSU was another long-time Oregon OMI small business PSU research partner, EST&D, to supply hardware, instrumentation and technology transfer portions of the project.

American Bridge is positioned to use this technology for competitive bidding on other large infrastructure erection projects and to implement the technology in their Reedsport Fabrication facility for girder and other subassemblies.



BUSINESS SUMMARY:

None available at this time.

ALUMINUM BAT PERFORMANCE

Participating Company: DeMarini

Company Contact: Ed Vander Pol

Participating University: Portland State University

PSU Principal Investigator: David Turcic

PROJECT SUMMARY:

DeMarini Sports is a world leader in development of high performance softball and baseball bats. All of these bats are manufactured from high-strength aluminum, in contrast to solid wood bats used in professional baseball. In order to improve bat design, DeMarini seeks a basic understanding of the factors that affect bat performance. The continuing study will refine the softball and baseball bat high speed test apparatus and experimental methods and develop new methods of testing the important bat performance characteristics. The new work will further improve the reliability and precession measurement of the impact mechanics of aluminum bats and the effects of material properties and bat structure on the bats' response characteristics. The project is ongoing.

BUSINESS SUMMARY:

DeMarini Sports is a world leader in development of high performance softball bats and baseball bats. All of these bats are manufactured from high-strength aluminum, in contrast to solid wood bats used in professional baseball. In order to improve bat design, DeMarini seeks a basic understanding of the factors that affect bat performance.

To continue as the leader in high performance softball and baseball bats, DeMarini needs to test and understand materials behavior under test conditions to provide input into the design and construction of softball or baseball bats. Based on the results of this effort, we are able to analyze various constructions and impact on bat performance.

This project allows DeMarini to perform testing in-house with faster turn-around. "Outside" testing would have an approximate one month turn-around. These new capabilities will develop into new designs and employee skill levels have been raised.

From this industry partnership graduate students learn to apply the theory and methods that they learn in classes to real world industrial applications. The research skills of the team and students were enhanced in the areas of machine design considering high speed impact, creative and innovative solution to challenging engineering problems, use of various high performance sensors, and use of high performance data collection systems.

Demarini Rayzr – Double wall high performance bat

INFLUENCE OF FRACTURE TEST METHODS ON THE EVALUATION MANUFACTURING PROCESSES AND PRACTICES

Participating Company: ESCO
Company Contact: Ian Bingham
Participating University: Portland State University
PSU Principal Investigator: William Wood

PROJECT SUMMARY:

This project analyzed the microstructural features of alloys cast in two ESCO manufacturing sites. The properties of the alloy produced at different facilities exhibited significantly different properties. This project addressed possible microstructural explanations for the variations in properties. The project has been completed.

The problem was that the properties of castings produced in different manufacturing facilities exhibit varying properties that cannot be explained based on each site's manufacturing processes. Determination of microstructural variations in materials produced at each site could be used to reverse engineer processes responsible for the property variations. A detailed microstructural analysis of material from each site was conducted.

The project results are designed to help optimize the manufacturing processes incorporated in ESCO's manufacturing technology.

Advanced materials characterization techniques employing PSU's advanced microscopy analysis center were used in this project. Utilization of the facilities required PSU researchers to develop advanced skills. These skills are available to apply to other research projects and to broaden PSU researchers advanced characterization skills. This research project has helped couple academic based research directly to industry manufacturing issues and hence helped to maintain the relevance of university research and researchers to Oregon industry.

BUSINESS SUMMARY:

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Two manufacturing plants that use similar processes produce products with different properties. The project focused on advanced metallurgical analysis in an effort to understand the key underlying causes for variation in properties. Understanding of the possible mechanisms underlying the variation could then lead to more focused efforts in making effective improvements to the manufacturing processes. The key benefit is an increased understanding of the material characterization and the resulting impact on mechanical properties. The ongoing learning in material characterization is critical to support

continuous improvement in our processes to maintain a competitive advantage in the market. The project utilized advanced testing and analysis equipment not commonly available in the industry.

