OREGON METALS INITIATIVE

2007 - 2008 Annual Report

Prepared By:
Public Affairs Counsel
P.O. Box 12945, Salem, OR 97309
503.363.7084 (Ph) / 503.371.2471 (Fx)
pacounsel@pacounsel.org

Oregon Metals Initiative
2007 - 2008
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. Oregon's metals industry is a vital part of the state's economy providing over 55,000 jobs in 1,700 companies with an average annual salary of $35,000.[1] 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, of 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

[1] Data from 1998.

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.

At this time, the metals industry contributes $500,000 annually on a 1:1 match basis with the state. 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:

- American Bridge (2 projects)
- Boeing (1 project)
- Coast Distributors (1 project)
- Columbia Steel (1 project)
- DeMarini Sports (1 project)
- ESCO (1 project)
- EST & D (1 project)
- FEI (1 project)
- Hewlett Packard (1 project)
- Intel (1 project)
- Northwest Pipe (1 project)
- Octavian (1 project)
- Oregon Cutting (1 project)
- Oregon Iron (1 project)
- Oregon Steel (1 project)
- PCC Structurals (2 projects)
- Wah Chang (1 project)

INVESTMENT:

During fiscal year 2007 – 2008, $554,871 from the industry was matched by $554,871 in state funds to conduct research projects.

TABLE OF CONTENTS:

ELECTROSLAG WELDING TECHNOLOGY APPLICATION DEVELOPMENT

Participating Company: American Bridge Company

Company Contact: John Callaghan

Participating University: Portland State University

PSU Principal Investigator: William Wood

PROJECT SUMMARY:

The new Oakland Bay Bridge fabrication includes welding complex thick steel sections. American Bridge is working with Portland State University to develop electroslag welding technology for application to the welding fabrication of thick section steel for the bridge. This work will extend the technology developed by PSU for fabrication of bridge girders to weld sections 300% longer than have been previously welded by this process.

This is a continuation of the work conducted during the OMI 2005-2006 year. American Bridge acquired welding systems to allow them to demonstrate the welding technology using their equipment rather than PSU's welding systems. PSU provided oversight and hands on support during this equipment shakedown transition period. This is a critical step in the demonstration and approval process. American Bridge will present the results to the bridge owner for approval to proceed with full scale manufacturing development during the next year.

In simplest terms, the problem the industry faces is that the single tower design contains very thick, long steel sections that need to be welded. These sections are vertically oriented with restricted access by the welders. Conventional welding processes requiring welding preheat and welding in confined spaces are impractical, if not impossible. Electroslag welding, if adapted to make these welds presents an excellent solution for this bridge fabrication requirement. However, it requires the electroslag welding process technology to be significantly extended beyond the current state of the art for this welding process.

In attempting to find a solution American Bridge initiated an OMI research and development project to extend the current state of art technology developed by PSU to include increasing the demonstrated acceptable weld length by more than 300% while maintaining acceptable weld properties. PSU has adapted welding process procedures, practices, and welding equipment in order to demonstrate process and property feasibility to American Bridge and to the bridge owners.

This enhances the research skills of the team and students because it required the research team to develop new technology and furthered its understanding of the electroslag process.

PSU will be able to utilize the enhanced thick section joining capabilities for other manufacturers in the infrastructure and transportation industry sectors.

PSU is currently pursuing a research contract for electroslag welding bridge girder fabrication for new high performance steel alloys. PSU will apply the understanding developed in this OMI research project to enhance the research to be undertaken under the planned FHWA research contract.

BUSINESS SUMMARY:

PSU has currently completed experimental work and has submitted results to America Bridge.

An anticipated benefit to the company is a field implementable and bridge owner accepted cost effective joining technology to help enable the construction of the new Oakland Bay Bridge.

An added benefit regarding this industry-research partnership project is the electroslag welding technology development efforts are adding to American Bridge's fabrication technology expertise and capabilities. It is expected that American Bridge will find new applications for this technology that will continue to enhance American Bridge's manufacturing competitiveness**.**

ANALYSIS OF ELECTROSLAG WELDMENTS

Participating Company: American Bridge

Company Contact: John Callaghan

Participating University: Portland State University

PSU Principal Investigator: William Wood

PROJECT SUMMARY:

The new Oakland Bay Bridge fabrication includes welding complex thick steel sections. American Bridge is working with Portland State University to develop electroslag welding technology for application to the welding fabrication of thick section steel for the bridge. This work will extend the technology developed by PSU for fabrication of bridge girders to weld sections 300% longer than have been previously welded by this process.

This is a continuation of the work conducted during the OMI 2005-2006 year. American Bridge acquired welding systems to allow them to demonstrate the welding technology using their equipment rather than PSU's welding systems. PSU provided oversight and hands on support during this equipment shakedown transition period. This is a critical step in the demonstration and approval process. American Bridge will present the results to the bridge owner for approval to proceed with full scale manufacturing development during the next year.

In simplest terms the problem the industry faces is the single tower design contains very thick, long steel sections that need welded. These sections are vertically oriented with restricted access by the welders. Conventional welding processes requiring welding preheat and welding in confined spaces are impractical, if not impossible. Electroslag welding, if adapted to make these welds presents an excellent solution for this bridge fabrication requirement. However it requires the electroslag welding process technology to be significantly extended beyond the current state of the art for this welding process.

In attempting to find a solution American Bridge initiated an OMI research and development project to extend the current state of art technology developed by PSU to include increasing the demonstrated acceptable weld length by more than 300% while maintaining acceptable weld properties. PSU has adapted welding process procedures, practices, and welding equipment in order to demonstrate process and property feasibility to American Bridge and to the bridge owners.

This enhances the research skills of the team and students because it required the research team to develop new technology and furthered its understanding of the electroslag process.

PSU will be able to utilize the enhanced thick section joining capabilities for other manufacturers in the infrastructure and transportation industry sectors.

