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# The Path Forward An Implementation Plan



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# The Path Foward An Implementation Plan

# BACKGROUND

The Energy Policy Act of 1992 provided the Department of Energy with a mandate to work with the largest energy users in the industrial sector to create a "meaningful, fiveyear research program" for the purpose of encouraging those industries to adopt more energy-efficient practices and technologies, thereby reducing the Nation's utilization of fossil energy and its emissions of greenhouse gases. This action occurred at a time when the U.S. forest and paper industry was facing one of the largest challenges to its global competitiveness ever encountered. Catalyzed by this DOE initiative, six vision industries (Glass, Metalcasting, Chemicals, Steel, Forest Products, and Aluminum) have now produced technology visions and research agendas for the future. The American Forest & Paper Association was the first to achieve this vision. Published in November of 1994, Agenda 2020 has become the basis for creating a path forward that goes well beyond the intent of the 1992 policy act.

On November 22, 1994, a Compact was signed calling for the development of a partnership between the Forest Products Industry and the Department of Energy. The basis for the partnership was to be the Agenda 2020 publication. In the Compact, five needs/drivers were identified that summarized the importance of the vision that Agenda 2020 represents to the industry. These drivers are:

- To advance the global competitiveness of the forest products industry by building technological leadership in the face of substantially increased research subsidies in major competitor nations in recent decades;
- To continue improving the sustained management of the forest resource recognizing its multiple uses and essential position as an available, stable, low-cost raw material basic to the industry;
- To be capable of meeting demanding environmental requirements without the predicted increases in capital expenditures, operating costs and energy consumption;
- To continue the significant progress in building energy self-sufficiency and to take full advantage of available by-product biomass as a fuel source; and
- To increase further the economic viability and use of recycled wood and paper materials.

This is the foundation on which the implementation of Agenda 2020 is based.

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# EXECUTIVE SUMMARY

Agenda 2020 now has broad acceptance and significant influence-both directly in the forest and paper industry and with the wider community who work with and support the industry. It defines significant industry priorities and it raises expectations. It is seen as current, relevant and important. It galvanizes support for the industry and brings together key industry, university and government resources to pursue common goals. The Chief Technology Officers Working Group, which has maintained oversight of the implementation process, has nurtured a successful structure for working together on planning collaborative research. A "pathways model" originally developed and used by the Environmental Performance Task Group for Cluster Rule discussions with the EPA has been productively applied in all six focus areas of Agenda 2020. In addition to Environment, the other areas are Sustainable Forestry, Energy Performance, Capital Effectiveness, Recycling, and Sensors & Controls. Based on these pathways, each task group has identified over-arching needs and initial focus areas and-through the process of project evaluation and prioritization-at this writing has had a three-year history of recommending funding for those projects that both meet the needs of the industry and have a sound technical basis for success.

By involving people from government organizations, industry professional organizations, academia, suppliers to the industry and the industry's technical leaders, the process has taken advantage of the diversity of those communities to concentrate on compelling, broadly applicable, pre-competitive research areas. The concepts underlying the implementation of Agenda 2020—provided by the CEO Executive Committee Working Group—are:

- The process is unequivocally led by industry with out-reach to experts to provide facts and data for decision making.
- American Forest & Paper Association's role is establishing priorities and oversight. Research management is left to the experts.
- AF&PA oversight starts from the issues defined in Agenda 2020 which are of broad interest to the industry; then it provides guidance to future research direction, the measurement of success and the dissemination of results to its members.
- Bureaucracy is minimized by capitalizing on available committees and processes for communication of issues and progress throughout the industry.

- Funding is addressed by first improving the effectiveness of what is already being spent on industry's behalf through identification of areas of major need and cooperative effort between universities, government labs and corporate research efforts. Next, a share of the government dollars allocated to industrial research is sought. Where additional funds are justified, these projects will be dealt with on a caseby-case basis.
- Optimization of the process is achieved by taking advantage of experience gained through initiatives such as the presentation of industry research plans to the Environmental Protection Agency in connection with the Cluster Rules and benchmarking results against the independent efforts of activities such as TAPPI's Research Needs Conferences.

These concepts have been followed as closely as possible in building the currently funded program, in developing pathways for each of the six focus areas, in developing more detailed principles of execution to be used by individual committees and researchers and in developing the Agenda 2020 implementation plan, which is the subject of this publication.

The realization of the objectives of the six task forces should:

- provide a common vision for communication with and education of stakeholders and publics;
- enhance the industry's ability to conduct research and implement new technology more cost effectively;
- provide leverage to each company's internal development efforts; and
- improve individual companies' global competitiveness through easy and early access to new technology.

# AGENDA 2020 — THE PATH FORWARD An Implementation Plan

# MISSION

The principle mission of Agenda 2020 is to maximize the efficiency and effectiveness by which the industry executes pre-competitive collaborative research and to ensure that programs that are undertaken are properly focused on the issues which address the industry's most pressing technology needs.

The basis for research planning is Agenda 2020, which defines the major gaps of broad interest and points out where new technology applications are required. The primary function is the recommendation of suitable research projects that will help to fill the technology gaps, as well as facilitating activities that will lead to commercial deployment of significant new process technologies and services. Based on this mission, the industry encourages the following:

- Support for the educational role of the universities and their continued supply of high-quality candidates for employment in the forest products industry over the long term.
- Broadening the base of researchers actively interested in the industry's issues and encouraging them to bring their talents to bear on them.
- Active solicitation of the chemical and equipment suppliers to the industry in the research process-particularly in their participation in the commercialization of the emerging technologies from this program.
- Contributing to technical and cost-effective environmental solutions.
- Continuing to improve and enhance the unique sustainability characteristics of the forest and paper industry.

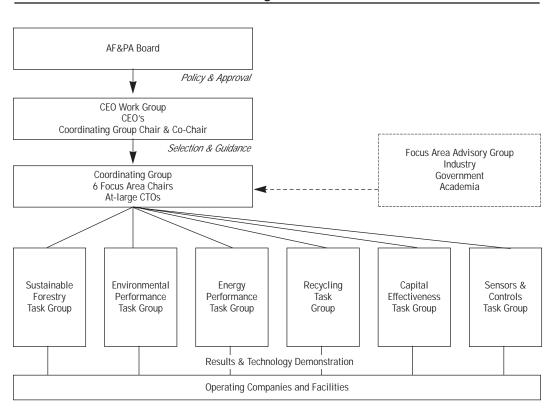
# STRUCTURE

Agenda 2020 is structured so that both the policies under which it operates as well as the perspective for its direction are provided by the CEOs of the industry through the American Forest & Paper Association's Board of Directors. The selection and guidance of specific programs is provided by the Chief Technology Officers of the industry through the CTO Working Group, which is made up of the Co-chairs of each of the six operating task groups and other technology leaders. Figure 1 provides a graphical representation of the organizational structure.

The program execution is carried out within each of the six area task groups, whose roles are to:

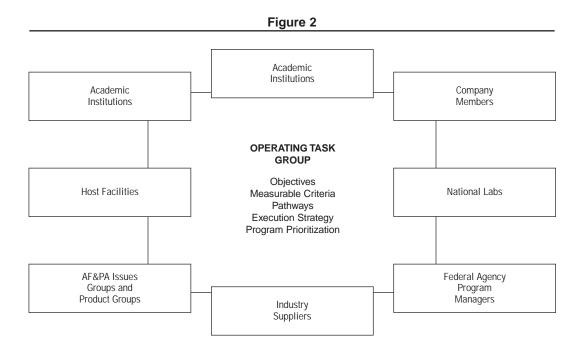
- define essential technology needs for the long-term future of the industry
- · develop pathways and execution strategies
- select technology areas amenable to pre-competitive, collaborative work
- seek out/encourage appropriate research organizations/consortia to address the needs
- document measurable criteria to determine success
- provide leadership and oversight to research program execution.

Figure 1



In carrying out these roles industry committees, institutions and existing professional societies are utilized to the maximum extent possible in keeping with the principles of minimizing-and where possible, reducing-bureaucracy.

Figure 2 exemplifies the various entities that each task group involves in carrying out its roles and responsibilities.



