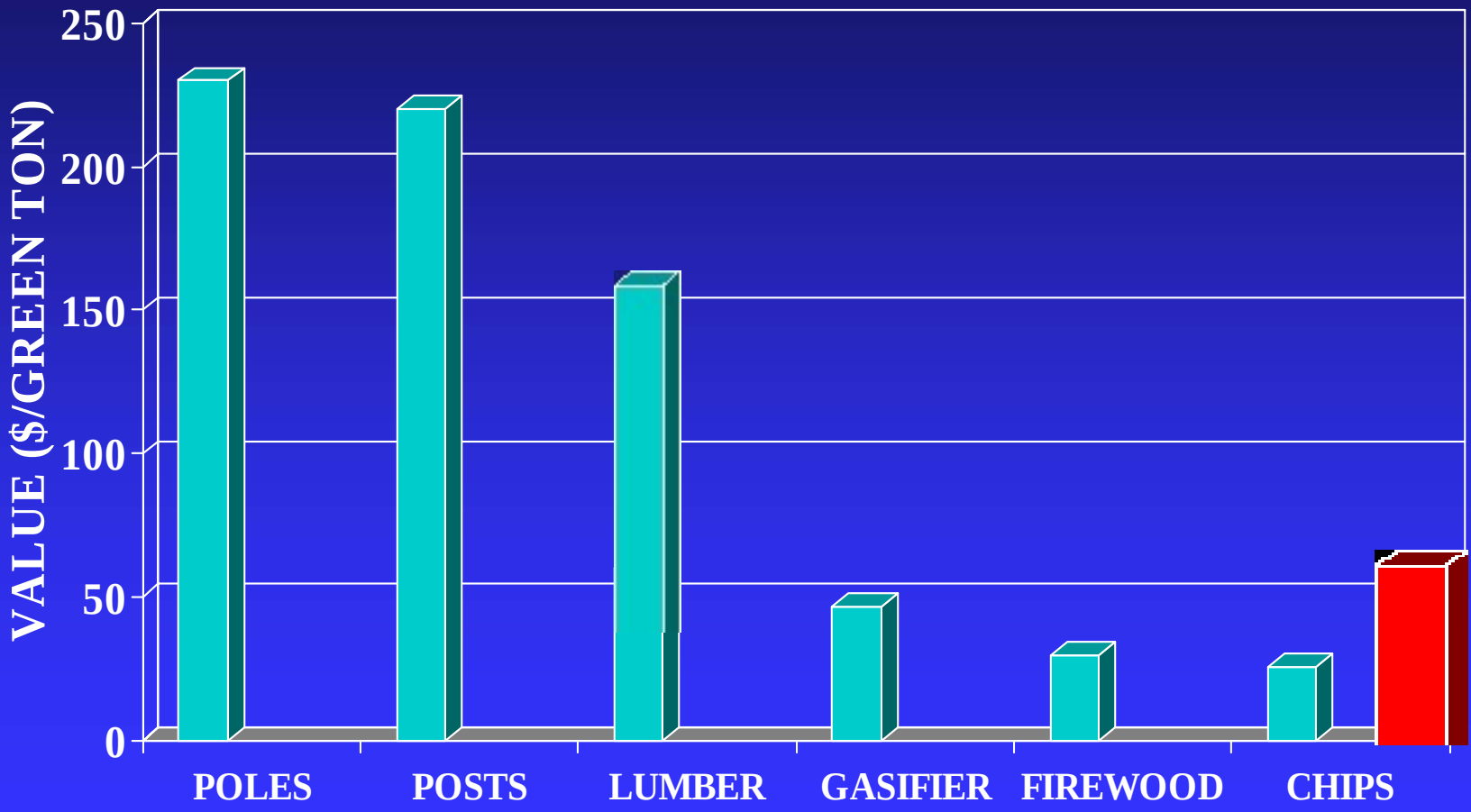
Uses for Forest-Thinning Material
&
Woody Biomass for Energy