PSU is currently pursuing a research contract for electroslag welding bridge girder fabrication for new high performance steel alloys. PSU will apply the understanding developed in this OMI research project to enhance the research to be undertaken under the planned FHWA research contract.

BUSINESS SUMMARY:

PSU has currently completed experimental work and has submitted results to American Bridge.

An anticipated benefit to the company is a field implementable and bridge owner accepted cost effective joining technology to help enable the construction of the new Oakland Bay Bridge.

An added benefit regarding this industry-research partnership project is the electroslag welding technology development efforts are adding to American Bridge's fabrication technology expertise and capabilities. It is expected that American Bridge will find new applications for this technology that will continue to enhance American Bridge's manufacturing competitiveness.

FINITE ELEMENT ANALYSIS OF INDUCTION HEAT TREATING OF A BEVEL GEAR

Participating Company: Boeing

Company Contact: Matthew Carter

Participating University: Portland State University

PSU Principal Investigator: William Wood, Victor Li

PROJECT SUMMARY:

This project involves developing modeling procedure in Magsoft Flux for the simulation of induction heat treating of a bevel gear.

The project is continuing in progress and is expected to complete in June 2009.

A problem that was facing the industry was the industry needed a better understanding of the physics in induction heat treating of gears to help adjust process parameters to achieve uniform case hardening.

This project enhances the research skills of the team and students because the modeling of induction heat treating is new for the research team and students at PSU. It is in fact a challenging subject for the whole induction heat treating industry.

This project utilizes or builds the capabilities of Portland State University by helping to get a perpetual license of Magsoft Flux software for electro-magnetic analysis.

This research plows through some new area in modeling materials processing.

BUSINESS SUMMARY:

We've seen some impressive modeling results of using Magsoft Flux in simulation of induction heat treating in the open literature. We would like to have materials group at PSU to learn and develop this capability.

The project appears to be much more challenging than we initially thought. It may be too much for a graduate student to handle. Nevertheless, PSU has made some adjustment and the project is in continuation and is expected to be completed in June 2009.

Lack of good understanding of the physics in induction heat treating, in quantitative manner, is the major problem the industry faces. This project addresses that need.

With the modeling procedure established and calibrated, this project can be used for parametric study to aid the development of induction heat treating process.

This project brings industrial application perspectives into PSU's materials research.

WELDING PROCEDURE SPECIFICATION AND QUALIFICATION DEVELOPMENT

Participating Company: Coast Distribution Systems, Inc.

Company Contact: Dennis Castagnola

Participating University: Portland State University

PSU Principal Investigator: William Wood

PROJECT SUMMARY:

Coast Distribution Systems markets a welded assembly designed for high service loads. Currently there are no predetermined welding procedure specifications to insure consistent reliable welding practices and weld joint properties. The purpose of the project was to develop welding procedure specifications and to assess whether non-destructive acoustic techniques could be used to perform quality assurance checks on the welded components.

The project was initiated in the second half of the 2007-2008 OMI year. PSU has examined the weld quality of current components by sectioning several components into a series of parallel sections. This is completed. Based on examination of these weldments, PSU ordered and has received welding electrode wire which it believes will be optimum for welding the Coast Systems components. With the receipt of this wire, PSU will complete the balance of project during 2008-2009.

The lack of a unified welding procedure and an inspection procedure can lead to unreliable weldments which in turn may lead to unpredictable reliability in service. By developing a standard weld practice and a method to non-destructively inspect components, Coast Distribution Systems, Inc. would be able to ensure product reliability.

This project integrated three research capabilities into one effort: non destructive examination, weld examination, and weld procedure development.

PSU has all the NDE, metallographic, and welding capabilities required to undertake the project.

The project broadened PSU's collaborative research network to include Coast Distribution Systems, Inc. for the first time.

BUSINESS SUMMARY:

Coast Distribution Systems markets a welded assembly designed for high service loads. Currently there are no predetermined welding procedure specifications to insure consistent reliable welding practices and weld joint properties. The purpose of the project was to develop welding procedure specifications and to assess whether non destructive acoustic techniques could be used to perform quality assurance checks on the welded components.

The project was initiated in the second half of the 2007-2008 OMI year. PSU has examined the weld quality of current components by sectioning several components into a series of parallel sections. This is completed. Based on examination of these weldments, PSU ordered and has received welding electrode

wire which it believes will be optimum for welding the Coast Distribution Systems components. With the receipt of this wire, PSU will complete the balance of project during 2008-2009.

The lack of a unified welding procedure and an inspection procedure can lead to unreliable weldments which in turn may lead to unpredictable reliability in service. By developing a standard weld practice and a method to non-destructively inspect components, Coast Distribution Systems, Inc. would be able to ensure product reliability.

A benefit of this project is improved welded product reliability, application of project related welding procedures, and analysis to other potential applications.

BEST PRACTICES FOR DISSIMILAR METALS JOINING

Participating Company: Columbia Steel

Company Contact: Shawn Delay

Participating University: Portland State University

PSU Principal Investigator: William Wood

PROJECT SUMMARY:

This project is studying how best to join two dissimilar high strength alloys configured with a high level of restraint. The goal is to develop an optimized welding procedure that will result in the highest level of reproducible weld heat affected zone properties with the maximum resistance to cracking.

The project's current status is that weld analysis has been completed and welding recommendations prepared. Columbia Steel has ordered welding wire to be used as part of the recommended welding procedure. PSU will use the recommended welding wire and procedures to conduct a final evaluation of the resulting welds. A major goal of the recommended welding procedure is to obtain optimum root pass penetration and to control the hardness of the low alloy steel heat affected zone.

A problem that the industry faced was periodic unpredictable weld related cracking in dissimilar welded alloys subjected to high service loads can lead to component failure. This project has been focused on developing an optimized welding procedure that will result in consistent crack resistant components.