### AF&PA Issues & Product Groups

To the greatest extent possible, existing AF&PA committees were utilized as the forum for discussion. This was done to ensure that any activities and directions undertaken by Agenda 2020 were fully consistent with the policies adopted by the Issues & Product groups. These include: the Forest Resources Research Committee (Sustainable Forestry); the Environmental Policy and Oversight Committees (Environmental Performance); the Energy Policy Committee of the Energy Council (Energy Performance); Advanced Sensors Working Group (Sensors & Controls); and the Paper Recycling Group (Recycling). Only in the case of Capital Effectiveness was there a need to evolve an additional structure. The membership of each task group is available through AF&PA's Agenda 2020 web page at www.agenda2020.org.

#### **Host Facilities**

It is envisioned that as research and development is completed within the Agenda 2020 program, technology demonstrations will be required as a step to commercial success. Those facilities within the industry that act as host for these demonstrations will become a valuable and integral element of commercial success.

#### **Academic Institutions**

A large share of ideas, innovations, proof of concept and teaching will come from the nation's university system. These institutions are sought out by task groups so that the best minds can be brought to bear on the highest priority issues. As a significant step in engaging key institutions in this process, the Pulp & Paper Education Research Alliance (PPERA) has been formed and provides effective links to the Agenda 2020 process.

The member institutions of PPERA are Auburn University, Georgia Institute of Technology, The Institute of Paper Science and Technology, Miami University of Ohio, North Carolina State University, the State University of New York at Syracuse, University of Maine, University of Minnesota, University of Washington, University of Wisconsin at Stevens Point and Western Michigan University. Each of these universities conducts education and research programs focused on the needs of the U.S. pulp and paper industry and is supported by a partnership with the industry through a corporate membership-based organization. Collectively, these institutions provide a major supply of BS, MS and Ph.D. scientists and engineers specifically educated for careers in the pulp, paper and allied industries. With industry advice and support, faculty at these institutions have a well established track record of providing research results for the industry's benefit. PPERA also affords Agenda 2020 an excellent basis to access the vast intellectual resources of the entire US academic community.

#### **Industry Groups**

The documentation of Agenda 2020 published in November, 1994, was supported by the National Council for Air & Stream Improvement (NCASI), Recycled Paperboard Technical Association (RPTA), Forest Products Society (FPS), Paper Industry Management Association (PIMA) and the Technical Association of the Pulp & Paper Industry (TAPPI). The relationships with these and other groups, such as the Adhesives Association, has matured since that time. TAPPI has played a large role in aligning its Research Needs Workshop activities with the Agenda 2020 vision. The TAPPI Journal and PIMA's Papermaker Magazine continue to act as major communication conduits. NCASI is playing a significant role in the oversight, guidance and management of the Environmental Performance and Sustainable Forestry programs. The Improved Capital Effectiveness task group has made an outreach to the American Paper Machinery Association and the Construction Industry Institute (CII).

#### **National Laboratories**

The National Laboratories represent an enormous resource, both in the form of intellectual assets and unique laboratory equipment and skills, and can reapply their experience working on other difficult technical questions outside the normal world of the forest products industry. Working with the DOE's Office of Industrial Technology and the National Laboratories Coordinating Council, the Agenda 2020 program has-for the first time-been able to focus this enormous resource on priority areas of importance to the industry. Like many other parts of Agenda 2020, this is an on-going activity where the participants are committed to becoming more efficient in the years ahead. Most recently, the National Laboratories Coordinating Council has designated a point person to become involved in all aspects of the collaboration between the industry and the National Laboratories. This individual will be available for all the research area operating task groups during their deliberations and, in this way, will be able to develop a unique perspective on how the process can keep improving.

## **Federal Government**

The Federal government plays a very special role in the implementation of Agenda 2020. It was the stimulus of DOE's Office of Industrial Technology and the Secretary of Energy that catalyzed the birth and development of Agenda 2020. The long-standing support of the Forest Service, particularly from the Forest Products Laboratory in Madison Wisconsin, offers another unique opportunity in improving the efficiency and effective-ness of how public monies are used to support forestry and wood products activities. Priorities evolving through the President's Committee on Science & Technology-particularly as they relate to the global warming issue-may also hold promise in redirecting federal funding mechanisms toward areas of high priority.

#### **Industry Suppliers**

The industry's reliance on its suppliers has increased during the last decade-a trend that is likely to continue. Many, if not most, of the innovations developed through Agenda 2020 can become a reality for the industry only if the industry suppliers are intimately involved in the planning, execution and ultimately the commercialization of process technologies and services. An outreach to suppliers has been and is continuing to be made.

#### **Company Members**

Each research area operating task group has about twelve members from among the membership of the American Forest & Paper Association. These individuals have been delegated the responsibility from the Chief Technology Officers' Working Group for recommending the research area priority program. They make the assessments of proposals that have been submitted and agree on the final recommendation. The Chair(s) for the research area operating task groups are selected from among the company members.

# PRINCIPLES OF EXECUTION

The following principles guide the task groups in carrying out their roles and responsibilities:

- The "Agenda 2020" vision is a partnership between the forest, wood and paper industry, government and academia and as such should strive to serve the legitimate needs of all parties.
- The partnership is meant to serve national needs and industry priorities. Industry plays a proactive role in defining goals, identifying research needs, and making specific recommendations on projects.
- The right program for the industry is developed and funding is sought, rather than fitting the program to the funds available. This assures that the high priority issues are addressed.
- Suppliers are engaged and encouraged to take on device- and equipment-oriented projects in a competitive mode as early as practical.
- Research, development & demonstration activities sponsored under "Agenda 2020" are pre-competitive to the producing industry where pre-competitive activities are considered as high risk; could include understanding a phenomenon; exploring a concept; and demonstration of commercial viability. Activities would not include dealing with product or process technologies that would likely provide competitive advantage or with taking a wood, paper or pulp product to market.
- In the spirit of partnership, the industry must support a recommended project with appropriate levels of direct or in-kind funds.
- Sunk costs in the form of past research expenses should normally not be considered as in-kind contribution but should be considered to justify path-forward matching funds.
- Decisions will be made with the greatest possible fairness to all parties with respect to resources provided as matching funds, in-kind contributions, and use of existing assets (land, forests, laboratories & manufacturing facilities). Land & timber as well as physical plant are valid capital assets in "Agenda 2020" program considerations.
- The outcome of the "Agenda 2020" partnership is anticipated to be an accelerated demonstration, evaluation and implementation of new technologies and scientific insights that will address several industry and national needs, including:
  - To advance the global competitiveness of the forest products industry by building technological leadership.
  - To continue improving the sustained management of the forest resource, recognizing its multiple uses and its essential position as an available, stable, low-cost raw material base to the industry.
  - To be capable of meeting demanding environmental requirements with minimal increases in capital expenditures, operating costs and energy consumption.
  - To continue the significant progress in energy efficiency, improving the economics of energy self-sufficiency and to take full advantage of biomass as a fuel source.
  - To increase the economic viability and use of recycled wood and paper materials.

## THE PATH FORWARD

Beginning with a technology vision and research agenda in late 1994, considerable progress has been made to define the relationship and roles of the various entities that are necessary for the success of Agenda 2020, particularly in the areas of defining research targets and selecting projects. Still ahead lies the development of proven processes and procedures for demonstration and delivery of the technologies and services that will emerge from this undertaking. The remaining sections of this document discuss in detail the pathways, priorities and the path forward for each of the six task group areas of Agenda 2020.

#### Pathways

A major initial effort of each focus task group was to develop a detailed vision of the future in their specific area, to identify the technology gaps that would have to be filled to achieve that vision and to evolve a prioritized high-impact program that would fill the gaps. To do this, they began with the November 1994 Agenda 2020 document as it was approved by the AF&PA Board. They next determined what areas of continuing research were going on in addressing a particular focus area; and then identified what future research would be necessary-along with the knowledge and tools to be developed and assimilated-in order to realize the desired result.

Each task group was encouraged to keep clearly in mind that all areas should have high impact and a high probability that success will advance the industry's global competitiveness. The essence of Agenda 2020 emphasizes pre-competitive research that is being conducted in a collaborative way between companies and related institutions. The task groups were further challenged to maintain a balance between what is needed to achieve the ultimate objective and producing early results in order that the benefit and the momentum of the program could be identified and maintained.

