

 Drive one.


The Drive for Sustainable Materials in Automotive

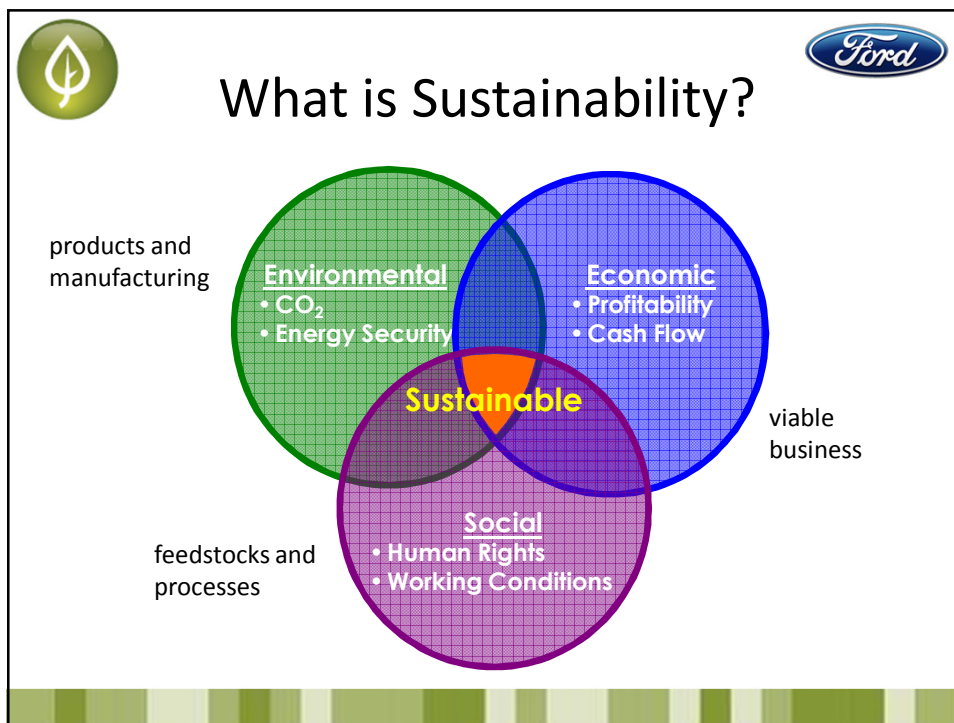
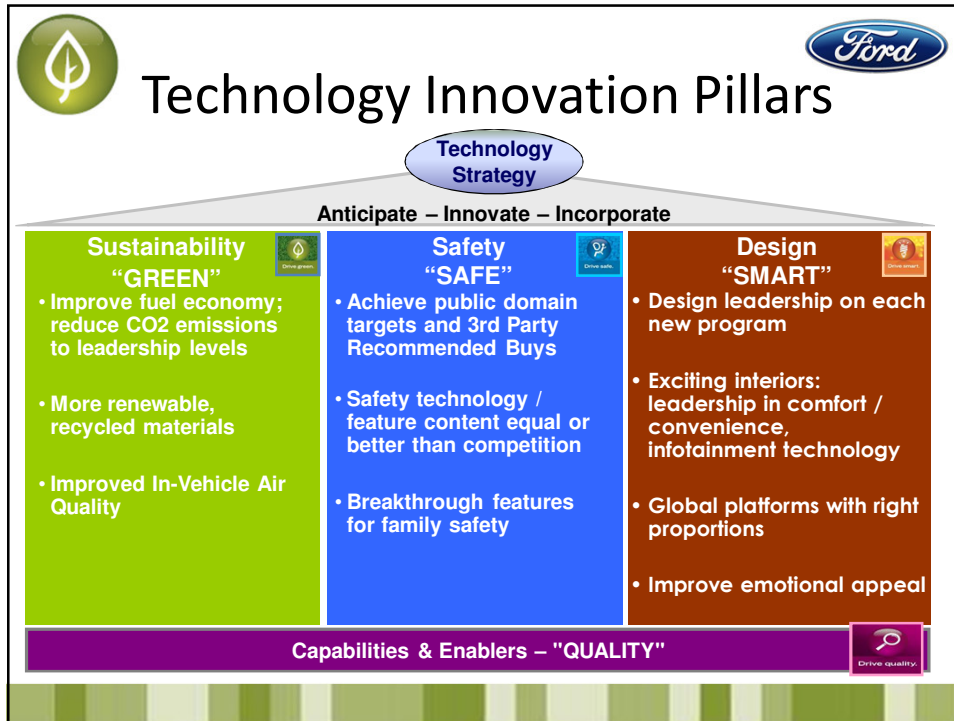
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Roadmap