This project introduced PSU researchers to 2 new wear resistant alloys and the metallurgical considerations required to weld them. PSU developed 2D micro hardness mapping profiles capabilities for the first time and it is expected that these techniques will be applied to various materials research projects.

This project enhanced PSU's ability to characterize the hardness distribution of weld heat affected zones; a critical aspect of assessing a welding procedure.

The project broadened PSU's collaborative research network to include Columbia Steel for the first time.

BUSINESS SUMMARY:

An anticipated benefit to the company is improved welded product reliability with the potential for increased sales. Application of project related welding procedures and analysis to other potential applications.

OMI project extended Columbia Steel Casting Corporation's research capabilities including weld analysis without requiring major investments in equipment and research personnel. Columbia Steel was able to maintain its focus on production without having to divert its resources to research and development.

ALUMINUM BAT PERFORMANCE (PHASE VIII)

Participating Company: DeMarini

Company Contact: Ed VanderPol

Participating University: Portland State University

PSU Principal Investigator: David Turcic

PROJECT SUMMARY:

DeMarini Sports is a world leader in the 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. The proposed continuing study will refine the softball and baseball bat high speed test apparatus and experimental methods to further improve the reliability and precession of the measurement of the impact mechanics of aluminum bats and the effects of material properties and bat structure on the bats' response characteristics.

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

The graduate students had the privilege of working on a real world problem and further developed their mechanical design and instrumentation skills.

The instrumentation and visualization capabilities at Portland State University were enhanced by working with DeMarini Sports.

Project has been completed.

BUSINESS SUMMARY:

DeMarini Sports is a world leader in the 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. The proposed continuing study will refine the softball and baseball bat high speed test apparatus and experimental methods to further improve the reliability and precession of the measurement of the impact mechanics of aluminum bats and the effects of material properties and bat structure on the bats' response characteristics.

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

This new capability will provide input into new designs. A patent is being considered. This project has been completed.

ABRASIVE WEAR BEHAVIOR OF WELD OVERLAYED STEEL

Participating Company: ESCO Corporation

Company Contact: Robin Churchill, John Dillon

Participating University: Portland State University

PSU Principal Investigator: William Wood

PROJECT SUMMARY:

A slurry erosion test system has been designed and fabricated under an earlier OMI project activity. During 2007-2008 OMI year a follow up project to assess materials prepared by ESCO was initiated. PSU has subjected all test coupons supplied by ESCO to one or more slurry erosion test conditions to evaluate how various materials respond to erosion. In this type of test, volume loss is the measured output from the test.

All samples received by ESCO during the year have been tested in the slurry erosion test system. A series of small operational improvements to the system have been incorporated as the system has now been fully tested. These changes did not result in any test condition changes, only improved the operation of the system itself. The challenge has been to measure the volume loss. Conventional analysis uses weight loss measurements, and then using density values. It calculates volume loss. Due to the large mass of the coupon and the small volume loss PSU has been unable to determine volume loss using weight based measurements accurate to the 0.01 micro gram resolution due to max weight limits on the balance. Additionally, at these small weight loss values, repeatability and environmental variable can influence measured outputs.

The testing of additional samples from ESCO will continue during the next year. PSU had a proposal to acquire a non contacting surface profilometer with the capability to make the critical measurements. PSU has continued to test samples while waiting for the proposal outcome. PSU's decision to withdraw its state based proposal for the equipment has resulted in forcing consideration of using an external laboratory to analyze the results. There are no comparable systems within Oregon. PSU has explored analysis with Nanovea and is in process of preparing samples to send for analysis. Rather than send actual samples, PSU has prepared replicas for analysis. If successful the original sample can be reused several times thereby eliminating a majority of the sample preparation work to be done by ESCO and allowing many more tests to be completed. The results for all samples tested by PSU today are expected within May 7, 2009 and will complete the 2007-2008 project. Once these results are completed PSU may also examine them in the SEM for erosion mechanisms.

Application of mining operations generate severe wear on system components. Slurry erosion testing is one of many accelerated wear tests that can be used to assess manufacturing variables that may result in improved performance. This project attempted to assess the slurry erosion properties of various materials produced by ESCO for application in mining operations.

The project developed new skills for wear testing and for post test analysis using replicas and a precision non contact profilometry analysis technique for surface metrology.

As a result of this research Oregon has a university-based slurry erosion test system for materials degradation research and training.

Other applications of surface degradation based on erosion principles may benefit from this development activity. Currently the OUS system is the only university system in the U.S. with this capacity.

BUSINESS SUMMARY:

A slurry erosion test system has been designed and fabricated under an earlier OMI project activity. During 2007-2008 OMI year a follow up project to assess materials prepared by ESCO was initiated. PSU has subjected all test coupons supplied by ESCO to one or more slurry erosion test conditions to evaluate how various materials respond to erosion. In this type of test, volume loss is the measured output from the test.

All samples received by ESCO during the year have been tested in the slurry erosion test system. A series of small operational improvements to the system have been incorporated as the system has now been fully tested. These changes did not result in any test condition changes, only improved the operation of the system itself. The challenge has been to measure the volume loss. Conventional analysis uses weight loss measurements and then using density values, calculates volume loss. Due to the large mass of the coupon and the small volume loss PSU has been unable to determine volume loss using weight based measurements accurate to the 0.01 micro gram resolution due to max weight limits on the balance. Additionally, at these small weight loss values, repeatability and environmental variable can influence measured outputs.

The testing of additional samples from ESCO will continue during the next year. PSU had a proposal to acquire a non contacting surface profilometer with the capability to make the critical measurements. PSU has continued to test samples while waiting for the proposal outcome. PSU's decision to withdraw its state based proposal for the equipment has resulted in forcing consideration of using an external laboratory to analyze the results. There are no comparable systems within Oregon. PSU has explored analysis with Nanovea and is in process of preparing samples to send for analysis. Rather than send actual samples, PSU has prepared replicas for analysis. If successful the original sample can be reused several times thereby eliminating a majority of the sample preparation work to be done by ESCO and allowing many more tests to be completed. The results for all samples tested by PSU today are expected within May 7, 2009 and will complete the 2007-2008 project. Once these results are completed PSU may also examine them in the SEM for erosion mechanisms.

