Emergent Industrial R&D Strategies for the Economic Recovery: The Importance of Industry-University Cooperation

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Outline

• Overview of Ashland

• Ashland’s R&D Strategy for Growth

• Ashland’s Experiences with NSF Centers

• Other Opportunities for I/U Collaborations with Ashland
Ashland Has Grown…..

- In late 2008, Ashland completed its acquisition of Hercules.
  - Strengthens our position as a specialty chemical company
  - Increases our sales from $8B to $11B

![Diagram showing Ashland Hercules Water Technologies, Ashland Performance Materials, Ashland Aqualon Functional Ingredients, Ashland Consumer Markets, and Ashland Distribution, with details on revenue and market positions.]

- Ashland Hercules Water Technologies
  - Revenue: $2.1B
  - The #1 global producer of papermaking chemicals.

- Ashland Performance Materials
  - Revenue: $1.6B
  - The #1 global leader in unsaturated polyester resins and vinyl ester resins.

- Ashland Aqualon Functional Ingredients
  - Revenue: $1.1B
  - The #2 global producer of cellulose ethers.

- Ashland Consumer Markets
  - Revenue: $1.7B
  - The #3 passenger car motor oil and #2 quick-lube chain in the United States.

- Ashland Distribution
  - Revenue: $4.4B
  - The #2 plastics and #3 chemicals distributor in North America.
Key Markets We Serve

Building & Construction
• Commercial
• Residential
• Infrastructure
• Wind Energy
• Paint & Coatings

Transportation
• Heavy Truck
• Light Vehicle
• Recreational/Marine

Automotive Lubricants & Chemicals

Water Treatment
• Pulp & Paper
• Industrial & Institutional
• Municipal
• Mining & Extraction
• Marine

Regulated Markets
• Food
• Personal Care
• Pharmaceutical

Packaging & Converting
Ashland Consumer Markets

• $1.7B in sales

• Strong brand recognition & marketing
  - Valvoline
  - Eagle One

• Business-to-Consumer products & services
  - Lubricants
  - Automotive chemicals
  - Car care / appearance products
  - Quick lube service
Ashland Distribution

- $4.4B in sales
- Leading distributor of chemicals and plastics in North America
- Major distributor of thermoplastics in Europe
- Over 90 warehouses / distribution facilities
Ashland Performance Materials

• $1.6B in sales

• Primary market focus
  - Transportation
  - Building & Construction

• Business-to-Business focus

• Major product lines
  - Resins for composites
  - High performance adhesives
  - Chemicals for metalcasting

• Products are based on **thermoset** resin chemistry
  - Unsaturated polyesters, vinyl esters
  - Urethanes, acrylics, phenolics, epoxies
Ashland Hercules Water Technologies

- $1.6B in sales

- **Primary market focus**
  - Pulp & Paper
  - Industrial Water Treatment
  - Municipal Wastewater Treatment

- **Business-to-Business focus**

- **Very diverse product portfolio**
  - Pulping aids
  - Sizing & wet strength aids
  - Surfactants, dispersants, defoamers
  - Corrosion inhibitors
  - Scale inhibitors
  - Biocides
  - Non-Chemical water treatment
Ashland Aqualon Functional Ingredients

- $1.1B in sales
- Very diversified markets
  - Coatings & Paints
  - Personal Care
  - Food
  - Pharmaceuticals
- Business-to-Business focus
- Major product lines
  - Thickeners
  - Rheology modifiers
  - Water retention aids
- Products are water-soluble polymers based on biorenewable materials
  - Cellulose ethers
  - Guar derivatives
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Strategies for Growth

• **Acquisition of Hercules**
  - Critical mass for water business
  - New markets for Ashland
  - Products based on biorenewable resources

• **Open Innovation**
  - External technology
  - Partnerships
  - Big Ideas
    • New applications for existing products
    • New products based on new chemistries
    • New point in the value chain

• **Focus on Growth Markets**
  - Wind energy
  - Infrastructure
  - Green buildings
Definitions

External Technology ≠ Open Innovation

- **External Technology:**
  - Finding technology outside your organization
  - Access + Assess

- **Innovation:**
  - New ideas that create new opportunities
  - Invention + Commercialization

- **Open Innovation:**
  - Looking outside for new technology, new models, new partners
    - Business models
    - Channel-to-market

Open Innovation > External Technology
My External Technology Role at Ashland

• Connect Ashland with other companies, universities, federal laboratories and other organizations that have already developed technology / products that we can use.

