Wisconsin Institute for Sustainable Technology

Annual Report

December 2018

Wisconsin Institute for Sustainable Technology
College of Natural Resources
University of Wisconsin-Stevens Point

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Contents

Research, laboratory services and education provided by the Wisconsin Institute for Sustainable Technology (WIST) help businesses and organizations meet their goals in ways that make more sustainable use of natural resources. Technology and ideas developed by WIST and its partners will spur economic growth in Wisconsin and the region and help preserve a healthy environment for future generations.

WIST is an institute within the College of Natural Resources at the University of Wisconsin-Stevens Point. It is a multidisciplinary institute powered by the energy and expertise of faculty, staff and students across the UW-Stevens Point campus.

A Note From the Director

Paul Fowler
Executive Director

Thank you for taking the time to read WIST's 2018 annual report.

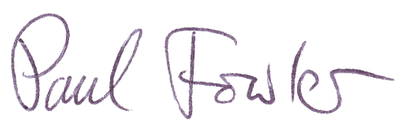
It has been a busy year across WIST's research, laboratory and education divisions.

Our long-term research and economic development project to uncover new opportunities from vegetable harvesting and processing wastes has seen us zero-in on the potential of potato vines as a source of an important health and wellness antioxidant, chlorogenic acid. As the project moves into its final phase, we are excited to explore the feasibility of domestic production on a commercial scale.

Our laboratory services group continues to provide expert analyses and testing to companies in Wisconsin and beyond. As well as working with long term pulp and paper industry clients, the group services sectors as diverse as waste water remediation and sustainable packaging. This year, WIST also became a licensed processor of industrial hemp and has focused on making its services available to growers in Wisconsin and those other states that have pilot programs.

In 2018, education offerings took the form of our highly-regarded paper industry short courses taught by Professor Emeritus Gerry Ring of the Paper Science and Chemical Engineering Program. We also hosted the eighth Focal Point in October, again targeting the burgeoning opportunities for paper-based food packaging and serviceware. This year we hosted, for the second time, the Midwest Compost School with attendees coming from as far afield as Massachusetts and Idaho. In September, I had the honor of presenting an educational seminar at Sustainable Packaging Coalition's Fall Event on the basics of compostable packaging. Earlier, in April, WIST co-hosted with the Compost Manufacturing Alliance a webinar titled Compostability Testing of Multi-Layer Materials Containing Paper.

I trust you continue to enjoy learning more about the work of WIST and should you have any questions please do not hesitate to call me at 715-346-3767.



Education

Hands-On Courses

WIST provided its Hands-On Papermaking education series again in 2018, with a total of 53 paper industry professionals taking at least one of the courses.

The full series includes Hands-On Papermaking, Advanced Hands-On Papermaking: Additives; and Advanced Hands-On Papermaking: Formation. Students can take one or all of the courses; none is a prerequisite for another. WIST also provided another course with a hands-on component: Coating and Lamination in Packaging Applications.

The institute also developed and provided for the first time a handmade papermaking workshop on request from West Bend, Wisconsin, artist Ann Meyer. She contacted WIST after she had been admitted to an artist-in-residence program at a cattle station in Australia that makes paper from local, native plants.

"I knew that when I got to Australia I was going to be involved in paper making, but I wanted to make sure that I was making something that was archival quality, so I was looking for true papermaking experts as opposed to simply a craft-type of class," Meyer said. She plans to make paper from local materials and use that handmade paper for the ink drawings she creates.

Students in the Hands-On Papermaking course discuss measurements taken at the headbox of the university's pilot paper machine.

2018 Midwest Compost School

The Midwest Compost School has been conducted annually since 1995, with its location varying between Illinois, Minnesota, Iowa and Wisconsin. WIST and the UW-Stevens Point Soil and Waste Resources Discipline in the College of Natural Resources hosted the school for the first time in 2017 and took on the role again in 2018. The school drew 32 students to campus in July.

Marcus Gamoke, owner of Busy Bee Compost, talks to students in the Midwest Compost School about his commercial compost operation.

