

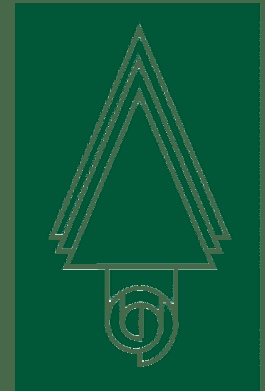
Nanotechnology and the Agenda 2020 Industry Technology Vision

Presentation to the 48th Annual Convention[®]
of the Society of Wood Science and
Technology

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Agenda 2020 Technology Alliance

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Today's Presentation

- What is Agenda 2020?
- Agenda 2020 Technology Vision
- Why Nanotechnology?
- Examples for Enabling Agenda 2020 Goals
- Dual Approach
- Questions and Answers

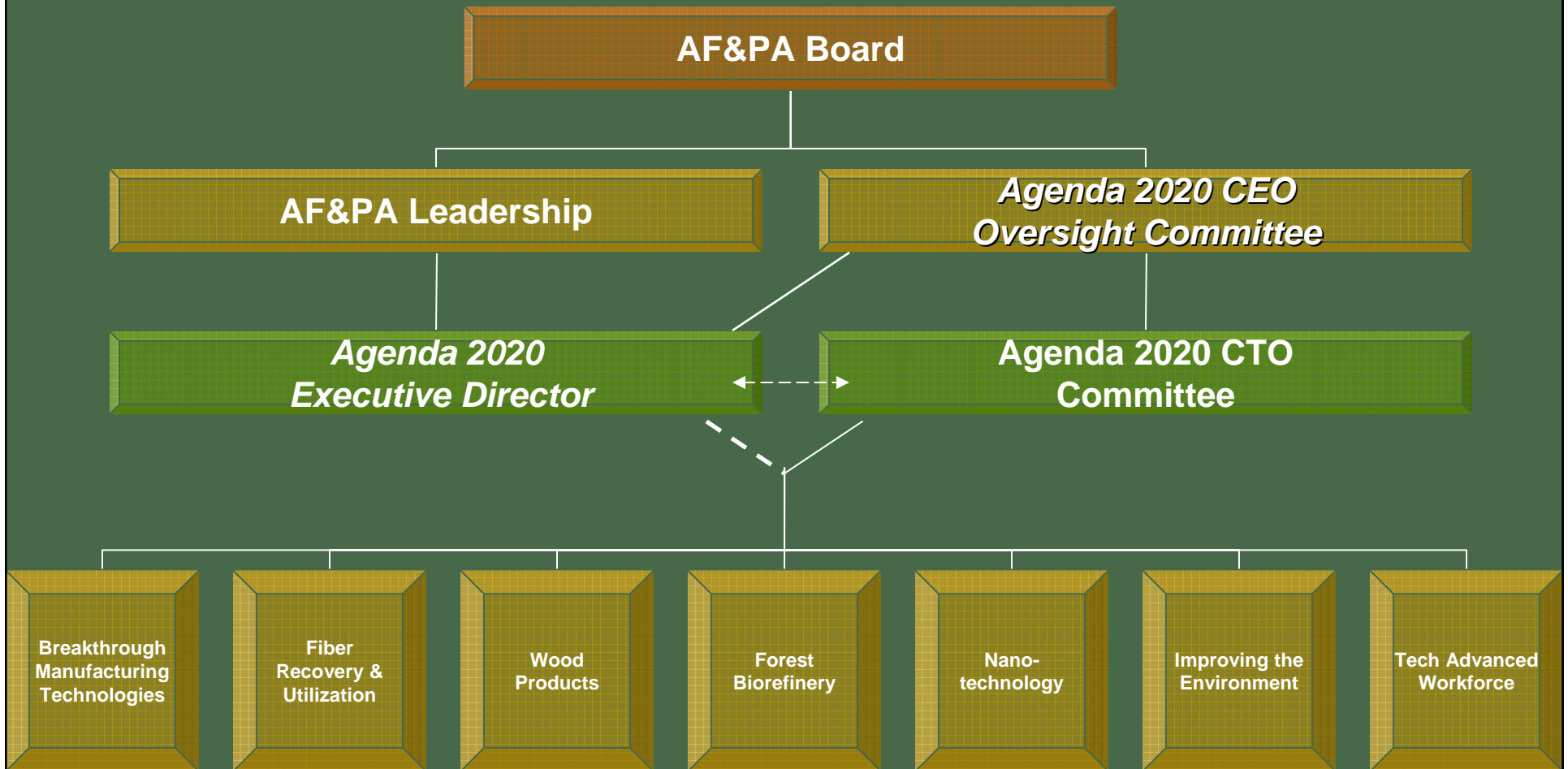


Today's Agenda 2020: The Forest Products Industry Technology Alliance

- Industry-led partnership with government and academia for collaborative, pre-competitive research, development and deployment
- Advance breakthrough technologies that hold the promise of reinventing America's forest products industry
- Intersection of improved financial performance with addressing shared industry and national goals
 - Provide the research foundation for new technology-driven business models that will enable the forest products industry to meet competitive challenges
 - Contribute solutions to strategic national needs associated with energy efficiency, energy security, diversified energy supply, and environmental performance