• Motivation:
  - Supplement our internal resources with external resources.
  - Accelerate the development of new products.
Sources of Technology

• **Universities**
  - University consortia
  - Industry / University Cooperative Research Centers (I/UCRC) and Engineering Research Centers (ERC)
  - University-Industry Demonstration Partnership (UIDP)

• **Federal Laboratories**
  - Technology Locator at www.federallabs.org

• **Companies**
  - Suppliers
  - Small businesses
    • SBIR Matchmaker program (NSF)
    • Asset program
More Sources of Technology

• **Networks**
  - Industrial Research Institute (IRI)
    • External Technology Network (ETN)
    • > 40 active members
    • Air Products, DuPont, Dow, General Electric, HP, Proctor & Gamble…..

• **Open Innovation Intermediaries**
  - NineSigma
  - yet2.com
  - SpecialChem
Key Networks in Ohio

• **PolymerOhio & the OhioPolymer Strategy Council**
  - Mission: Sustain and grow the chemical industry in Ohio
    - Supply chain connections
    - State funding

• **CMPND = Center for Multifunctional Polymer Nanomaterials & Devices**
  - Lightweight nanocomposites

• **OBIC = Ohio Bioproducts Innovation Center**
  - Biorenewable raw materials
  - Agriculture + polymers = new jobs in Ohio
Partnering with Other Companies

• Ashland looks for both upstream and downstream partners in the value chain.

• Upstream partners
  - Biorenewable raw materials

• Downstream partners
  - Fabricators
  - Channel-to-market
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• Overview of Ashland

• Ashland’s R&D Strategy for Growth

• Ashland’s Experiences with NSF Centers
  - WBC
  - AEWC
  - IPRIME

• Other Opportunities for I/U Collaboration with Ashland
Why I/UCRCs?

• Very efficient network builder
  - Multiple universities
  - Multiple departments

• “Finger on the pulse”
  - Customers
  - Competitors
  - Students
The I/UCRC Model

- Multi-university increases the research base
- Multiple companies provide interaction capabilities
Ashland’s Relationships with Some NSF Centers

- WBC at Virginia Tech
- AEWC at the University of Maine
- IPRIME at the University of Minnesota
WBC = **Wood-Based Composites Center**

- The WBC is a consortium of four universities led by Virginia Tech.
  - VT
  - Oregon State
  - University of Maine
  - University of British Columbia

- Ashland and Hercules were both members before the acquisition.

- Motivation: Basic and applied R&D on adhesives for engineered wood
  - I-joists
  - Laminated veneer lumber (LVL)
  - Plywood

- The WBC has been awarded an I/UCRC planning grant.
Benefits of Membership in the WBC

• Multiple universities, multiple disciplines
  - Va Tech: Chemistry
  - Oregon State: Wood Science
  - Maine: Mechanical & Civil Engineering

• “Finger on the pulse”
  - Important industrial trends and needs
    • Steering committee involvement
  - Exposure to key customers
    • Boise Cascade, Weyerhaeuser…..
  - Students
    • Poster sessions at semi-annual meetings
Other Benefits of WBC Membership

• Short courses
  - Multiple instructors
  - Multiple disciplines

The Seventh Annual Short Course on
Wood Adhesion
A WBC Center Short Course
March 8-9, 2006
Corvallis, Oregon
OSU Oregon State University
Virginia Tech Invent the Future
Other Benefits of WBC Membership

• Consulting help / expertise / technology transfer from academic experts.

• uv stereomicrographs showing penetration of adhesive into wood.
AEWC = Advanced Engineered Wood Composites Center

- Located at the University of Maine

- Began in 1991 with EPSCoR funding from NSF
  - Experimental Program to Stimulate Competitive Research.

- $10^+$ professors + $20^+$ professional staff + $100^+$ students

- 10 integrated labs under one roof
  - Wood Plastic Composites Pilot Plant
  - Resin Infusion Laboratory
  - Mechanical Testing Laboratory
  - More….

- Scope goes far beyond wood composites.
Advanced Engineered Wood Composites Center (AEWC)

• Relevant research:
  - Engineered wood & wood adhesives
    • Oriented Strand Board (OSB)
  - Thermoset composites
  - Wood plastic composites
    • Thermoplastic WPCs
  - Hybrid composites
    • Thermoplastic – thermoset
    • Wood – thermoset

• Impressive testing facilities:
  - Large samples
  - ISO 17025 accredited
Evolution of a Relationship

• Ashland joined the Wood-Based Composites Center (WBC) headquartered at Virginia Tech in early 2006.
  - Motivation: relevant work on adhesives for wood bonding

• The University of Maine became a member of the WBC in mid-2006.
The Changing Face of the WBC… and its’ Overlap with Ashland

• In 2006, Maine and the University of British Columbia replaced Minnesota and Southern Miss as members of the WBC.