The school provides an immersive three days of instruction aimed mainly at large-scale composters such as commercial operators, municipalities and agricultural operations. Topics covered ranged from the technical end of composting – equipment, recipe development, measurement and data analysis – to bigger-picture aspects such as challenges in developing a composting program for a small city and marketing and economics of composting. Expert instructors from throughout the Upper Midwest led the students through classroom training and exercises, hands-on exercises in building compost piles, and field trips to area commercial compost operations.

Laboratory Services

A secondary headbox built by a paper science and engineering senior design team (see story page 12) adds new laboratory services and research capability. Paper pulp is shown exiting the headbox on the right side.

WIST updated it laboratory services price list and services array in 2018. The institute now offers more than 50 paper testing and analysis services ranging from the ABC Pulping Liquor Test to the Zero-Span Tensile test.

But those tests are just part of the array of laboratory services the institute provides. Others include pulping and bleaching, pilot coating and laminating, papermaking, and compostability testing. The laboratory provides analyses such as ion chromatography for carbohydrates, organic acids and alcohols.

WIST laboratory services were in high demand throughout 2018. Eighty quotes were issued, up 38 percent on 2017's total. Of those 80 quotes, 51 were converted to invoiced contracts or on-going projects. Work ranged from repulpability and compostability testing, art and blotter paper production, paper machine and coating trials, waste water remediation testing, to carbohydrate analysis, and industrial hemp fiber evaluation.

WIST laboratory service areas

- Pilot coating and laminating
- Papermaking including trial and small production runs
- Pulping and bleaching for wood and non-wood biomass including food-processing waste and agricultural residual materials
- Paper testing to standard TAPPI and other methods
- Compostability testing and certification, including preliminary screening, biodegradation testing; disintegration testing, and disintegration and ecotoxicity testing
- Fermentation and hydrolysis

Research

Industrial hemp is new research area for WIST

Cannabidiol – CBD – oil is among the hottest products on the market. Claims are being made that it fights cancer, reduces inflammation and helps fight anxiety, among others. There's even CBD oil for dogs. A November 2018 article in the Milwaukee Journal Sentinel reported that entrepreneurs jumping in to produce CBD oil have created a "gold rush atmosphere."

WIST isn't panning for that particular gold, but recognizing that the increasing amount of hemp grown to produce the oil also means quantities of hemp fiber being produced, the institute in 2018 became one of the first organizations in Wisconsin to be granted a processor permit for research on industrial hemp. WIST plans to focus on fiber qualities of industrial hemp, with an eye toward new uses in papermaking and packaging.

Lindsey Hoffman, WIST laboratory and papermaking project specialist, adds hemp fiber to a vessel to convert the material to pulp.

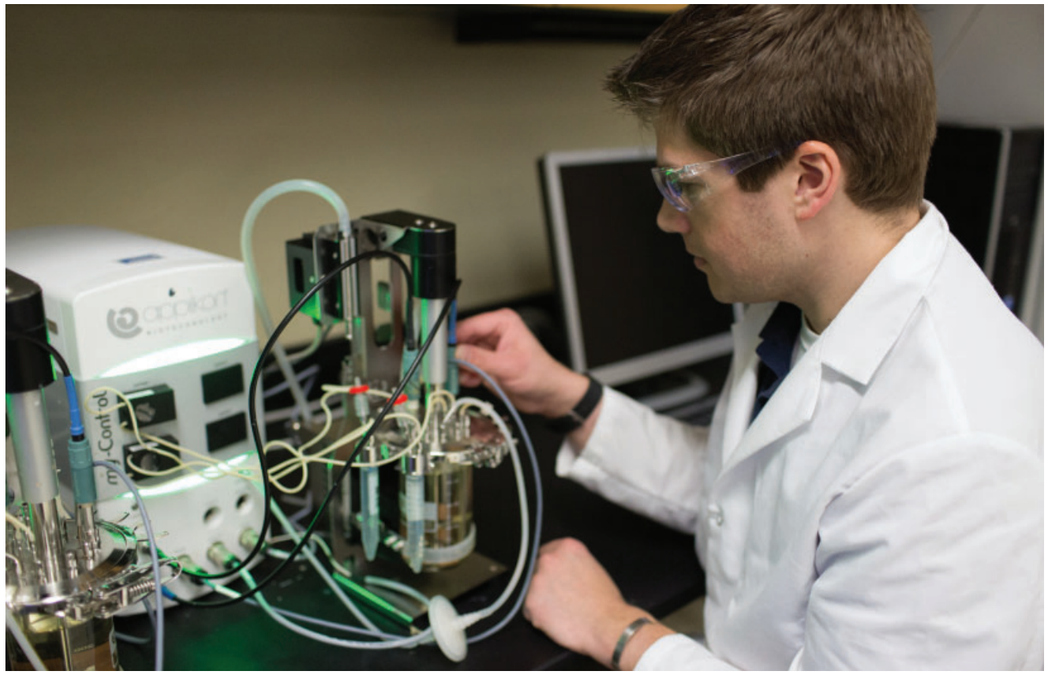
Industrial hemp is the same species as marijuana, Cannabis sativa L., but does not have the same psychotropic properties because it contains a low percentage of tetrahydrocannabinol (THC). It won't get you high. The WIST research permit specifies that any hemp the institute receives for research must be certified to have a THC content no greater than 0.3 percent.

