Executive Leaders’ Panel: Transforming to the Forest Biorefinery

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Presentation Objective

Forest industry strategists are talking about “revenue diversification” and industry transformation via the forest biorefinery….

…but do forestry company executives know how to go about designing and implementing the forest biorefinery?

…and do forestry executives recognize that the biorefinery represents more than revenue diversification?

…it is a change in the core business… it requires enterprise transformation to be successful…
Presentation Outline

- Case study: ethanol is an interesting biorefinery product to consider, but it involves risks
- The basic issues:
  - Biorefinery implementation strategy
  - Biorefinery design strategy
  - The critical supply chain context for the ethanol case study
- Preliminary concepts for designing the biorefinery supply chain:
  - Operational-level scheduling including…
  - Margins-centric operating policy
  - Operations-driven process model
  - Tactical level SC considerations
- ...and this represents an important transformative change
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Is Cellulosic Ethanol the Right Strategy?

Ethanol price volatility due to:
- Volatile crude oil and natural gas prices
- Changes balance between supply and demand
- Diverse feedstock types and their relative competitiveness
- Energy legislation – tax credits and incentives

In 4 months, ethanol prices dropped by half...

How can companies stabilize margins in the context of volatility and uncertainty?

Source: Gulf Ethanol Corp

Peak at ≈3 $/gal

12 November <1.5 $/gal

Source: Gulf Ethanol Corp
Biochemical Ethanol Technology

Building on Past Successes

Source: NREL - 2006
Should Biochemical Ethanol be Implemented Today?

Building on Past Successes

State of Technology Estimates

July 2007 Scenario @ 3 $/gal

November 2007 Scenario @ 1.5 $/gal

2005 Yield
65 gal/ton

Feed $35/ton
Yield 90 gal/ton

Feed $35/ton
Yield 104 gal/ton

Source: NREL - 2006
Implementing the forest biorefinery is about mitigating risk…

…and clearly ethanol represents a great opportunity, but also presents risks

These risks can be mitigated as part of an overall forest biorefinery product design strategy, e.g.

- What derivatives can be made from ethanol?
- What opportunities are there with by-product lignin?
- What manufacturing flexibility between products is required?
- How should the biorefinery products be delivered?

Is Cellulosic Ethanol the Right Product?
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- What derivatives can be made from ethanol?
- What opportunities are there with by-product lignin?
- **What manufacturing flexibility between products is required?**
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How do we use SC analysis to evaluate product portfolio options & manufacturing flexibility, and the implied enterprise transformation?
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Definition: Building Blocks and Derivatives...

Chips Biomass → Pulp and Paper Mill → Building Block → Derivative → Co-products or wastes?

Waste → P&P Products

Reducing Volumes, Flexible Throughputs…

Incorporating Process Complexity

Main Biorefinery Products to Market

$\$$

Increasing Process Complexity
Case Study Example: Ethanol to Ethylene to Polyethylene...

Chips Biomass → Pulp and Paper Mill → Ethanol → Ethylene → PE

Waste
Strategic Approach for Implementing the Biorefinery

**Phase I**
Lower Operating Costs:
- Replace fossil fuels at mill (natural gas, Bunker C), and/or
- Produce “building block” chemicals
- Lower risk technologies

**Phase II**
Increase Revenues:
- Manufacture of derivatives
- Market development for new products
- Higher process complexity and technology risk
- Partners essential

**Phase III**
Improve Margins:
- Knowledge-based manufacturing and production flexibility
- Business flow transformation
- Product development culture
- Off-shoring, Outsourcing, etc…

Compete internally for capital
Select the most sustainable product platform and partner(s)
Company culture transformation
SCM key to success

Strategic Vision: Phase III must determine Phase I
Strategic Approach for Implementing the Biorefinery

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Let’s elaborate on this…

Margins improvement is the goal

Strategic Vision: Phase III must determine Phase I
Designing the Transition to the Forest Biorefinery

**Product Design**

- Promising Biorefinery Products
- Technology Strategy

**Process Design**

- LCA
- Advanced Thermal Pinch Analysis
- Large Block Analysis of Processes
- Process Simulation
- Set of Preferred Biorefinery Configurations
- MCDM
- Supply Chain Management
- Reconciled Process and Economic Data

**Preliminary Engineering**
Design the Transition to the Forest Biorefinery

Product Design

Promising Biorefinery Products

Technology Strategy

LCA

Advanced Thermal Pinch Analysis

Large Block Analysis of Processes

Process Simulation

Set of Preferred Biorefinery Configurations

MCDM

Supply Chain Management

Reconciled Process and Economic Data

Preliminary Engineering
The Biorefinery Supply Chain will be Significantly More Complex
“Unleashing” Supply Chain Value

Forestry Company

Forest Biorefinery

Chemicals Company

Supply Chain

Supply Chain

Supply Chain

...but there is more value to be unleashed
Manufacturing Flexibility

- Forestry Company
- Ethylene Biorefinery
- Chemicals Company

Ethylene to Partner

Engineered Polyethylene

Ethanol to Blend Tank
Do we need break-through technologies for the biorefinery?

