



IT'S A COMPOSITE WORLD

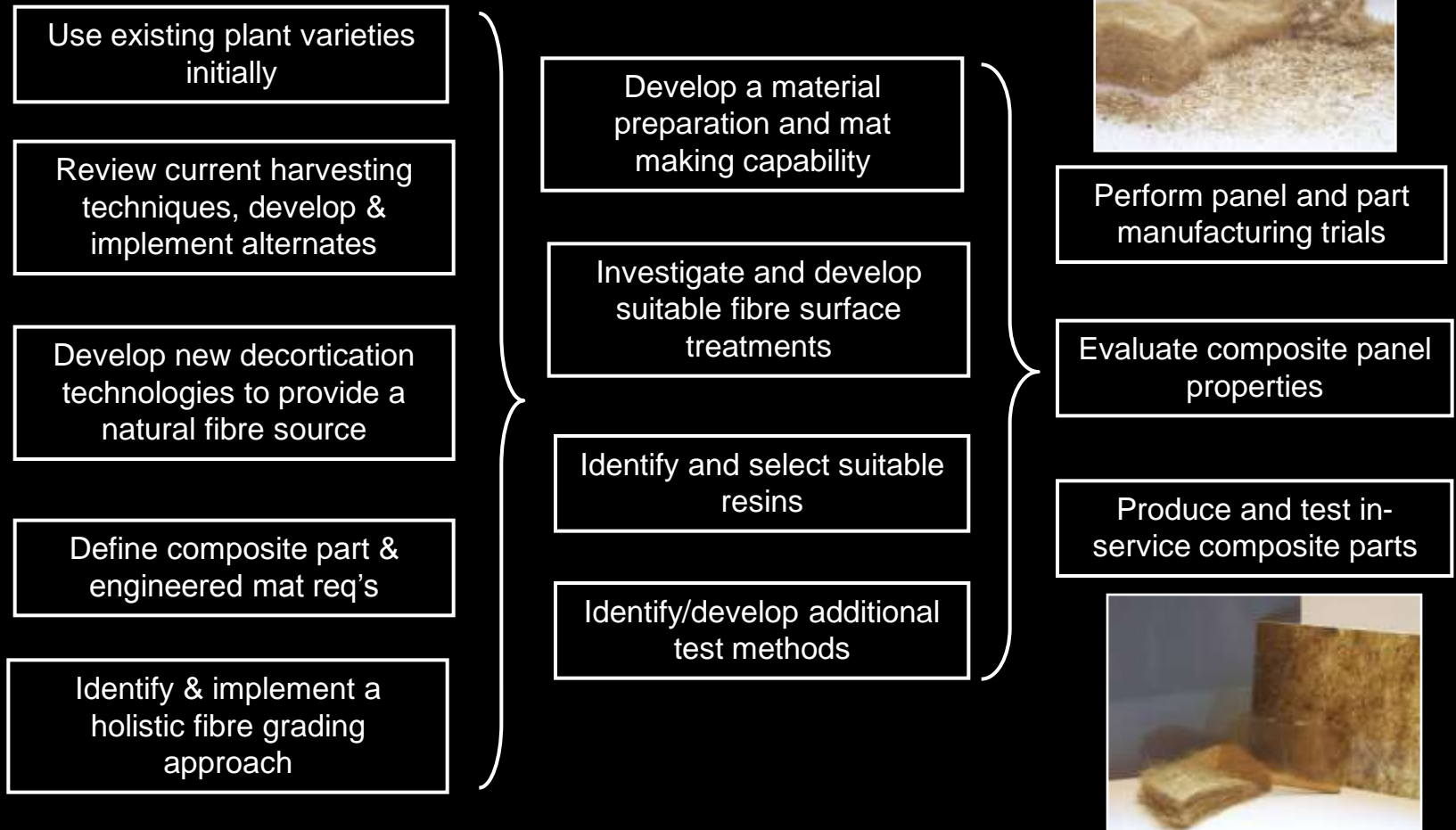
 **Composites
Innovation Centre**

Moulding solutions for the new world

Near Ready, Real Potential

**The Feasibility of Using Natural Fibres for
Reinforcing Thermoset Composite Parts for
Ground Transportation Applications**