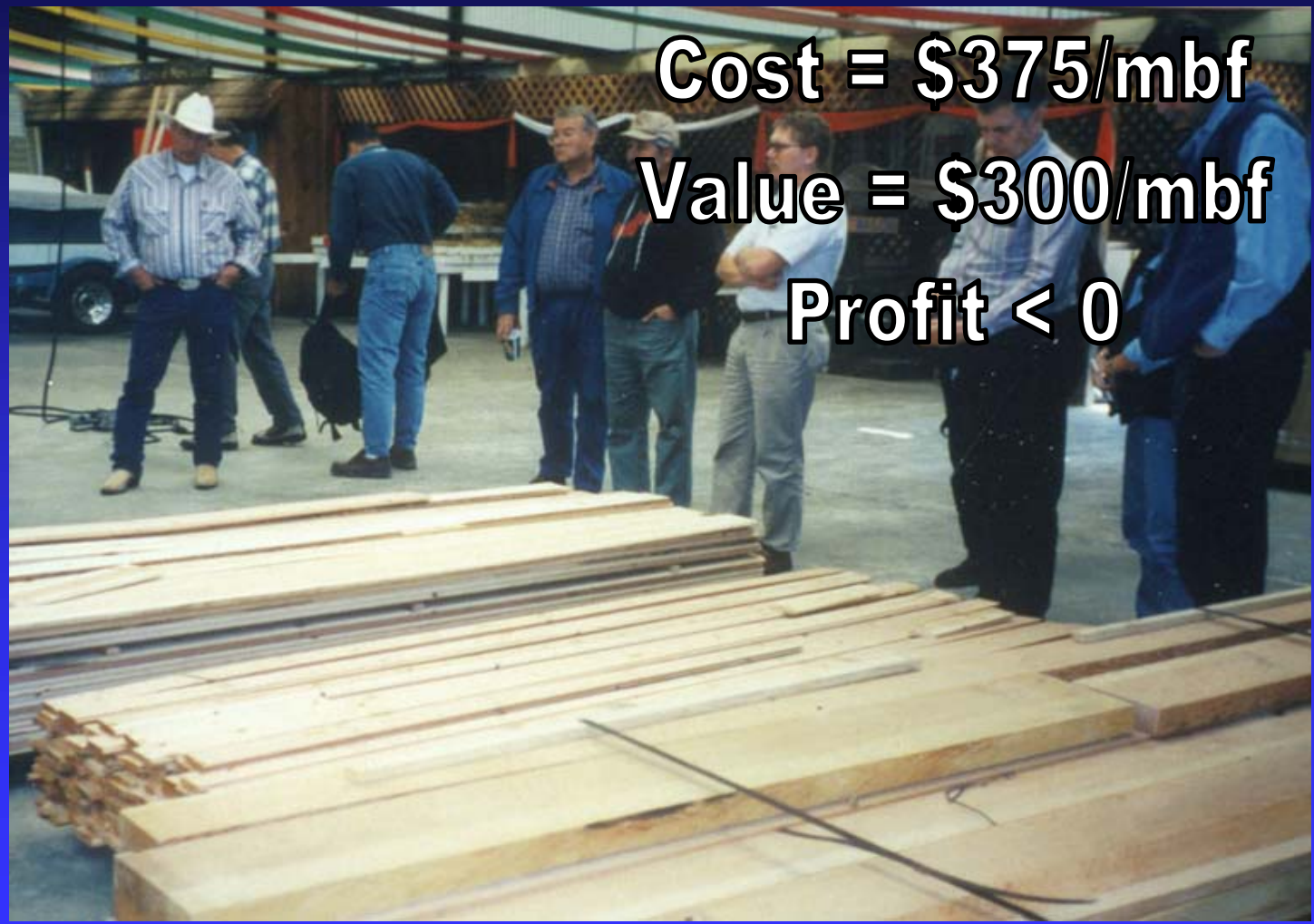
Mark Knaebe – Forest Products Laboratory