Hemp was once widely grown as an industrial material used in the making of rope – sailing vessels were rigged with it – clothing and paper. By the early 20th century, cotton for clothing and wood for paper had largely supplanted hemp. Then cultivation of the plant was banned in many places including the United States, tangled up in bans on marijuana with increasing concern about recreational drug use.

U.S. federal and state governments began easing those bans beginning in 2014 with federal law changes that allowed limited production of industrial hemp by universities and state departments of agriculture. By 2018, more than 20 states had enacted industrial hemp pilot programs. The 2018 federal farm bill passed in December legalizes industrial hemp cultivation nationwide, removes hemp from the list of controlled substances and allows states to be primary regulators of its cultivation. Industry analysts such as the Hemp Business Journal say the law change will spur even more rapid growth in hemp, which the journal estimated at $820 million retail value in 2017.

Production of and research on industrial hemp in Wisconsin is regulated by the Department of Agriculture, Trade and Consumer Protection under legislation passed in 2017.

Paul Fowler, WIST executive director, said the new research area fits well with the institute's mission and track record.



Justin Hall checks samples in benchtop fermenters in a WIST laboratory. The fermenters are used in a variety of research projects including one to help a Wisconsin company develop better enzyme products for wastewater treatment.

Hemp research, continued

"We've done testing, analysis and pilot paper production on a number of novel fiber sources," Fowler said. "For example, we've done some work for a brewery around the use of spent grain fibers to be used in the production of paper. It could be a nice sustainability gain. We see hemp similarly as a material that fits in the sustainability arena."

The research also fits with WIST's mission of working with agriculture for economic gains. "We figure that investigating hemp for 21st century uses of the fiber was the right thing to do from the point of view of economic development, valorizing the whole hemp industry in Wisconsin," Fowler said.

Contract research for industry

WIST provides bespoke research and analysis services including ion chromatography, high performance liquid chromatography and mass spectrometry.

"The biggest research we've been doing this year in the fermentation lab is with a company, Aquifix, which I've worked with before," said Justin Hall, WIST technical project manager. "We're testing out an enzyme that they're developing to help break down fatty acids in wastewater. The fatty acids in wastewater are becoming a very big problem, and they come from restaurants, fast-food places, really any place that produces grease."

Hall tested the enzyme against nine known sources of fat, comparing its effectiveness in breaking down those fats to a blank sample, which didn't contain the enzyme. "The enzyme did, in fact, help break down the fatty acids," Hall said. He added that the company made several modifications to the enzyme based on the research results, and already has the product on the market.

Valuable Chemicals from Vegetable Production Waste

Commercialization possibilities indicated

WIST is nearing the end of a three-year research project to determine whether residual materials from vegetable production and processing can generate valuable chemicals, and the results look promising.

Since March 2016, WIST has been analyzing materials such as potato peels and cranberry leaves for presence of antioxidants or other chemicals commonly used in production of pharmaceuticals, personal care products and health aids.