Application of mining operations generate severe wear on system components. Slurry erosion testing is one of many accelerated wear tests that can be used to assess manufacturing variables that may result in improved performance. This project attempted to assess the slurry erosion properties of various materials produced by ESCO for application in mining operations.

ANALYSIS OF ELECTROSLAG WELDMENTS WITH COMPLEX GEOMETRIES

Participating Company: EST&D

Company Contact: Daniel Danks

Participating University: Portland State

PSU Principal Investigator: William Wood

PROJECT SUMMARY:

This project is designed to optimize electroslag welding technology for applications requiring complex geometries rather than conventional butt joint configurations.

One of the problems the industry faced is that heavy section electroslag welding has been largely developed for structural steel applications for bridges. Potential non-bridge applications may include ESW of complex geometries. There is little documentation and virtually no established electroslag welding procedures for complex geometries

The project continues to build the expertise and breadth of electroslag welding at PSU.

The project used PSU's high bay research laboratory facilities. No new capabilities were required.

A benefit of this project is electroslag welding continues to gain popularity across the United States. This project helps maintain the national electroslag joining leadership position in Oregon.

ESW Weld analysis has been completed.

BUSINESS SUMMARY:

This project is designed to optimize electroslag welding technology for applications requiring complex geometries rather than conventional butt joint configurations.

One of the problems the industry faced is that heavy section electroslag welding has been largely developed for structural steel applications for bridges. Potential non-bridge applications may include ESW of complex geometries. There is little documentation and virtually no established electroslag welding procedures for complex geometries

An anticipated benefit to the company is development of new markets and applications for electroslag welding.

LIFETIME AND RELIABILITY IMPROVEMENTS OF NOVEL ION SOURCES

Participating Company: FEI

Company Contact: Greg Schwind

Participating University: Portland State University

PSU Principal Investigator: William Wood, Jack Devletian

PROJECT SUMMARY:

The objective of this research was to extend the lifetime and reliability of FEI's recently developed high brightness plasma ion source and liquid metal alloy ion source. The project included selecting materials, brazing of metal-to-ceramic parts, and applying electrically conductive metal coatings onto ceramic materials. Material selection and preparation for both the plasma ion source and liquid metal alloy ion source were critical to achieve lifetime and to prevent degradation of the critical source components.

This project was successful in design and testing is still on going. It is expected another design revision will be required.

The problem the industry faces was to improve the life and stability for a higher power plasma ion source.

The team would identify problems and develop critical thinking skills.

This project utilized the capabilities of PSU because we were able to understand the mechanism to increase the life of ion sources.

This project helped the industry because it is better able to understand the scientific method of research.

BUSINESS SUMMARY:

Project demonstrated a successful prototype and a next generation version of the product is in progress.

The primary technical challenges were finding suitable ultra high vacuum compatible materials and "joints" that could withstand several years at the elevated temperatures and RF fields required for operation of the ion source.

This new product should open up an entire new market driven by the high volume cross-sectioning application and high throughput TEM sample preparation. Several patent applications related to this product likely will be filed.

Establishing a relationship and interacting with the local university is very positive and makes it easier to initiate joint efforts in other disciplines.

IDENTIFY AND QUANTIFY KEY VARIABLES INFLUENCING GASKETED RESTRAINED PIPE CONNECTIONS

Participating Company: NW PIPE

Company Contact: Randy Ridgley

Participating University: Portland State University

PSU Principal Investigator: Jack Devletian

PROJECT SUMMARY:

In the development of new, alternative, pipe connection systems different structural effects resulted from varying pressure and deflection conditions. This project identified key variables influencing performance of a pipe joint. It also quantified material characteristics to the extent that safety factors were developed under different pressure conditions.

Problem was that key variables influencing performance of a pipe joint needed to be identified so they could be controlled in the design process.

The team would identify problems and develop critical thinking skills.

This project helped because we were able to understand the mechanism of alternative pipe joint systems.

The project enhanced the industry because they were better able to understand the scientific method of research.

This project has been completed.

BUSINESS SUMMARY:

The purpose of the project was to further the development of new pipe connection systems and design. It was necessary to discover performance limitations of materials over a variety of conditions.

This phase of the project is complete allowing for subsequent development to occur.

Installation methods of pipelines can be a significant factor in the overall cost of a project. Northwest Pipe seeks to develop new designs and techniques which will reduce the cost to installers and make steel pipe a better value to the customer.

It is likely that products would cost more from the manufacturer, but would be more than offset by the savings gained in less expensive installation.

Additional welding and product assembly positions would be needed if the project is successful. It is anticipated that use of steel pipe in diameters of 24” down to 18” would increase.

A patent is not being applied for and unlikely in the future.

Another benefit from the project is the relationship built between the academic/technical faculty at PSU and the technical staff at Northwest Pipe Company which has been enhanced.

PROPERTY CHARACTERIZATION OF HARD THIN WEAR RESISTANT COATINGS

Participating Company: Oregon Cutting/Blount

Company Contact: Charlie Moore, John DeHaven

Participating University: Portland State University

PSU Principal Investigator: William Wood, Wendelin Mueller

PROJECT SUMMARY:

The project involved research for coatings on special-application tools, as alternatives to electrolytic hard chromium (EHC) – phenomenal in performance. The modeling of EHC was completed and the study of alternatives was initiated with pursuit continuing into the next fiscal year.

The problem was to model the characteristics of EHC as a baseline and then acquire for Blount a coating for high-strength steels as its viable alternative. Environmental concerns and associated federal regulations have resulted in a need to pursue alternative materials and technologies, yet most processes employ parameters that deteriorate engineered properties in the steel substrate.