Market Values For SDRW



Value of Green Logs

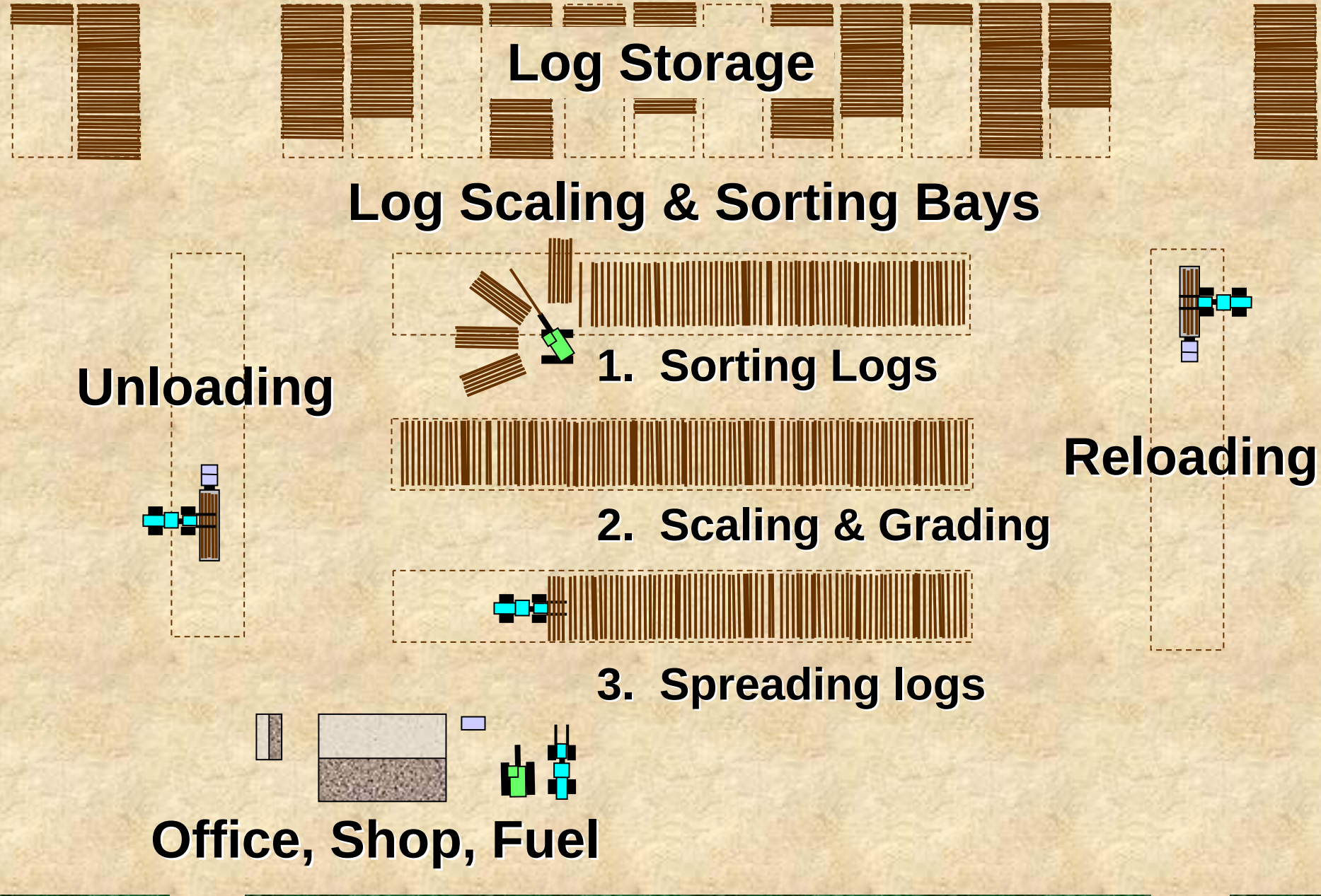
Value of Rough, Green Lumber



Value of Douglas-fir Flooring

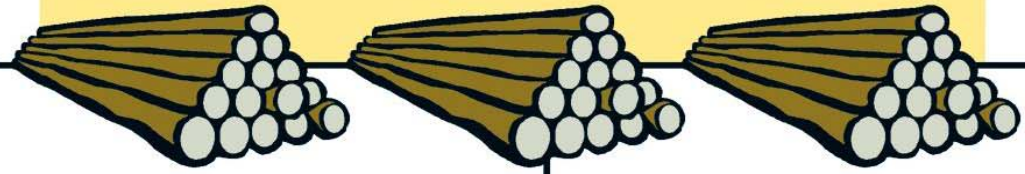
Small-Diameter Douglas-fir

--Sort--Yard--



Yard Layout & Operations

Log-sort yard



Hierarchy of uses for small-diameter material

Value-added uses
by local community

- Flooring
- Paneling
- Littas/vigas
- Cabinets
- Furniture
- Millwork

Traditional uses
by existing mills

- Sawlogs
- Structural lumber
- Nonstructural lumber
- Poles and posts
- Pulp chips