ELECTROSLAG WELDING ADVANCED TECHNOLOGY DEVELOPMENT

Participating Company: EST & D
Company Contact: Daniel Danks
Participating University: Portland State University
PSU Principal Investigator: William Wood

PROJECT SUMMARY:

This project is a continuing effort to advance the science and application of electroslag welding, a highly economical process for joining thick sections in a single pass. This year's focus was on computer modeling the process in order to provide analysis that can provide guidance for optimizing the welding process variables with a reduced amount of experimental trials.

A computer simulation model with anticipated results has been provided. The electroslag joining process requires optimization of several key dependent process variables. The effects of each are difficult to quantify experimentally. A computer analysis of the thermal history during welding and the influence of process variables on this thermal history would provide key insights into how to best optimize the joining technology.

A computer model based analysis will help shorten development times normally associated with experimentally driven adaptation of the basic process to specific application requirements. The research project helped faculty with research expertise and specialized computational capabilities to connect with real industrial problems.

This project has helped continue the integrative materials science and engineering research to link computational techniques with experimental methods.

BUSINESS SUMMARY:

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The problem faced by industry with this project was that the electroslag joining process requires optimization of several key dependent process variables. The effects of each are difficult to quantify experimentally. A computer analysis of the thermal history during welding and the influence of process variables on this thermal history would provide key insights into how to best optimize the joining technology.

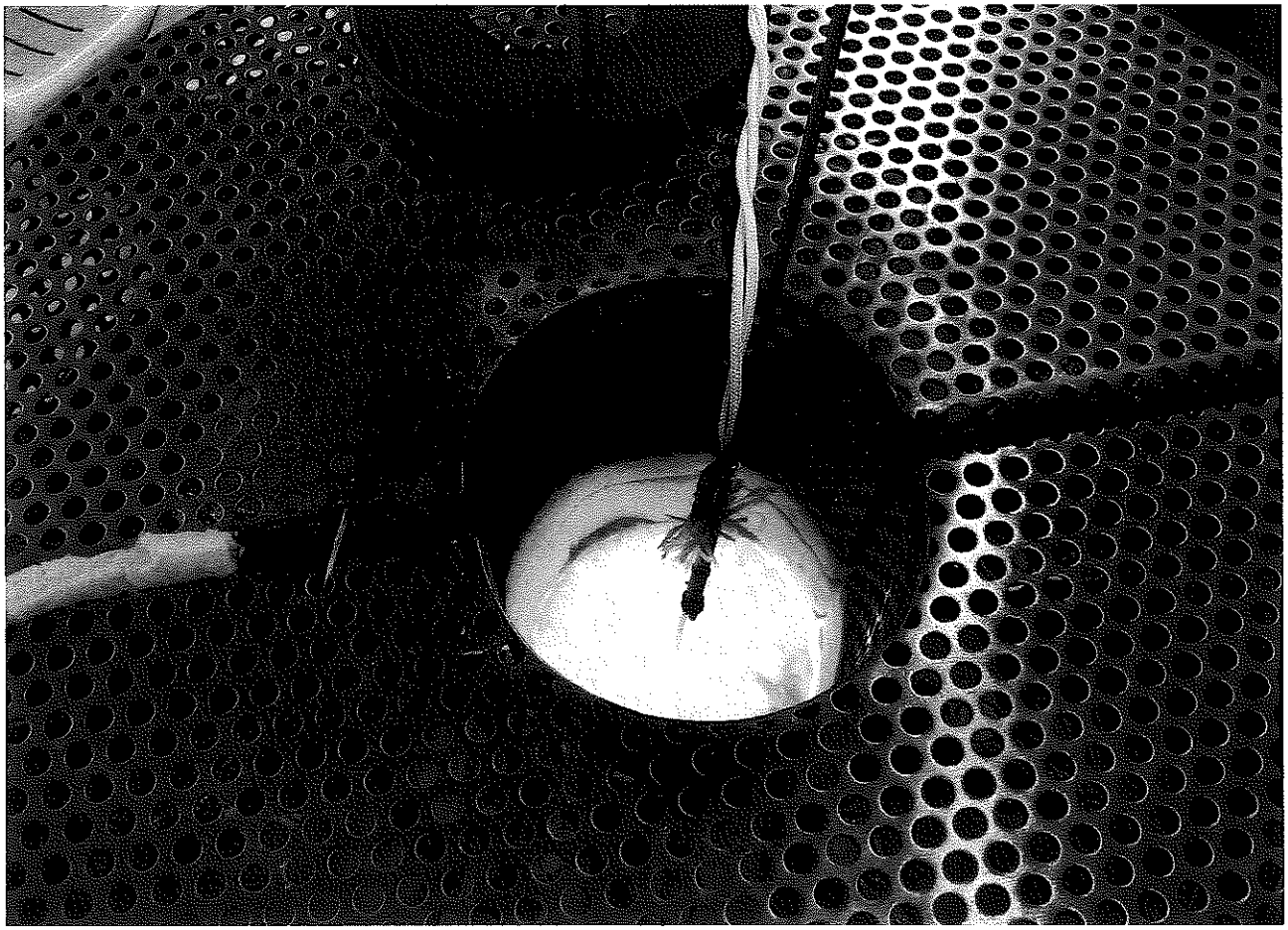
A computer model based analysis will help shorten development times normally associated with experimentally driven adaptation of the basic process to specific application requirements. The research project helped faculty with research expertise and specialized computational capabilities to connect with real industrial problems. This project has helped continue the integrative materials science and engineering research to link computational techniques with experimental methods.

