



USDA Forest Products Laboratory and the Military

A Successful Long-Term Partnership

Dr. Christopher Risbrudt

Director

Forest Products Laboratory

Forest Products Laboratory

The Nation's only federally funded wood research laboratory



- Founded in 1910 by U.S. Forest Service
- The Nation's source for unbiased wood research and technical information

Forest Products Laboratory

Mission

To promote healthy forests and forest-based economies through the efficient, sustainable use of our wood resources



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Supporting the Nation's military since 1916

- Long history of cooperative research and technical services to DoD and other agencies
- Since 1916, 10,000 articles, reports, manuals, and other technical publications and communications to DoD



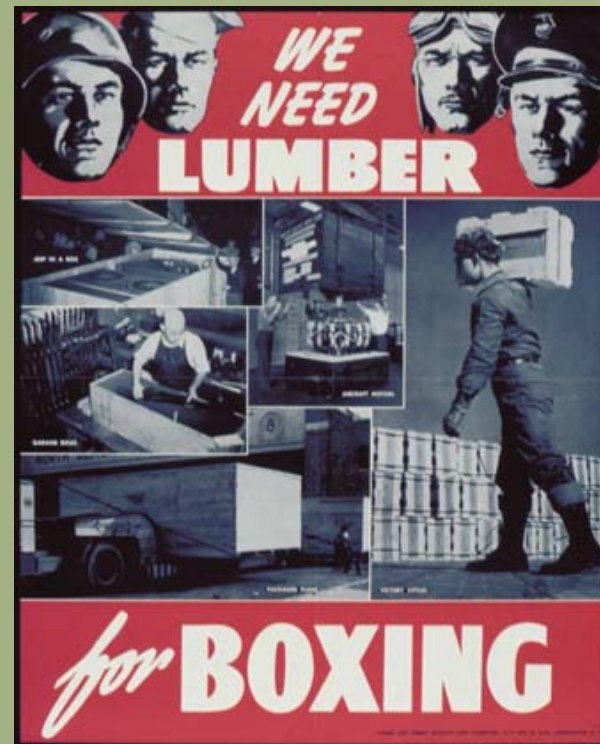
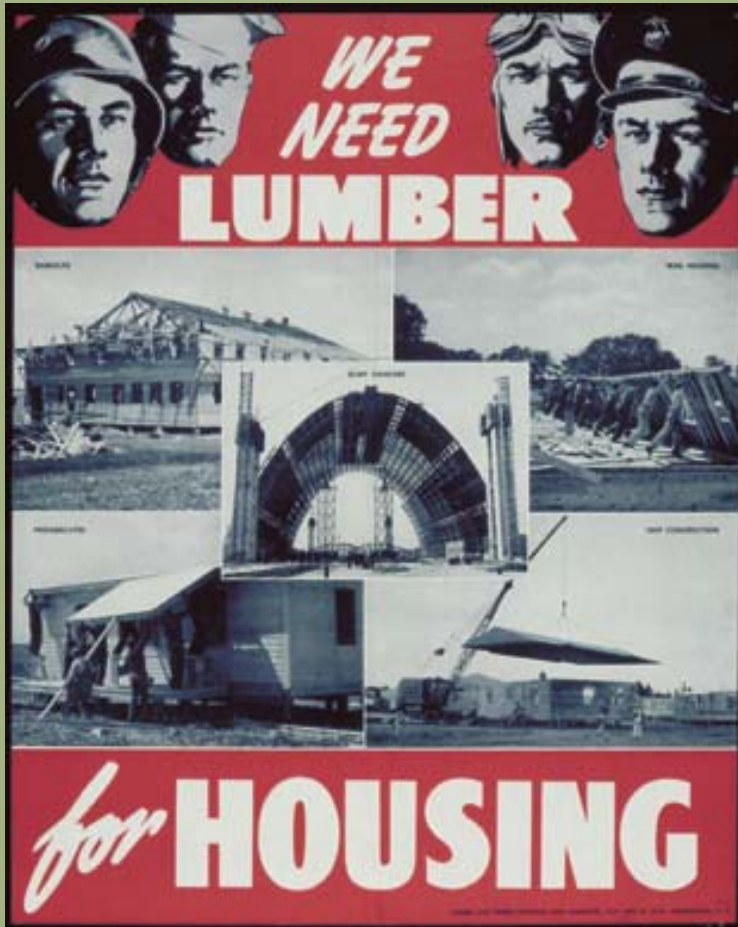
Wood demand during WWII

- 200,000 board feet for each battleship
- 700,000 board feet for each liberty ship
- Each minesweeper contained enough wood to build 10 average houses