Residue uses

- Biomass energy
- Ethanol
- Firewood
- Pulp
- Composting

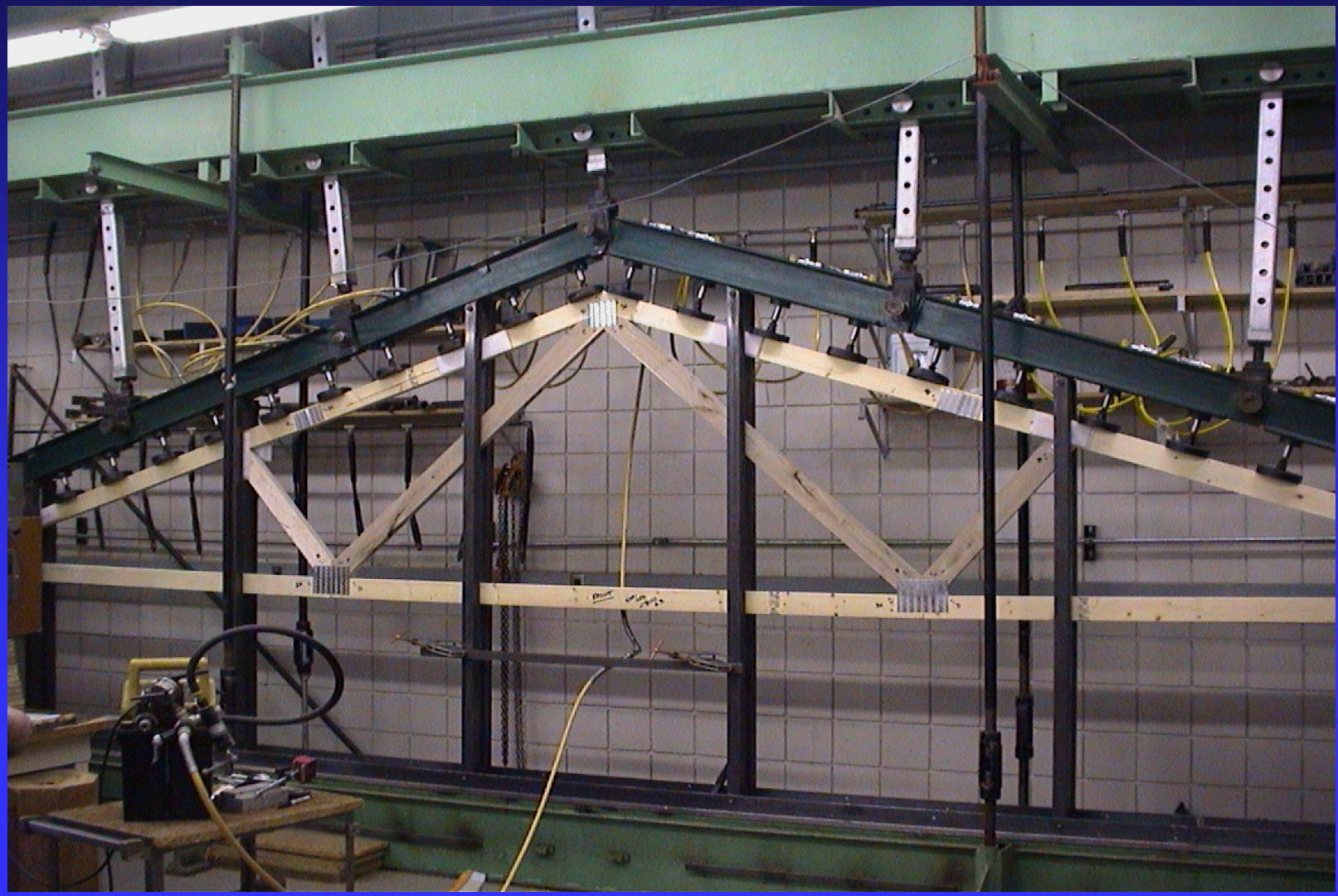
Hardwoods for Structures

Grading Hardwood Lumber

- Structural lumber
  - Visual grading
  - Machine stress rated lumber

Maple Truss

Testing Maple Truss



Stress Laminated Deck Bridge

Red Oak Sawn Lumber

Crawford Co. PA

Schuylkill Co., PA

Lancaster Co., PA

Ponderosa Pine Glulam

Newer grading rules for PP so don’t need DF in high stress area

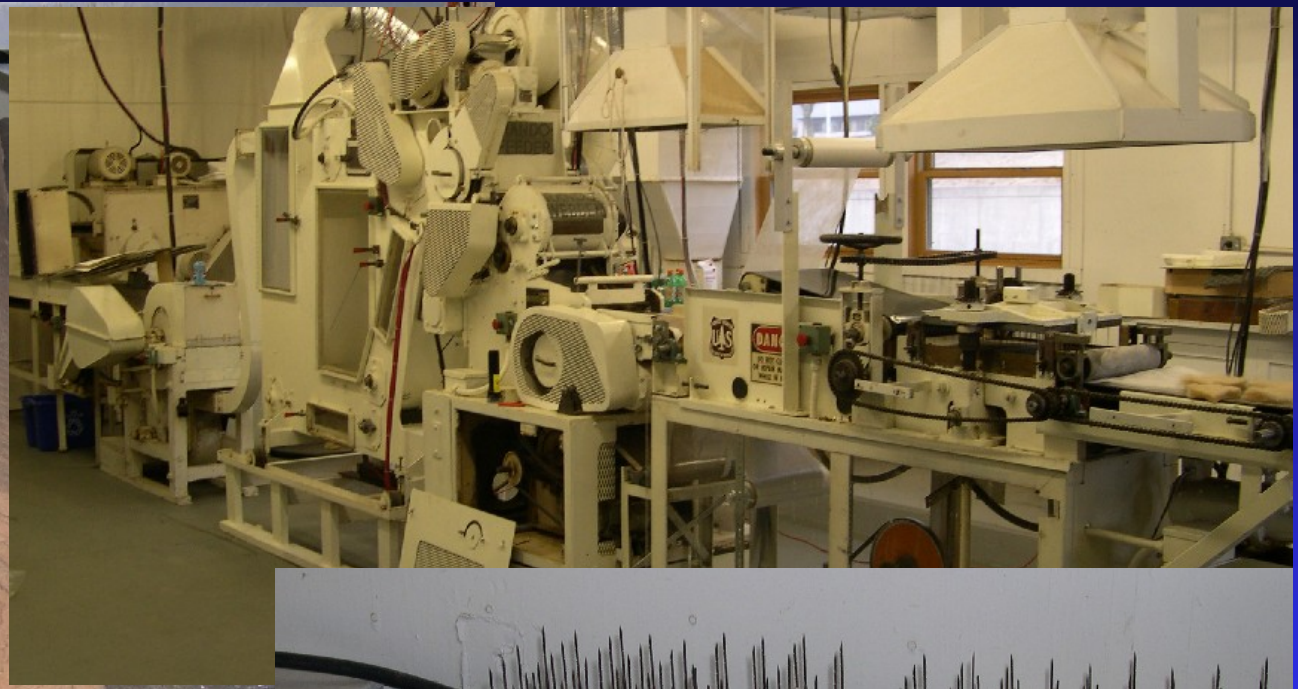
Finger-Jointing

Finger-jointed stud

Structural Lumber

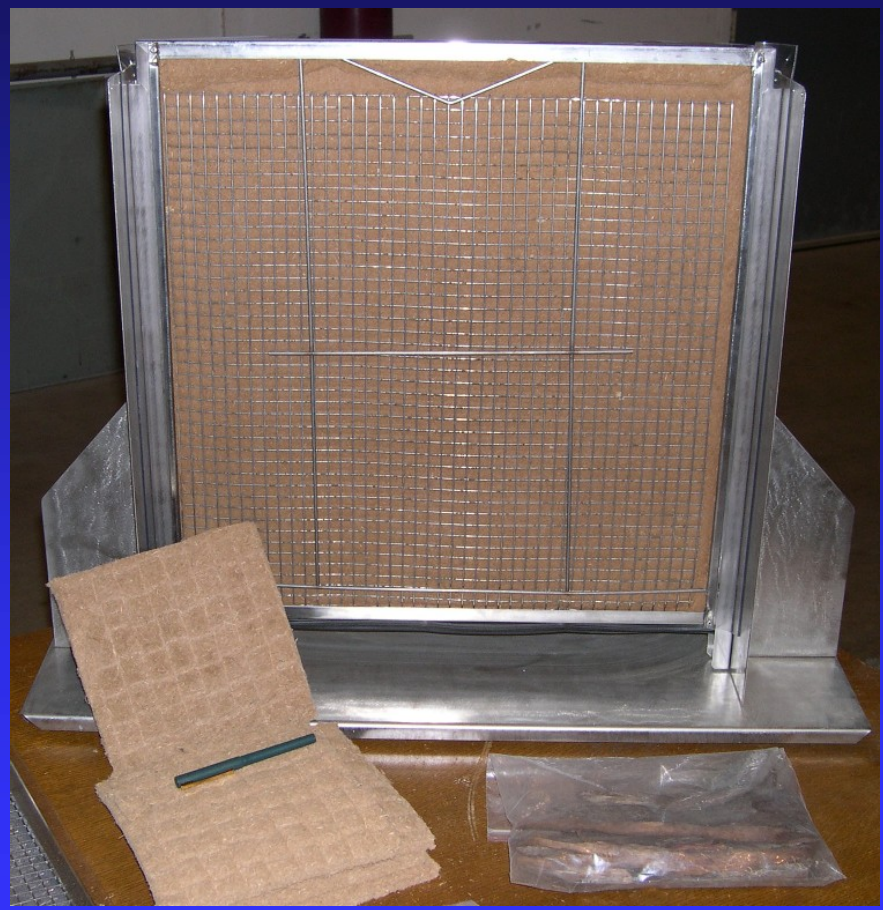
Strong headers made from crooked trees

Wood Fiber Mat



Wood Fiber Mat

Use as is, or
Chemically
modify