Biofibres Development Approach





Market Size (E-glass Composites)

- The demand for E-glass fibre in North America in 2004 was estimated to be around 1.4 billion lbs, or over 632,000 tonnes
- Available in a variety of forms, of which chopped strand and chopped strand mat are initially the most favourable forms for biofibres

Oilseed Flax Fibre Availability (Canada)

Flax Volume

Low Estimate 36,562 m³

High Estimate 138,571 m³

Favourable Glass Forms Volume

Canada 4,213 m³

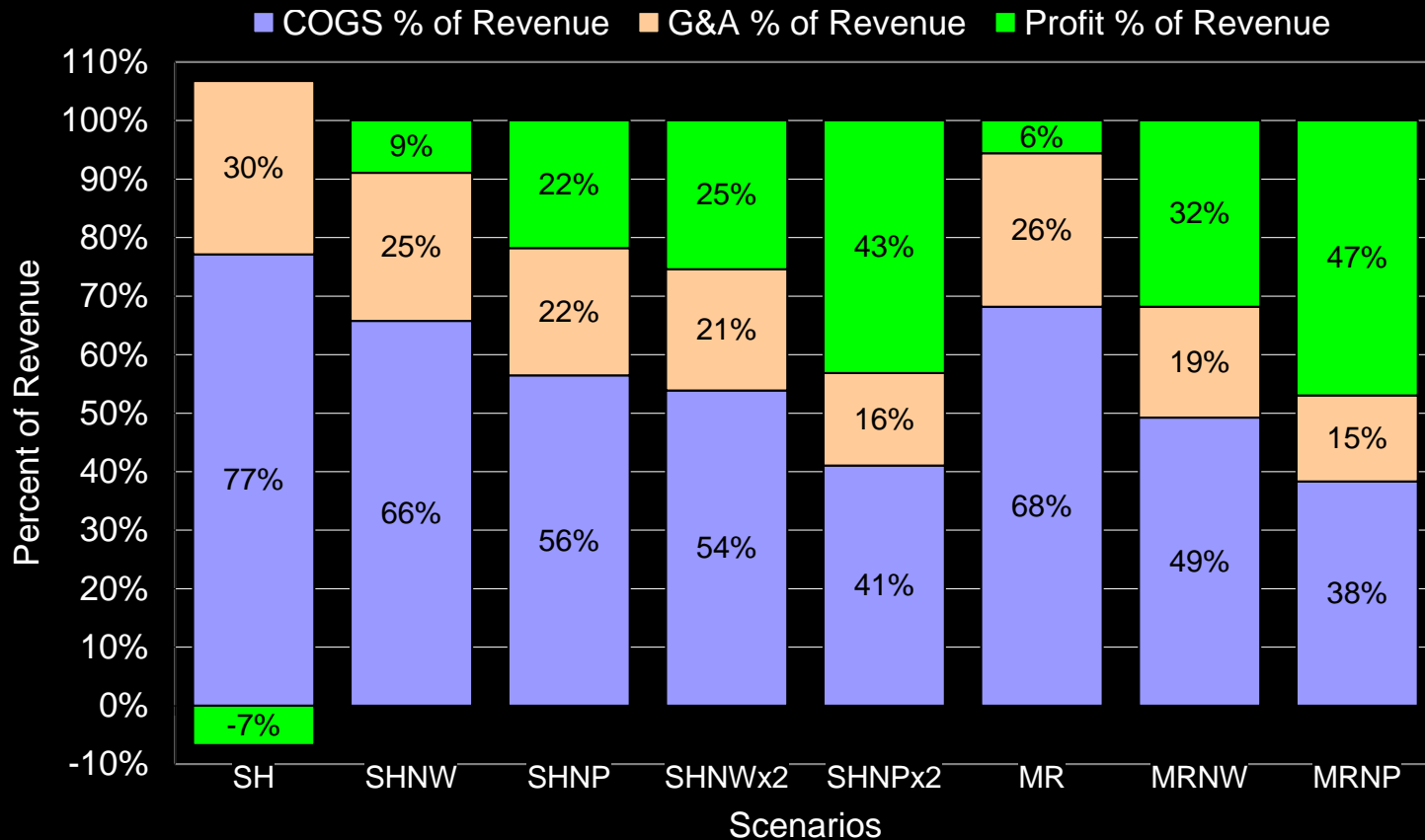
North America 42,130 m³

Scenarios Investigated

Scenario Abbre.	Raw Fibre Input	Primary Processing	Secondary Processing	Glass End Market Target
SH	Salvaged Oilseed	Hammer Mill + Screening		Loose Fibre, Low Quality
SHNW	Salvaged Oilseed	Hammer Mill + Screening	Nonwoven Mat	Chopped Strand Mat, Low Quality
SHNP	Salvaged Oilseed	Hammer Mill + Screening	Nonwoven + Needle Punch	Chopped Strand Mat, Low Quality
SHNWx2	Salvaged Oilseed	Hammer Mill + Screening	2 lines Nonwoven Mat	Chopped Strand Mat, Lowest Quality
SHNPx2	Salvaged Oilseed	Hammer Mill + Screening	2 lines Nonwoven + Needle	Chopped Strand Mat, Low Quality
MR	Managed Oilseed	Roller / Shaker		Loose Fibre, High Quality
MRNW	Managed Oilseed	Roller / Shaker	Nonwoven Mat	Chopped Strand Mat, Low Quality
MRNP	Managed Oilseed	Roller / Shaker	Nonwoven + Needle Punch	Chopped Strand Mat, Mid Quality



Calculated COGS, G&A and Gross Profit As % Of Revenue







- Scenarios incorporating a biofibre mat line(s) suggested sizable profits could be gained.
- The production of loose fibres from oilseed flax was the only form that was not considered commercially viable
- Hemp also has some potential to be more economical than flax due to increased biomass per hectare

- Full Marketing Report available for download at:
<http://www.compositesinnovation.ca/FTP/website/biofibre.php>
 - Fibre Processing Scenario Comparison Tool (Excel) available with Marketing Report to produce custom scenario analysis



Baseline Technical Ability

Objectives