Wood demand during WWII

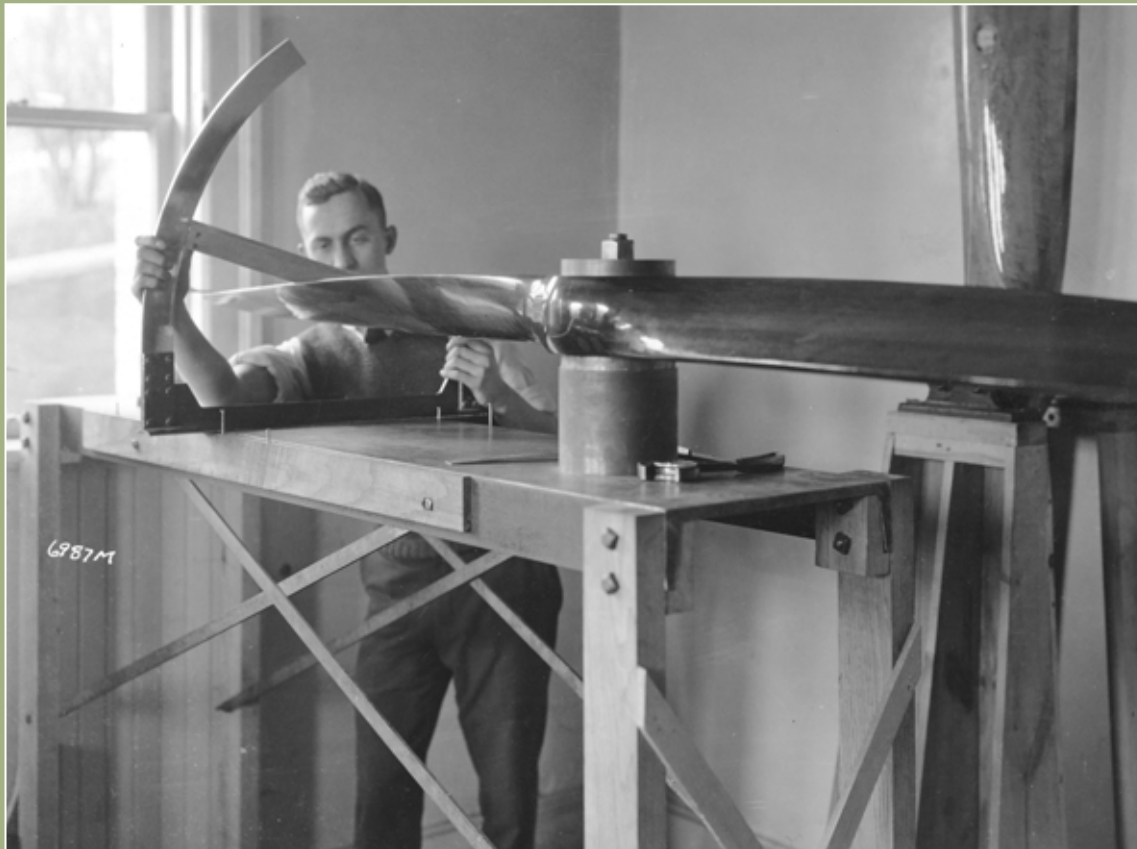
- 300,000 prefabricated housing units and military structures
- In 1944 alone, 17 billion board feet used for packaging



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World War I

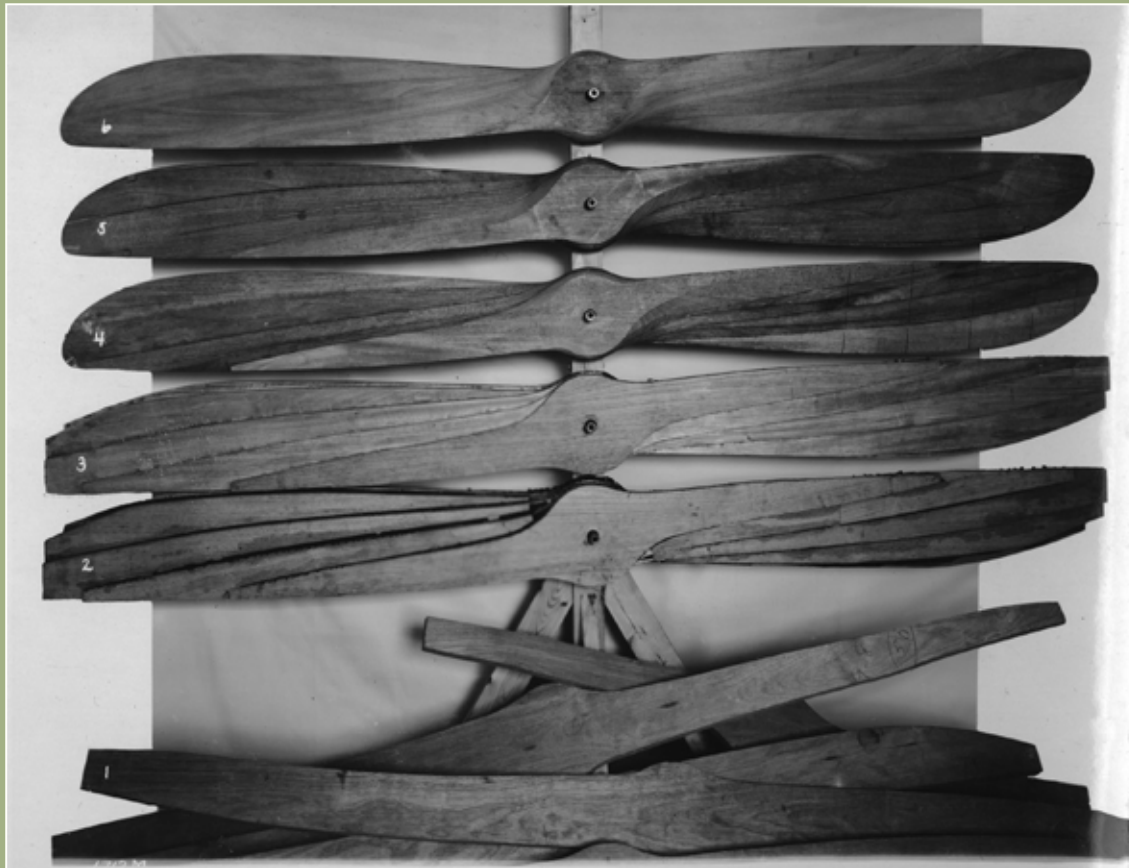
Experimental propeller plant



Allotments from
War Department

- Produce propeller blades that resist warp, twist, and unbalancing with changes in humidity