Since the vision of Agenda 2020 is a long-range vision, there needs to be a consistent and continuous set of reasons why companies that make up the forest, wood and paper industry will continue to believe in the journey and to support it. The first basis is having a sound working process to develop an agreed priority research program. The second basis is being built on the links to the suppliers and a proven demonstration process. Importantly, as the process continues, it needs to be able to point to early successes. These elements together are necessary for continued broad-based support, growth and funding.

With these principles and objectives in mind, pathways were developed in each of the six focus areas. Since the specific directions and elements of these pathways must change as new things are learned and the world around us also changes, the pathways themselves will need to be revisited on a 3-5 year cycle.

## Sustainable Forestry Task Group

Sustainable Forest Management is one of the key research areas identified in Agenda 2020. As its fundamental raw material, wood fiber is a common denominator to all facets of a diverse forest products industry. Maintaining an adequate, reliable, and cost-effective fiber supply is of vital strategic significance. This is a key element in maintaining the global competitiveness of the industry. Ever increasing regulatory and other restrictions have a cumulative impact in restricting fiber supply.

Agenda 2020 sustainable forestry research focuses on improving forest productivity. Four key research pathways have been identified:

- Biotechnology
- Basic Physiology
- Soil Productivity
- Remote Sensing.

These pathways focus research efforts on areas that are realistic for the industry to address. Sustainable forestry task group participants advocate a "bottom-up" approach to advancing this research agenda. Direct, ongoing communication of industry needs with individual agency, university, and national laboratory researchers will result in more viable research projects. Revitalizing regional industry forest research committees is the key to a more collaborative, local effort.

Examples of research priorities and current projects:

- Marker-aided gene selection
- Identifying and cataloguing useful genes
- Uptake and utilization of nutrients
- Carbon gain and allocation
- Determining physiological mechanisms of tree response to forestry practices
- · Soil limitations to forest productivity and increased growth rates
- Improved and more efficient inventory techniques.

# Positive New Developments

Significant recent developments have helped the SF2020 Program gain momentum.

- USFS Partnership: The FS&TC successfully expanded the SF2020 partnership to include the USFS. Strong support from the USFS on both the national and regional levels has already produced funding for four projects.
- Plant/Crop 2020: The DOE is currently developing a Plant/Crop Agenda 2020 program with the forestry and agricultural communities. This represents a potential source of new funding for research efforts under the Biotechnology Pathway and will be administered separately from the current program. AF&PA is participating in initial planning as a member of the Executive Steering Committee.
- NAPFSC Summit: It is hoped that this event will attract additional support for forestry research efforts.

Pathway for Addressing Industry Information Needs Related to Sustainable Forestry — **Biotechnology** 

Agenda 2020 Focus Area	Continuing Research	Future Research Direction	Knowledge & Tools Delivered and Assimilated	Results Realized
<ul> <li>Locate and identify genes for impor- tant quantitative traits</li> <li>Improve tools for genetic transforma- tion in tree species</li> <li>Improve tissue cul- ture technology for tree species</li> </ul>	<ul> <li>Marker-aided selection in model tree species</li> <li>Sequencing the active genome of model plant species: e.g., Arabidopsis</li> <li>Identification of genes controlling quantitative traits in tree species</li> <li>Developing mass propagation technologies for model tree species</li> </ul>	<ul> <li>Sequence the active genomes of select- ed Pinus taeda and Populus genotypes</li> <li>Validate marker- aided selection methods</li> <li>Improve genetic engineering and mass propagation technologies for model tree species</li> <li>Develop informa- tion needed to address environ- mental/regulatory concerns</li> <li>Develop techniques for inducing and demonstrating sterility in model tree species</li> </ul>	<ul> <li>"Library" of genes for use in genetic engineering of trees</li> <li>Reliable, economi- cally-feasible meth- ods for mass prop- agation of superior genotypes</li> <li>Environmentally- acceptable systems for testing and deployment of genetically-engi- neered trees</li> <li>Useful correlation of genetic markers &amp; desirable tree traits</li> </ul>	Significant gains in productivity resulting from deployment of superior genotypes

# Pathway for Addressing Industry Information Needs Related to Sustainable Forestry — **Basic Physiology of Forest Productivity**

Agenda 2020 Focus Area	Continuing Research	Future Research Direction	Knowledge & Tools Delivered and Assimilated	Results Realized
<ul> <li>Research to understand critical limitations to accelerating plant growth</li> <li>Research to support genetic engineering</li> <li>Research to support forest management</li> <li>Research to support ecosystem management</li> </ul>	<ul> <li>Tree development processes and their linkages to genetic controls</li> <li>Stand dynamics of plant forests</li> <li>Tree and stand interactions with environmental variables (ecophys- iology)</li> <li>Interactions of tim- ber management with other forest products and val- ues</li> </ul>	<ul> <li>Improve under- standing of key physiological processes including carbon gain and allocation, wood formation &amp; quality, nutrient uptake, juvenile/mature transition, sec- ondary metabolism</li> <li>Develop better information on mechanisms of stand responses to silvicultural treat- ments</li> <li>Develop physiologi- cally-based process models to test hypotheses and maximize the value of information from field studies</li> </ul>	<ul> <li>Knowledge of tree development processes will enhance our ability to: (s) locate &amp; identify genes con- trolling important quantitative traits, and (b) improve tissue culture tech- nology</li> <li>Knowledge of tree/stand physiolo- gy will enhance our ability to design sil- vicultural systems and select geno- types that minimize environmental stress, optimize resource utilization, &amp; increase produc- tivity</li> <li>Knowledge of processes control- ling productivity will enable us to model management results and funda- mental ecosystem</li> </ul>	Significant gains in productivity resulting from: a) more rapid advances in forest biotechnology, and b) improvements in silvicultural practices

processes

# Pathway for Addressing Industry Information Needs Related to Sustainable Forestry — **Sustainable Soil Productivity**

Agenda 2020 Focus Area	Continuing Research	Future Research Direction	Knowledge & Tools Delivered and Assimilated	Results Realized
<ul> <li>Understanding effects of intensive management on soil productivity</li> <li>Diagnosing soil limitations to pro- ductivity</li> <li>Treatments to enhance soil pro- ductivity</li> </ul>	<ul> <li>Diagnosis and amelioration of nutrient limitations</li> <li>Effects of intensive management sys- tems on soil organ- ic matter, soil chemical/physical properties, &amp; water quality</li> <li>Use of mill residu- als as beneficial soil amendments</li> <li>Models of soil responses to bio- mass removals, atmospheric depo- sition &amp; other processes</li> </ul>	<ul> <li>Evaluate positive and negative effects of intensive man- agement options for important soil types</li> <li>Develop nutrient budgets for impor- tant soil types, including effects of harvest</li> <li>Understand nutrient cycling processes in major forest/soil types</li> <li>Improve under- standing of root diseases &amp; other soil biological fac- tors affecting forest productivity</li> <li>Develop model- based methods for diagnosing soil lim- itations to produc- tivity</li> </ul>	<ul> <li>Improved tools for diagnosing soil lim- itations to produc- tivity</li> <li>Guidelines to pre- vent or ameliorate adverse effects of intensive manage- ment practices</li> <li>Knowledge of processes control- ling productivity in important soil types</li> <li>New options for enhancing soil pro- ductivity</li> </ul>	Significant improve- ments in long-term soil productivity

# Pathway for Addressing Industry Information Needs Related to Sustainable Forestry — Remote Sensing Technologies to Improve Forest Inventory and Stand Management