We located a source that could provide various coatings with relatively ideal conditions for the study. The first of various coatings were produced for analysis, carrying into the next fiscal year.

Estimated cost of savings and efficiencies gained in resource use or re-use, human-hours saved, utilized lower cost or locally produced materials in terms of how it will be used is indeterminable at this time. No new markets or products were developed as yet-still in research phase. No additional jobs were created and there have not been any other benefits from the industry-research partnership. The research did not lead to a new patent application or new patent.

BUSINESS SUMMARY:

The project involved research for coatings on special-application tools, as alternatives to electrolytic hard chromium (EHC) – phenomenal in performance. The modeling of EHC was completed and the study of alternatives was initiated with pursuit continuing into the next fiscal year

The problem was to model the characteristics of EHC as a baseline and then acquire for Blount a coating for high-strength steels as its viable alternative. Environmental concerns and associated federal regulations have resulted in a need to pursue alternative materials and technologies, yet most processes employ parameters that deteriorate engineered properties in the steel substrate.

We located a source that could provide various coatings with relatively ideal conditions for study. The first of various coatings were produced for analysis, carrying into the next fiscal year.

The estimated savings and efficiencies gained in resources used are indeterminable at this time. There were no additional jobs created during this project and no patents or applications were submitted. As of now, no new markets were captured or developed but it is still in the research phase. There has not been any other benefit from the industry-research partnership.

LINKED COLUMN SYSTEM ANALYSIS AND COMPONENT TESTS PHASE II

Participating Company: Oregon Iron Works

Company Contact: Thomas Hickman

Participating University: Portland State University

PSU Principal Investigator: Nordstrom, William Wood

PROJECT SUMMARY:

The project aims to develop a braced free structural steel building system for resisting earthquake loads while being capable of rapid return to occupancy after a major earthquake event. The structural system relies on specially designed bolted link beams, which are distributed between double columns and intended to be replaced when damaged by an earthquake. Numerical simulation of the structural system showed a potential for achieving the desired performance levels. In this second phase, the feasibility of a replaceable link beam is to be experimentally investigated.

Detailed numerical analyses were conducted on the linked beams, focusing on shifting the plastic strains away from the connections. Based on the numerical model results, two options of using a stiffening plate at the ends of the beam were selected for the experiments.

Test setup has been designed for the link beams and is being fabricated. The project had to be put on hold for over 10 months due to an unrelated fire that occurred in the laboratory. The recovery from the fire has taken significant time in clean-up, equipment repair, and human resources. The frame fabrication is scheduled for mid-February, followed by assembly and leading to the planned testing that is expected to commence in March 2009.

The current building design philosophy for resisting extreme events, such as earthquake, is life safety with no considerations toward returning to occupancy after an event. However, the expectations are now moving toward performance based design and new building systems are needed to be developed. This project is looking for one such solution that would take advantage of structural steel in its ability to deform and connect.

In this phase, the focus is on the critical beam links that are expected to dissipate energy during an earthquake and yet still be replaceable. Although numerical analyses had been done, verification of the model is needed via large-scale tests. In total, eight specimens are being constructed and include a base conventional detailing case and three alternatives. The tests will be carried out under cyclic loads to simulate earthquake effects and will be taken to failure in order to study the entire behavior.

The students learned critical thinking and advanced analysis techniques. The teams of graduate and undergraduate students have developed analysis skills that they would not have gained through traditional instruction. Furthermore, the practical nature of designing and physically testing the design has made the students appreciate the need for communication with the fabricators in order to attain not only a functional design but also a practical design.

A short conference paper is being submitted for consideration to an international conference on

structural design of steel structures.

PSU expertise in structural and earthquake engineering has been taken advantage of and subsequently enhanced through this project. This phase of the work will involve the unique capabilities of infrastructure Testing and Applied Research (iSTAR) Laboratory, where large-scale experiments will be conducted. These facilities are some of the most unique in the Pacific Northwest, with large hydraulic actuator and state of the art data acquisition system used to measure the performance of the critical components. The components will be tested at large scale and all the way to failure.

The partnership with industry is extremely valuable in providing practical outlook on solving the problem. The students as well as the faculty have learned from the industry partnership.

BUSINESS SUMMARY:

This project allows for the steel building industry to stay ahead of the trends in performance based design of buildings so that options can be made to engineers and owners when needed. The ideas being researched take advantage of the benefits of structural steel so that a competitive advantage can be gained over other types of construction. With the design shifting toward a more performance based approach, the importance of structural systems such as those being investigated in this project are very important.

ASSESSMENT OF THE IMPACT OF PROCESS PARAMETERS IN PLATE ROLLING AND COILING PRACTICE

Participating Company: Oregon Steel Mills

Company Contact: Greg Ebel, Ross Bordon

Participating University: Portland State University

PSU Principal Investigator: William Wood, Lemmy Meekisho

PROJECT SUMMARY:

For several years, Oregon Steel Mills which transitioned to Evraz Oregon Steel Tubular (EOST) made steel plates that were shipped to a pipe forming mill in Napa California. The pipe making technology used in Napa was relatively straightforward since it involved forming the plate from a flat conjunction to a U-shape followed further forming to an 0-shape. The gap was closed by two longitudinal submerged arc welding beads, one on the inside surface and the other on the external surface.

EOST built a new pipe mill right on the premises at its plant in north Portland. The pipe making technology used in the new mill involves a much more complicated process of spiral-forming plate material into a tubular shape. The resulting spiral gap is welded on the inside and outside surfaces using submerged arc welding processes.

Spiral forming and welding has many challenges. EOST needed to establish a reliable practice in which the plate forming produces consistent pipe diameter and a reproducible constant spiral gap followed by continuous and good penetration weld seams.