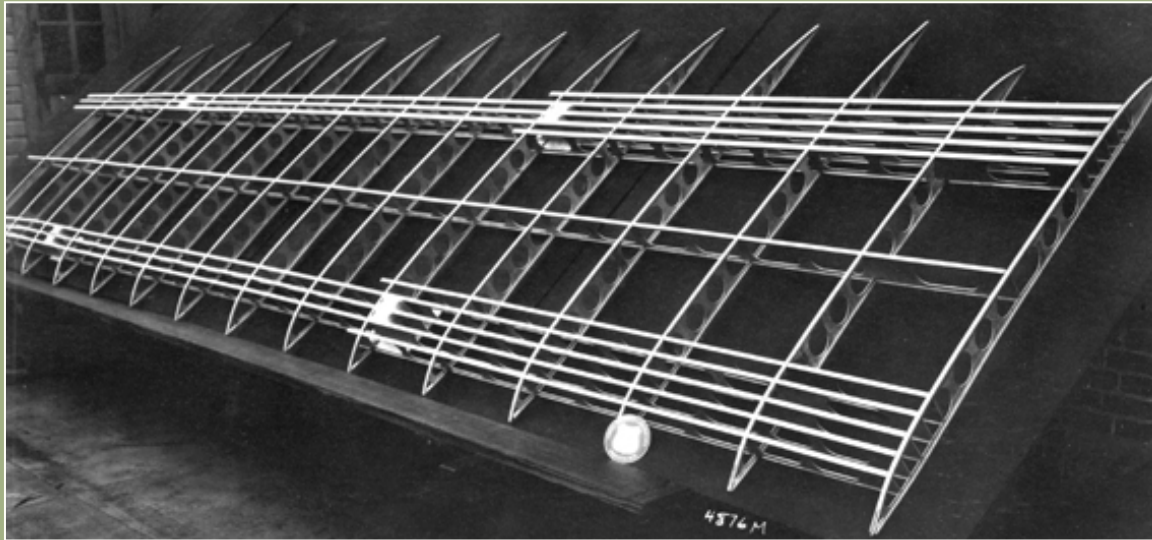
Experimental propeller blades



FPL studied how to eliminate blade failures caused by humidity changes

- Experimental propellers produced from 7 species
- 10 per week made by workers on 3-shift/day schedule

Internal web for all-veneer wing



Goal: Strength with less weight

- FPL data provided designs with twice the strength but half the weight of those by commercial manufacturer

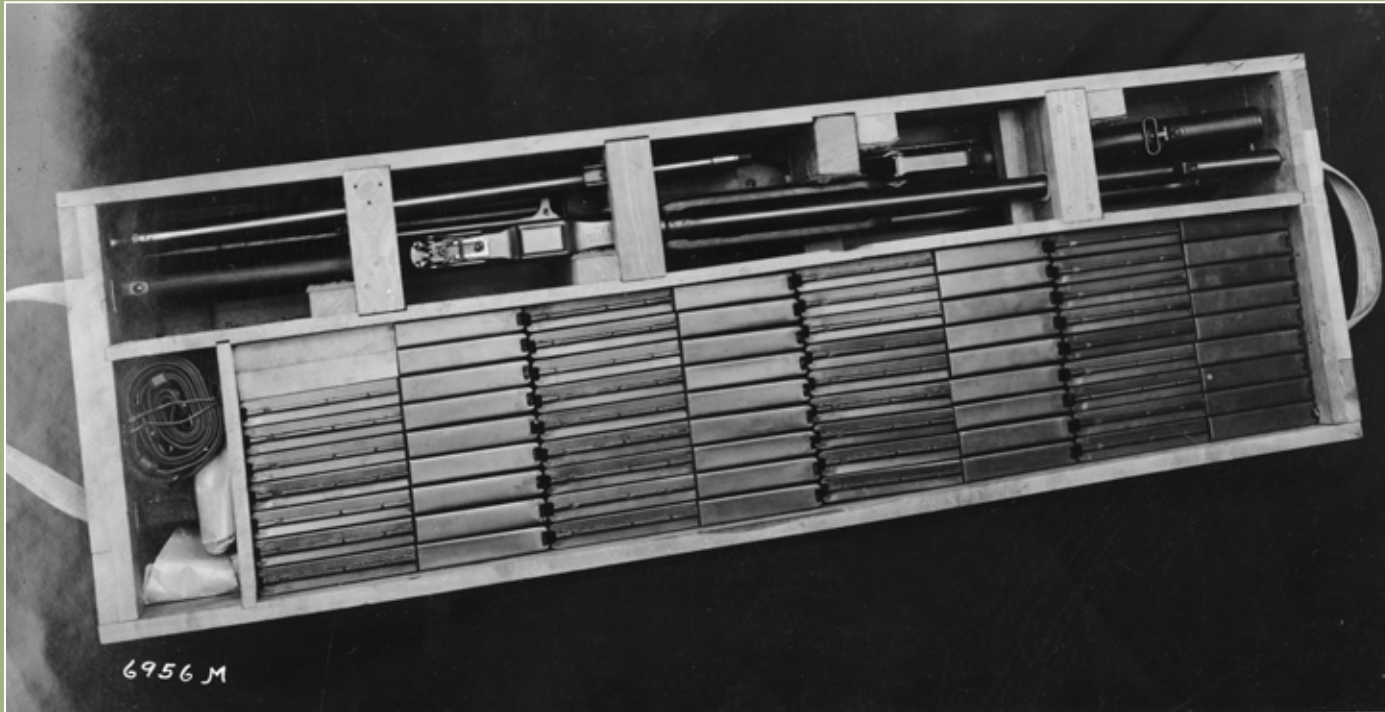
More efficient packaging



FPL worked to save cargo space and material

- Complete redesign of boxes and containers
- Size and number of nails for most efficient box