MATERIAL PROPERTIES OF FORMING MATERIALS AND CAST ALLOYS

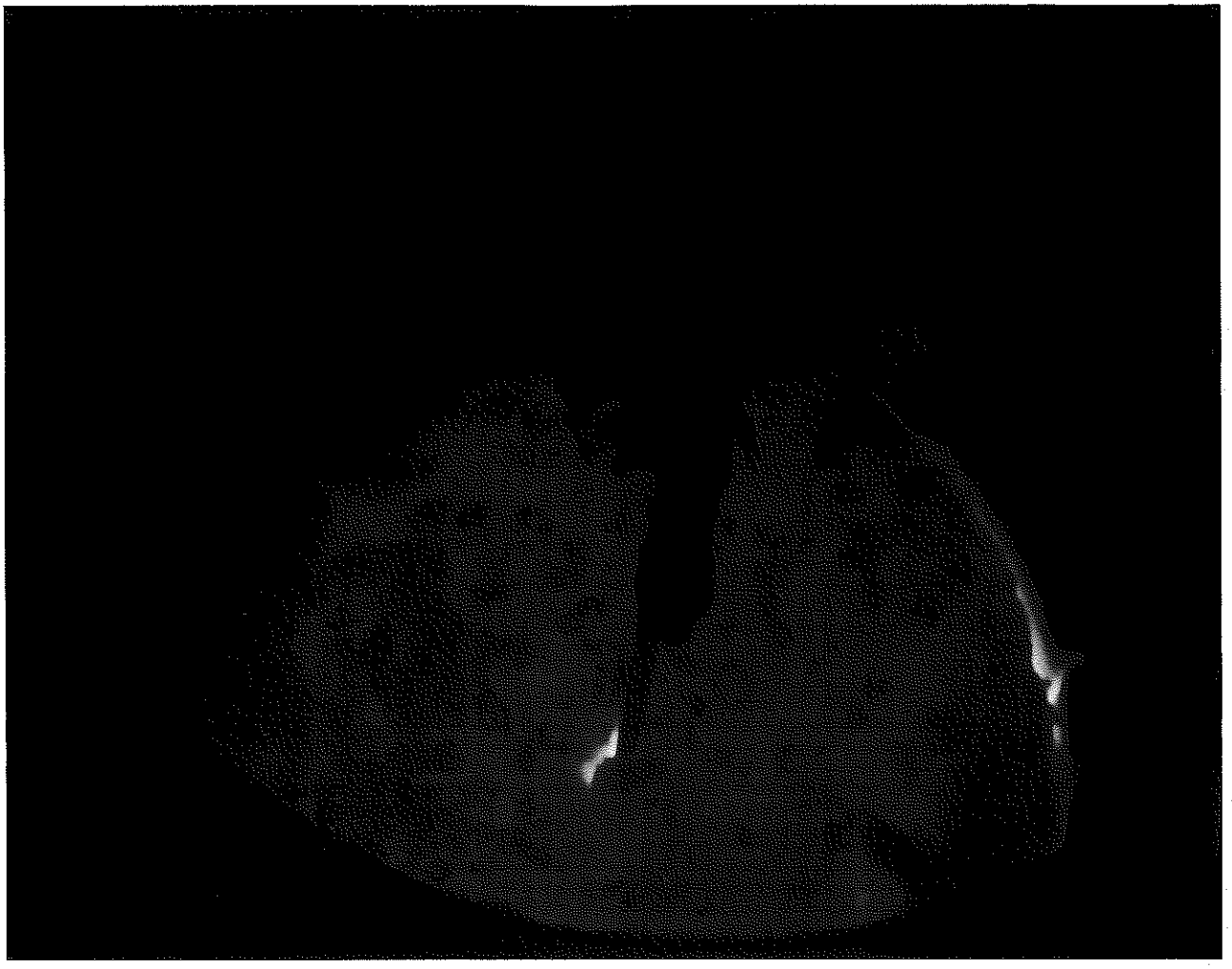
Participating Company: PCC
Company Contact: Laura Aldessio
Participating University: Portland State University
PSU Principal Investigator: William Wood

PROJECT SUMMARY:

This project objective was to measure the high temperature thermal properties of ceramics and insulating materials used in the investment casting process.



Variations in the thermal insulating properties of insulating and ceramic materials are able to influence the solidification cooling conditions in castings. Various vendors offer competitive materials but the thermal properties of these materials are poorly documented. As such, it is difficult to make intelligent purchasing decisions. Additionally, variations in the thermal properties add uncertainty to computational predictive analysis of complex components. It will be used as input data for computer models and also used to provide selection criteria for purchasing materials from multiple vendors.



The project required precision measurement of high temperatures over long periods of time. This required developing acquisition capabilities and modifying a high temperature furnace to operate for long times at temperatures up to 2600oF and acquiring data every 2 seconds. Students and professional staff gained expertise and experience in the operating requirements and in long term data acquisition. Significant improvements to the high temperature furnace have been incorporated that have enhanced the ability of the furnace to contribute to other research activities.

BUSINESS SUMMARY:

This project uses the Gleeble thermal testing equipment to compare the thermal characteristics of different possible ceramic materials and insulation materials used in the investment casting process. Properties of the materials as determined by Gleeble simulations will help to identify the best materials for use in PCC's process. The project has been completed.

Investment casting is a very thermally-driven process. The differences in the thermal characteristics of ceramic materials and insulation materials used affect the solidification and cooling of metals. Understanding the differences and variations is critical in producing sound cast parts. This project

provided a direct comparison of thermal characteristics and variation of selected ceramic materials and insulation materials allowing PCC to choose materials that help to provide the highest quality product.

PCC uses computer simulation to understand how the properties of the materials in the process affect the quality of the final part. The findings in this project helped provide material properties to feed into the computer simulations. Accurate and specific properties, as opposed to approximations, improve the prediction accuracy of the simulations. This will help to better understand the process and potentially replace the existing insulation materials with new generation of insulation materials.