WIST Technical Project Manager Justin Hall, who performed primary laboratory research for the project, early on focused on potato peels. But in the second year of the project, Hall began to look at potato vines, as well, and found that some varieties hold chlorogenic acid quantities in the same range as other current industry sources for the chemical. That indicates the vines may be a commercially viable source. Hall developed processes at laboratory scale to achieve 70 percent purity of the chlorogenic extract, a level that is currently marketed.

Paul Fowler, WIST executive director, presents data to the project advisory board.

Chlorogenic acid is an antioxidant, a type of chemical important to industry in uses such as shelf-life stabilizers. People may be more familiar with antioxidants for their health-enhancing reputation. Starbucks, for example, is promoting beverages containing “green coffee extract,” touting the presence of antioxidants including chlorogenic acid in the drinks.

Besides the residuals from potato harvest and processing, WIST analyzed processing residuals from carrot peels and carrot tops and onions peels. Several of these show promise, such as the presence of the antioxidant quercetin in onion peels.

The research project is collaborative. The U.S. Economic Development Administration provided $499,965 in funding over the three-year period. Matching contributions from WIST, Del Monte Foods, Heartland Farms, the Midwest Food Products Association and the Wisconsin Potato and Vegetable Growers Association pushed the total project funding to just over $1 million. Each of those organizations also provided expertise and logistical support. The Wisconsin Economic Development Corporation and the WiSys Technology Foundation provided additional consultation and expertise.

The EDA grant came through that agency’s Regional Innovation Strategies program, which aims to promote collaborative entrepreneurism to spur economic development. With that in mind, WIST formed a project advisory board early on, comprising representatives from each of the project’s supporting partners.

Wisconsin farmers harvest about 1.4 million tons of potatoes annually. Peels and vines contain natural chemicals that may be valuable in food, beverage and other consumer product industries. (Photo: iStock.com/BrianBrownImages)

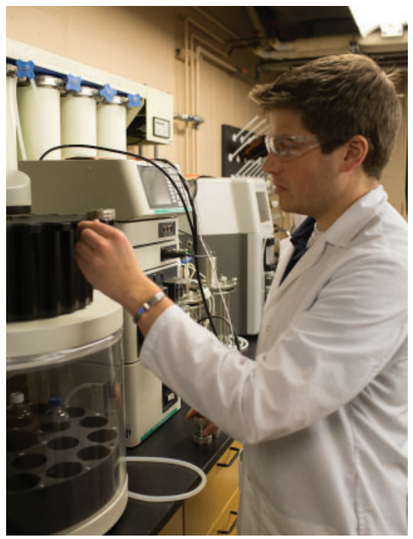
The EDA project officially wraps up in March 2019, but WIST and project partners are exploring opportunities to continue the research and evaluate commercialization possibilities. Additional work may include further purification of the extract chemicals and testing processes at quantities scaled up from the laboratory.

Industry importance

Wisconsin ranks third in the nation in production value of vegetables and growing and processing these crops represents $6 billion in economic activity. The research project aims to support this important Wisconsin industry.

Peelings plus undersized, blemished or otherwise unsuitable potatoes amount to about 15 percent of the crop brought to processors and all those residuals must be disposed of. Other vegetable processing also results in residual material.

Disposal represents a cost, although in some cases material brings a small return such as when used in pet or other animal food. Deriving additional value from what are now waste products would improve profitability of the specialty vegetable industry, support jobs and help grow the rural economy.



Justin Hall works with chemical analysis equipment in the WIST laboratory.

Student Connections

Pilot Paper Machine Gets Added Capability

WIST has new capability to produce two-layer paper on the UW-Stevens Point pilot paper machine, thanks to a successful senior design project of the university's paper science and chemical engineering class.

Seniors are required to complete a capstone engineering design project. In spring semester 2018, a four-person team of Farrah Scears, Justin Okruszynski, Luke Mason and Joe Kinscher designed a second headbox for the pilot machine.

Paper pulp is more than 99 percent water when it starts its journey through the paper machine. A headbox on a paper machine controls the flow of pulp onto a forming wire, a continuously moving wire mesh belt where the pulp begins to lose water and form into paper.

A year earlier, a senior design team had built a second headbox but without complete success. This year's team took up that project with the intention to improve performance but, after examining the prior design, realized they had to start from scratch on the headbox.

"We rebuilt everything," Scears said.