• The addition of Maine to the WBC has increased the overlap with Ashland to include the Composite Polymers business group.
Relevant Research Projects at AEWC

Inflatable Composite Structures
- Alternative technology for short-span precast bridges using lightweight transportable forms.
- Allows for rapidly deployable structures.
- Minimal construction costs and time.
- Funders: U.S. Army Natick Soldier Center.

Mark V.1 Composite Boat
- Existing US Navy Mark V aluminum hull boat has shock and vibration problems; composite hull has superior properties.
- Commercial partner: Maine Marine Manufacturing.
- Funders: Office of Naval Research and U.S. Army Natick Soldier Center.

Composite Roof System
- Combines framing, insulation and sheathing into a single product.
- Potential to garner large share of residential roofing market.
- Funders: Maine Technology Institute, US Department of Agriculture.

Delta Strand Lumber
- Uses pulpwod grade sticks.
- Two to three times stronger than solid wood.
- Lumber for structural framing.
- Funders: US Department of Agriculture.

Disaster Resistant Panels
- Two to three times stronger, more impact resistant and more ductile than presently marketed shear wall.
- Two patents issued.
- Funders: National Science Foundation, National Institute of Standards and Technology.

Ballistic Tent Inserts
- Working with US Army to develop advanced composite panels.
- Improved ballistic performance for force protection.
- Funders: US Army Natick Soldier Center.

Composite Roof System
- Combines framing, insulation and sheathing into a single product.
- Potential to garner large share of residential roofing market.
- AEWC working with NeForms development team supported by Maine Technology Institute.

Shear Wall Kits for Disaster-Resistant Housing
- Two to three times stronger, more impact resistant and more ductile than presently marketed shear wall.
- Promise of saving lives.
- Two patents issued.
- Maine OSU plants have interest in technology.
- UMaine MS student exploring the feasibility of a spinoff company to manufacture the product.

I-Joists Using Maine SPF Flanges
- Product is for floor and roof joists.
- R&D has demonstrated that Maine species are well suited for this application.
- Commercial partner in Maine has developed a business plan with implementation projected for 2009.

Pile Wraps
- Repair of damaged marine piers and piling.
- Composite onion skin wrapping protects pier from shipworms.
- In situ installation reduces cost.
- Recent market analysis demonstrated feasibility.
- Two Maine companies working to commercialize product.
Complementary Skill Sets

Ashland

- UPE & VE Chemistry
- Forming method-specific formulations
- Catalysis
- Curing Mechanisms
- Adhesives
- Pre-pregs
- Coatings

AEWC

- Mat’l Science & Engineering
- Mechanical & Civil Engineering
- Prototypes
- Hybrid Composites
- Modeling
- Testing
Bridge in a Backpack Technology from the AEWC

- Ashland resins are used in the AEWC’s “Bridge in a Backpack” technology for repairing bridges.
  - Arches = Hybrid of Concrete + Fiber-Reinforced Composite
  - Resin = Vinyl Ester Resin (VER)

- Video
Rapid Bridge Repair

Bridge in a Backpack technology is already being used to repair bridges in New England.
Wind Energy

• Ashland and Maine have just begun collaborating on an off-shore wind energy project.

• Blades are made with vinyl ester resins (VERs).
  - Strong, tough, lightweight

• Towers may also be made with VERs.
  - Corrosion-resistant
Collaboration on Off-Shore Wind Energy


EERE News

Recovery Act Announcement: Secretary Chu Announces New Investments in Cutting-Edge Wind Energy Research Facilities

October 15, 2009

University of Maine (Orono, Maine) - up to $8 million

The University of Maine plans to design and deploy two 10 kW and one 100 kW floating offshore turbine prototypes. Two turbines will be located at the University of Maine’s Deepwater Offshore Wind Test Site that will be located in a pre-selected site in state waters and one turbine will be operated at an offshore test site in the Isle of Shoals by the University of New Hampshire. The University consortium’s research and development plan includes optimization of designs for floating platforms by evaluating: (1) options for using more durable, lighter, hybrid composite materials, (2) manufacturability, and (3) deployment logistics. Educational initiatives include a model Master of Science Degree in Renewable Energy and the Environment with a focus on deepwater wind energy and a new undergraduate minor in Deepwater Wind Energy. The University will target educational grants at individuals who are participating in Maine-based wind energy education and training in order to enter the job market.