Water filters

Wood fiber for
watershed restoration

Filter box

- Oil
- Toxic heavy metals
- Ammonia
- Pesticides and herbicides
- Phosphate and nutrients

Mine Waste Clean Up

- Juniper
- Aspen
- Eastern hemlock
- Birch
- Red maple

Parking lot pollution

Wood Fiber Mat

Add seed

Astronaut amusement

Geotextiles for Erosion Control

Erosion Control Mats From Juniper

Wood Fiber Mat

Add Plastic, Heat and Pressure

Wood Composites

Particleboard, medium-density fiberboard, oriented strandboard…$$

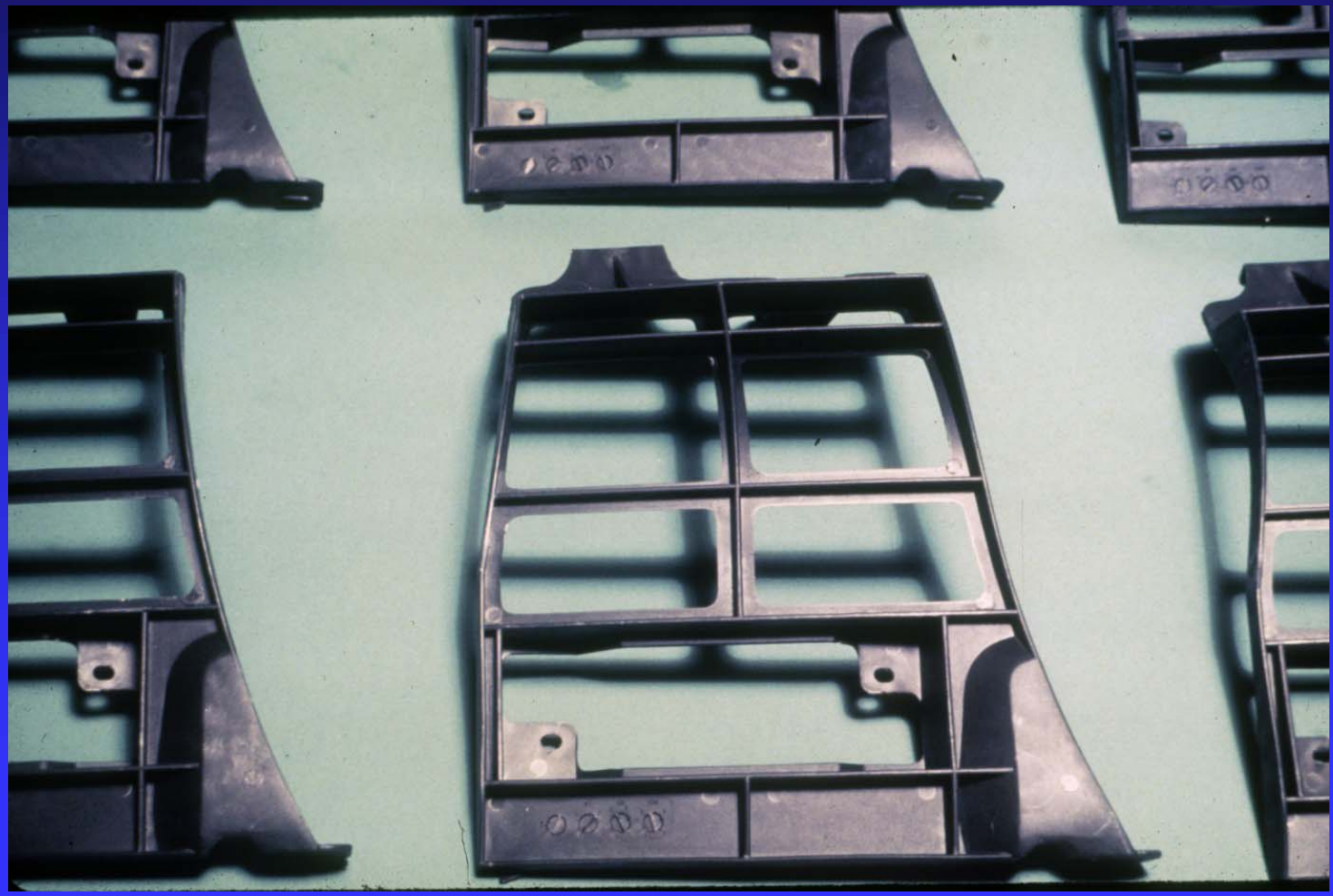
Wood/Plastic Composites

- **Offer opportunities on smaller scale**
- **Can be configured to meet regional needs**
- **Localized applications using local problematic resource**