- Creating and capturing value through innovation in processes, materials, *and markets*



Agenda 2020 Technology Alliance Organization (2005)



Agenda 2020 Members & Partners

(June 2005)

- **Industry Alliance Members (Full)**
 - Georgia Pacific
 - Longview Fibre
 - MeadWestvaco
 - Potlatch
 - SAPPPI
 - Stora Enso NA
 - Weyerhaeuser
- **Associate Alliance Members (Platform)**
 - Arborgen
 - Imerys
 - TRI
- **Affiliate Alliance Member**
 - CTT
- **Affiliate Technical Partners**
 - PPERA
 - TAPPI
 - NCASI
 - FPS
 - FPL
 - IPST
 - SWST



Agenda 2020 Focus for the Future

The Six Technology Platforms – Crafted for High Value/Low Risk with a Proven Portfolio Tool

Positively Impacting the Environment

- ↳ *Expand the Carbon Cycle Benefits*
- ↳ *Enhanced Site, Activity and Product Environmental Footprint*

Next Generation Fiber Recovery and Utilization

- ↳ *Recycled Fiber Indistinguishable from Virgin Fiber*



Advancing the Forest "Biorefinery"

- ↳ *Sustainable Forest Productivity*
- ↳ *Extracting Value Prior to Pulping*
- ↳ *New Value from Residuals and Spent Liquors*



Breakthrough Mfg. Technologies

- ↳ *Major Manufacturing Cost/Capital Reduction*
- ↳ *Significant Enhancement in Product Properties with Existing Assets*
- ↳ *Substantial Improvement in Energy Efficiency for Existing Processes*