Estimated cost savings would be $75,000 in simulation time and resources that would otherwise have been needed to run trials. More accurate properties as input to computer simulations, result in more accurate predictions. This ultimately makes the simulation process more accurate and helps to predict the process better from the start, reducing the need for costly trials and iterative investigation loops.

This project results in a better quality part by improving materials using the existing process and personnel. No additional jobs were created or changed nor were any new markets considered. No patents or patent applications have been applied for.

This project utilized equipment and expertise in testing to determine material properties that PCC does not have the means to obtain. PCC gained insight into basic properties for some of its ceramic materials as well as awareness of the instrumentation and equipment needed to obtain these properties. In addition, it broadened PSU students' knowledge of ceramic properties and the types of materials used in industry.

EFFECT OF TEMPERATURE AND STRAIN RATE ON THE FLOW STABILITY OF ADVANCED AEROSPACE MATERIALS

Participating Company: ATI Wah Chang
Company Contact: John Foltz
Participating University: Portland State University
PSU Principal Investigator: William Wood

PROJECT SUMMARY:

Forging, rolling, extrusion, and related deformation manufacturing processes essential to the manufacturing technology of advanced high strength, temperature and corrosion resistant materials are complex processes each tailored to individual alloy characteristics. Optimum processing traditionally requires lengthy and expensive empirical trials and optimization. For each small change in alloy chemistry these processing parameters must be redeveloped. This project was designed to develop specific deformation related materials properties that could be incorporated into predictive computer models as well as be directly implemented in the manufacturing process development. PSU's dynamic Gleeble test system is uniquely capable of simulating high temperature deformation manufacturing processing.

The project is complete.

Optimizing ATI manufacturing processes for individual alloys requires knowledge of very specific high temperature materials properties. Without these properties experimental trials are required which are time consuming and very expensive. The Gleeble test system enabled determination of these properties in a laboratory environment. The results of this project will be used to provide key materials properties used in computer models of the manufacturing process.

PSU researchers developed more detailed and broader expertise in physical simulation of manufacturing processes. This project led to an expanded research effort to couple experimental and computational materials engineering analysis. This broader expertise will enable PSU to undertake a broader class of research with additional Oregon manufacturing organizations.

BUSINESS SUMMARY:

This project was an attempt to generate material property data that was not currently available and was needed for computer modeling of metalworking processes. This project has been completed.

