Pilot Scale Forest Products Production

PRIMARY CONTACTS

foresteconomy@maine.edu

umaine.edu/foresteconomy

Shane O'Neill
Forest Industry Business Development Manager
207.581.2812
shane.r.oneill@maine.edu

Jake Ward
Vice President of Strategic Partnerships, Innovation and Engagement
207.581.2201
jsward@maine.edu

Dr. James Beaupré
Director of Industrial Cooperation
207.581.1345
james.beaupre@maine.edu

For over a century, the University of Maine has provided research, development and commercialization services to forest-focused businesses and communities in Maine and beyond.

Decades of strategic investment into pilot and near-commercial scale manufacturing capacities allows UMaine to deliver state-of-the-art solutions which support the competitive challenges of a global economy.

Contents

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Solid Sawn Wood and Drying

Solid Sawn Processing

Portable Bandsaw Mills

Timber Harvester 30HT25

- 30” (760 mm) maximum log diameter; 20’ (6 m) log cut length.
- Fully Hydraulic Control: All log handling and sawhead positioning are hydraulically powered and controlled from the sawyers station. Since the sawhead is semi-automatic, the sawyer is able to multi-task, pulling sawn lumber and increasing throughput rates.
- Reversible Chain Turner: A heavy-duty roller chain and hardened-tooth turner allows sawyers to quickly position the first log face and ease in sawing.
- Hydraulic Log Lift: Once the sawyer rolls the log onto the lift arms, the 3,000 pound (1,360 kg) capacity log lift will quickly and easily lift the log completely onto the mill.
- Hydraulic Saw Guide: From the remote control box the sawyer can readily adjust the roller guides to follow the dimension of the log which will maintain maximum blade stability and assure positive positioning.

Wood Mizer LT15

- 28” (710 mm) maximum log diameter; 17’ 8” (5.3 m) log cut length.
- Manual log dogs and crank feed provides simple, low maintenace operations.
- Trailer packaged system (with registration) allows onsite log breakdown and training during in field operations, outdoor classrooms & remote facilities.

Wood Drying & Conditioning

Dry Kilns

Nyle Dehumidification Kiln

- 5,000 board foot (11.8 m^3) capacity.
- 160°F (71°C) maximum dry bulb; 120°F (50°C) maximum wet bulb.
- PLC controlled boiler and airflow system.

Conventional Kiln

- Steam powered kiln with computer controlled venting and humidity regulation.
- 1,500 board feet (3.5 m^3) capacity.
- Optimized for drying most softwood species.

Conditioning

Walk-In Environmental Chambers

- Hastest Solutions Environmental Test Chamber: 10,600 ft^3 (300 m^3) chamber volume; Interior dimensions 22’ x 22’ x 20’ (6.8 m x 6.8 m x 6.1 m); Door opening 14.1’ x 14’ (4.3 m x 4.25 m); Temperature range -40°F to 140°F (-40°C to +60°C); 20% to 95% Relative Humidity (RH) range; Ramp rate in thermal cycling ±10°C per hour; Capability to conduct fatigue tests within chamber environment.
- Small Chamber: 6’W x 8’H x 20’L; -30°C to 70°C; 20% to 80% Relative Humidity (RH); computer interface for monitoring and control.

Heated Log Tank

- Capacity to presoak ten 5’ long x 12” diameter logs can be soaked and/or heated at a time to 150°F (66°C).

Wood Finger Jointing System

Lobo SFJ-400G Finger Joint Shaper

- Maximum specimen processing: 400mm width (15.75”); 120mm height (4.75”).
- 7.5kW motor powering 160mm diameter tenon cutter.
- Pneumatically controlled semi-automatic clamping and feed table system.
- Onboard fully enclosed automated spray glue system for finger joints.

Wood Composites

Wood Composite Production

Mechanical Breakdown

Carmanah 12/48 Lab Strander

- Generate strands from 3” to 12” (12-300 mm) long for OSB/LSL production.
- 48” (1.2 m) ring stranding head.

Bliss E1906 Hammermill

- Capable of grinding several types of materials, converting wood and other materials into uniformly sized particles.
- Hardened-steel hammer bladed rotor; 3600 RPM speed; 15 HP (11 kW) motor.
- Desired particle adjusted through the use of interchangeable perforated screens of varying pore sizes.