Rifle crates



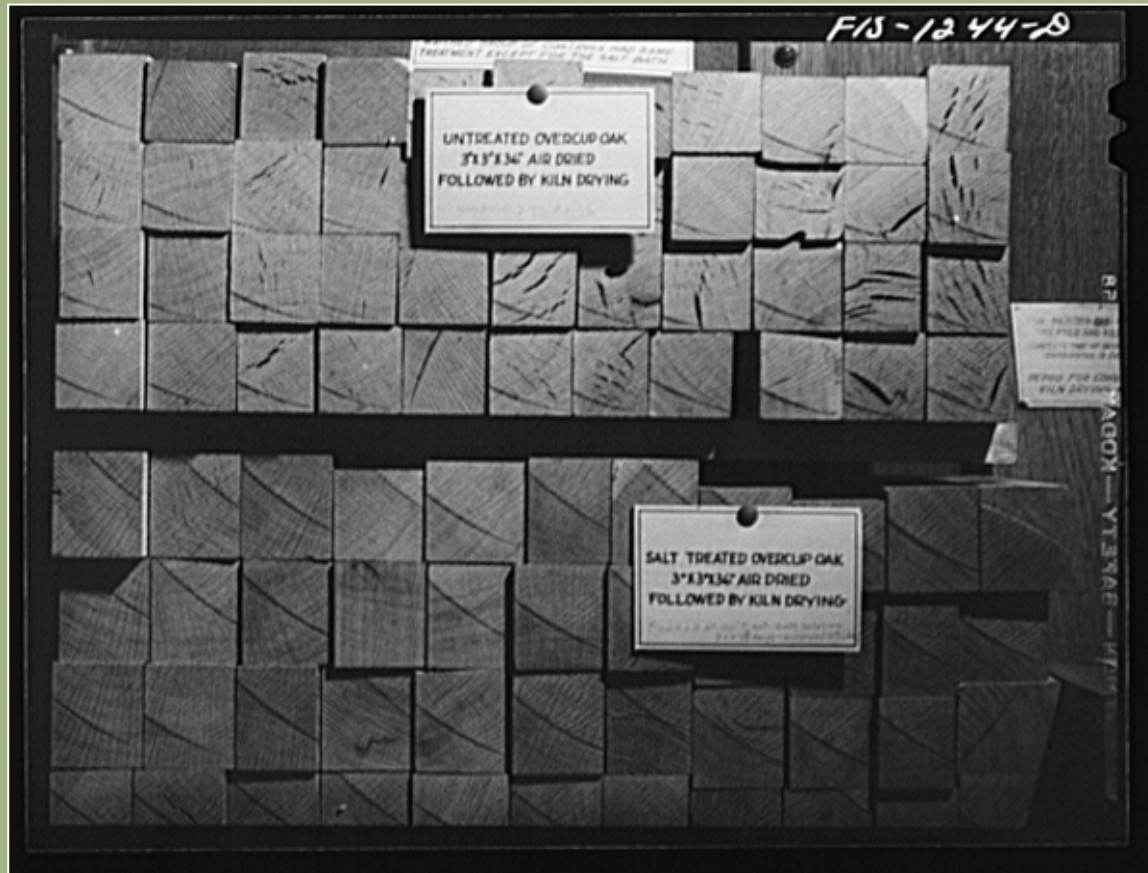
*PROJECT L-207-2-ND
PROPOSED BOX FOR BROWNING AUTOMATIC MACHINE RIFLES
AND
EQUIPMENT
FOREST PRODUCTS LABORATORY
MADISON WISCONSIN
OCT. 25 1918*

Black walnut gunstock blanks



- High wartime demand for black walnut
- FPL developed black walnut kiln-drying principles that led to increased production of gunstock blanks

Oak for wheels, wagons, ordnance



- FPL developed oak drying schedules for Bureau of Ordnance
- New schedules allowed 3-inch-thick oak to kiln dry in 100 days