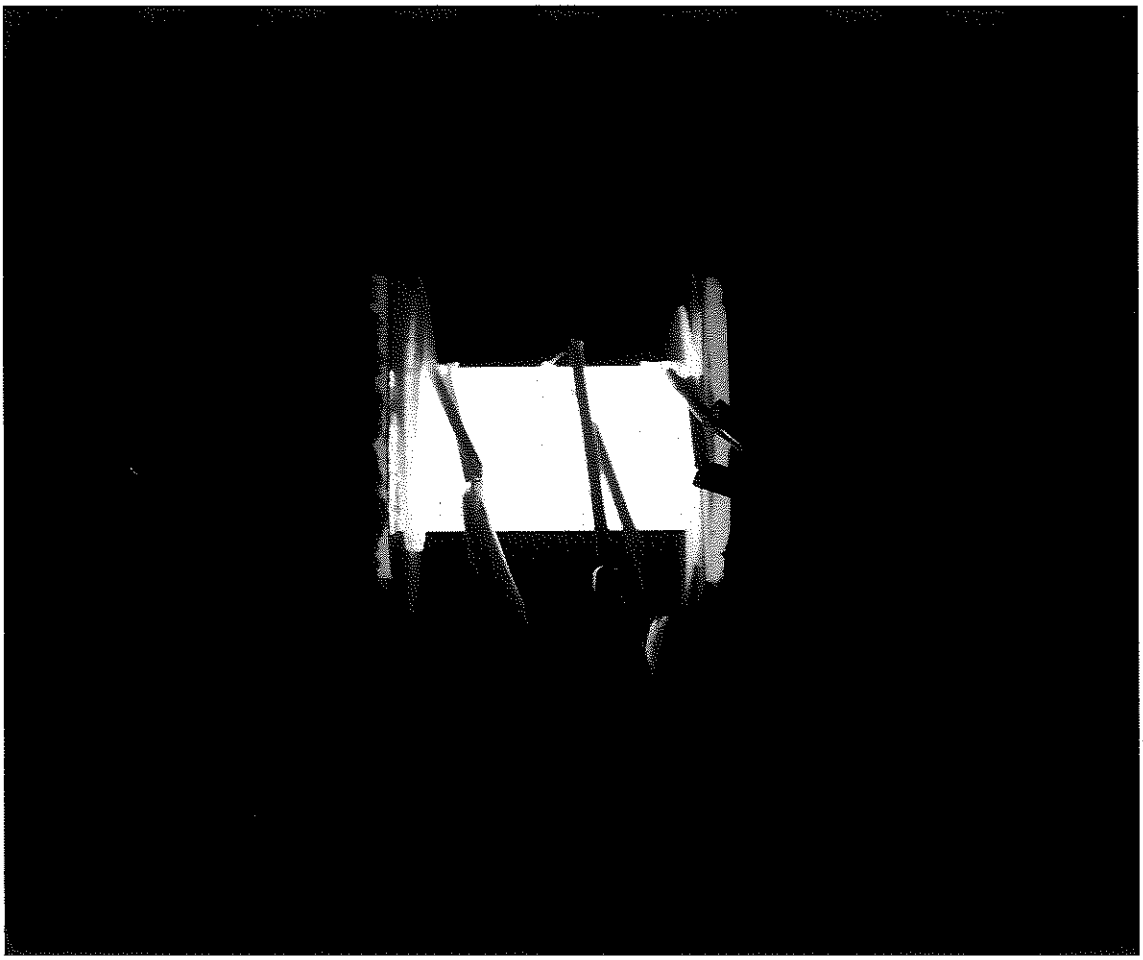
The necessary material property data for use in computer modeling of metal working processes was lacking. This project provided the data needed to allow this modeling work.

This project will enable computer modeling of metalworking processes that were not possible without the data generated by this project. The use of computer modeling of metalworking processes is

growing in our company. We have the expectation that it can reduce development cost and time for new processes and products as well as improve existing processes and production methods.

Cost savings are strongly dependent on how many trials are needed to develop and qualify a new process. Best estimate is $5,000 to $25,000 per development trial and it typically takes 3 or more trials to get a process developed and qualified. There were no real efficiencies gained. This project affected 4 to 5 employees at our company. No new jobs were created as a result of this project at this time. No new markets have been captured or new projects developed as of yet as the work is ongoing. The project has not lead to any new patents or patent applications as of yet.

This project has expanded the use of computer modeling of metalworking processes now that we have the necessary material property data for the computer modeling. This project has been a benefit to our company with increased exposure to academic research capabilities, both equipment and personnel, within Oregon.



EXECUTIVE SUMMARY

A team of three faculty members from the University of Oregon were retained in July 2012 to work in collaboration with Manufacturing 21 (MFG 21) and Portland Development Commission (PDC) to assess the feasibility for establishing the Northwest Collaboratory for Sustainable Manufacturing (NWCSM). The goal of this project was to assess the interests and needs of various stakeholders in the proposed collaboratory to bring together industry and educational institutions for supporting business and technological needs through research, experiential education, and workforce training and development, among others. This study also provides relevant options for configuring, governing, and operationalizing this collaboratory.