Pellet Feedstock

Pellet Feedstock

Automobile Parts



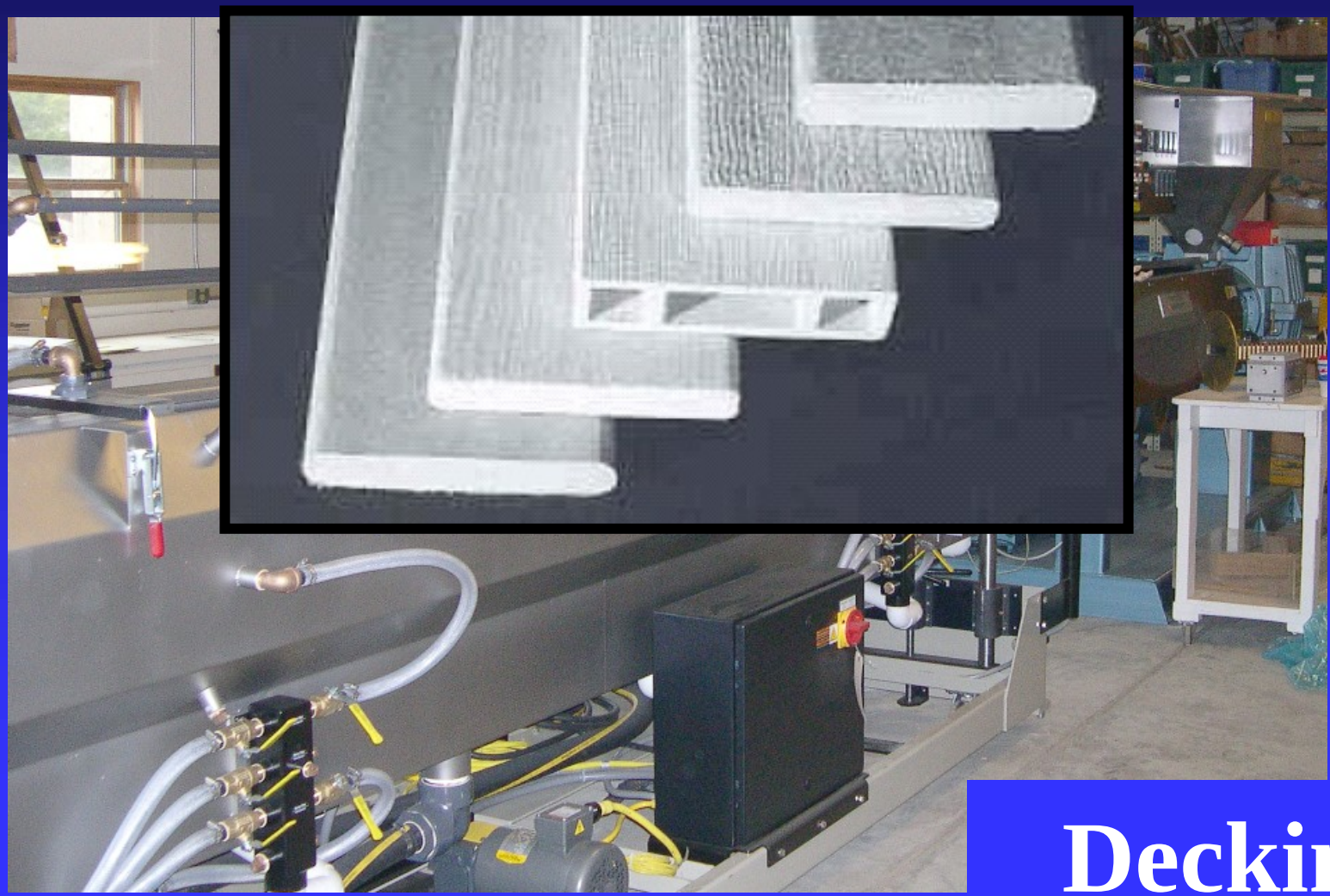
Juniper

Highway Signs

Research Demonstration House

Composite Shingles

Wood Plastic Extruder



Decking

Agro-Fiber Composites

- Straw
- Sugarcane Bagasse
- Kenaf
- Hemp
- Guayule
- Wheat

2 by 4
chipped and
formed into
a pipe