"That was a bit of a decision, itself, that we were reluctant to do," Okruszynski said. "Our original job was to try to optimize last year's headbox."

But after attempting to work with the first design, the team realized that several elements amounted to fatal flaws, including a rod meant to stabilize the box that warped the baffles and base. Also, the headbox was suspended above the wire, which decreased stability and meant its location couldn't be adjusted.

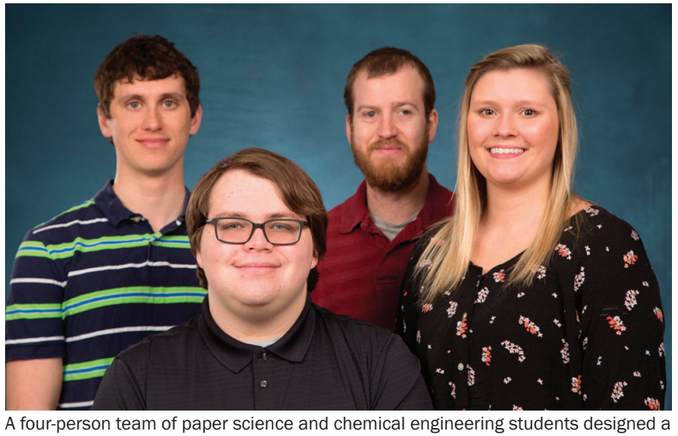
The 2018 team created a headbox that rests on a platform that can be moved along the wire and routed feed lines so that pulp can be added to the wire in the second headbox, creating that second layer.

"It's a lot more stable," Scears said. "We have two separate stock tanks and each stock tank can feed the separate headboxes so we do have that capability to have two completely different types of furnish to the different layers. We can also control the basis weight for each."

The adjustable headbox location proved its mettle during trial runs. "It helped our drainage and helped improve the formation of the sheet," Kinscher said.

Paul Fowler, WIST executive director, said the institute typically presents several ideas each year to the senior class instructors for projects that have capacity to broaden WIST services and fill new customer needs. WIST contributes to funding the senior projects and the students get to work on real-world design challenges.

"We've had several inquiries in the past couple of years for development projects where two-layer production of rolls and sheets is required," Fowler said. "I'm excited about the success the students had with this and look forward to putting it to the test with a commercial application."



A four-person team of paper science and chemical engineering students designed a second headbox for the university's pilot paper machine. Pictured from left are Joe Kinscher, Justin Okruszynski, Luke Mason and Farrah Scears.

Student Employee Spotlight

An early December weekday morning found UW-Stevens Point sophomore Chris Gibson not in class, but in another environment he is getting to know well – the paper testing laboratory in the university's Science Building. A WIST student employee, he was preparing materials for a Kappa test, an analysis that indicates the amount of lignin remaining in pulp. He is one of 19 students WIST employed in 2018.

"I fit this in between my classes, so it works out well," Gibson said.

A little over two years ago, entering his senior year at his Chicago high school, he could not have imagined doing this, for the simple reason that he'd never heard of paper science.

"I was going for either electrical or chemical engineering," Gibson said. A friend who had gone to Gibson's high school, and who is now an alum of UW-Stevens Point, told him the school had a good chemical engineering program. "So I came up here for a visit with some of my friends from high school and I heard it was paper science and engineering. And I was like, I don't know what that is. Then I talked to the department head, Dr. [Karyn] Biasca, and she introduced me to all of this stuff, gave me a tour of the paper machine and I was like, this is amazing, this is what I want to do."

Gibson's spring semester paper science class gave him his first real opportunity to experience the university's papermaking and testing equipment.

At the end of the semester, Lindsey Hoffman, WIST's laboratory and papermaking project specialist, offered Gibson a job for the summer and then extended that into the school year.

Hoffman said the students gain experience working on real-world projects for WIST customers, under supervision of herself and Brian Bandow, WIST papermaking and laboratory specialist.

"Having the students available to help us gives us the opportunity to expand the quantity of work that we do while still maintaining the high quality of work that we desire," Hoffman said. "Students learn from the ground up. I'm here, Brian is here — we're making sure that they are always doing these tests accurately, according to TAPPI standards."