Agenda 2020 Focus Area	Continuing Research	Future Research Direction	Knowledge & Tools Delivered and Assimilated	Results Realized
<ul> <li>Application of existing technology to improve outdated nation-wide forest inventory program</li> <li>Development &amp; testing of new methods for moni- toring forest health and productivity</li> </ul>	<ul> <li>Basic research on remote sensing &amp; survey methods for forest inventory</li> <li>Large-scale ecolog- ical studies of for- est community dis- tributions, impacts of human activities (e.g., tropical defor- estation), and for- est biogeochemical cycles</li> <li>Studies of methods for detecting forest stress</li> </ul>	<ul> <li>Conduct intensive cooperative study during 1996-1997 to determine how best to incorporate modern remote sensing technolo- gies/systems in the U.S. nation-wide forest inventory system</li> <li>Develop methods for cost-effective monitoring of for- est growth in rela- tion to target goals</li> <li>Develop methods for detecting &amp; diagnosing growth- limiting conditions at the stand level. Conditions of inter- est include nutrient limitations, insect &amp; disease problems, overstocking or understocking &amp; excessive weed competition</li> </ul>	<ul> <li>A cost-effective design for a revital- ized U.S. nation- wide forest invento- ry system that meets the needs of industry &amp; other user groups</li> <li>New methods for sub-regional moni- toring of forest pro- ductivity</li> <li>New methods for stand-level determi- nations of factors that limit forest productivity</li> </ul>	<ul> <li>Significant improvements in the timeliness &amp; quality of informa- tion for national &amp; regional assess- ments of timber availability, forest health &amp; the effec- tiveness of man- agement strategies</li> <li>Significant cost reductions &amp; quali- ty improvements in systems for requir- ing stand-level information to sup- port management decisions</li> </ul>

#### **Environmental Performance Task Group**

Environmental Performance continues to be a major improvement area for the industry. It is critically important to provide for an improved margin of environmental safety and to do so by improvements to the basic manufacturing processes, the identification of new process technologies that reduce or eliminate environmental releases, and by improvements to existing treatment systems or the development of economically attractive novel treatment options-including recycling and reuse. As knowledge of environmental impacts improves, the industry is in a better position to prioritize impact issues and guide the development of process and treatment alternatives.

To help the industry move toward the goal of meeting ever changing and more demanding environmental requirements without increases of capital expenditures, operating costs and energy consumption, Environmental Performance focuses on three strategic pathways:

- Improved Margins of Environmental Safety (understanding impacts)
- Process Alternatives Consistent with Pollution Prevention (in-mill improvements)
- Treatment Areas (treatment system improvements, new treatment options, waste utilization)

The resulting pathways are described on the following pages.

Environmental Performance Priority Areas of Interest

- Impacts and control of non-process elements, soluble ions and organics
- Improved delignification and bleaching technologies
- Odor reduction
- In-process water reuse technologies
- Beneficial use of by-products (Pulp & Paper and Wood Products)
- Biomass fuels from wastes
- Energy efficient wastewater treatment technologies
- VOC/HAP's reduction from wood products manufacture
- Enhanced wood recycling

## Pathway for Achieving Goals Relating to Improved Margins of Environmental Safety

Agenda 2020 Focus Area	Continuing Research	Future Research Direction	Knowledge & Tools Delivered and Assimilated	Results Realized
Environmental Performance (Impacts) • Human and envi- ronmental effects • Energy and envi- ronmental trade- offs	<ul> <li>Biological &amp; health effects character- ized and under- stood; e.g., bio- markers and hor- mone mimicking</li> <li>Risk assessment of HAPs</li> <li>Impact of pulping and bleaching alter- natives quantified</li> <li>Environmental impact of LVHC &amp; HVLC disposal by combustion assessed</li> </ul>	<ul> <li>Expand scientific knowledge relative to areas of interest; e.g., aquatic effects and atmospheric chemistry</li> <li>Develop methodol- ogy to analyze resource and envi- ronmental burdens of technical and regulatory changes; e.g., pulping &amp; bleaching alterna- tives, LVHC &amp; HVLC management, recovery alterna- tives</li> <li>Understanding of new issues</li> </ul>	<ul> <li>Credible scientific understanding of cause and effect relationships</li> <li>Rigorous modeling approach that will act as a basis for setting standards for new mills and recognizing site- specific needs of existing mills</li> <li>Resolution of iden- tified concerns</li> </ul>	Scientific basis on which to prioritize impact issues and allocate resource commitments

# Pathway for Achieving Environmental Goals Relating to **Process Alternatives Consistent** with Pollution Prevention

Agenda 2020 Focus Area	Continuing Research	Future Research Direction	Knowledge & Tools Delivered and Assimilated	Results Realized
Environmental Performance (Process) • Impacts of liquid effluent • Impacts of gaseous discharges • Non-process ele- ments • Energy reduction	<ul> <li>Alternative pulping and bleaching processes that are in harmony with the environment</li> <li>Technologies for treating effluent streams for reuse</li> <li>Designs, sensors and controls for operating stable processes</li> <li>Methods for organ- ic/inorganic separa- tion</li> </ul>	<ul> <li>Alternative pulping technologies; e.g., AQ, polysulfide, enzymes, split sul- fidity</li> <li>Alternative bleach- ing technologies; e.g., ozone, pres- surized peroxide, peracetic acid, enzymes</li> <li>Bleach effluent recycle technolo- gies; e.g., supercrit- ical water oxidation, membranes evapo- ration-crystalliza- tion, freeze crystal- lization, precipitator management</li> <li>Black liquor pro- cessing alterna- tives; e.g., black liquor gasification combined cycle</li> <li>Future options assessed</li> </ul>	<ul> <li>Commercial demonstration</li> <li>Corrosion-resistant materials of con- struction</li> <li>Operating econom- ics, availability and maintainability</li> <li>Flexibility to imple- ment as part of normal moderniza- tion capital cycle</li> <li>Commercialization of preferred options pursued</li> </ul>	Economically attrac- tive processes that improve the margin of environmental safety while main- taining global com- petitiveness

Agenda 2020 Focus Area	Continuing Research	Future Research Direction	Knowledge & Tools Delivered and Assimilated	Results Realized
Environmental Performance (Treatment) • Solid waste mini- mization • Impacts of gaseous discharges • Impact of liquid discharges	<ul> <li>Processes for han- dling gaseous dis- charges</li> <li>Improvement and optimization of effluent treatment systems</li> <li>Processes for uti- lization or disposal of solid waste</li> </ul>	<ul> <li>Thermal oxidation technologies, biofil- tration</li> <li>Fundamentals of the impact of bio- logical processes; e.g., AOX</li> <li>Waste minimization approaches</li> <li>Recycle</li> <li>Ethanol manufac- ture</li> <li>Supercritical water oxidation</li> </ul>	<ul> <li>Commercial demonstration</li> <li>Corrosion-resistant materials of con- struction</li> <li>Flexibility to imple- ment as part of normal moderniza- tion capital cycle</li> </ul>	Improved margin of environmental safety through waste mini- mization

#### Pathway for Achieving Environmental Goals Relating to Treatment Areas

## **Energy Performance Task Group**

Energy Performance, a fundamental research area for Agenda 2020, has identified five subject areas central to a successful program for the next few decades. They include:

- Fuel Production and Enhancement
- Fuel Conversion and Electricity Production
- Manufacturing Process Efficiency and Heat Recovery
- Environmental Impact of Energy Production & Utilization
- Wider Use of Renewable Resources

Pathways for these five research areas are shown in the following pages.

Examination of the pathways should begin with the fundamental understanding that the forest products industry's raw material is a fuel. Upgrading the fuel to higher valued products-including wood products, paper, electricity, chemicals, etc.-is what the industry does. In these many processes, energy is consumed and some material is not utilized. The economic arena in which the Energy Performance Task Group focuses on precompetitive research involves the utilization of non-upgraded materials for an energy source, the use and efficiency of use of energy, the environmental impacts of energy use and the production of products in two areas-energy and chemicals. Research in these areas overlaps all of the Agenda 2020 program areas.