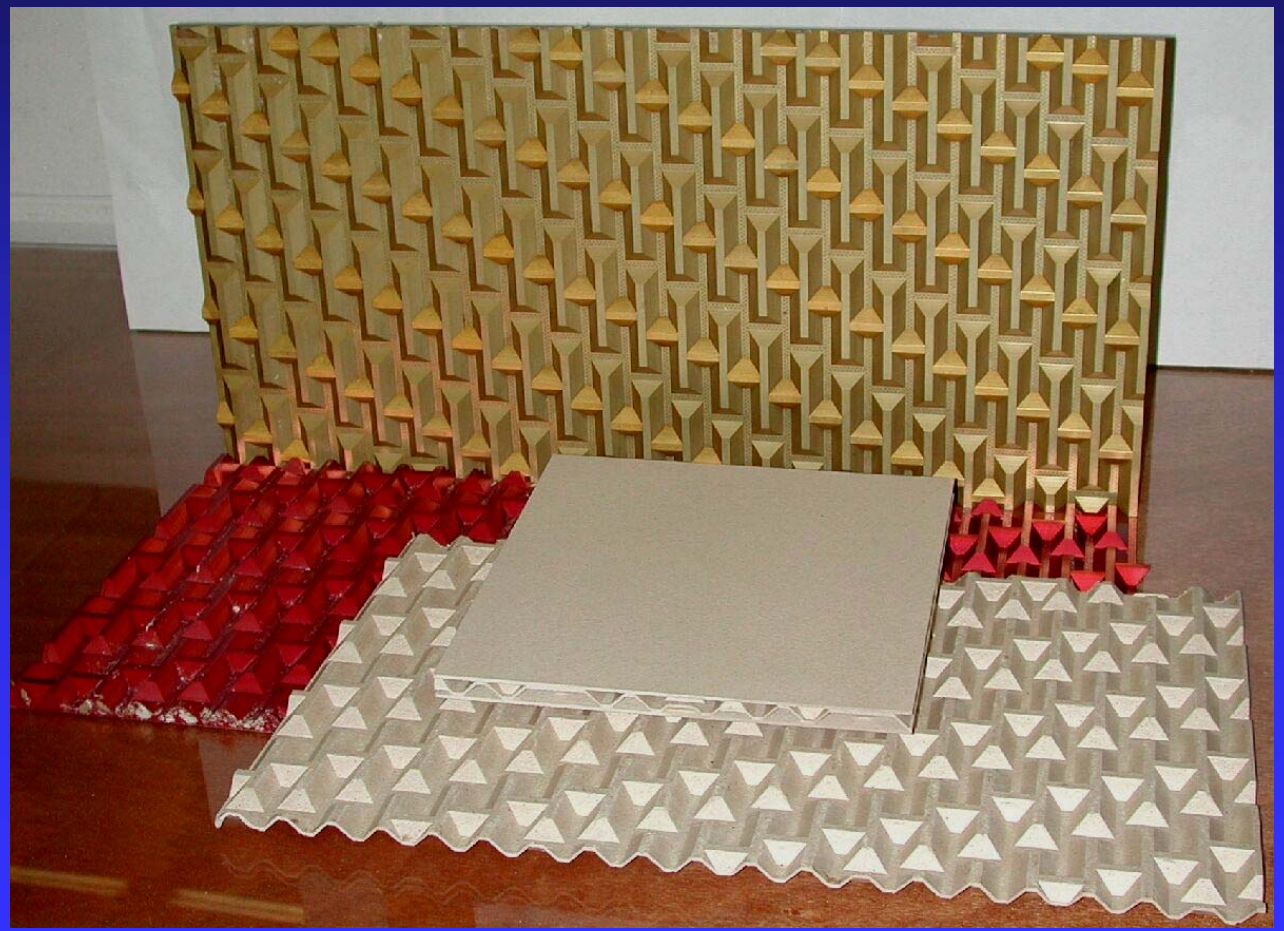
Money

Inorganic-Bound Wood Composites

Wood/Concrete Composite

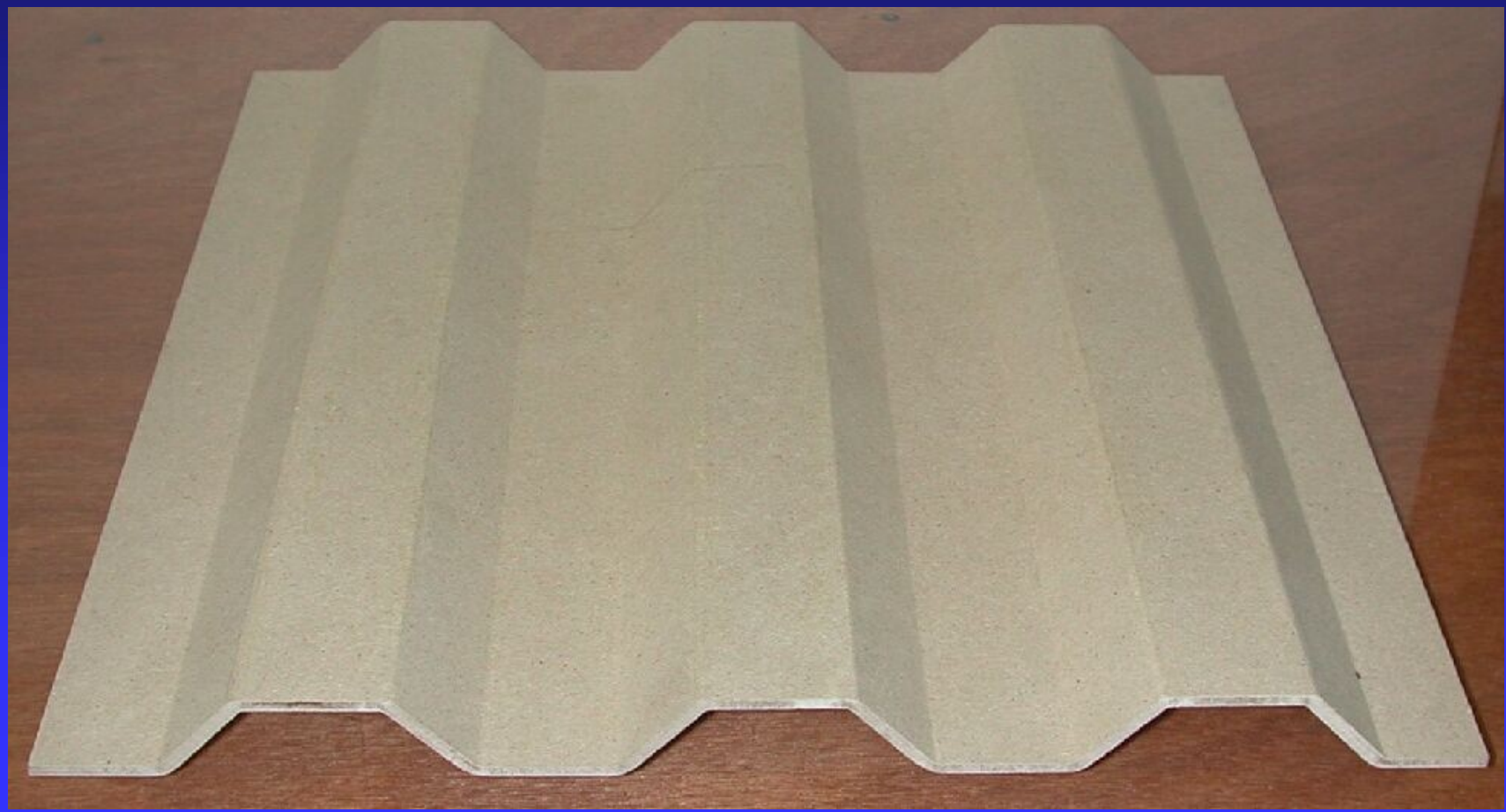
Structural Fiber Products

3D Truss-core



Structural Fiber Products

Corrugated Fiberboard



Playground Safety & Accessibility

Surface Resiliency **Impact/Energy Absorption**

Wood shavings – animal bedding