Ashland selected to supply resin for DoE University of Maine wind energy project

DUBLIN, Ohio - Ashland Performance Materials, a commercial unit of Ashland Inc. (NYSE: ASH), will join a consortium of companies and university experts to develop, deploy and test three wind turbines off the Maine coastline. A recent announcement by the U.S. Department of Energy awarded $8 million to the University of Maine for offshore, deepwater wind energy research, and Ashland was selected as a partner in this program.
Ashland’s Relationship with the AEWC

- Collaborative R&D with the AEWC and with spin-off companies.
  - Ashland: Resin development
    - Product Development & Tech Service
  - AEWC: Design, prototypes, testing

- Other forms of support
  - Market research & market development
  - Political / legislative support
  - Partnerships with Ashland customers
Networking Benefits

• The AEWC is an excellent example of the networking value of a multi-university center.
IPRIME = Industrial Partnership for Research in Interfacial and Materials Engineering

- Located at the University of Minnesota
- Grew out of the NSF-funded Center for Interfacial Engineering (CIE), an ERC founded in 1988.
- Strong connection to NSF-sponsored MRSEC
  - Interdisciplinary Research Groups (IRGs)
    - Engineered Multi-block Polymers
- 54 faculty from 10 departments
- Eight major programs
  - Microstructured polymers
  - Nanostructured materials
  - Coating process fundamentals
  - More....
- Pre-competitive research
Benefits of IPRIME

- Multiple professors, multiple perspectives
  - M. Hillmyer: Biorenewable polymers
  - T. Lodge: Block copolymers
  - F. Bates: Toughening mechanisms
  - C. Macosko: Rheology
  - D. Morse: Modeling

- Networking
  - 36 member companies

- Students
  - Presentations & posters at annual meetings
  - Thesis defense
More Benefits from IPRIME

• Workshops:
  - Toughness in Polymers, Jan 10th
  - Speakers from Minnesota, other universities and industry.

• Webinars:

Polymers from renewable resources: Monomer design, polymerization catalysis, and material properties

Marc A. Hillmyer
UMN Department of Chemistry

Kelly Anderson
Laurie Breygole
Esther Frick
Jennifer Lowe
Carolyn Wanamaker
Charlotte Williams
Catherine Zhang

Prof. William Tolman

Program:

9:00 AM Introduction Frank S. Bates
9:05 Hung-Jue Sue, Texas A&M (hisue@tamu.edu)
Nan-Scaled Toughening and Strengthening Phenomena in Polymers
9:35 LaShanda Korely, Case-Western University (lk13@case.edu)
Bio-inspired Strategies for Mechanical Enhancement
10:05 Chris Macosko, University of Minnesota (macosko@umn.edu)
Functional Polyelectrolytes for improved adhesion and fracture toughness
10:35 Break
10:55 Michael Kessler, Iowa State University (mkessler@iastate.edu)
Toughness Enhancement in Ring Opening Metathesis Polymerization Based Nanocomposites
11:25 Marc Hillmyer, University of Minnesota (hillmyer@umn.edu)
Block copolymer strategies for toughening polylactide
11:55 Break for lunch
1:30 Kim Chaffin, Medtronic Corp. (kchaffin@medtronic.com)
Interfacial Toughness
2:00 Robert Bubeck, Michigan Macromolecular Institute (bubeck@mmi.org)
The Micromechanics of Deformation in Rubber-Toughened Thermoplastics
2:30 Frank S. Bates, University of Minnesota (bates@cemn.umn.edu)
Toughness through Multiblock Copolymer Architectures
3:00 Wrap up
Industry-driven R&D projects that are mutually beneficial.

- Center catalyzed by a small investment from NSF.
- Primarily funded by industry members, with NSF taking a supporting role.
- Like a research management “franchise” with operations protocol & evaluation tools.
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• Other Opportunities for I/U Collaboration with Ashland
  - External technology needs list
  - NineSigma projects
  - Collaborating on government-funded projects
My External Technology Role at Ashland

• Connect Ashland with other companies, universities, federal laboratories and other organizations that have already developed technology / products that we can use.