Furnish Preparation

Koch Bros. Inline Conveyor Dryer

- 3’ X 10’ (1 m X 3 m) forced air dryer; extended 4’ (1.3 m) infeed & outfeeds.
- 250 lb (110 kg) water removal capacity per hour.
- Maximum drying temperature: 325°F (163°C)
- Maximum airflow: 7,500 ft^3/min (212 m^3/min)

Coil Spinning Disc Atomizing Resin Blenders (2)

- 3’ X 6’ (1 m X 2 m) and 5’ X 10’ (1.5 m X 3 m) drums, rotating up to 20 RPM.
- 30 lb (13 kg) and 120 lb (54.5 kg) capacities respectively.
- 15,000 RPM spinning disc atomizer heads fed by peristalic pumps ensure uniform distribution and application of resins and waxes onto furnish.

Pressing

Diffenbacher Laboratory Press

- 450 ton hydraulic pressure; 34” X 34” (860 mm X 860 mm) platen area.
- 450°F (232°C) thermal oil or 250 psi (1.7 MPa) steam injection allowing thick strand composite panel manufacture.

Erie Mill & Press Large Platen Press

- 1,800 ton hydraulic pressure; 52” X 100” (1.3 m X 2.5 m) platen area.
- 500°F (260°C) thermal oil or radio frequency (10 kV, 30 kW Thermex-Thermatron).

Wood-Plastic Composite Production

Davis-Standard Woodtruder™

- 94 mm 28:1 L/D counter-rotating twin screw compounding extruder.
- 75 mm single screw extruder for polymer melting & injection into compounder.
- 500 PPH (225 kg/hr) finished product throughput.
- PLC controlled gravimetric feeders for all material delivery.
- Atmospheric venting system allowing higher moisture content furnish in system.

Boy 80 E Injection Molder

- Fully controlled four-tie bar cantilevered two platen clamping system (800 kN max force)
- Family die to generate multiple formats of molded testing coupons for evaluation.

Biochemicals and Bioproducts

The University of Maine operates the Technology Research Center (TRC), a 40,000 ft^2 facility dedicated to validation, demonstration, and commercialization support for bioproduct development. The center is a one-stop shop for processing and analysis of technologies at an industrially relevant scale.

The TRC facility houses several pilot-scale unit operations dedicated to advancing developing fuel, chemical and advanced material technologies for processing woody biomass into various bioproducts. The facility meets all necessary approved environmental permitting standards, accepts any cellulosic feedstock and features state-of-the-art process control and process information systems.

Chemical Breakdown

Biomass to Bioproducts Pilot Plant (B2P2)

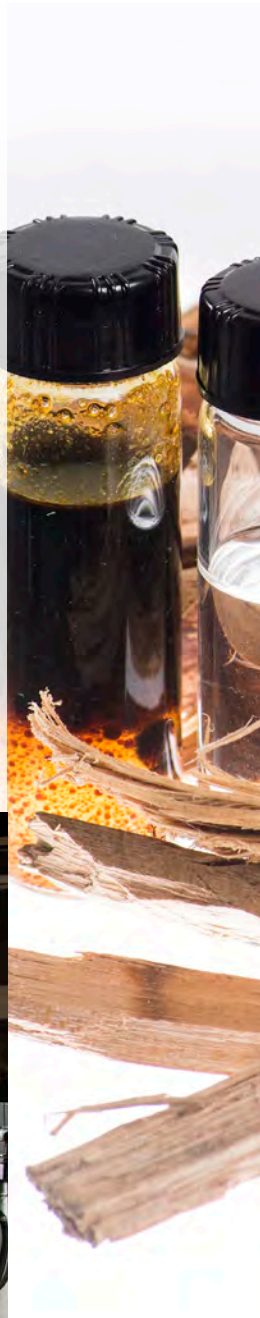
- Converts up to one ton of woody biomass per day into chemicals (levulinic acid, formic acid, furfural and biochar) for use as feedstock to manufacture bioproducts.
- Can use a variety of woody biomass products, including wood residues, waste paper/cardboard, and other woody municipal solid waste.

Sprout-Bauer 12-1CP Thermo Mechanical Pulping Refiner

- 12” refiner plates capable of processing TMP, RPM and CTMP in 2 kg batches.
- Capable of continous processing in atmospheric mode.