Technologically Advanced Workforce

- ↳ *From Workforce to Knowledge Workers in 7 years*

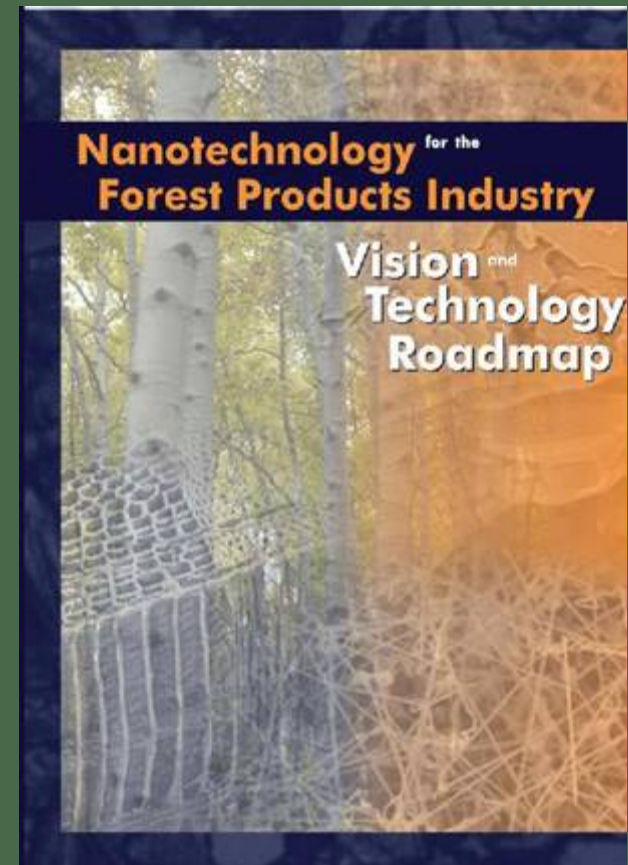
Advancing the Wood Products Revolution

- ↳ *Improved Building Systems*
- ↳ *Reduced System Costs*



Why Nanotechnology to Meet Agenda 2020 Objectives?

- Applications Perspective: Potential use promises significant improvements in quality and functionality for products and processes
- Materials Perspective: Stewards and converters of an abundant, renewable biological raw material which has not yet been explored and exploited at the nanoscale



Nanotechnology Roadmap: Priority R&D Areas

- Polymer Composites and Nano-Reinforced Materials
- Self-Assembly and Biomimetics
- Cell-Wall Nanotechnology
- Sensors, Processing, and Process Controls
- Analytic Methods for Nanostructure Characterization

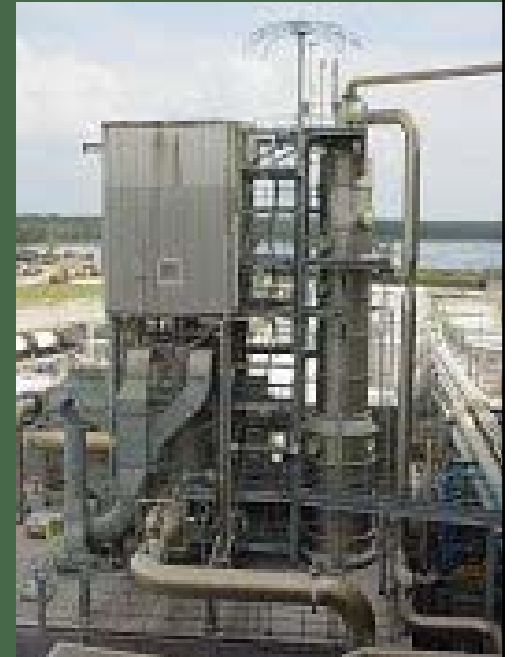


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Breakthrough Manufacturing Technologies

Utilize new/emerging knowledge and technologies to achieve:

- *reduction in manufacturing cost* through a focus on significant process change
- *reduction in capital intensity* through a focus on simplifying or eliminating process steps
- *increase in fiber/product properties* through better understanding of chemistry, biochemistry and physics.

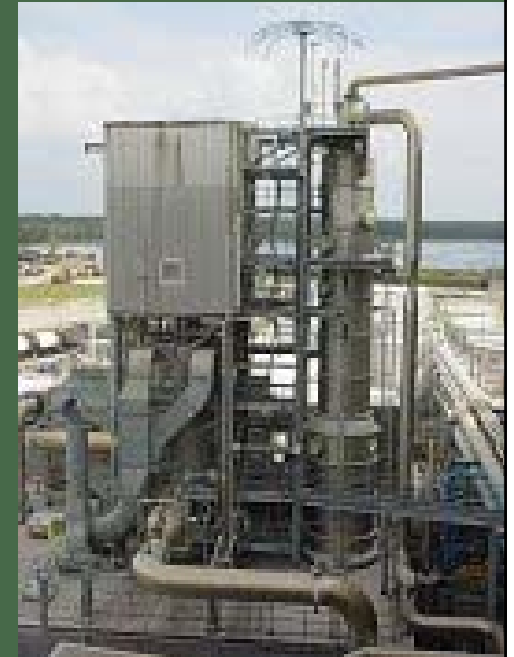


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Breakthrough Manufacturing Technologies

Enabling Nanotechnology R&D:

- Basis for making lighter-weight products from less materials and with less energy requirements
(composites/nano-reinforced materials)
- Reduced energy usage in drying
(composites/nano-reinforced materials)
- Tagging fibers, flakes, and particles to allow customized property enhancement (sensors/process)