It is difficult to attach a specific figure of cost-saving associated with the success of this project, however, it is safe to observe that spiral forming and welding of pipes offers significant manufacturing flexibility of a wide range of pipe diameters and wall thicknesses with low setup cost. The economic benefits associated with the success of this project are thus clearly far reaching.

Savings in the setup costs for different pipe dimensions, as explained above, will improve the efficiency of the use and re-use of raw materials and other resources.

The objective of the project was to establish good insights on how to tweak process parameters by a combination of instrumented testing as well as computer-assisted modeling, in order to achieve smooth and repeatable pipe forming practice. To achieve this objective was envisioned to be a multi-year effort. Clearly once this objective is achieved EOST would be in a position to make a wide range of pipe diameters and wall thicknesses with limited loss to yield due to forming or welding errors. This in turn would ensure a good pipe market share for EOST.

The project was a good source of learning opportunities for the principal investigator as well as greatly enhancing the research experience for the graduate student. The graduate student who worked on this project learned useful industry skills that will be helpful to him in the workplace. The graduate student also compiled a technical report that will form a good starting point for the continuation of this project into the next phase.

There have been benefits for this industry-research partnership. The student and the principal investigator of this project had numerous opportunities to be at the pipe mill to observe plant practices and record scientific measurements. This was a mutually beneficial setting in which the plant engineers could relate their concerns about the project directly to PSU as the research partners and vice versa. This setting thus enabled the industry university partnership to seamlessly integrate theory and practice.

BUSINESS SUMMARY:

For several years, Oregon Steel Mills which transitioned to Evraz Oregon Steel Tubular (EOST) made steel plates that were shipped to a pipe forming mill in Napa California. The pipe making technology used in Napa was relatively straightforward since it involved forming the plate from a flat configuration to a U-shape followed further forming to an O-shape. The gap was closed by two longitudinal submerged arc welding beads, one on the inside surface and the other on the external surface.

EOST built a new pipe mill right on the premises at its plant in North Portland. The pipe making technology used in the new mill involves a much more complicated process of spiral-forming plate material into a tubular shape. The resulting spiral gap is welded on the inside and outside surfaces using submerged arc welding processes.

Spiral forming and welding has many challenges. EOST needed to establish a reliable practice in which the plate forming produces consistent pipe diameter and a reproducible constant spiral gap followed by continuous and good penetration weld seams.

It is difficult to attach a specific figure of cost-saving associated with the success of this project, however, it is safe to observe that spiral forming and welding of pipes offers significant manufacturing flexibility of a wide range of pipe diameters and wall thicknesses with low setup cost. The economic benefits associated with the success of this project are thus clearly far reaching.

Savings in the setting up costs for different pipe dimensions as explained in response above will improve the efficiency of the use and re-use of raw materials and other resources.

There were no additional jobs created with his project and the project did not lead to a new patent or application.

The objective of the project was to establish good insights on how to tweak process parameters by a combination of instrumented testing as well as computer-assisted modeling, in order to achieve smooth and repeatable pipe forming practice. To achieve this objective was envisioned to be a multi-year effort. Clearly once this objective is achieved EOST would be in a position to make a wide range of pipe diameters and wall thicknesses with limited loss to yield due to forming or welding errors. This in turn would ensure a good pipe market share for EOST.

The project was a good source of learning opportunities for the Principal Investigator as well as greatly enhancing the research experience for the graduate student. The graduate student who worked on this

project learned useful industry skills that will be useful to him in the work place, and he also compiled a technical report that will form a good starting point for the continuation of this project into the next phase.

The student and the principal investigator of this project had numerous opportunities to be at the pipe mill to observe plant practices and record scientific measurements. This was a mutually beneficial setting in which the plant engineers could relate their concerns about the project directly to us (University research partners) and vice versa. This setting thus enabled the industry-university partnership to seamlessly integrate theory and practice.

PHASE III GOLD ALUMINUM GOLD COPPER CONTACT ASSESSMENT, A NOVEL APPLICATION TO SEMICONDUCTOR TEST

Participating Company: Octavian Scientific

Company Contact: Chuck Wiley

Participating University: Portland State University

PSU Principal Investigator: Rob Daasch, Jack Devletian

PROJECT SUMMARY:

The original project task was to investigate the electrical and mechanical contact of Gold with Aluminum for applications in the testing of semiconductor chips. The project is completed.

A solution to the problem was mostly solved, but the least expensive of semiconductor chips must be tested for functionality and specifications while they are still in wafer form; aka wafer testing. Establishing contact to a semiconductor chip in wafer form is tedious and expensive. This project was part of a larger effort to both reduce the complexity and expense of contacting semiconductor chips for wafer testing and increase the reliability of the contact.

Cost savings are realized by reducing capital equipment expenditures and increasing labor efficiency during the wafer testing process.

The results of this research has helped in the development of a full-wafer contactor for test and burn-in, which is a key ingredient in increasing test throughput and improving equipment utilization.

With this project it is likely that the more highly skilled jobs will continue and some of the less skilled jobs may no longer be needed, but the product has not yet been deployed so currently nothing has been affected.

New products are in development for the semiconductor wafer test market. Since integrated circuits are already in production, they would not be new markets. But since the new products will help reduce the costs of the semiconductors on the wafers, this can initiate or grow new semiconductor applications.

Provisional patent submissions are planned.

The research team gained invaluable access to state-of-the-art facilities. Unique research experiments were completed and previously unavailable data from the experiments shared. Frequent research meetings provided a venue for new inventions and concepts likely not possible without the collaboration.

Complementary research directions in the wafer-testing area have emerged from the collaboration. The new directions hold similar promise for improving the cost-structure in semiconductor design-for-test and wafer-testing.

BUSINESS SUMMARY:

The original project task was to investigate the electrical and mechanical contact of Gold with Aluminum for applications in the testing of semiconductor chips. The project is completed.