Hodgins Extractor Reactor

- UMaine system designed for the pre-extraction of wood sugars prior to pulping
- Four (4) electrically heated 15 gallon (60 L) capacity vessels mounted on 360 degree rotatable assembly to optimize heating and agitiation.
- 15.4 lb (7 kg) oven dried wood chip capacity per vessel, generating 21 gallons (84 L) of extract daily.



Bioproducts Manufacture

Synthetic Crude Oil Pilot Plant (Syn-COPP)

- UMaine developed IP, allows continuous conversion of biobased mixed acids into low sulphur synthetic crude oil through a thermal deoxygenation (TDO) process.

Fermenters

- Three (3) 50 gallon (200L) capacity computer controlled fermenters.
- Operational in either aerobic or anaerobic modes for bioethanol production.

Lawson Mills Pellet Mill LM72A

- Roller & die pellet mill; 350 PPH (160 kg/hr) throughput capacity.
- Integrated fines removal and dust collection system
- Allows use of up to two additive binders for formulation studies with various types and compositions of biomass and natural binder systems.

Pulp and Fiber Processing

Pulping

UMaine is equipped to perform pulping studies to evaluate wood and non-wood raw materials and chemical additives. These studies can be performed on any stage of chemical or mechanical pulp production.

Pulping Equipment and Pulp & Fiber Analytical Equipment:

- Rocking digester (4:1 liquor to wood ratio)
- 4 ft^3 steam-heated digester
- Bomb digester/reactor
- Alkali profiling pulping system
- Slotted flat screen
- 12” (300 mm) TMP/CTMP/RMP pilot disc refiner
- Chip classifiers
- Standard pulp evaluation apparatus
- Gas and liquid chromatography
- UV spectrometry Calorimetry

Bleaching

The main objective of bleaching is to produce a brighter pulp. This is accomplished in chemical pulps primarily through lignin removal. The removal of other compounds is another objective of the bleaching process. These compounds include resins, fatty acids, and other extractives. For many years UMaine has worked closely with the pulp and paper industry to develop new and effective bleaching sequences. We can perform a wide range of bleaching sequences on mechanical, recycled, and chemical pulps.

Bleaching Equipment

- Medium consistency oxygen reactor
- Quantum reactor
- Laboratory bag bleaching apparatus (Cl_2, ClO_2, H_2O_2, E stage, H, FAS, etc.)
- Ozone generator and reactor
- 100% ClO_2 generation reactor
- Stainless steel handsheet set-up

Stock Preparation and Refining

Our pilot plant is fully equipped to perform all major areas of stock preparation, including size reduction, repulping, cleaning, screening, and refining. We can take virtually any raw material – from wood, agricultural residuals, plant, or synthetic source – and produce a wide range of products.

Refining is a critical operation in which the inherent properties of the paper are developed. UMaine has three double-disc refiners (one 13-inch and two 20-inch), one 20" single-disc refiner, and two conical refiners. All refiners are equipped with variable-speed motors. The refiner loop is connected to several tanks for refining studies in recirculation or single-pass mode. The refiners allow for a range of refining prior to papermaking as well as for a comparison of the benefits provided by each type of machine.

Stock Preparation Equipment:

- Hydrapulpers (2) – pilot-scale
- Stock tanks (5) – interconnected and agitated
- Disc refiners – 13” double disc, 20” single disc, and (2) 20"/24" double disc
- Conical refiners – PRO1 and Conflo
- Ink removal cleaner
- Combination cleaner
- Forward & reverse flow cleaners
- Centrifugal screen
- Thickening screen

Papermaking

Fourdrinier Paper Machine

UMaine's pilot paper machine is available to businesses and researchers for raw material and process operation studies. Steady-state is reached in less than thirty minutes, allowing multiple trials in a single day. Fourdrinier machine specifications include a 25-220 g/m^2 basis weight, 1 lb/min (0.5 kg/min) average production rate, 13" (330 mm) trim width, and 10-100 fpm (3-30 m/min) mat speed.