Gibson said the work at WIST has helped him in his paper science courses and he credits the experience with helping him land an internship with PCA in International Falls, Minnesota. He'll be there from late January to August.

"When they found out Lindsey had taught me how to do an array of tests and everything, they were like, oh, that's fantastic," Gibson said. "We can use you in the testing lab. That's actually my starting position when I get there."

Gibson isn't sure yet where his path will take him after college but figures the internship will be one more important step pointing the way.

"I know they have a pulp mill as well as a paper mill up there," he said. "So I think being rotated through there will help me figure out what I want to do more specifically."

Chris Gibson, a sophomore studying paper science and engineering, prepares material for analysis in the paper testing laboratory.

Annual Packaging Conference Showcases Latest Trends

Focal Point 2018
Paper-Based Food Packaging and Serviceware
Enhanced performance and reduced environmental footprint
October 9/Dreyfus University Center, UW-Stevens Point

Daniel Ahern, director of global innovation and design at Graphic Packaging International, provided the opening address at Focal Point 2018

"Frozen is the new fresh," Daniel Ahern told participants at the 2018 Focal Point conference at UW-Stevens Point, as he relayed that and other latest food packaging trends in a keynote address. Clean labels and innovations for consumer convenience also headline 2018 trends, Ahern said.

Ahern is director of global innovation and design at Graphic Packaging International, one of the world's leading manufacturers of folding cartons, microwave packaging and other packaging materials. A company focus is on attractive design that stands out in the highly competitive retail marketplace.

Focal Point, hosted by WIST on October 9, drew nearly 60 attendees from paper, packaging and related industries for a one-day look at innovations and ideas to grow the market for paper-based food packaging and serviceware.

Ahern said that consumers today, led by the huge millennial generation, view frozen foods more favorably than consumers previously and that is driving changes in packaging. Concerned about food waste, people increasingly view frozen as a better alternative. Crediting Marketwatch.com, Ahern noted that frozen meals and appetizers make up the largest portion of the frozen food market and the category's three percent growth last year was the highest in five years.

That ties in with a related trend toward increasing convenience for an on-the-go society. Companies like Lyfe Kitchen and Feel Good Foods (tag line: get fresh with frozen) are targeting the market with packaging that takes the food easily from freezer to microwave to table.

Other presenters looked at industry niches, such as a presentation by MillerCoors about increasing fiber usage in beer packaging, and at technical aspects, such as new paper-coating chemicals that protect food while at the same time being safe for consumers and the environment.

WIST has hosted Focal Point at UW-Stevens Point each October for the past eight years and has scheduled the 2019 conference for October 29.

Paper Machine Gets Updates

The pilot paper machine at UW-Stevens Point is at the heart of not only the university's heralded Paper Science and Chemical Engineering Program but much of WIST's work with private industry. WIST's contract work and WIST staff help support maintenance of the machine, and 2018 saw some significant updates completed.

Brian Bandow, WIST paper machine and laboratory specialist, said major items included new sleeves for dryer cans, updated software for the MORFI analyzer and maintenance of refiner plates.

Dryer cans – steam heated cylinders over which paper passes to force moisture out of the newly formed sheet – must have frictionless surfaces to prevent the paper sticking to the cans and tearing. Bandow said the university machine still had its original Teflon tape, and the tape was worn and not completely effective.

"Replacing the sleeves turned out to be a big job," Bandow said, explaining that the hood of the paper machine had to be removed and much machinery disassembled. "That was like two 13-hour days to get this done."

The new sleeves were shrunk onto the cans and are more durable because they are real skins, not a tape, he explained.

"The reason why you want Teflon sleeves on these is it gives you a little more flexibility in adding compounds or chemicals ahead of the size press, so you can run a whole bunch of different coatings here and not worry that it's going to stick to the can," Bandow said. "It gives you a lot of flexibility on what you can run at the size press."

Pfaudler, an engineering and technical services company, donated the Teflon sleeves and WIST paid for the installation.

The MORFI analyzer was old and when it was damaged during an electrical surge related to a power outage, the university seized the opportunity to upgrade.

"This is a completely new computer and software," Bandow said. "What this does is it allows us to analyze fibers for length and shape, and by having that ability we can do blends. It's a good revenue maker for us because people will send in samples and want an analysis done."