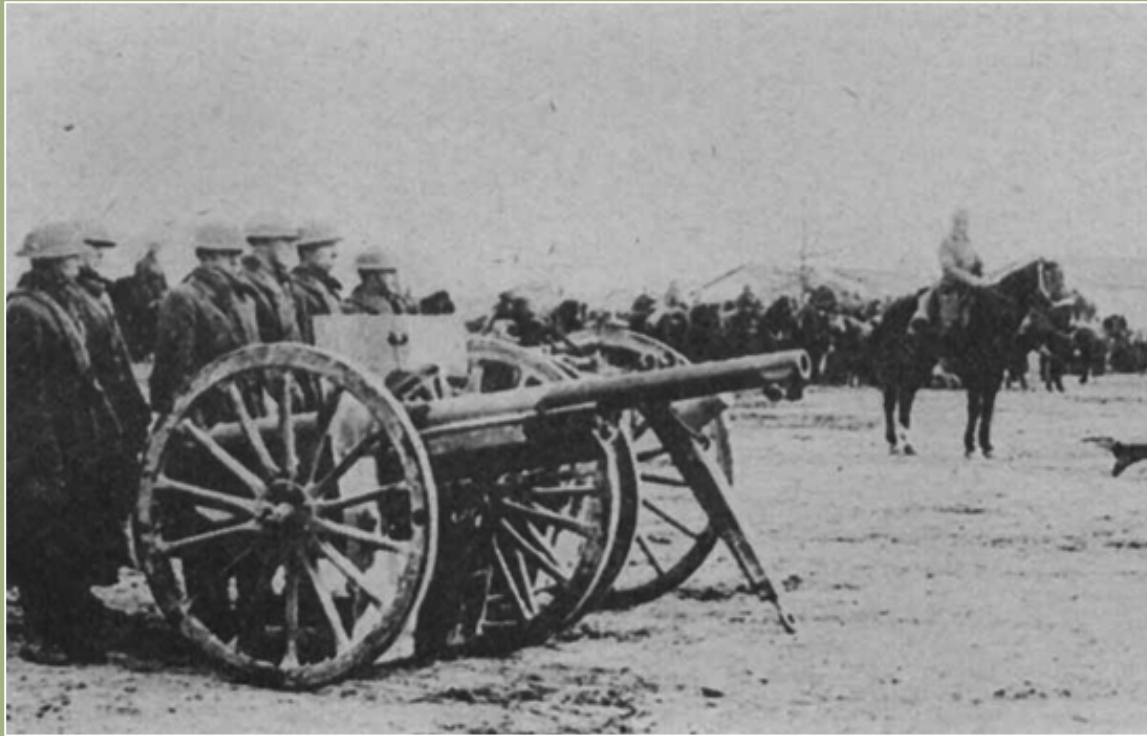
Protective masks



FPL studied charcoal to absorb chlorine gas

- Coconut charcoal most effective
- Then charcoal from hydrolyzed wood waste

Cannon powder



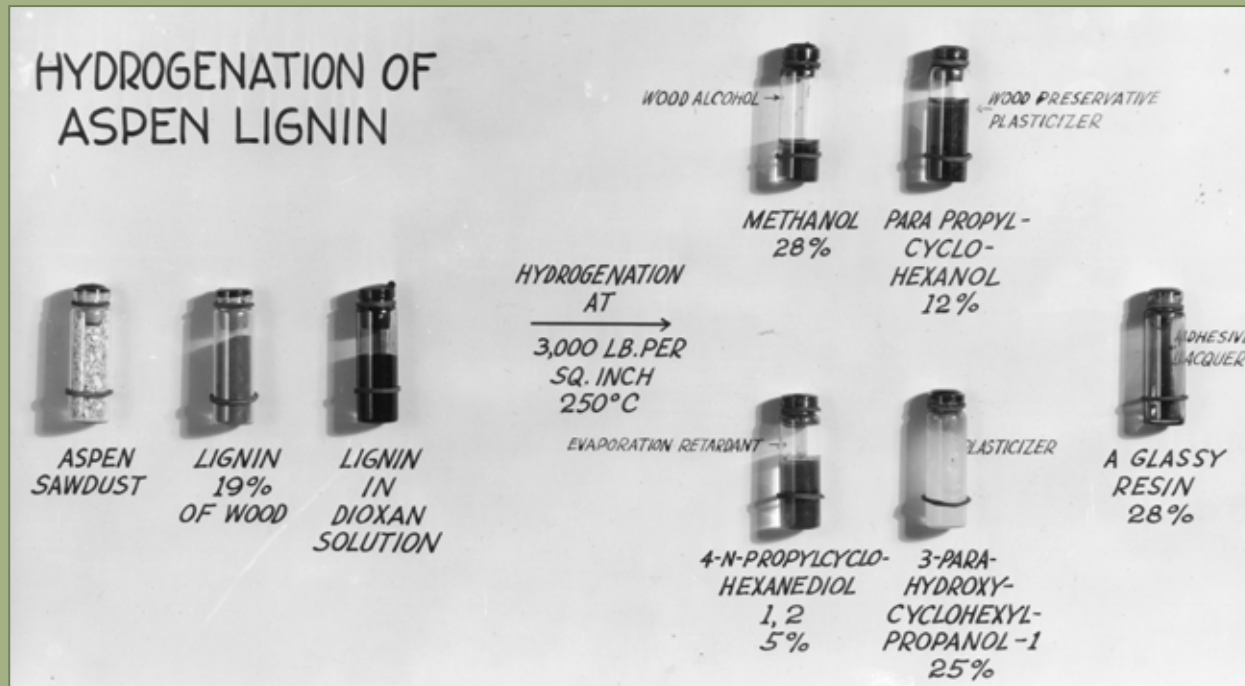
Library of Congress, Prints & Photographs Division

- Needed alternative to cotton linters for manufacturing nitrocellulose
- FPL developed several types of wood pulp, which were nitrated and made into cannon powder

Alcohol from wood

High wartime demand for alcohol

- FPL studied yields of ethyl alcohol from dilute acid hydrolysis and fermentation
- Two successful commercial plants



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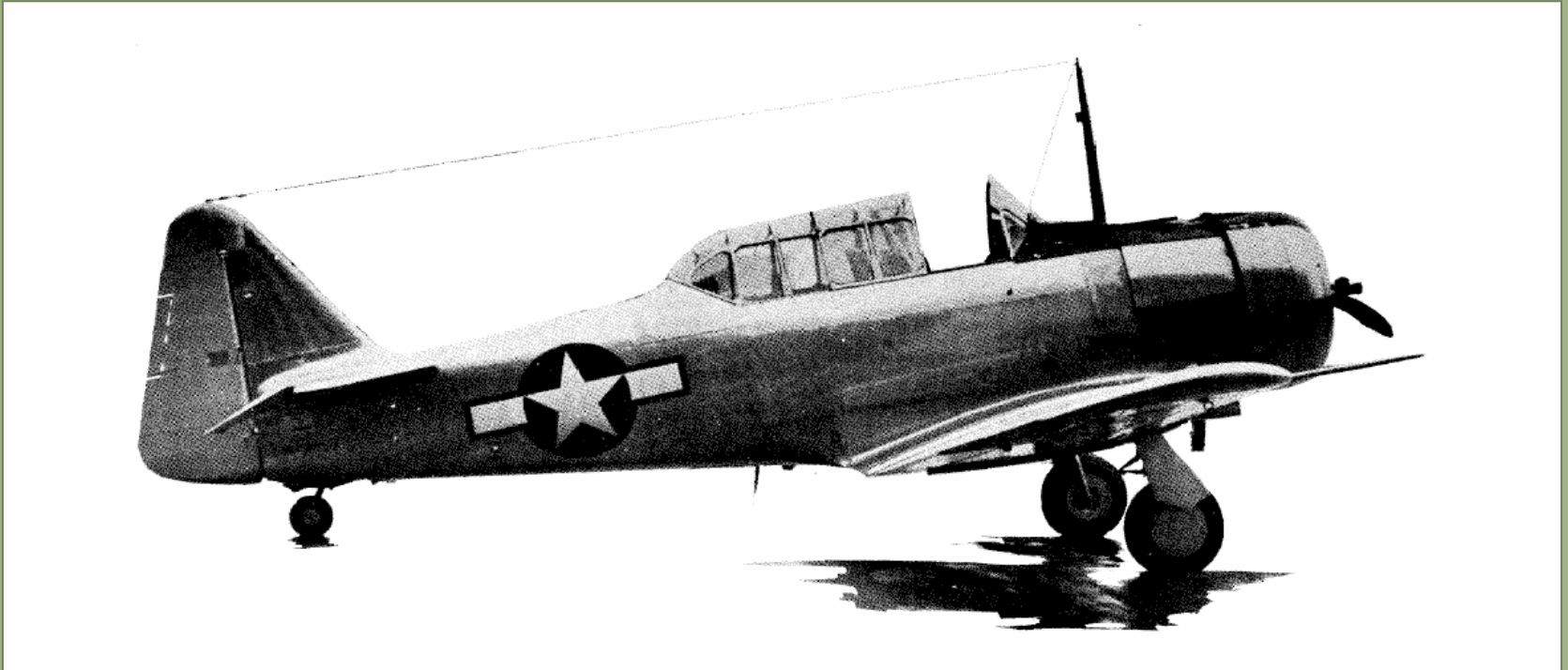
World War II