A solution to the problem was mostly solved, but the least expensive of semiconductor chips must be tested for functionality and specifications while they are still in wafer form; aka wafer testing. Establishing contact to a semiconductor chip in wafer form is tedious and expensive. This project was part of a larger effort to both reduce the complexity and expense of contacting semiconductor chips for wafer testing and increase the reliability of the contact.

Cost savings are realized by reducing capital equipment expenditures and increasing labor efficiency during the wafer testing process.

The results of this research has helped in the development of a full-wafer contactor for test and burn-in, which is a key ingredient in increasing test throughput and improving equipment utilization.

With this project it is likely that the more highly skilled jobs will continue and some of the less skilled jobs may no longer be needed, but the product has not yet been deployed so currently nothing has been affected.

New products are in development for the semiconductor wafer test market. Since integrated circuits are already in production, they would not be new markets. But since the new products will help reduce the costs of the semiconductors on the wafers, this can initiate or grow new semiconductor applications.

Provisional patent submissions are planned.

The research team gained invaluable access to state-of-the-art facilities. Unique research experiments were completed and previously unavailable data from the experiments shared. Frequent research meetings provided a venue for new inventions and concepts likely not possible without the collaboration.

Complementary research directions in the wafer-testing area have emerged from the collaboration. The new directions hold similar promise for improving the cost-structure in semiconductor design-for-test and wafer-testing.

METALLURGY AND PROPERTIES OF ADVANCED NICKEL ALLOYS

Participating Company: PCC Structurals

Company Contact: John Peng, Jim Barrett

Participating University: Portland State University

PSU Principal Investigator: W Robert Daasch, Victor Li, William Wood

PROJECT SUMMARY:

This project investigates the kinetics of gamma prime precipitation in cast nickel alloys.

The heat treating specifications for many cast nickel alloys were developed many years ago based on trials. Alloy castings are typically held in high temperature for aging over long hours. With a better understanding of the gamma prime precipitation kinetics, it is possible to shorten the heat treating time, thus translates into energy and cost savings.

This project gives the research team an opportunity to investigate the formation of microstructure of nickel alloys in heat treating with combination of electron microscope and computational modeling.

This project utilizes and builds the research portfolio on electron microscopy with nickel alloys.

Research such as this opens the door for the metal industry to move heat treating from experience based or trial based to science based. It realizes that a science based design of heat treatments can be used to achieve required properties with energy and cost savings.

Currently the project is continuing to progress.

BUSINESS SUMMARY:

This project investigates the approaches to soften cast nickel alloys before repair welding.

We are looking into better ways to soften materials before welding to minimize the risk of weld cracking.

An anticipated benefit to the company is to find ways to minimize the amount of rework.

This is a collaborated effort between PSU and the industries to improve daily production activities and/or take challenges often encountered in the manufacturing or construction environment. By directly participating in the industrial activities, PSU can discern the current and future needs of local industries, and provide in-depth educational program and research projects to PSU students, who will eventually become the backbone of our business. In the mean time, we can all greatly benefit from the use of the state of the art equipment at PSU and the profound knowledge of the faculty members at the school.

The project is continuing in progress and will be completed before June 2009.

WELDING OF CAST NICKEL ALLOYS

Participating Company: PCC Structurals

Company Contact: John Peng, Jim Barrett

Participating University: Portland State University

PSU Principal Investigator: William Wood, Victor Li

PROJECT SUMMARY:

This project investigates the approach of heat treating cast nickel alloys to softest condition for repair welding and simulation of repair welding.

Over-aging is a common practice to soften cast nickel alloys. However, existing over-ageing is based prolonged ageing time at specified ageing temperatures. This project attempts to re-design heat treating processes to soften the material by considering the thermodynamics and kinetics of gamma prime precipitation and precipitation coarsening.

This project promotes creative thinking in designing materials processing to meet the need for material properties.

This project blends computational materials modeling and experimental investigation.

This research leverages the strength of computational materials modeling to guide the design of materials processing.

The project is continuing in progress and is expected to complete in June 2009.

BUSINESS SUMMARY:

This project investigates the approaches to soften cast nickel alloys before repair welding.

We are looking into better ways to soften materials before welding to minimize the risk of weld cracking.

An anticipated benefit to the company is to find ways to minimize the amount of rework.

This is a collaborated effort between PSU and the industries to improve daily production activities and/or take challenges often encountered in the manufacturing or construction environment. By directly participating in the industrial activities, PSU can discern the current and future needs of local industries, and provide in-depth educational program and research projects to PSU students, who will eventually become the backbone of our business. In the mean time, we can all greatly benefit from the use of the state of the art equipment at PSU and the profound knowledge of the faculty members at the school.

The project is continuing in progress and will be completed before June 2009.

SIMULATION OF METAL EXTRUSION FACILITY

Participating Company: Wah Chang
Company Contact: Gordon Dobbie
Participating University: Oregon State University
OSU Principal Investigator: David Kim

PROJECT SUMMARY:

This project is a simulation of a proposed new extrusion facility, for justification and design purposes.

A problem the industry faced is understanding and predicting the performance of a newly designed system, with expensive machinery it is difficult. Simulation can help reduce uncertainty and understand the system better.

Estimated cost of savings is very difficult to estimate. If the facility goes forward, having a good system design could save millions of dollars. Efficiencies gained in resource is also very difficult to estimate. There were no additional jobs created and existing jobs didn't have a raised skill level. There were also no new markets captured. This research did not lead to any new patents or patent applications.

This project helped researchers gain more experience with another real problem, which can be transferred to the classroom. An additional benefit from this industry-research partnership is that solid contact has been established.

BUSINESS SUMMARY:

This project is a simulation of an extrusion facility in order to aid design and cost analysis.

A problem the industry faced was the scale of operation and process flow for a new extrusion facility. This can be crucial in understanding necessary equipment and layout. A simulation can help improve confidence in the design.