- Perhaps… but it is the unique product portfolio and its delivery that are key
- Operating policies and corporate culture:
  - Manufacturing-centric
  - Margins-centric
- Once you have transformed to a margins centric operating policy, then you can exploit manufacturing flexibility
- Achieving this transformation is essential for biorefinery success
- …but what does this involve?
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Supply Chain 101: The Three SC Levels

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<th>Supply Chain Cycles</th>
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<td>Design the Supply Chain Network: facility location, transportation mode, etc.</td>
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<td>Coordinate &amp; set the appropriate operating performance targets</td>
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<td>Manage the activities that need to be performed to meet performance objectives</td>
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The Key to Success is Defining the Unique Biorefinery SC

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This represents a significant transformation for manufacturing-centric industries such as P&P...

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**Supply Chain Cycles**
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Using ABC-Like Accounting for the Biorefinery

Traditional Cost System (Evolution of Taylorism)

- Key limitations
  - Poor feedback for decision making
  - Cost distortion due to inappropriate treatment of overheads
  - Misrepresentation of mill operations due to the use of inappropriate standards

- Advantages
  - Simple
  - Focuses on unfavorable variances for each period
  - Consistent and thus, adequate for financial reporting

Activity-Based Costing (Developed in mid-'80/'90s)

- Key limitations
  - Focuses on overheads
  - Simplified approach typically used for the analysis of direct costs in complex manufacturing environments
  - Cost modeling approach typically applied in discrete industries, not adapted for continuous-process production environments

- Advantages
  - Elaborated for the needs of modern manufacturing environments
  - Models how resources are consumed by the “hidden factory”
  - Uses a set of resource & activity drivers based on observable measures

Operations-Driven Cost Model
Representing the Biorefinery

Legend
Cost Flow:
Input – « Bottom-up »:
Input – Overhead:
Arbitrary Allocation:
Specific Allocation:
Understanding the Direct Costs

This information can be effectively incorporated into the margins-centric SC
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**SUPPLY CHAIN CYCLES**
For a given product portfolio:

- Fixed number of SC design configurations based on system analysis
- Explore the margins-based SC management strategy: this implies a significant transformation…
- Explore the impact of key factors on profit – especially price scenarios based on possible market conditions
- Design for manufacturing flexibility in the biorefinery…
Case Study: BCTMP Mill

Fibre Procurement Cycle

Fibre Supply
- Procurement & production cycles
- Higher-level: 1 year fibre procurement plan based on forecasts
- Lower-level: 2-3 months, select the best opportunities → right timing (according to production plan), right cost

Fibre Demand
- Production & demand cycles
- Higher-level: 2-3 months, campaign plan on each line
- Lower-level: allocation of confirmed & current orders, respect promised time windows

Focus: Profitable alignment of fibre supply, production capacity and pulp requirements
Three Scenarios Examined

- **Non-Integrated Planning**
  - Production campaigns are fixed according to industrial heuristics - *5 weeks maple, 1.5 weeks birch*
  - Fibre procurement needs to adapt accordingly
  - Recipes are fixed according to mill’s standards

- **Integrated Margins-Centric Planning**
  - Procurement and production planning are optimized simultaneously
  - Recipes are fixed according to mill’s standards

- **Integrated Planning Accounting for Recipe Flexibility**
  - Procurement and production planning are optimized simultaneously
  - The best recipe can be chosen from a set of possible scenarios
Exploiting Process Flexibility

Biorefinery SC strategy should exploit manufacturing flexibility

Profit Improvement

-5%  0%  5%  10%  15%  20%

Supply chain optimization considering manufacturing flexibility

Supply chain optimization considering tactical planning at the operations level

Base case profit

Case III
New Supply Opportunities
### Key elements to develop a unique SC capability

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Bio-diesel is a natural extension for a company whose core business is adding value to wood raw material—primary fibres will remain in pulp and paper production.
Take-Away Messages

- **Risk mitigation** associated with the implementation of the biorefinery can be achieved by employing systematic product and process design methodologies.

- The characteristics of the **product portfolio** are the key to robust business models.

- Transforming to a **margins-centric** supply chain is critical for manifesting biorefinery value.

- This should be coupled with design for **manufacturing flexibility**, and development of **knowledge-based systems**.

- These transformational issues are key to having a unique biorefinery-enhanced SC that will result in a **sustainable biorefinery**.
Executive Leaders’ Panel
Transforming to the Forest Biorefinery

Thank you!