Research

A detailed diagram of the supply chain in eco-system helped develop familiarity with key issues. The project then used a number of methods of understanding the dynamics of the metals industry in addition to considering the needs and issues of companies who are operating within Oregon and SW Washington. These methods included the following:

- Reviewing current industry reports by sector
- Reviewing previously written reports about the industry within Oregon
- Developing an updated database of industry participants in the targeted region
- Conducting telephone and in-person interviews with executives of thirteen (13) companies across the major NAICS categories, with the companies identified and prioritized by the project's liaisons at MFG 21 and the PDC
- Developing and administering an online survey sent to more than 740 companies throughout Oregon and SW Washington from the established industry database.

The team conducted an initial review of secondary industry research with more than thirty (30) detailed industry reports. The major themes that emerged from these industry reports helped shape the direction of the project's benchmarking, industry outreach, university discussions, and association/agency interviews.

Database of Companies

We then developed an overall database of companies in the targeted NAICS clusters throughout Oregon and Clark County in Washington using the same four primary NAICS codes employed by the Portland Development Commission work in 2009:

- 331 - Primary Metal Manufacturing
- 332 - Fabricated Metal Product Manufacturing
- 333 - Machinery Manufacturing
- 336 - Transportation Equipment Manufacturing

Recommendations

Using the same topics from the benchmarking institutions, we recommend that NWSCM be built upon the following recommendations.

- **Scope of Industry Served:** NWSCM should continue with its planned focus on the metals manufacturing industry and broadened to include the larger supply chain or ecosystem including suppliers and customers.
- **Industry Engagement:** NWSCM must explicitly work to include small, medium-sized, and large firms in the region.
- **Scope of Services, Projects and Research:** The primary initial focus of NWCSM should be to expand university-industry linkages in the areas of applied engineering, technology and operations.
- **Breadth and Balance of Network:** Work force development and technical training are of greatest interest to industry, but should not be the primary program focus of NWCSM. Building strong network relationships with organizations to provide resources in lean manufacturing and other areas of expertise will enable the collaboratory to act as a 'concierge' to members.
- **Faculty, Students and Workforce:** The selection and matching of projects to faculty interests must be done with an appreciation of the need to balance competitive imperatives for the firm with the academic interests.
- **Structure:** NWCSM must be structured as a connector between the universities and industry with a lean and flexible staff to efficiently deliver services.
- **Financial Commitments and Revenue Model:** NWCSM needs a substantive multi-year commitment from both the state, governmental organizations, and founding/leading corporate members of the industry.
- **Governance:** The NWCSM governance structure must include members of each core stakeholder group.

Immediate Next Steps to Further Validate Scale and Scope for NWCSM

- Organize a major NWCSM kickoff retreat to engage a) key faculty across OUS and WSU-V with significant interest in academic and applied research related to the needs of the metals firms; b) department chairs; c) deans; d) members of the industry; e) other key stakeholders (e.g. PDC and other economic development agencies) to understand assets, expertise, and capacity across OUS and WSU-V vis-à-vis the demand for business and technological needs of metals manufacturing firms.
- Explicate the nature, scale, and scope of the technological needs of the metals-based manufacturing sector in the region.
- Identify key assets, expertise, and capacity required in OUS and WSU-V with reasonable specificity (to meet the needs for applied research and technical services for the industry).
- Discussion at the retreat should be primarily moderated by an academic champion

years. Stage 1 will advance the engineering needs of the industry as the infrastructure is set up for the first two years of operation. This will include supporting the expansion of OMI by leveraging common faculty. The NWCSM organization will establish a number of priorities for its staff to facilitate forming relationships between universities and industries, industry outreach, developing faculty and resources, building and maintaining a virtual communications hub, developing marketing materials, establishing funding and managing milestones.