Some of the areas that have received considerable research proposal interest and acceptance include:

- Fundamental Understanding of the Thomlinson Recovery Furnace
- The Role of Impurities in Pulping Liquors on Recovery Operation
- Black Liquor and Biomass Gasification
- Non-Combustion Environmental Control Processes
- Utilization of Unused Biomass

# Pathway for Addressing Energy Performance Needs Related to **Fuel Production and Enhancement**

Agenda 2020 Focus Area	Continuing Research	Future Research Direction	Knowledge & Tools Delivered and Assimilated	Results Realized
Technologies for maximizing the value of waste materials and bio- mass as an energy source	<ul> <li>Agricultural residues as fuel and as feedstock for chemicals</li> <li>Non-recyclable recoverable materi- als as a fuel</li> </ul>	<ul> <li>Forest and planta- tion management strategies and pre- scriptions that will optimize "energy fiber" generation while enhancing overall productivity</li> <li>Collection and har- vesting systems and techniques to increase forest residual availability and reduce costs</li> <li>Improved moisture reduction tech- niques, including drying</li> <li>Technologies for beneficiation of wastes and other recyclable materials handling technolo- gy</li> </ul>	<ul> <li>New integrated systems for growing, harvesting, sorting and developing energy fiber from forests &amp; planta- tions</li> <li>Systems for col- lecting, sorting and beneficiating nonre- cyclable recovered material for energy</li> </ul>	<ul> <li>Maximum value of forest resources</li> <li>Flexibility to utilize the cheapest fuels</li> <li>Shelter from fossil fuel price perturba- tions and energy taxes</li> <li>Waste Reduction</li> </ul>

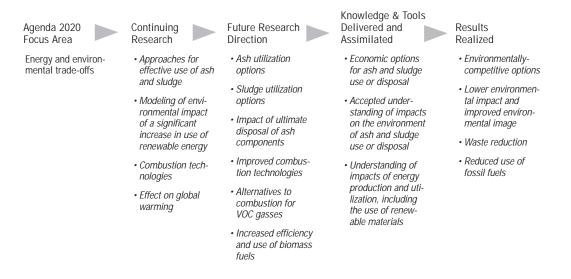
# Pathway for Addressing Industry Energy Performance Needs Related to **Fuel Conversion** and **Electricity Production**

Agenda 2020 Focus Area	Continuing Research	Future Research Direction	Knowledge & Tools Delivered and Assimilated	Results Realized
<ul> <li>Independence from fossil fuel and pur- chased power needs</li> <li>Effective partner- ships with energy providers in achiev- ing renewable ener- gy goals</li> </ul>	<ul> <li>Biomass and black liquor gasification technology devel- opment, including hot gas cleaning</li> <li>Tomlinson furnace</li> <li>Black liquor gasifi- cation technology development</li> <li>Combustion tur- bines for dirtier and lower Btu fuels</li> <li>Smaller cost-effec- tive turbines</li> <li>Cleaner and more efficient combus- tion</li> </ul>	<ul> <li>Biomass &amp; black liquor gasification combined cycle commercialization</li> <li>Improved under- standing of the fun- damentals of ener- gy conversion tech- nologies, including: <ol> <li>fluidized bed</li> <li>gasification</li> <li>combustion of fuels and black liquor</li> </ol> </li> <li>Development of technologies; e.g., fuel cells; to be used in combina- tion with gasifica- tion to enhance energy efficiency</li> <li>Model development to allow size and plant integration optimization</li> <li>Concept &amp; tech- nologies for life extension of Tomlinson furmaces</li> </ul>	<ul> <li>Commercially- demonstrated gasi- fication combined cycle technologies</li> <li>Energy conversion technologies opti- mized from an operating and maintenance per- spective</li> <li>Advanced com- bined cycle sys- tems</li> </ul>	<ul> <li>Reduced capital for energy conversion</li> <li>Successful partner- ships with energy providers</li> <li>Major reductions in net dependence on fossil fuels and purchased power</li> <li>Smaller scale, cost- effective installa- tions</li> <li>Environmentally effective combus- tion and generation</li> </ul>

## Pathway for Addressing Industry Energy Performance Needs Related to **Manufacturing Process Efficiency & Heat Recovery**

Agenda 2020 Focus Area	Continuing Research	Future Research Direction	Knowledge & Tools Delivered and Assimilated	Results Realized
Energy efficiency, including methods of low-level heat recovery	<ul> <li>Drying and other water removal concepts</li> </ul>	<ul> <li>New technologies for recovery of low- level heat</li> </ul>	<ul> <li>Commercial alter- natives for low- level heat recovery</li> </ul>	Operations that are globally competitive from an energy-use
	Pulping, bleaching and papermaking processes	<ul> <li>New or more effec- tive approaches to water removal prior to drying</li> </ul>	<ul> <li>Commercial alter- natives for water removal, including drying</li> </ul>	perspective • Optimum utilization of process equip- ment
	<ul> <li>Wood products processes</li> <li>Process measure- ments and controls</li> </ul>	<ul> <li>Commercialization of new and improved drying concepts</li> <li>Reduced process variability/improved process control</li> <li>Improved wood products, pulping and paper manu- facturing processes</li> <li>Effective and effi- cient lime kiln oper- ation</li> </ul>	<ul> <li>Commercial process control techniques</li> <li>Commercial alter- native manufactur- ing processes</li> </ul>	<ul> <li>Reduced use of fossil fuels</li> <li>Environmentally effective manufac- turing</li> </ul>

# Pathway for Addressing Industry Energy Performance Needs Related to Environmental Impact of Energy Production & Utilization



## Pathway for Addressing Industry Energy Performance Needs Related to **Wider Use of Renewable Resources**

Agenda 2020 Focus Area	Continuing Research	Future Research Direction	Knowledge & Tools Delivered and Assimilated	Results Realized
Technologies for maximizing the value of waste materials and bio- mass as an energy source	<ul> <li>Biomass-to-chemi- cal conversion processes</li> <li>Technologies for recycling wood</li> <li>Life extension of wood products</li> </ul>	<ul> <li>Commercialization of improved bio- mass-to-chemicals conversion tech- nologies</li> <li>Process integration alternatives allow- ing for attractive chemical produc- tion opportunities</li> <li>Improved technolo- gies for wood prod- ucts recycling</li> <li>Understanding of the energy efficien- cy in production and use of forest and paper products relative to compet- ing products</li> <li>Greater life of wood buildings via design and repair</li> </ul>	<ul> <li>Options for effective partnerships with utilities, chem- ical and oil compa- nies, designers and repair entities</li> <li>Substantial energy efficiency informa- tion for forest and paper products</li> </ul>	Maximum value of forest resources

# **Capital Effectiveness Task Group**

One of the key research areas described in Agenda 2020 was Capital Effectiveness. A team has been trying to bring strategic focus to this complex area. This team identified major industry research needs and ways to link with specific research proposals. It recognized the benefits to the industry of Agenda 2020, which go beyond the planning of research, and includes the communication of a long-term sense of responsibility and stewardship. This is important as the industry seeks to build and further its reputation-including the attractiveness to potential new technically skilled resources, as well as other stakeholders.

It was agreed that Capital Effectiveness should be looked at more broadly than just invested capital, but rather on a total basis, considering the "life cycle" of the investment. This would include the initial capital, operating, service and maintenance costs, as well as operating efficiency. This approach resulted in three strategic pathways:

- Systems and Process Technologies (what is built)
- System Fabrication and Construction (how it is built)
- System Efficiency (how it is operated)

The resulting detailed pathways are presented on the following pages. The goal is to support research and development work in areas that likely will have the greatest significance to the industry's long-term success.

Since significant impacts are being sought, it is critical that input from the industry's owners, suppliers and technical institutions is obtained. It is also critical that the scope of requests are narrowed-recognizing that resources are limited. The Task Group believes

that it is also critical to have teams of investigators from various resources that reflect true expertise. More intense collaboration between universities, research institutes, national laboratories and industry associations is highly encouraged and valued.