Emergency plywood orders



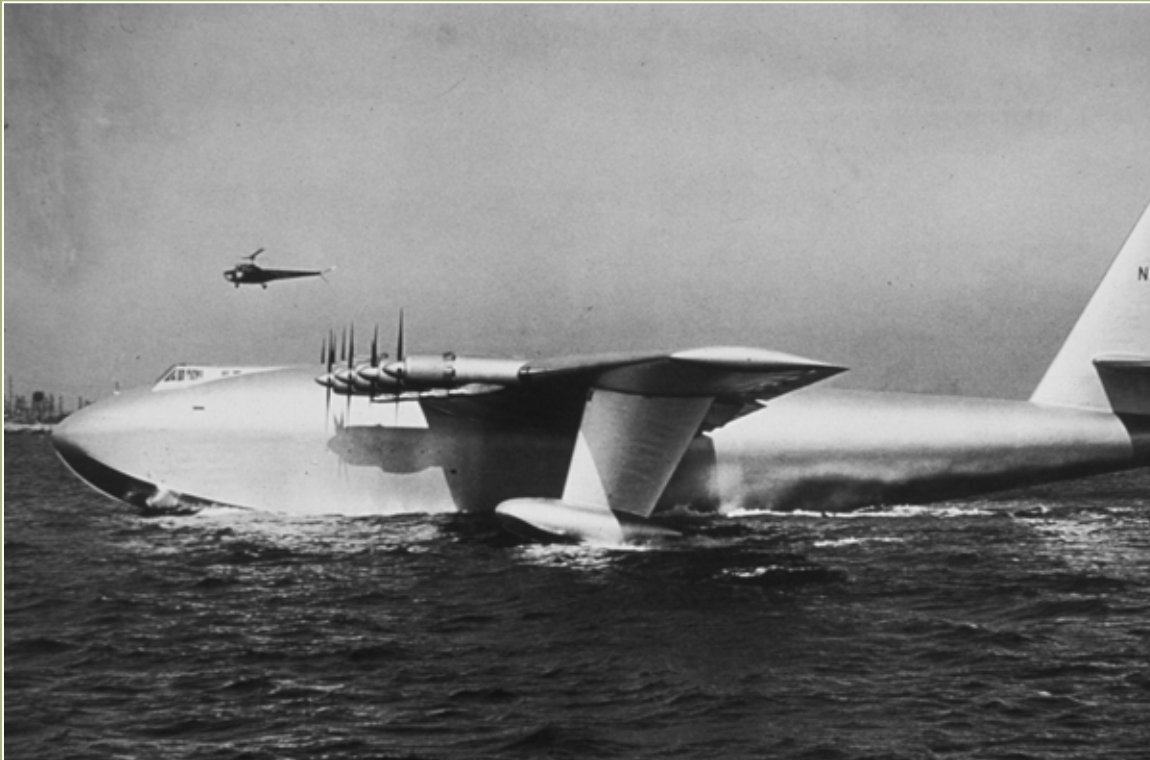
- Technical advise for emergency orders by Great Britain
- Molded plywood parts for military aircraft

High demand for training aircraft



FPL studied substitutes for spruce in solid wood and plywood

Support for aircraft industry, 1941



Technical reports

- Plywood
- Adhesives and gluing
- Finishes
- Laminated wood
- Methods for testing aircraft woods

Comprehensive publications

August 1942

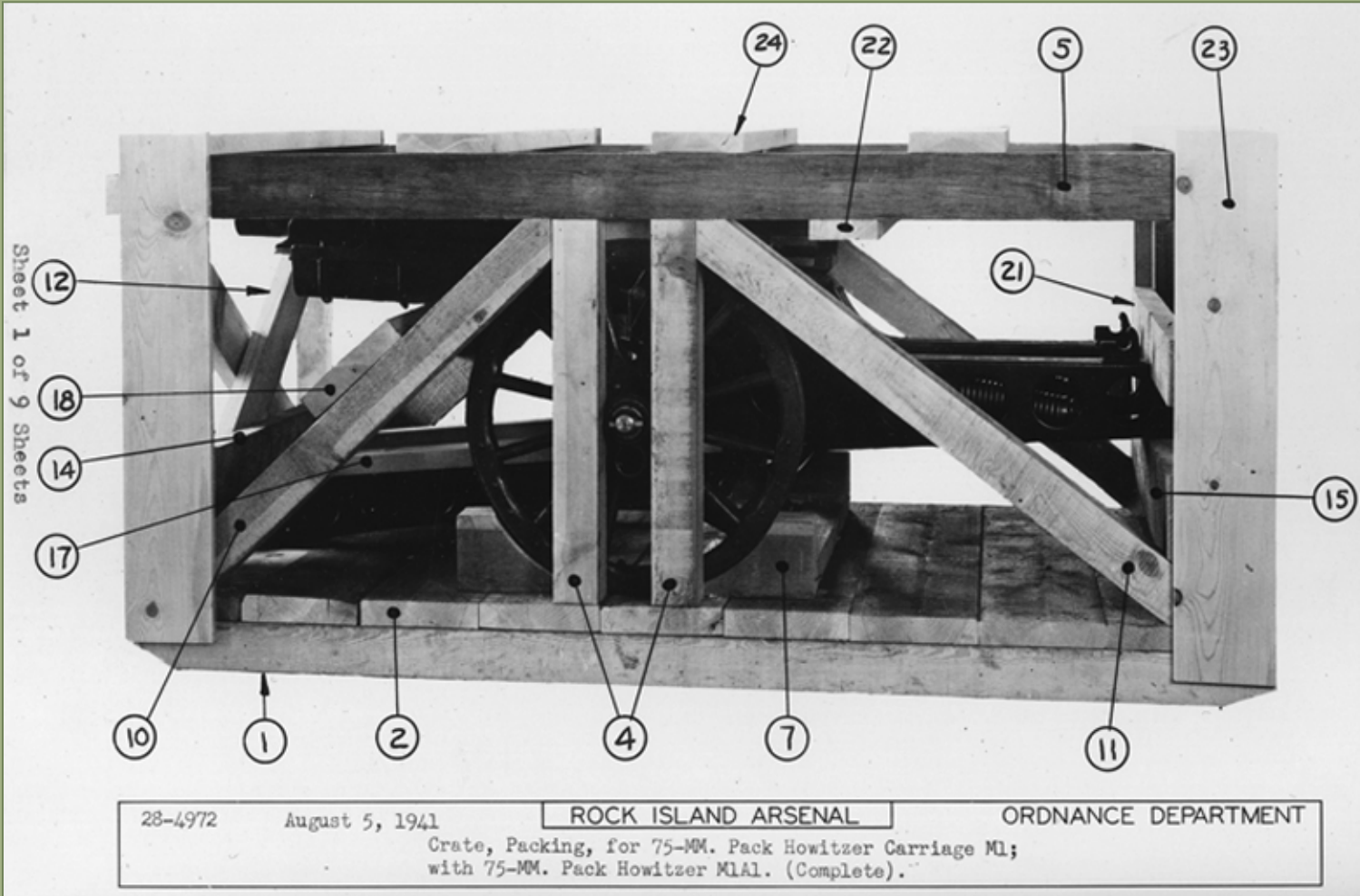
- *Wood Aircraft Fabrication Manual*
- *ANC Handbook on the Design of Wood Aircraft Structures*