- Sustainability at Ford
- Bio-based materials development and manufacturing
- Case studies
- Challenges
- Future perspective







Ford's Commitment

*"Ford is committed to offering customers affordable, **environmentally friendly technologies** in vehicles they really want. We are focused on providing solutions that can be used not for hundreds or thousands of cars, but for millions of cars because that is how Ford can truly make a difference."*



-Alan Mulally
President & CEO
Ford Motor Company



Ford's Sustainable Materials Strategy

- **Vision**
 - Ford Motor Company will ensure that our products are engineered to enable sustainable materials leadership without compromise to Product Quality, Durability, Performance or Economics.
- **Key Positions**
 - Recycled and renewable materials must be selected whenever technically and economically feasible. We will encourage the best green technologies to meet the increasing demand for these materials.
 - When we use recycled and renewable materials, there will be no compromise to Product Quality, Durability & Performance or Economics.
 - We will enhance technologies, tools and enablers to help validate, select and track the use of these materials in our products.
 - The use of recycled and renewable content is increased year by year, model by model where possible.



Why Bio-Based? Why Now?



- Petroleum limited, prices unstable
- Waste management
- Climate change
- Consumer drivers
- Need sustainable solutions: environmental, social, economical



Benefits / Value of Bio-based Mat'ls



- minimize dependence on foreign petroleum
- sustainability
 - renewable resources, non-food sources
 - reduced CO₂ emissions
 - equivalent or improved end-of-life options
- improved properties in select functions: e.g., lightweight, better energy absorption, viscoelastic properties, etc.



History of Biomaterials at Ford



- 1937 Ford was producing 300,000 gallons of soy oil a year for use in car enamels (*Soybean Digest* 1947).
- 1939 the Ford Motor Company was harvesting about 100,000 bushels of its own soybeans
- The "Soybean Car" was unveiled by Henry Ford on August 13, 1941
- 'Fordite' material used in steering wheels contained wheat straw



From the Collections of The Henry Ford
Robert Boyer and Henry Ford with the Soybean Car

"Someday you and I will see the day when auto bodies will be grown down on the farm."
— Henry Ford



From the Collections of The Henry Ford
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Soybean Car assembly image showing production of plastic panels.