Capital Effectiveness Priority Areas of Interest

- Developing and sharing best capital management practices
- Black liquor and biomass gasification
- Paper machine production and quality improvements
- Improved materials of construction
- Improved modeling, simulation, optimization and operator training
- · Biotechnology raw materials/pulping and bleaching
- Minimum-impact manufacturing
- Intelligent maintenance approaches
- Direct causticizing

## Pathway for Addressing Industry Capital Effectiveness Needs Related to **System and Process Technologies**

Agenda 2020 Focus Area	Continuing Research	Future Research Direction	Knowledge & Tools Delivered and Assimilated	Results Realized
Systems and Process Technologies	<ul> <li>Lower cost, safer and more efficient processes</li> <li>Continued process design and enhancement by suppliers</li> <li>Continued funda- mental research and innovation by key universities and technical institu- tions</li> </ul>	Raw Materials • Improved fiber pro- cessing and yield (through the sys- tem value) • Alternative fiber sources Pulping and Bleaching • Alternative processes • Bio-delignification • In-digester bleaching • Split sulfidity pulping Chemical Recovery • Black liquor and biomass gasifica- tion • Direct causticizing Paper Machines • Forming, pressing, high intensity dry- ing • Faster machine speeds • Size press elimina- tion • Improved uniformi- ty Minimum-Impact Manufacturing • Reduced water usage • Multi-media closure	<ul> <li>New processes brought from con- cept through first commercial imple- mentation</li> <li>Leanings and best practices from uni- versities, technical institutions and consortiums widely shared</li> <li>Improved under- standing of funda- mentals that allow early introduction of new, lower cost technologies and processes</li> </ul>	Improved global competitiveness by impacting the nature of technologies used to manufacture pulp and paper/wood products

# Pathway for Addressing Industry Capital Effectiveness Needs Related to **System Fabrication** and **Construction**

Agenda 2020 Focus Area	Continuing Research	Future Research Direction	Knowledge & Tools Delivered and Assimilated	Results Realized
System Fabrication and Construction	Sharing of best prac- tices • TAPPI Engineering • CII • Owner/Supplier col- laboration to opti- mize value • Other Continued supplier, engineering and con- struction industry development • Value engineering • Shop fabrication • Site construction and labor efficiency • Cooperation to reduce installed capital costs • 3D-CAD Support established programs at DOE in areas aligned with capital effectiveness (e.g., recovery boiler materials of con- struction)	Simplified and stan- dardized design Size and scale Paper machine speed, width, press loadings and roll covers Improved materials of construction • Boilers, digesters, bleach plants • Cheaper to use, less expensive to maintain and resilient to harsh environments • Improved durability (wear) in wood yards Improved construc- tion • Foundation and structural • Large scale/modu- lar • Modernizing exist- ing mills Improved welding techniques	<ul> <li>Better understand- ing of the funda- mental phenome- non impacting equipment failure and corrosion</li> <li>Best practices from suppliers, consul- tants, and engi- neering firms shared across the industry</li> <li>Partnerships devel- oped</li> <li>Rapid application of new, lower cost equipment, processes and pro- cedures</li> </ul>	Improved global competitiveness through the efficient application and implementation of the capital deployed by the forest prod- ucts industry

# Pathway for Addressing Industry Capital Effectiveness Needs Related to System Efficiency

Agenda 2020 Focus Area	Continuing Research	Future Research Direction	Knowledge & Tools Delivered and Assimilated	Results Realized
System Efficiency	<ul> <li>Developing skilled resources for the industry</li> <li>Maintenance and operations</li> <li>Disciplined engi- neers</li> <li>Process engineers</li> <li>Continued develop- ment of process monitoring tools for the industry by suppliers</li> <li>Continued develop- ment of fundamen- tal process knowl- edge by key techni- cal institutions and suppliers</li> </ul>	Improved modeling, simulation, optimiza- tion and operator training tools Diagnostic and smart sensors to reduce unscheduled down- time Intelligent Maintenance • Proactive • Allow to design process and sys- tems on the edge • Maintain facilities "on the run" Reduced raw materi- al variability Chemical and energy optimization	<ul> <li>A diverse set of skilled resources capable of meeting the challenges of the future</li> <li>Improved process models and tools for optimization</li> <li>Improved econom- ics, availability and maintainability of core manufacturing processes</li> </ul>	Improved global competitiveness through better man- ufacturing asset uti- lization

#### **Recycling Task Group**

Research in the Agenda 2020 Recycling area is aimed at reducing energy usage, improving fiber yield, and eliminating stickies contamination. These activities form the basis to significantly improve and expand the use of recycled fiber. The targeted research pathways encourage development toward these goals.

A new, top priority research pathway was also defined to support the development and characterization of new pressure sensitive adhesives. Breakthrough work is sought to commercialize removable adhesives that help circumvent high processing costs associated with stickies.

The recycling research pathways below are listed in order of priority:

- Develop environmentally benign pressure sensitive adhesives (PSA).
- Improving separation technologies.
- Develop tools and methodologies that establish a valid statistical characterization of raw material streams and to develop innovative sorting and collection techniques, systems, and equipment.
- Understand surface chemistry and fiber to fiber bonding.
- Develop new technologies for sludge use and disposal.

## Pathway for Addressing Industry Recycling Needs Related to **Developing Environmentally** Benign Pressure Sensitive Adhesives (PSA)

Agenda 2020 Focus Area	Continuing Research	Future Research Direction	Knowledge & Tools Delivered and Assimilated	Results Realized
Develop environ- mentally benign pressure sensitive adhesives (PSA)	<ul> <li>Adhesive properties to enhance separa- tions technolo- gies—size integrity for screening, den- sity gradients for cleaning, surface chemistry for flota- tion</li> <li>Characterize forma- tion and behavior of microstickies</li> <li>USPS and FPL work in developing recyclable PSAs</li> <li>Understanding of the true impact and cost of stickies on the industry</li> <li>Testing procedures and standards for stickies and micro- stickies</li> </ul>	<ul> <li>Develop benign pressure sensitive adhesives (PSAs)</li> <li>Reformulated adhe- sives for removal by conventional screening technolo- gies by academic research institu- tions</li> <li>Partnerships among suppliers, converters, end users, paper collec- tion &amp; recycling industry (e.g. USPS model program)</li> </ul>	<ul> <li>Cooperative relationships among colleges &amp; universities, adhesive suppliers, converters, end users and paper recyclers aimed at the common goal of low cost, screenable PSAs</li> <li>Standards for quantifying recyclability of adhesives</li> <li>Standards for measurement of final product stickies</li> <li>Novel process equipment developments that control adhesive contaminants in a cost-effective manner with minimal impacts on energy requirements, fiber properties &amp; yield</li> </ul>	<ul> <li>Decrease volume of PSA-contaminated paper going to landfills</li> <li>Ability to cost- effectively utilize lower grades of recovered paper in higher quality recy- cled papers with no impact on quality and operability</li> <li>Industry-supplier- end user-academic research working relationships that can serve as a model for future endeavors</li> <li>Implementation of new &amp; unique tech- nologies contribut- ing to the long- term viability of the recovered paper industry.</li> </ul>

# Pathway for Addressing Industry Recycling Needs Related to Improving Separation Technology

Agenda 2020 Focus Area	Continuing Research	Future Research Direction	Knowledge & Tools Delivered and Assimilated	Results Realized
Improving separation technology	<ul> <li>Reduce maintenance costs (longer life of wearable parts)</li> <li>Improve efficiency of separation of lightweight contam- inants (centrifugal cleaning, fine slot- ted screening, washing, flotation)</li> <li>More efficient processes -system design -operating condi- tions -unit operations</li> <li>Testing procedures &amp; standards</li> <li>On-line testing/identifica- tion of contami- nants, fiber proper- ties, brightness, etc.</li> <li>Identification &amp; removal of stickies</li> </ul>	<ul> <li>Reduce number of unit operations (e.g., 2-stage sys- tems)</li> <li>Reliable sensors for accurate on-line measurement of stickies, inks, etc.</li> <li>Reliable measure- ments to reduce variability in sepa- ration efficiency</li> <li>Improved chemical treatments to enhance separation techniques</li> <li>Novel approaches to separation tech- nology</li> <li>Improved material of construction for separation equip- ment</li> <li>Reduction in ener- gy consumption</li> <li>Reduce water con- sumption per ton of recovered material processed</li> </ul>	<ul> <li>Documented partnership between suppliers &amp; user to develop knowledge and tools that mea- sure/improve/opti- mize separation technology</li> <li>Improved funda- mental understand- ing of processes and products (cause and effect relationships)</li> <li>Novel commercial methods/process/e quipment that meet criteria of maxi- mum efficiency, minimum fiber loss &amp; reduced specific energy consump- tion</li> <li>Improved methods for fabricating and maintaining equip- ment</li> <li>Lower effluent vol- umes to waste treatment</li> </ul>	<ul> <li>Increased utilization of recycled fiber with improved eco- nomic justification</li> <li>Higher yield of fiber at lower energy consumption</li> <li>Reduced water consumption</li> </ul>