Stage 2 (i.e., Years 3, 4, & 5) will build on these initiatives and continue to offer programs to support applied and relatively short-term engineering needs of the industry while also bringing longer-term research projects for the industry into the mix. Projects will continue to be done on a company-specific and proprietary basis, but evidence of both inter-university collaboration and industry shared projects begins to emerge, spurred on by NWCSM Board of Directors and member groups striving to gain synergies through gainful collaborations across the collaboratory. NWCSM begins to build advanced manufacturing capabilities at large, extending beyond the metals cluster, up and down the supply chain to offer full service to the manufacturing base. The scale and scope of projects focused on larger business challenges increases as they also include issues related to strategy, operations, supply chain, and sustainability. There is now in place an active membership model spanning large to smaller firms complemented by discrete programs.

Financial Implications

The financial requirements to support this evolutionary model are substantial and will require an industry with longer term start-up commitments, industry involvement with an engaged membership revenue stream, OUS support for faculty positions, and state of Oregon funding for the cluster. Our initial estimates of the implications of the proposed model are as follows:

Stage 1: Years 1 and 2

- **OMI Expansion:** OMI expansion will go through the existing OMI channels, funded by industry and matched by state funds. Efforts should be made to double the size of the OMI budget from approximately $900,000 per biennium to $2 million per biennium and to establish an additional $ 1 million seed fund that would provide $500,000 per year to the OMI during Stage 1. Starting up an OMI Seed Fund requires additional work to set up, but we would expect that to be funded by industry and the state overall, particularly given the potential impact this would have on the state's smaller and fastest growing members of the cluster.
- **Applied Research Faculty Positions:** The OUS should expect to fund five new faculty positions from OUS and/or state monies. For planning purposes we have assumed that it will be necessary to make these hires from out of the region. Total cost for this effort would be approximately $2.1-$2.2 million over 3 years, with the potential need to fund labs or equipment as well.
- **NWCSM Capacity:** Hire one Director for Year 1 and grow staff to include administrative support in Year 2. Total staff and organizational costs for the first two years are estimated at $665-$670K.

- Membership agreements developed and put in place
- Virtual presence and online experience usage
- Member satisfaction
- Operation of a full board of directors representing all stakeholders

For the second phase of NWCSM (Years 3, 4, & 5) at least some, if not all, of the following measures should be considered:

- A total **annual budget of $4.5 - $5.0M** to fund operations of staff of NWCSM, core OUS/WSU-V faculty in NWCSM, and expanded OMI projects
- Staff of 4+
- Increase in members by tier
- Membership retention rates
- Number of completed projects
- Number of programs and events run
- Attendance and participation by event
- Increase in graduate students who are working on these projects and are therefore funded for their studies
- Publications and presentations on project results
- Public relations hits on NWCSM's activities

Financial Model: Stage 1 (Years 1 & 2)

-OMI Expansion *$800,000 per year*

- Raise OMI budget to $1.5 million per biennium to be matched by $1.5 million from industry
- Establish an additional $500k seed fund per biennium to OMI ($250k from the state, $250k from industry)

-Applied Research Faculty Positions (4) *$600k per year / **$1.2M for Stage 1***

- Fund four new faculty positions, preferably Research NTTF using OUS and/or state monies with at least 3 years commitment
- Assess any additional seed money to fund labs or equipment as well

-NWCSM HR Capacity *$185k in Year 1 and $230k in Year 2 / **$415k for Stage 1** to be partially matched by $250,000k from industry*

- Hire one Director for Year 1 and grow staff to include admin support in Year 2

-Membership Revenue *Amount to be Determined*

- Founding member membership model to start at inception. Operating funds and staff will be paid from these monies. Tier 2 and 3 membership model to start in Year 2.

-Total Costs: *$3.115M for Stage 1 (equipment/lab not included)*

Total Stage 1 (Years 1 & 2) Costs ***Match***

	OUS/State	Industry
OMI Expansion	$.800	$1.5M
Seed Fund	$.25M	$0.25M
Research Faculty	$1.2M	$0
NWCSM HR	$.165M	$.25M
Membership Revenue	$0	To be Determined
Total - Operation	$2.4	$2.0M
Capital Allocation	$1.0	
Total Operation & Capital	$3.4	