Packing crates for air transport



FPL designs reduced weight and maintained durability of packing crates during air transport

Howitzer carriage



Packaging courses



April 1942 to end of 1945

- >16,000 military and civilian personnel attended FPL courses
- 303 courses at FPL or in the field

Revised crating specifications



- Saved equivalent of 0.5 million tons of shipping capacity
- Losses by damage in shipment down from 50% to 3%

Publications

- Nine manuals, 37 specifications, 1,500 packaging instructions, numerous guides and directives
- U.S. Army Specification 100-14A, *Army–Navy Specification for Packaging and Packing for Overseas Shipment*
- TM 38-305, *General Instructions for Corrosion Preventative Processing and Packaging*
- TM 9-2854, *Instruction Guide, Ordnance Packaging and Shipping (Posts, Camps, and Stations)*

Increased production of laminated parts



Production in
2 years by one
manufacturer

- 70 laminated skegs per day for Higgins landing craft
- 11,000 keels for landing craft
- Keels and stems for 100 PT boats

Papreg



B-24 Liberator bomber

Library of Congress, Prints & Photographs Division

A paper-based laminated plastic developed at FPL

- Gun turret parts for B-24 Liberator bomber
- Gunner seats
- Gun shields
- Aircraft ammunition boxes

Performance of gasogens

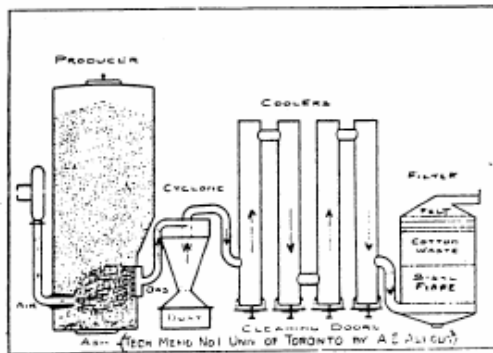


Figure 6.--Gasogen mounted on FPL truck--1942.

Devices attached to motor vehicles that convert wood and charcoal into fuel

- Limited study by FPL in 1942
- Series of road tests using a range of woods and charcoals

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Korean conflict

Sandwich composites



- Solid wood combined with metals, plastics, and paper
- Low weight; high strength and stiffness
- For jet aircraft and rocket-propelled missiles

Sandwich composites



U.S. Air Force file photo

- New adhesive systems to withstand temperature extremes in high-altitude flights
- New bonding and fastening techniques
- Engineering analysis and design specifications

Publications

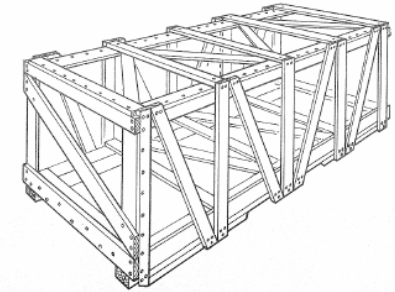
- ANC-23 Bulletin, Part II, *Sandwich Construction for Aircraft*
 - Published in 1955 by Air Force, Bureau of Aeronautics, and Civil Aeronautics Administration
- *Lumber and Allied Products Handbook*
 - Published by FPL for Army Corps of Engineers

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**1960 through
Desert Storm**

Publications

- Military Handbook 304, *Package Cushioning Design*
 - Engineering principles for cushioning machinery, equipment, and instruments during transit
 - Published for Air Force
- *Wood Crate Design Manual*



WOOD CRATE design manual

AGRICULTURAL HANDBOOK NO. 252 • U.S. DEPARTMENT OF AGRICULTURE • FOREST SERVICE

U.S. Army, Picatinny Arsenal

Funded two-phase FPL program (1988–1989)

- Phase 1: Develop method to screen wood and wood-based products for resistance to chemical agents
- Phase 2: Evaluate treatments and treatment methods for enhancing performance of wood products used in pallets, consolidators, and skids

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Recent research

Wood propellers for drones



AAI Corporation

- Shrinkage from changes in humidity caused by shipping from Florida to Middle East
- Determined potential shrinkage and provided preventive measures

Mine countermeasure vessels



Recycling lumber and timber



Military partners

- Twin Cities Army Ammunition Plant
- Fort Ord, California
- Fort Campbell, Kentucky

Recycling lumber and timber



Working cooperatively with FPL, the U.S. Army recycled more than 4,700 cubic meters of lumber and timber

Developed information on grades of lumber reclaimed from deconstructed buildings

USS Constitution

- Information on live oak used to construct the ship
- Advice on inspection and repair methods
- Methods to manufacture live oak glued-laminated replacement timbers



3-dimensional engineered fiberboard



- New structural biocomposite
- Can be made with unwanted or low-value material
- Very strong yet light weight