-  Establish a method to manufacture composite panels from flax fibre mat using existing industry practices
-  Determine baseline properties through physical and mechanical testing and compare results to E-glass panels of similar fibre volume content
-  NOT optimized – a starting point from which optimization can occur
-  Process selected was resin infusion using a polyester thermoset resin matrix



Properties

Properties	Comparative Results for Flax Panel
Acoustic Transmission Loss	<ul style="list-style-type: none">• Better sound damping capabilities than glass
Water Absorption	<ul style="list-style-type: none">• Small increase in water absorption over glass in 2 hr submersion• Large increase in water absorption over glass in 24 hr submersion• No measurable swelling
Surface Flammability	<ul style="list-style-type: none">• Reduced flammability resistance compared to glass
Heat Distortion	<ul style="list-style-type: none">• Reduced performance at high temperatures compared to glass• Improved performance over neat resin
Charpy Impact	<ul style="list-style-type: none">• Significantly reduced performance compared to glass• Reduced performance compared to neat resin







Properties Continued




Properties	Comparative Results for Flax Panel
Corrosion Resistance	<ul style="list-style-type: none">• Properties similar to glass
Operating Temperature	<ul style="list-style-type: none">• No visual degradation• Properties similar to glass
Flexural Strength	<ul style="list-style-type: none">• Significantly reduced performance compared to glass• Reduced performance compared to neat resin
Tensile Strength	<ul style="list-style-type: none">• Significantly reduced performance at high temperatures compared to glass• Reduced performance compared to neat resin
Flexural Modulus	<ul style="list-style-type: none">• Reduced stiffness compared to glass• Improved stiffness over neat resin
Tensile Modulus	<ul style="list-style-type: none">• Reduced stiffness compared to glass• Improved stiffness over neat resin