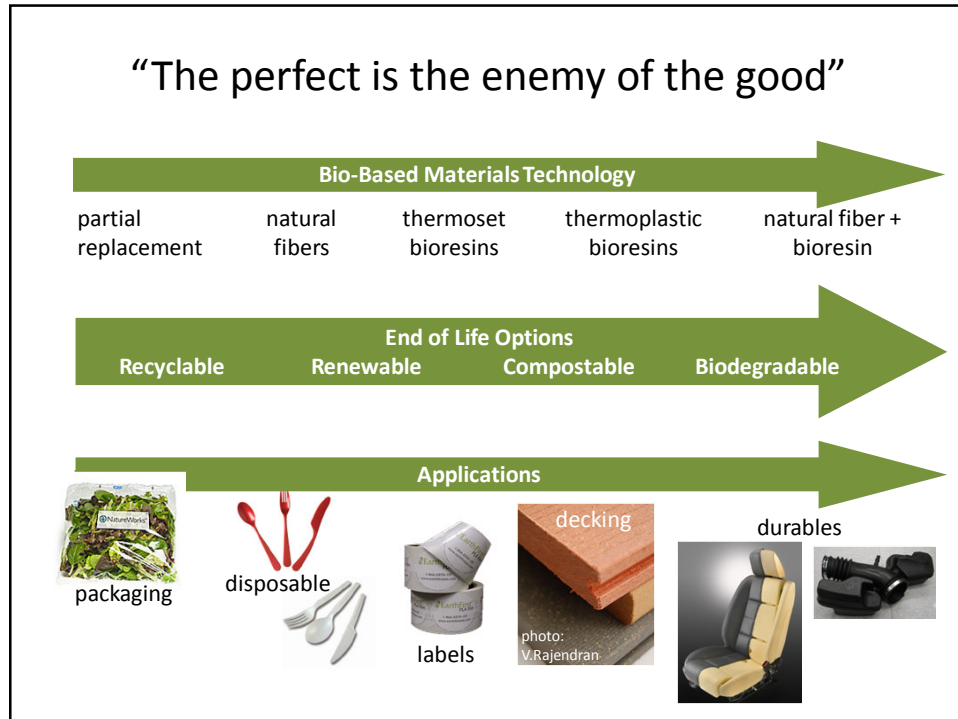




Biomaterials at Ford Today



- renewable oils in partial substitution of petroleum for foams
 - soy oil based urethanes and foam
 - castor oil based foam
- renewable fibers and fillers in plastic composites
 - reinforcements: wheat straw, hemp, cellulose, coconut coir
 - fillers: soy hulls, soy flour, coconut shell powder
 - impact modifiers: TKS, guayule
- renewably sourced thermoplastic resins
 - bio-polymers: PLA, Sorona (PTT), etc.
 - bio-based chemicals: PE, PP, PET, etc.