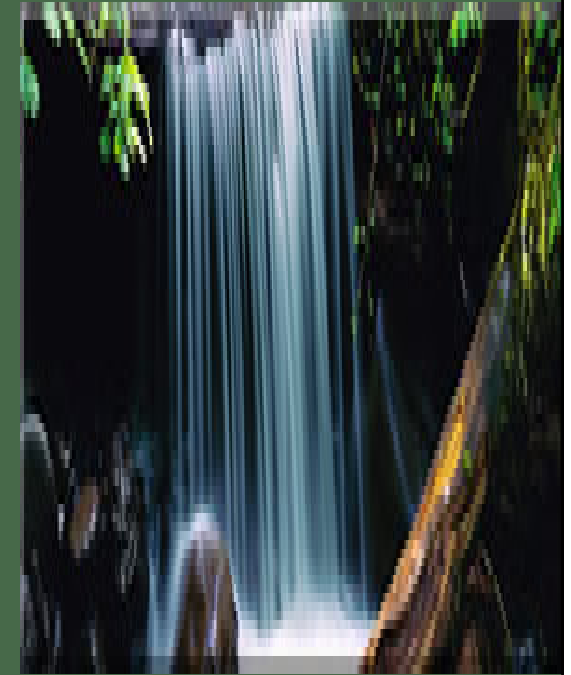


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Environmental Performance

Build in environmental improvements as a key benefit to new products and processes

- Reduce industry-wide *effluent discharges*
- Reduce *power consumption* and eliminate the use of fossil fuels in air pollution control devices
- Develop *beneficial uses for paper mill sludge* which will convert it from a waste to a commodity

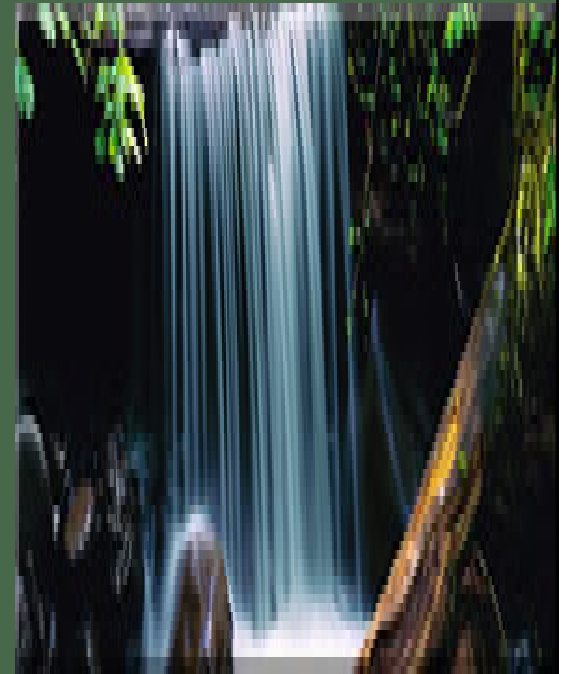


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Environmental Performance

Enabling Nanotechnology R&D:

- Nanostructured catalysts that can liberate cellulose nanofibrils from wood as well as selectively remove lignin and/or hemicelluloses in environmentally preferable ways (**sensors/processing**)
- Improved water removal and elimination of rewetting to enhance environmental sustainability (**sensors/processing**)
- Use of nanoscale materials and nanotechnology to improve conversion efficiencies (**composites/nano-reinforced materials**)



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Next Generation Fiber Recovery and Utilization

Make recycled fiber interchangeable with virgin fiber with respect to *product quality and economics* allowing competition with virgin fiber on all metrics:

- availability
- strength potential
- quality
- processing performance and cost



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Next Generation Fiber Recovery and Utilization

Enabling Nanotechnology R&D:

- Processes using less raw material and energy inputs, and increasing the ability of these products to be recovered and recycled
(nanomaterials/nanosensors)
- Use of low energy or passive nanosensors for fiber tagging to enable fiber separation and identification for recyclability
(sensors/process)
- New polymerization techniques for synthesis of liquid-compatible reinforced fibers; incorporating biochemical and biomimetic techniques can make these products more recyclable while also improving performance
(nanomaterials/biomimetics)