Areas for Optimization

-  Fibre Matrix Bond
-  Reducing impurity content in flax
-  Fibre consistency
-  Engineered mat structure

Current Applications

-  Non-structural, dry environments where weight savings with comparable acoustic damping needed
 -  Ducts
 -  Headliners



☞ Compatibility of the Matrix/Fibre Bond

☞ Objective

- ☞ Identify a commercially available thermosetting resin which exhibits strong bonding capability with natural fibres
- ☞ Assess the strength of an interface bond and fibre/resin compatibility using multiple test methods

☞ Constraints

- ☞ Several thermosetting polymeric resins to be investigated
- ☞ Resin selection will be based on typical industry practices and material prices
- ☞ Oilseed flax fibre currently grown in Canada
- ☞ Vacuum assisted resin infusion processing



☞ Compatibility of the Matrix/Fibre Bond

- ☞ Multiple evaluation techniques in consideration, minimum of three to be used
 - ☞ Atomic Force Microscopy
 - ☞ Single Fibre Pull-Out
 - ☞ Confocal Laser Scanning Microscopy





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Compatibility of the Matrix/Fibre Bond

-  This slide will contain data on the results we have collected as of September
-  Scheduled end of project for Beginning of October








Developing Engineered Mats

Objective

-  Develop an engineered mat from natural fibres to replace E-glass chopped strand mat (CSM) in fibre reinforced thermoset components
-  Targeted end-use is in resin infusion processes to produce parts for the ground transportation industry
-  Primary fibres are flax and hemp varieties currently cultivated in Canada, although other materials may be added to meet performance specifications

Developing Engineered Mats

-  Specifications are finalized for a mat product: purity, consistency, physical and mechanical properties and compatibility with thermoset resins and processes
-  Four potential sources are identified capable of mat manufacture and/or development of pre-commercial equipment to produce the mat
-  Existing flax and/or hemp mats are obtained from other sources, panels fabricated, tested and compared with E-glass
-  Mat process method(s) is/are selected for upgrade to pre-commercial pilot plant scale
-  Economic processing data is generated sufficient to prepare a business case that supports economic viability of the processes selected






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Developing Engineered Mats

-  This Slide will contain information on the current status of the project by September
-  Project has just started (June 11th)
-  Project scheduled to be completed March 2008




Fibre Testing Protocol









Objectives

-  Identify relations between fibre properties and affect on composite performance
-  Establish test methods to quantify fibre properties which affect performance and document the procedures
-  Perform multiple fibre tests and create composite samples from fibre forms to build statistical data on fibre properties vs composite performance
-  If possible, identify acceptable ranges of variation in fibre properties which do not adversely affect the composite end product for use in quality control




Fibre Testing Protocol









 Proposed Fibre Tests may include, but are not limited to:

-  Degree of Ret
-  Fineness
-  Straightness
-  Impurity Content
-  Strength
-  Density
-  Fibre Constituents (wax, cuticle, lignin and or pectin content)
-  Hydrophobicity






Fibre Testing Protocol

 Proposed Composite Tests may include, but are not limited to:

-  Microstructure analysis
-  Resin/matrix interface properties
-  Density
-  Water Absorption
-  Flexural Strength
-  Tensile Strength
-  Impact Resistance
-  Fibre Content



Fibre Testing Protocol

-  This slide will discuss any progress achieved or test results collected before September
-  Project scheduled to start Mid July
-  Project schedule for completion March 2008



☞ Near Ready, Real Potential

- ☞ Producing fibre for the composites industry has potential to make money for farmers, processors and composite manufacturers
- ☞ Current baseline flax material harvested in Canada and processed using known technology is able to manufacture non-structural composite parts and show a weight saving
- ☞ Resins will be selected to optimize matrix/ fibre bonds
- ☞ Engineered mats to be produced to introduce natural fibres to structural applications
- ☞ Fibre assessment system to be developed to quantify fibres with their composite performance and ultimate lead to standardized testing and grading systems