Brian Bandow, WIST paper machine and laboratory specialist, indicates the new Teflon sleeves installed on dryer cans on the university's pilot paper machine.

Regarding the refiner, Bandow said it turned out the plates are in excellent shape and everything's working the way it should, but the training provided by two industry experts was invaluable

"This is an Andritz refiner, and Pat Walter from Andritz volunteered his time, and then Steve Peterich from BPM volunteered his time," Bandow said. "They both came in, they showed us how to open this up, how to check the plates. That was a big deal. Now we know what's in there."

WIST Staff


Brian Bandow

Brian Bandow is WIST's paper machine and laboratory specialist. Bandow's duties span activities in both WIST and the paper science and chemical engineering department. He assists in operating and maintaining the pilot paper machine and equipment in support of the paper science and engineering undergraduate program. For WIST, Bandow supports the institute's industry-focused contract research laboratory projects. His work includes outreach, research, testing, analytical and paper machine services to industry and other clients. Bandow brings a wealth of experience in papermaking and in related industries. He has a bachelor's degree from UW-Oshkosh and did post-graduate studies at UW-Eau Claire.


Amber Davidson

Amber Davidson is the compostability testing laboratory manager at WIST. She oversees the compostability testing services provided by the institute and performs laboratory tests to determine how well certain packaging composts under industrial composting conditions. In addition to laboratory work, she assists WIST in public outreach for compostability testing. She is a December 2012 graduate of the UW–Stevens Point with a Bachelor of Science degree in water resources and a minor in soil science and business administration.


Paul Fowler

Paul Fowler, WIST executive director, has 18 years of experience in contract research and development of new products and opportunities from biobased materials. At WIST, Fowler networks with public- and private-sector organizations and companies to develop new sustainable technologies with commercial applications to benefit the economy and the environment. Before taking the helm at WIST in 2010, he was director of the Welsh Institute for Natural Resources, a financially self-supporting unit at Bangor University in Wales, UK. Fowler has a doctorate in organic chemistry and extensive knowledge of biobased, renewable materials and applications.


Justin Hall

Justin Hall is a technical project manager at WIST. His duties include analytical work on WIST research projects. He also provides support for WIST research projects by maintaining and operating analytical instrumentation. Hall is experienced in ion chromatography, gas chromatography, liquid chromatography, and mass spectrometry. In addition to research support, Hall provides laboratory services for outside companies. He is a 2011 graduate of UW-Stevens Point with a bachelor’s degree in water resources and a minor in chemistry.


Angie Hauer

Angie Hauer, WIST program development coordinator, coordinates daily office activities, supplies and correspondence. She has a bachelor’s degree in resource management from UW-Stevens Point and a master’s degree in outdoor recreation administration from Southern Illinois University at Carbondale.


Lindsey Hoffman

Lindsey Hoffman carries out industry-focused projects and work performed on the UW-Stevens Point pilot paper machine as well as paper testing provided to industry by WIST. She also coordinates student and contract work, along with providing support for the paper science and engineering undergraduate program. Hoffman graduated in 2014 with a bachelor’s degree in paper science and engineering and a minor in chemistry from UW-Stevens Point.


Ron Tschida

Ron Tschida, WIST communications manager, handles public relations, marketing and outreach, institute publications and the WIST website. Tschida has worked as a beat reporter and feature writer at several daily newspapers in the West, and before coming to UW-Stevens Point in 2005 he was city editor of the Bozeman Daily Chronicle in Bozeman, Montana. He has a master’s degree in journalism from the University of Montana.


Rebecca Vagts

Rebecca Vagts, WIST business manager, is responsible for the fiscal management of WIST grants and contracts including developing budgets in grant narratives, budget review, account reconciliation and fiscal reporting. Vagts has an MBA with a global emphasis and a bachelor's in business management from Upper Iowa University.

State funds were not used to print this publication

The Wisconsin Institute for Sustainable Technology —

Creating sustainability solutions and economic opportunities

WIST is an institute within the College of Natural Resources at UW-Stevens Point. Offices and laboratories are in the Science Building and the Dan Trainer Natural Resources Building on the UW-Stevens Point campus.

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