Mechanical behavior of advanced materials

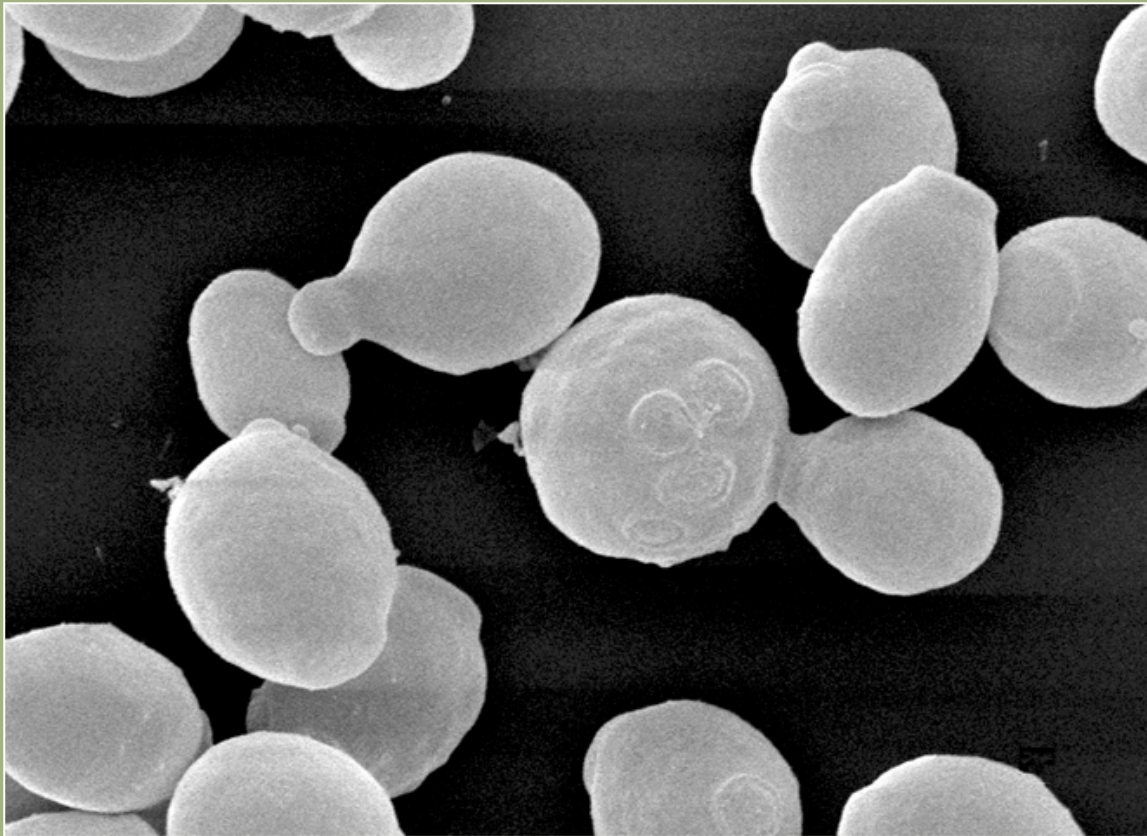
- Cooperative research with Naval Research Laboratory
- Provide test protocols that simulate actual in-service loading conditions



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**Other research areas of
interest**

Ethanol and biobased fuels



Energy and biomass



Advanced wood structures



Nanotechnology



Recycling



Other research areas of interest

Center for Wood Anatomy Research



Wood adhesives



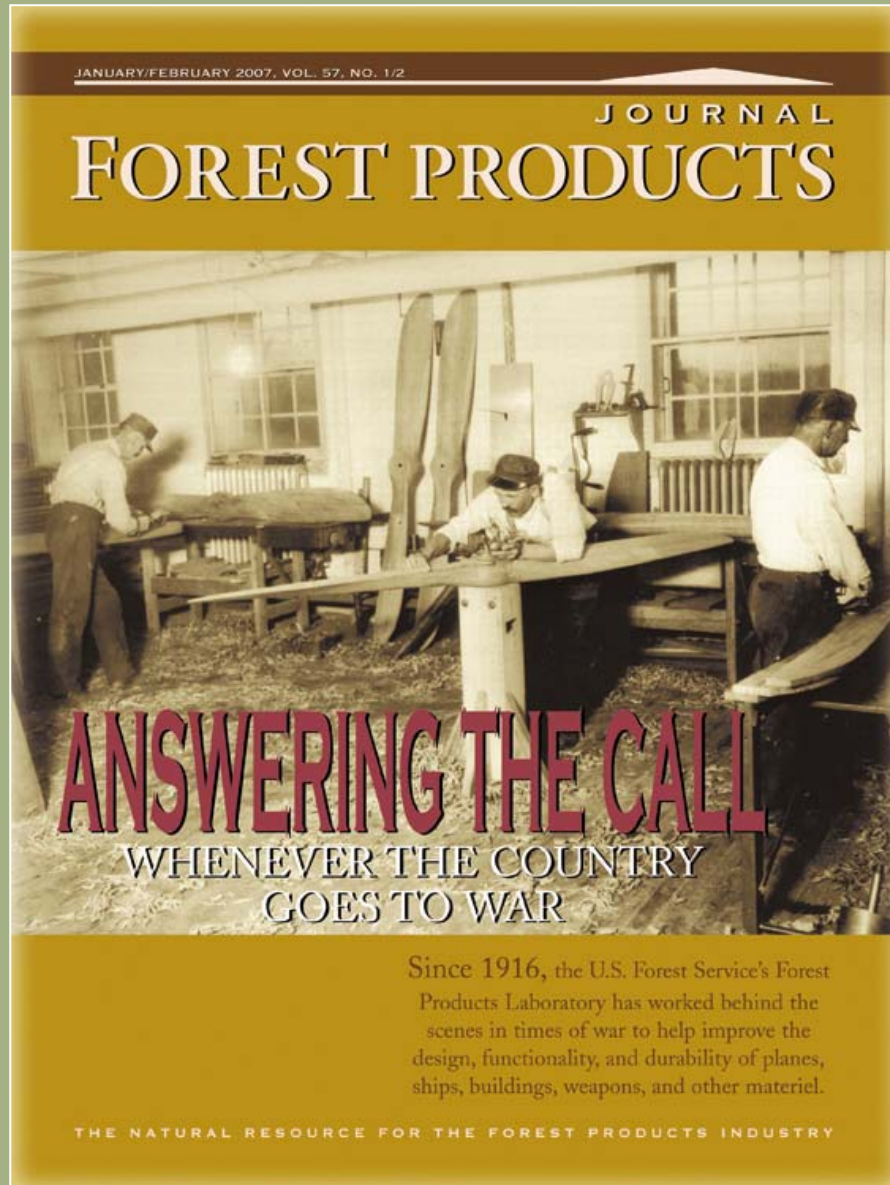
Preservation and biodeterioration



Wood surface chemistry



Questions and comments?



See us at
Booth 1034