It is difficult to estimate the savings in cost, but any simulation that can describe the potential and limitations for a process will be very beneficial. Millions of dollars could be saved. Efficiencies gained in resource use or re-use, human-hours saved, utilized lower cost or locally produced materials would be realized as the simulation is modified and adjusted with updated information. The benefit would be similar to item. No additional jobs were created nor were employees affected at this time. There is potential, but no new markets or jobs were developed at present. The research did not lead to a new patent application or patent.

The project enhanced the research skills of the team and students because the research team was exposed to a practical manufacturing problem.

Teamwork and new relationships between the industry participants and research team were developed.

DEVELOPMENT OF LEAD-FREE PIEZOELECTRIC MATERIALS AND DEVICES

Participating Company: Hewlett Packard
Company Contact: Pater Mardilovich
Participating University: Oregon State University
OSU Principal Investigator: David Cann

PROJECT SUMMARY:

The project is focused on the development of environmentally benign materials for piezoelectric applications, where a piezoelectric material is defined as one that changes it's shape upon application of a voltage. The project has been underway since April and three faculty members (David Cann, Brady Gibbons, and Mas Subramanian) are all working on different aspects of this objective.

The problem the industry faced is the most common material used in piezoelectric applications is lead zirconate titanate, which contains lead as a major constituent. Lead is one of the substances listed in the Reductions of Hazardous Substances (ROHS) directive which aims to eliminate hazardous materials world wide. This project aims to find a suitable replacement material.

Estimated cost of savings is difficult to estimate, there is a worldwide search going on (primarily in the US, EU, Japan and China) and the development of a new material would represent a significant advancement. At this time no additional jobs were created or efficiencies gained in resources used. New markets captured is still in progress right now. At this time there are no new patents or patent applications.

A team of three faculty, threee students and one post-doctoral scholar are working on this project. A number of experimental capabilities have been developed and the students have greatly benefited from interactions with the industrial collaborators.

A strong collaborative relationship has been developed that may lead to other joint research and educational activities.

BUSINESS SUMMARY:

The project involves the development of Pb-free piezoelectric materials in bulk and thin film forms for actuator applications.

There are many problems with existing materials, and HP and OSU researchers are looking at improving the performance of existing materials and investigating new materials. All companies are looking at removing Pb and other hazardous substances from their products.

The estimated cost savings is not easily evaluated – however working with OSU is an effective mechanism for research and development. OSU researchers work closely with HP researchers, and the project is directly related to HP's product development. This project has great potential for HP. The research did not lead to a new patent application or new patent.

Students have been involved in all aspects of the project. I think the students have learned a lot about industrial research and they will be better prepared for their future job post graduation.

OSU and HP have a strong relationship and this project has been a significant contribution to that relationship.

SPUTTERING OF METAL FILMS FOR MICROELECTRONICS PROCESSING

Participating Company: Intel

Company Contact: David Sauer, Scott Lantz, and Jonathan Thibado

Participating University: Oregon State University

OSU Principal Investigator: Milo Koretsky

PROJECT SUMMARY:

This research is a collaboration between OSU and engineers at Intel who are responsible for sputter deposition of metal films. Two topics are being investigated: (1) Self forming barrier layers using CuX targets and (2) Intermetallic formation and diffusion path evolution in under bump metallurgy and Tin containing solders. Two students are working on the project. An update meeting with three engineers from Intel (Scott Lantz, David Sauer, and Jonathan Thibado) was held October 23, 2008.

A problem the industry faced is large-scale integrated circuits have an interconnect structure made with conducting materials and insulating dielectric materials. Copper is used as the conductor due to its low resistivity. In order to prevent interdiffusion of the copper to the insulators, a barrier layer needs to be deposited between these two layers. The barrier layer increases the effective resistivity and decreases device performance. We are investigating a novel process that both decreases the resistivity of the barrier layer and reduces the number of processing steps.

There are no estimated cost savings to date. This project is helping provide groundwork for process development. Constant improvement is critical to remaining competitive in the IC market. This project will provide knowledge to improve process capability in integrated circuit manufacturing. This will contribute to the competitiveness of the industrial sponsor.

There is potential to produce future generations of faster computer chip as this technology develops. The research did not lead to a new patent or patent application.

Two MS students and an undergraduate are getting research experience relating to a practical industrial problem. In addition, this project will sponsor a team of three undergraduates in their capstone undergraduate laboratory. This project has enabled the purchase and installation of an AJA sputter system enhancing the ability for the CBEE School to conduct materials processing research and education

A benefit of this industry-research partnership is the Intel sponsors have agreed to give a seminar in ChE 4441544, ***Thin Film Materials Processing.***

BUSINESS SUMMARY:

This project explores some of the scientific issues to develop a self-forming barrier layer technology to prevent copper diffusion into dielectric films. The principle is to grow a copper film with an additive element that segregates to the surface upon heating and forms a protective layer between the copper and the dielectric.

Several films are needed to prevent diffusion of Cu in dielectric which is costly and complicated. This research will provide part of the knowledge base to develop a simpler alternative process.

Manufacturing processes in the integrated circuit industry are highly complex and integrated. This research adds to the knowledge foundation needed to evaluate and develop cheaper and more effective process alternatives for future generations of computer chips.

If this process were to be implemented, the cost savings realized is estimated to be approximately $50 per wafer processed in high volume manufacturing. This would translate into a savings of billions of dollars over the lifetime of the process. This process would allow twenty fewer thin film layers in the present integrated circuit architecture. No additional jobs were created. There will be new alloy targets that would be needed for this process. The research did not lead to a new patent application or new patent.

There are two graduate students and three undergraduate students gaining hands-on experience in thin film processing and characterization. These skills are directly useful in the manufacturing environment. A new sputter system has been purchased as a result of this project. This system is enhancing other research projects at OSU.

Based on this partnership, a seminar was delivered to 28 students in senior level undergraduate/graduate chemical engineering class at OSU. In a broader context, it strengthens connections for future intern and employment opportunities.