Paper Machine Features and Equipment:

- 6-slice dilution headbox with Holey roll
- Closed white water system with on-line suspended solids and charge monitoring for highly efficient wet-end chemical studies
- Two wet press nips with metal and/or composition rolls
- Upgraded size press
- Versatile size press coating supply system
- In-line, multi-nip steel-steel calendar stack
- High precision drive system
- On-line continuous monitoring of basis weight, moisture, caliper, and ash (video of Honeywell Experion MX Scanner)
- Unwind stand to enable size press/coating experiments using customer supplied base paper rolls
- Flexible metering system for wet-end additives for multiple additive strategies.
- Off-line calender (conventional or hot soft nip configuration), rewinding & sheeter

Coating, Finishing and Forming

UMaine routinely works with clients to improve product properties and lower costs by formulating and applying coatings to their products. Coating a thin layer of material is a very effective method of adding functionality and value to printing papers, paper cups, grease-resistant food packaging, and high-strength composites.

Coating Equipment:

- 12" (300 mm) Faustel Laboratory Coater capable of process webs at speeds of up to 100 fpm.
- The Cylindrical Laboratory Coater (CLC 6000) operates at speeds up to 6,000 fpm with pigmented coatings of up to 70% solids.

Calendering

Calendering improves the printing properties of paper and is controlled by base sheet moisture content, coating composition, line speed, pressure, and temperature. UMaine has an on-machine calender located prior to the reel of the paper machine, as well as an off-line, heated, soft-nip calender.

Printing

UMaine has a wide variety of print tests for paper and paperboard products, including a KRK Universal Printability Tester for testing of the pick, gloss, and mottle and an IGT Printability Tester for evaluating surface strength.

Fiber Thermoforming

Kiefel Packaging's commercial Natureformer KFT90 unit uses a suction process in combination with cold pre-pressing technology to reduce the residual moisture to approximately 60%. The final pressing is accomplished with a heated tool that lowers residual moisture to approximately 7%.

Nanocellulose

Nanocellulose Pilot Plant

Opened in 2012, the UMaine Nanomaterial Pilot Plant is a cutting-edge addition to the University of Maine. The pilot plant was funded through a joint venture with the USDA Forest Service and is the only one of its kind in the country. Constructed in parallel to the Cellulose Nanocrystal Pilot Plant at the Forest Products Lab (FPL) in Madison, Wisconsin, the plant provides samples of biobased nanomaterials for application development.

This state-of-the-art facility allows UMaine to produce cellulose nanofibrils at a rate of one ton per day. UMaine is the only facility that can manufacture CNF at this scale in the United States.

The purpose of the facility and the program is to:

- Provide researchers with working quantities of a wide range of forest-based nanomaterials
- Develop scalable methods to convert wood components into high-performance nanomaterials
- Improve methods to isolate and characterize the various forms of nanocellulose
- Develop standards for various grades of nanocellulose
- Support emerging markets for products made from wood-derived renewable nanomaterials
- Provide a fee-for-service facility that clients can use to advance their own research and development projects

Pilot Plant Capabilities

- Ultrafine Grinder – The Masuko MKZB15-50J super mass colloider creates a high shear zone that helps to liberate nanofibers present in natural lignocellulosic fibers. The final product is a slurry of about 3 wt% cellulose nanofibers that can then be further processed.
- Upgraded Refiner Laboratory – The stock preparation and refining pilot plant includes high-efficiency pumps, piping, and agitators in order to handle the large volume and viscosity of the cellulose nanofiber slurry produced in the plant.
- Spray Dryer – The GEA Process Engineering VSD-6.3-P Spray Dryer produces dry nanofibers. This is particularly useful for applications that cannot utilize a water-based slurry or in cases where the product needs to be stored for long periods of time. The dryer has the ability to dry several pounds of nanocellulose per day. The dryer also allows for chemical modification of the material, which helps impart additional functionality.

Additional Equipment

- 100 gal. Black Clawson repulper
- 2000 gal. GL&V repulper
- 13” disc refiner – inline or recirculating; variable speed drive
- 20” disc refiner – inline or recirculating; variable speed drive with anti-clash unit
- Masuko pilot scale and benchtop super mass colloider
- GEA spray dryer
- Centrisorter
- Various centricleaner systems
- PFI mill
- 1,000 gal. machine chest
- 1,000 gal. blend chest
- (2) 1,500 gal. stock chests
- (4) 3,000 gal. stock chests

Additive Manufacturing

Bio-Based Additive Manufacturing

For more than 25 years, UMaine has been on the cutting edge of bio-based composites made with Maine wood products and is developing bio-based, renewable feedstocks using cellulose nanofibrils for additive manufacturing. Adopting the low cost of bio-derived and bio-filled feedstocks for use in additive manufacturing will pave the way for reducing manufacturing costs with partner industries looking to utilize this technology.