# Pathway for Addressing Industry Recycling Needs Related to **Sorting and Collection/Methodologies and Tools**

Agenda 2020 Focus Area	Continuing Research	Future Research Direction	Knowledge & Tools Delivered and Assimilated	Results Realized
Sorting and collec- tion/methodologies and tools	<ul> <li>Identify the most effective means of collection for an area's demograph- ics, population den- sity &amp; economics</li> <li>New techniques or instrumentation that optimizes the quantity and quality of fiber recovered</li> <li>Development of standards which clarify recyclability</li> <li>Techniques to establish statistical characterization of recovered paper &amp; recycled fiber raw material streams</li> </ul>	<ul> <li>New designs that will result in lower equipment, labor and maintenance costs</li> <li>Improve material handling technolo- gy</li> <li>Develop on-line detection tools to measure and con- trol efficiency of sorting</li> <li>Research on mate- rials now consid- ered nonrecyclable</li> </ul>	<ul> <li>Reliable and economical methods for collection and sorting</li> <li>Reduced costs associated with fiber recovery</li> <li>Improved quality of fiber recovered</li> <li>Improved quality of finished product</li> </ul>	<ul> <li>Increased percentage of paper recovered and utilized</li> <li>Industry's environmental impact minimized</li> </ul>

# Pathway for Addressing Industry Recycling Needs Related to **Surface Chemistry and Fiber-Fiber Bonding**

and fiber - fiber properties ty properties of improved recycled fiber compara bonding sheet and board fiber properties virgin fiber	Agenda 2020 Focus Area	Continuing Research	Future Research Direction	Knowledge & Tools Delivered and Assimilated	Results Realized
<ul> <li>Chemical or enzyme treatment to increase and recover water retention/fiber con- formability</li> <li>Fines reactivation and retention</li> <li>Fundamental stud- ies to model fiber entworks contain- ing recycled fiber</li> <li>Mechanical treat- ments for recovery of performance properties</li> <li>Effect of cyclic humidity and the minimization of these effects</li> <li>Improved sheet properties</li> <li>Understanding of process surface chemistry and influence on fiber yield</li> <li>More efficient use of process chemi- cals</li> <li>More efficient use of performance properties</li> <li>Effect of cyclic humidity and the minimization of these effects</li> </ul>		<ul> <li>properties</li> <li>Chemical or enzyme treatment to increase and recover water retention/fiber con- formability</li> <li>Fines reactivation and retention</li> <li>Fundamental stud- ies to model fiber networks contain- ing recycled fiber</li> <li>Mechanical treat- ments for recovery of performance properties</li> <li>Effect of cyclic humidity and the minimization of</li> </ul>	ty properties of sheet and board • Improved sheet properties • Biotechnology applications • More efficient use of process chemi-	improved recycled fiber properties • Understanding of process surface chemistry and influence on fiber	Quality of recycled fiber comparable to virgin fiber

Pathway for Addressing Industry Recycling Needs Related to **New Technologies for Sludge** Use and Disposal

Agenda 2020 Focus Area	Continuing Research	Future Research Direction	Knowledge & Tools Delivered and Assimilated	Results Realized
Sludge use and disposal	<ul> <li>Fiber/clay mini- mization</li> <li>Impact of land application</li> <li>Efficient energy recovery</li> <li>Processes for fiber/ash utilization</li> <li>Efficient dewatering</li> </ul>	<ul> <li>Waste minimization approaches</li> <li>Develop model- based methods for diagnosing soil lim- itation to sludge application</li> <li>Ethanol production</li> <li>Off-site fiber and ash recovery</li> <li>Alternative prod- ucts from sludge</li> <li>Combustion and gasification of sludge</li> </ul>	<ul> <li>Commercial demonstration</li> <li>Improved operating economics, avail- ability and main- tainability</li> <li>Credible scientific understanding of sludge disposal/reuse alternatives</li> <li>Energy conversion technologies</li> </ul>	<ul> <li>Economically attractive processes that improve utiliza- tion of recycled paper sludge</li> <li>Environmentally competitive options</li> <li>Waste reduction</li> <li>Improved global competitiveness</li> </ul>

## Sensors & Controls Task Group

Efficient manufacture of wood and paper products requires effective control of production processes to achieve precision in operations and uniformity in products. Good control in turn requires timely knowledge of process parameters, including accurate measurement or estimation of key variables. The Sensors and Controls Task Group identified a diverse set of needs that should be fulfilled in order to accomplish the Agenda 2020 vision for the industry. These needs are grouped in five pathways as follows:

- Actuators and control devices Final control devices that reduce variability
- Measurement and diagnostics Reliable cost-effective sensors for critical properties
- Process and product models Optimal control facilitated by robust and accurate models
- Data presentation, interpretation, and human interface Systems that help human operators manage processes safely and efficiently
- Control system effectiveness Systems that achieve and sustain efficient operations

Together, these pathways cover almost all aspects of process control systems. For the past three years, the Task Group has emphasized sensor development in recommending projects for funding and in soliciting project proposals. The priority given to new sensors recognizes the inherent difficulties the industry faces in getting useful process measurements. These difficulties arise because the primary raw material is naturally variable and because the process operations often prevent timely and accurate measurements.

The members of the Task Group regularly review the priorities before new project proposals are requested. For the 1999 project selection process, specific need areas are targeted as described below.

Current Priorities for Sensors and Controls

- Final control elements that achieve more uniform fiber distribution in papermaking
- Reliable, affordable real-time sensors to measure non-process elements in harsh pulping, bleaching and recovery processes
- On-line measurement and control of colloidal chemistry in paper machine water systems
- Cost-effective on-line sensors for pulp and fiber properties prior to papermaking
- Non-contacting sensors for the paper machine that measure paper properties critical to high-quality printing
- Diagnostic tools that aid process understanding and more efficient operation, with emphasis on pulping and papermaking
- Techniques and systems that sustain effective performance of control systems without deterioration over time

# Pathway for Addressing Industry Sensors & Controls Needs Related to Actuators and Control Devices

Agenda 2020 Focus Area	Continuing Research	Future Research Direction	Knowledge & Tools Delivered and Assimilated	Results Realized
Surface chemistry and fiber - fiber bonding	<ul> <li>Microprocessors at actuator level</li> <li>Improved flow control</li> <li>Head box dilution control</li> <li>Actuators to stabilize processes</li> </ul>	<ul> <li>Techniques/meth- ods to minimize/eliminate variability</li> <li>Actuators that keep up with control system develop- ment</li> <li>Actuators that sat- isfy product requirements</li> <li>Actuators for new processes</li> <li>Self-diagnostic</li> </ul>	<ul> <li>Actuators for critical product variables</li> <li>Actuators for critical process variables</li> <li>Actuators for raw material variables</li> <li>Actuators for environmental variables</li> </ul>	<ul> <li>Reliable and cost- effective actuators enabling optimal process operation, environmental per- formance, safe per- formance and cus- tomer satisfaction</li> <li>Productivity</li> <li>Quality</li> </ul>

# Pathway for Addressing Industry Sensors & Controls Needs Related to **Measurement and Diagnostics**

Agenda 2020 Focus Area	Continuing Research	Future Research Direction	Knowledge & Tools Delivered and Assimilated	Results Realized
<ul> <li>Complexity of processes and need for maximum effi- ciency and low cost require significantly improved measure- ment and control systems</li> <li>Diagnostic capabili- ty that provides increased knowl- edge of fundamen- tals of structural, optical, etc. attrib- utes is necessary to make possible higher product per- formance at less cost</li> </ul>	Raw Materials • Fiber & filler char- acterization • Tree analysis Product • Paper physics • Surface characteri- zation Process • Chemical & physi- cal analysis of process streams and equipment • Corrosion monitor- ing Environmental • Continuous emis- sion monitoring • Lower detection limits	<ul> <li>Effective process measurement/mon- itoring sensors</li> <li>Measurement sys- tems that allow sig- nificant product improvements</li> <li>Environmental- related sensors— internal &amp; external</li> <li>Diagnostic tools</li> </ul>	<ul> <li>Characterization of all critical product variables</li> <li>Characterization of all critical process variables</li> <li>Characterization of all critical raw material variables</li> <li>Characterization of all critical environ- mental impact vari- ables</li> <li>Sensor validation</li> </ul>	<ul> <li>Reliable &amp; cost- effective measure- ments enabling optimal process operation, environ- mental perfor- mance, safe perfor- mance and cus- tomer satisfaction</li> <li>Economically acceptable tools that enable increased funda- mental understand- ing</li> </ul>