• Motivation:
  - Supplement our internal resources with external resources.
  - Accelerate the development of new products.
Technology Needs Lists

• Non-confidential list of technology needs
  - Applied needs
    • By Division / Business Group
  - Basic / Platform needs
    • Cut cross multiple business units

• Continually-updated

• Intended to facilitate and focus discussions with external parties
Ashland’s Business Group-Specific Needs and Interests

• **Composites**
  - Bio-based resin building blocks
    • For unsaturated polyester (UPE) and vinyl ester (VE) resins
  - Styrene replacement / reduction in UPE and VE resins
  - Resins with improved fire resistance
    • Lower smoke and toxicity
  - Low density composites
    • Natural fiber-based
  - Antifouling gel coats
  - New uses of composites

• **Adhesives**
  - Structural adhesives
    • Higher heat resistance – for wood, composites
    • Improved impact resistance
  - Pressure-sensitive adhesives
    • 100% solids
    • Emulsion-based psa’s with performance comparable to solvent-based
  - Robust flexible packaging adhesives
  - Replacements for Bis Phenol A
  - Adhesives for low surface energy surfaces
    • Pressure-sensitive adhesives
    • Structural adhesives
  - Bio-based adhesives
    • Urethanes, acrylics
Our Business Group-Specific Needs and Interests

• **Casting Solutions**
  - Low odor / low emission binders for sandcasting
    - VOCs, HAPs, BTX
  - Heat-resistant thermosets
    - For casting of aluminum (660° C) and iron (1550° C)
  - Bio-based binders
  - Faster-drying aqueous refractory coatings

• **Water Technologies**
  - Non-chemical methods for water treatment
    - For corrosion inhibition, scale inhibition and biofilm inhibition
  - Water-soluble acrylic polymers / copolymers
    - For corrosion control, scale inhibition, flocculation
  - Biodegradable polymers for water treatment
  - Non-leachable antimicrobials for coatings
  - Sensors for system performance
    - Scale, biofilm formation; corrosion

• **Valvoline**
  - Low wear, high thermal conductivity fluids
  - Low cost base oil feedstocks
  - Bio-based lubricants
Our More Basic Needs and Interests

- **Bio-based Materials**
  - Bio-derived alternatives to petroleum-based raw materials
    - For composite resins, adhesives, lubricants, water treatment chemicals
    - Polyols, acids, acrylcs, aromatics
    - Formation, isolation, reactivity
  - Biomimetic materials for adhesives, composites

- **Catalysis**
  - Novel room temperature cure chemistry for thermosets
    - Organometallic catalysts
  - uv cure systems
  - Encapsulated catalysts & reactants
  - Enzymatic catalysis

- **Resins & Additives**
  - Reactive diluents
  - uv-stable resins, uv stabilizers
  - Low shrinkage thermosets
  - Thermoset resins with improved thermal stability
  - Block copolymers
  - New tackifiers
  - New impact modifiers, tougheners
Our More Basic Needs and Interests

• **Engineering**
  - Consistency, predictability in batch reactors
  - Continuous (heterogeneous) synthesis of thermoset resins
  - On-line process monitoring

• **New Test Methods / Method Development**
  - Weatherability
    • Accelerated testing methods
  - Toughness tests
  - High throughput testing methods
  - Characterization of composites

• **Other**
  - Recycling, re-use of thermosets
  - Waste minimization
  - Utilization of waste streams
Who is NineSigma and What Do They Do?

- They are an open innovation intermediary who connects companies like Ashland to a vast network of “Solution Providers” who may have already developed technology that we need.

- They work with us to develop an RFP (Request for Proposal) that describes our needs.

- They funnel responses to the RFP from their network to us.
Ashland’s RFP for Fire-Resistant Composite Resins

This RFP led to sponsored research at NIST and UDRI.
Collaborating to Secure Government Funding

• State funding:
  - Ohio Third Frontier Advanced Materials Grant
  - Accelerating the Commercialization of Bio-Based Building Products
  - Key Collaborator = Ohio Bioproducts Innovation Center at Ohio State

• Federal funding:
  - Congressional appropriation
  - Rapid-Curing Resin Technology for Agile Combat Support
  - Key Collaborator = University of Texas

I/U collaborations can increase the likelihood of funding.
In Summary……

• Accessing external technology is a very important element of Ashland’s growth strategy.

• Ashland prefers the I/UCRC approach to collaborating with universities.
  - Multiple universities
  - Multiple departments
  - Multiple professors
  - Multiple benefits
Thank You !!

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