As part of a Hub and Spoke research collaboration with Oak Ridge National Laboratory, UMaine's partnership advances 3D printing with wood products, creating a new market for Maine's forest products industry, an industry that has been the backbone of Maine's economy for generations. More information on the Hub and Spoke Program can be found at https://umaine.edu/biomaterials/

Ingersoll – MasterPrint 3x

UMaine's custom Ingersoll MasterPrint 3x at the time of commission was certified by Guinness World Records as the world's largest thermoplastic additive manufacturing 3D printer utilizing high throughput thermoplastic pellet extrusion.

- Print volume: 60' long x 22' wide by 10' tall (18.3 m x 6.7 m x 3 m).
- Print output rate: up to 500 lb (227 kg) per hour.
- Includes an integrated CNC 5-axis machine for subtractive manufacturing methods including cutting, surface finishing, and part geometry finishing.
- Currently funded ongoing expansions of the MasterPrint include the addition of an automated fiber placement (AFP) module.

Stratasys Fortus F900

The Stratasys Fortus F900 is another 3D printer that utilizes FFF to produce accurate and repeatable parts as large as 914 mm x 610 mm x 914 mm (36 in x 24 in x 36 in).

With over 16 compatible printer materials – such as carbon, glass, bio fiber filled materials, ULTEM, and PEEK – this technology is suitable for building fixtures, factory tooling, end-use parts as well as most demanding functional prototypes.

Featuring integrated MT Connect software, this printer is capable of digital twin creation and documentation of all prints through in-situ real-time data collection and processing.

Juggerbot3D – Tradesman Series P3-44

- Print volume: 39" x 39" x 39" (1 m X 1 m X 1 m).
- The P3-44 utilizes thermoplastic pellet extrusion with a throughput up to 30 lb (13.6 kg) per hour.
- Similar to other AM systems at UMaine, the P3-44 can use a variety of materials for printing, including bulk commodity and flexible thermoplastics, engineering-grade, high-temperature and high-fill natural and synthetic fiber thermoplastics.

Cincinnati – BAAM 100 – Alpha Size 2

Made by Ohio-based manufacturer Cincinnati Incorporated, the BAAM (Big Area Additive Manufacturing) series of machines are capable of producing very large 3D printed parts on a print area measuring 12' x 5.5' x 6' (3.6 m x 1.7 m x 1.8 m).

The Alpha Size 2 utilizes the proven design and technology from the company's laser platform, including machine frame, motion system, and control has been adapted with an extruder and feeding system.

The unique features that define this model include heated build chamber, pellet extruder, and a 5-axis machine head, as well as the Alpha 2's use of material extrusion 3D printing technology.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FOREST ECONOMY SERVICE PROVIDERS

To learn more about our forest-focused services contact:

Shane O'Neill, *Forest Industry Business Development Manager*
207.581.2812 | shane.r.oneill@maine.edu

Jake Ward, *Vice President, Innovation & Economic Development*
207.581.2201 | jsward@maine.edu

Dr. James Beaupré, *Director, Industrial Cooperation*
207.581.1345 | james.beaupre@maine.edu

Alphabetical list of forest economy service providers:

Advanced Manufacturing Center
207.581.2713 | umaine.edu/amc

Advanced Structures and Composites Center
207.581.2123 | composites.umaine.edu

Center for Research on Sustainable Forests
207.581.3794 | crsf.umaine.edu

Cooperative Forestry Research Unit
207.581.2893 | umaine.edu/cfru

Chemical and Biomedical Engineering
207.581.2277 | umaine.edu/chb

Forest Bioproducts Research Institute
207.581.1489 | forestbioproducts.umaine.edu

Maine Agricultural and Forest Experiment Station
207.581.3205 | umaine.edu/mafes

Margaret Chase Smith Policy Center
207.581.1648 | mcspolicycenter.umaine.edu

Mitchell Center for Sustainability Solutions
207.581.3195 | umaine.edu/mitchellcenter

Paper Surface Science Program
207.581.2277 | umche.maine.edu/PSSP

Process Development Center
207.581.2237 | umaine.edu/pdc

Office of Innovation and Economic Development
207.581.2201 | umaine.edu/econdev

School of Forest Resources
207.581.2841 | forest.umaine.edu

Wildlife, Fisheries, and Conservation Biology
207.581.2862 | umaine.edu/wle

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