# Pathway for Addressing Industry Sensors & Controls Needs Related to **Process and Product Models**

Agenda 2020 Focus Area	Continuing Research	Future Research Direction	Knowledge & Tools Delivered and Assimilated	Results Realized
<ul> <li>Advanced control, expert and mill information sys- tems will assist in efficient operation</li> <li>Cost-saving models will be available that can help achieve the desired performance and characteristics of wood &amp; paper products</li> </ul>	Process • Unit operations • Total system • Predictive mainte- nance Product • Planning & sched- uling • Finite element analysis Raw Materials • Wood density • Chemical composi- tion Environmental • Dispersion • Impact models • Emission models • Emission models • Expert systems • Neural networks • Factor analysis	<ul> <li>User-friendly methodologies for modeling:</li> <li>-complex systems</li> <li>-chaotic processes</li> <li>Productivity models that optimize the relationship of raw materials and process character- istics to fundamen- tal product charac- teristics</li> <li>Dynamic models that optimize raw material value &amp; consumption, including chemicals</li> <li>Effective models for:</li> <li>-predictive mainte- nance</li> <li>-environmental impact</li> <li>-sustainable forestry</li> </ul>	<ul> <li>Robust/accurate process models</li> <li>Effective integration of sub-system models</li> <li>Key individual learnings embed- ded in process models</li> <li>Fundamental understanding of process &amp; product</li> <li>Predictive econom- ic models</li> </ul>	<ul> <li>Optimization— stump to customer</li> <li>Enhance product performance</li> <li>Consistent prod- uct/productivity</li> <li>Improve process design</li> <li>Safer workplace</li> </ul>

# Pathway for Addressing Industry Sensors & Controls Needs Related to **Data Presentation**, Interpretation & Human Interface

Agenda 2020 Focus Area	Continuing Research	Future Research Direction	Knowledge & Tools Delivered and Assimilated	Results Realized
<ul> <li>The view of the future includes highly automated equipment operated safely in comfortable environments</li> <li>Education &amp; training of process managers, as well as scientists and engineers, will be of increasing importance</li> <li>Complexity of processes &amp; need for maximum efficiency &amp; low cost require significantly improved measurement and control systems</li> <li>Diagnostic capability that provides increased knowl-</li> </ul>	<ul> <li>Automated data reduction</li> <li>Data reduction and validation</li> <li>Abnormal situation management</li> <li>Simulation</li> </ul>	<ul> <li>Automated data validity checking and data reduction</li> <li>More effective modes of human process interaction</li> <li>More effective training tools</li> <li>Rapid prototyping of finished product</li> <li>Technologies that allow realistic dis- plays of process equipment internals utilizing real-time data and tailorable to individual process manager's preferences</li> </ul>	<ul> <li>Actual process is better documented</li> <li>Better alarm man- agement, including predictive operation</li> <li>On-line trouble shooting</li> <li>Increased system security</li> <li>Effective informa- tion presentation</li> </ul>	<ul> <li>Critical information available to users in effective and timely way</li> <li>On-line training capability utilizing real information and displays</li> <li>Safety and system security</li> <li>Agile manufactur- ing and product responsiveness</li> </ul>

edge of fundamen-

tals of structural, optical, etc. attributes is necessary to make possible

higher product performance at less

cost

# Pathway for Addressing Industry Sensors & Controls Needs Related to **Control System** Effectiveness

Agenda 2020 Focus Area	Continuing Research	Future Research Direction	Knowledge & Tools Delivered and Assimilated	Results Realized
<ul> <li>Advanced control &amp; mill information systems will enable efficient operation</li> <li>Computer based control systems will extend into dis- tribution and logis- tics networks to reduce inventories and shorten prod- uct delivery cycles</li> </ul>	<ul> <li>See Pathways 1-4</li> <li>Building robust algorithms</li> <li>Multi-variable and non-linear control</li> <li>Evaluation of exist- ing system perfor- mance</li> <li>Open Systems</li> </ul>	<ul> <li>Reliable control systems that imple- ment process and measurement developments</li> <li>Control systems for automating start-up and transitioning</li> <li>Advanced controls</li> <li>Control system diagnostics and sustained effective- ness</li> </ul>	<ul> <li>Self-regulating and adaptive control systems with 100% utilization</li> <li>Skilled and trained process managers</li> <li>Optimizer for sen- sor and actuator placement and type</li> <li>Process design for effective control</li> <li>Mill-wide control optimization</li> </ul>	<ul> <li>Uniform quality productivity</li> <li>Process variability minimized or elimi- nated</li> <li>Product loss during transitions mini- mized or eliminated</li> <li>Flexible manufac- turing</li> <li>Safe manufacturing</li> </ul>

## **Current Status**

As Agenda 2020 matures, it is resulting in a new paradigm for industry, academia, and government cooperation. The universities are aggressively responding through networks and consortia such as the PPERA. The DOE National Laboratories are closely linked to the process through the National Laboratory Coordinating Council. The Forest Service Laboratory in Madison, Wisconsin, is a full participant. NCASI is integrally involved in providing oversight and management in environmental activities. TAPPI plays a key role in information transfer through its unique ability of communication with the industry's professionals. PIMA is acting as a communication link to the industry's management as well.

Suppliers are becoming involved in increasing numbers and in diverse ways, and the industry is facing its first major commercialization challenge. Agenda 2020 foresaw that the industry would need significantly more efficient and self-sufficient energy generation. The gasification combined cycle co-generation technologies have been developed to the point where the industry has a specific demonstration plan. Through the "Request for Proposals" process, the industry is also seeking additional research and deployment ideas. As a result of the published plan, entitled "The Forest Products Industry Gasification Initiative", the industry has agreed to seek significant matching funds from the Department of Energy to enable the large-scale demonstration of biomass and black liquor gasification combined cycle technologies. These technologies have the potential for making major impacts on the energy, environmental and capital performance of the industry. This initiative represents the first time the AF&PA has been authorized to seek additional government funding for research, development and demonstration aimed at improving the industry's global competitiveness.

The Agenda 2020 vision represents the first time that the US pulp & paper industry has achieved a high degree of alignment around a set of strategic goals. Agenda 2020 has received significant attention and respect from such institutions as suppliers, universities, and the forest products community of other countries. The industry's thoughtful commitments outlined in Agenda 2020 command respect and are a basis for attracting new people into the member companies.

Guided by Agenda 2020, a research, development, and demonstration program is in progress. This is the structure that will allow the industry to fulfill the commitments in Agenda 2020-the results of which will have significant impact on the Industry's competitiveness in the very near future. A common review process has been established for overseeing the program. The research area operating task groups are the leaders of these reviews in the same way as they lead the prioritization of new projects. Their recommendations go to the Chief Technology Officers for any action that might be needed.

The quality and standard of the proposals submitted continues to improve and is at a very high level. The DOE continues to be engaged, and the knowledge of how to effectively utilize the vast resources of the national laboratories continues to increase. Already significant and increasingly interesting ideas have come forth by virtue of being involved in the visioning process with other industries and crosscutting technological concepts have been identified.

In its first three years, Agenda 2020:

- Was a significant factor in Cluster Rule negotiations
- Is the basis for a similar impact on the Administration's Global Climate Change initiative
- Is already showing early winners
- Has resulted in excellent cooperation between academic institutions
- Has facilitated significant understanding and engagement of national laboratory capabilities
- Has leveraged identification of technology needs
- Has produced pathways and leveraged industry-guided research projects in each of the 6 focus areas
- Has become a communication vehicle, with a common voice, for a wide range of constituencies
- Has been an added basis for improving the industry's reputation
- · Has enabled an appropriate level of industry collaboration
- Has significantly increased the awareness and willingness of talented people to work on the Industry's issues (technical respectability).

The vision that Agenda 2020 established in 1994 is being aggressively pursued in 1999 and, with continuous improvement and growing success, will become a reality in the years ahead.

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