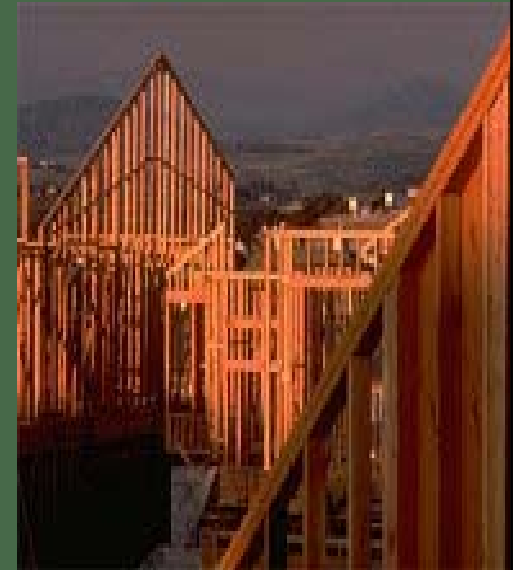


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Advancing the Wood Products Revolution

Through the creation of superior, low-cost, high-value, sustainable wood products and systems

- increase durability
- increase disaster resistance
- increase energy efficiency
- reduce environmental impact



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Advancing the Wood Products Revolution

Enabling Nanotechnology R&D:

- Intelligent wood-based products with nanosensors for forces, loads, moisture levels, temperature, etc. (sensors/process)
- New nanocomposite adhesives and surface coatings could provide enhanced durability, resistance to moisture and decay, and fire retardancy (composites/nano-reinforced materials)
- Monitor or control of temperature, pressure, volatile organic compounds (VOCs), moisture content, mold, and insect attacks (sensors/process)
- Understanding physical and chemical properties of cell wall constituents to engineer materials with new bulk or surface properties (cell wall)



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Advancing the Forest “Bio-refinery”

Evolve existing chemical pulp mills into forest bio-refineries that

- Produce *new forest-based products*
- Export substantial amounts of *renewable energy*
- Continue to meet growing demand for traditional pulp and paper products.



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Advancing the Forest “Bio-refinery”

Enabling Nanotechnology R&D:

- Understanding how molecules self-assemble, leading to the use of the constituents as a chemical feedstock (**self-assembly/biomimetics**)
- New methods for extracting and isolating the lignin and hemicelluloses in a form that is marketable (**cell wall**)
- Improved product diversity and properties through engineering of wood feed stock to meet product-specific requirements (**cell wall**)
- Faster growing trees that retain industrially useful properties to maximize productivity of plantation forest land (**cell wall**)



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Technologically Advanced Workforce

Training and education to ensure that the technologies chosen to create the forest products industry of the future are operated and managed by a technically superior workforce resulting, increased industry profitability



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Technologically Advanced Workforce

Enabling Nanotechnology Activities:

- Ensure funding for university basic research and education
- Develop curriculum within forestry and pulp & paper university programs
- Engage undergraduate and graduate students in research
- Link with researchers in other institutions and centers





Dual Approach Strategy

- Adapt and deploy existing nanotechnologies
- Create and deploy novel new nanotechnologies



Strategy 1: Adapt and Deploy Existing Nanotechnologies

- Reduces costs by leveraging existing capital investment
- Shortest time for deployment
- Exploits existing nanotechnology knowledge base
- Adds value and functionality to existing products
- *Forge partnerships with funded national centers and other industry alliances, e.g.*
 - *NNI funded centers*
 - *Chemicals and Electronics industries*
- *Identify technologies for transfer to industry*



Strategy 2: Create and Deploy Novel New Nanotechnologies

- Exploits the unique nanoscale components and properties of wood
- Enables new generations of cost-effective products and materials
- Exploits the full potential of wood as a material
- Achieves maximum efficiency of material use
- *Partner with research funders and performers*
 - *Federal, state, and international research agencies*
 - *Key universities and national labs*
- *Influence direction and focus of nanoscale science, engineering and technology research*



Questions?

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