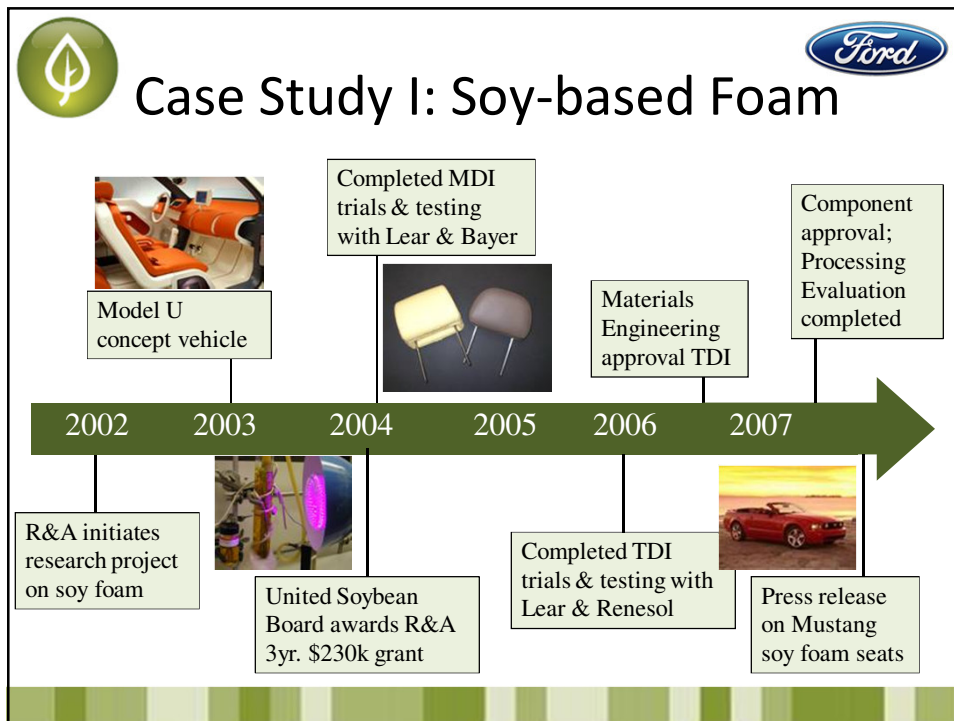
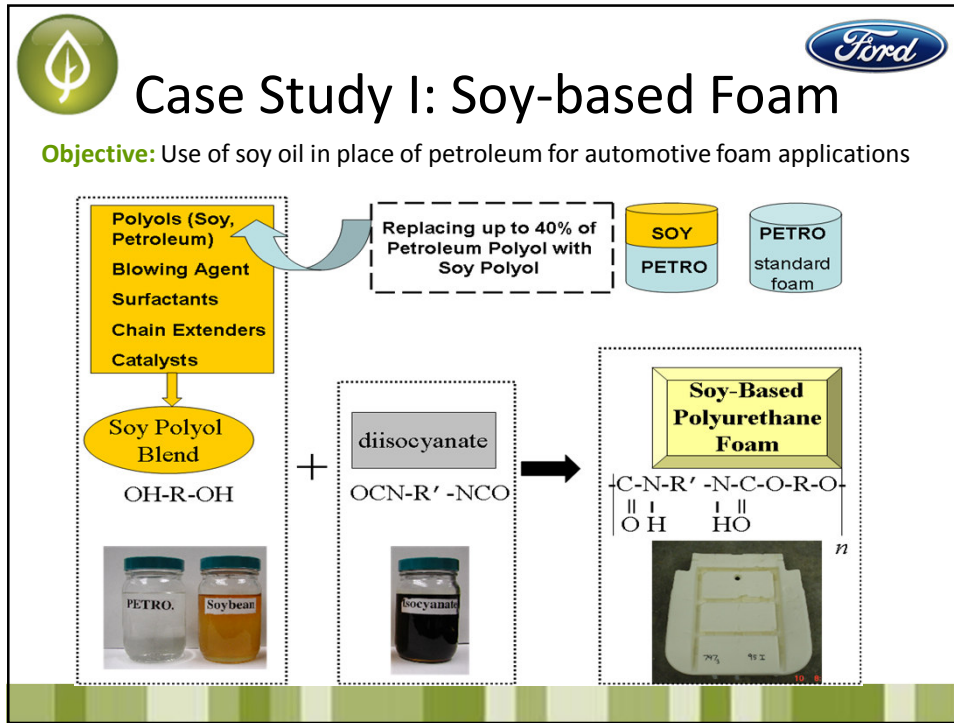






Automotive Requirements


- harsh operating environments
 - temperatures from -30 C to 100 C; 90%+ RH for interiors
 - temperatures from -30 C to 150+ for underhood
 - dent/ding mar resistance for exteriors
- long product lifetime
- large volumes
- fast cycle times
- mass customization







Case Study I: Soy-based Foam

Status: Ford is leader in technology and first OEM to launch in production; migration to other non-automotive applications





Soy foam headliner





Soy foam seats

- all vehicle platforms in North America with soy foam seats
- 75% of vehicle platforms in N.A. with soy foam headrests
- Ford Escape with soy foam headliner
- diverts 3 million lb petroleum annually
- reduces CO₂ emissions by 15 million lb

Case Study I: Soy-based Foam

- passes all material and performance specifications
- cost neutral or cost reduction over petroleum based foam
- decreased use of petroleum
- CO₂ emissions reduced by over 15 million lbs annually
- potential agricultural impact: all FMC interior foams could use 844 million bushels of soy annually!

Case Study II: Wheat Straw PP

Objective: Replace fiberglass and mineral reinforcements in plastics with natural fiber for injection molding materials

Wheat straw/PP versus conventional composites

Material Replaced	Cost Reduction	Density Reduction	CO ₂ Reduction
Talc/PP	0 - 5%	5-10%	0.58 kg CO ₂ /kg
GF/mica/PP	5 - 10%	10-15%	0.61 kg CO ₂ /kg
ABS	10 - 15%	15-20%	1.3 kg CO ₂ /kg

Benefits: Sustainable material
Environment – by-product; CO₂ reduction; reduced petroleum
Social – local agri-economy
Business – weight reduction; cost equivalent or reduction; reduced processing energies



Wheat Straw Bio-Filled Polypropylene

Industry and World-First Usage in Quarter Trim Bins on 2010 Ford Flex



Wheat Straw

Extrusion Compounding



Wheat Straw / Polypropylene Resin



Injection Molding



Wheat Straw Bio-Filled Polypropylene Quarter Trim Bin



reduces petroleum usage by some 20,000 pounds per year and reduces CO₂ emissions by 30,000 pounds per year



Case Study II: Wheat Straw PP

- decreased petroleum usage by 20,000 lb annually
- decreased CO₂ emissions by 30,000 lb annually
- migration plan in progress
- 8-10% reduced processing costs
- 10% reduced weight versus fiberglass/talc reinforced PP
- does not compete with food chain

Case Study II: Wheat Straw PP

3Q07: Ford joins BioCar Initiative

4Q07: UWaterloo, OMTEC, A.Schulman approach Ford R&A

2Q08: ongoing material property testing, material formulation

3Q08: meets 293-B & 941-A material specs

5/09: Part "A" trial 1

1Q09: part selection interior

7/09: Part "C" trial

6/09: Part "B" trial

9/09: Part "A" trial 2

9/09: Trial Ford Flex Bin/Cover

Fall 2009: Ford Flex component level testing

10/09: meets necessary interior component level requirements

11/09 IMPLEMENTED

Ontario BioCar Initiative → compressed timeline



Bio-Based Resins

- renewable feedstock for thermoplastic resins
 - “new chemistry”
 - Polylactide (PLA) – corn, sweet potatoes, sugarcane
 - PTT (Sorona) – corn
 - PHA (Mirel) – corn
 - nylons (PA610, PA1010, PA410) – castor oil
 - bio-based chemical precursors
 - polyolefins (PE, PP) – sugarcane
 - nylons (PA6, PA11) – castor oil, corn, biomass
 - polyesters (PET, PBT) – corn, biomass
- performance and durability
- natural fiber reinforced bio-resins

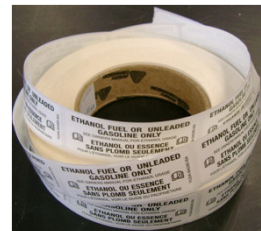


Case Study III: PLA Labels

Objective: Replacement of petroleum based PET film with renewable based PLA for label substrates

Benefits: Reduced carbon footprint; sustainable messaging

Status: Passes requirements for select locations/applications; currently cost increase over PET labels





Case Study III: PLA Labels

- Material testing:
 - material specification WSS-M99P41-A31 or 32
- Durability testing
 - personal vehicles
 - durability vehicles
 - several locations



Case Study III: PLA Labels

- PLA film passed in all areas excluding:
 - high UV exposure
 - high thermal (heat) exposure
 - fuel C environments
- Target label applications: protected location areas of the vehicle, e.g. door jab



Challenges for Biomaterials

- material challenges
 - processing: modifications or completely new methods
 - material properties
 - part design and geometry
 - different failure modes
 - crop to crop variations
- supply chain challenges
 - infrastructure for agricultural feedstocks and pre-cursors
 - volumes – supply and demand
 - cost – economies of scale



Future vision

- need for initiatives like BioCar to accelerate use of bio-based materials
- continue to take small steps and implement when ready
- development of new material technologies can be accelerated by collaboration with all partners in supply chain
- people vote with their wallets – consumers will drive the migration of bio-based materials