What can you do with chips this size?

Better than wood pellets!

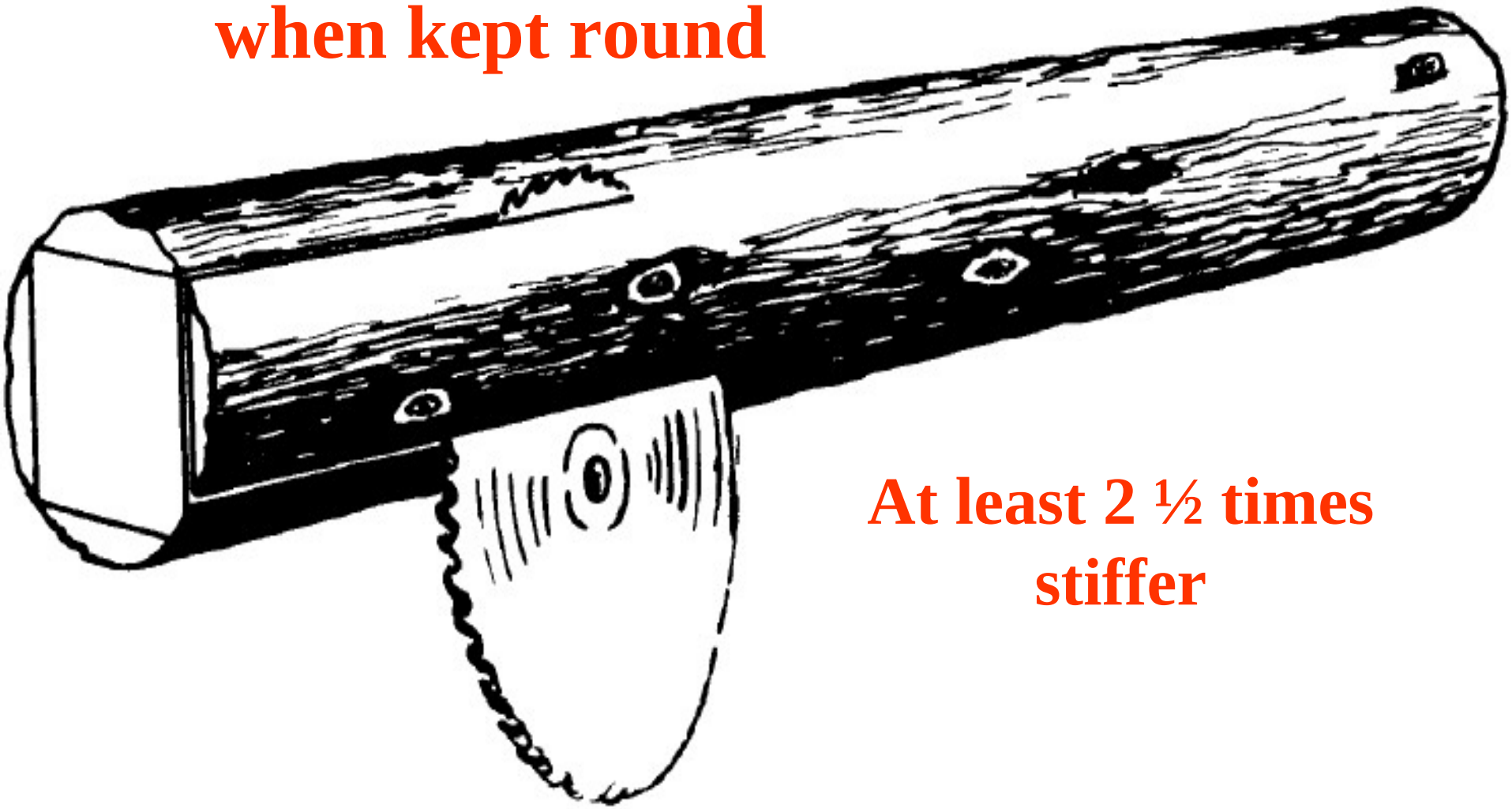
You may need a hammer mill and sifter to make the perfect product.

Then all you need is a bagger and marketing.

Most communities have wood chippers that will only require a slight modification to make shorter chips.

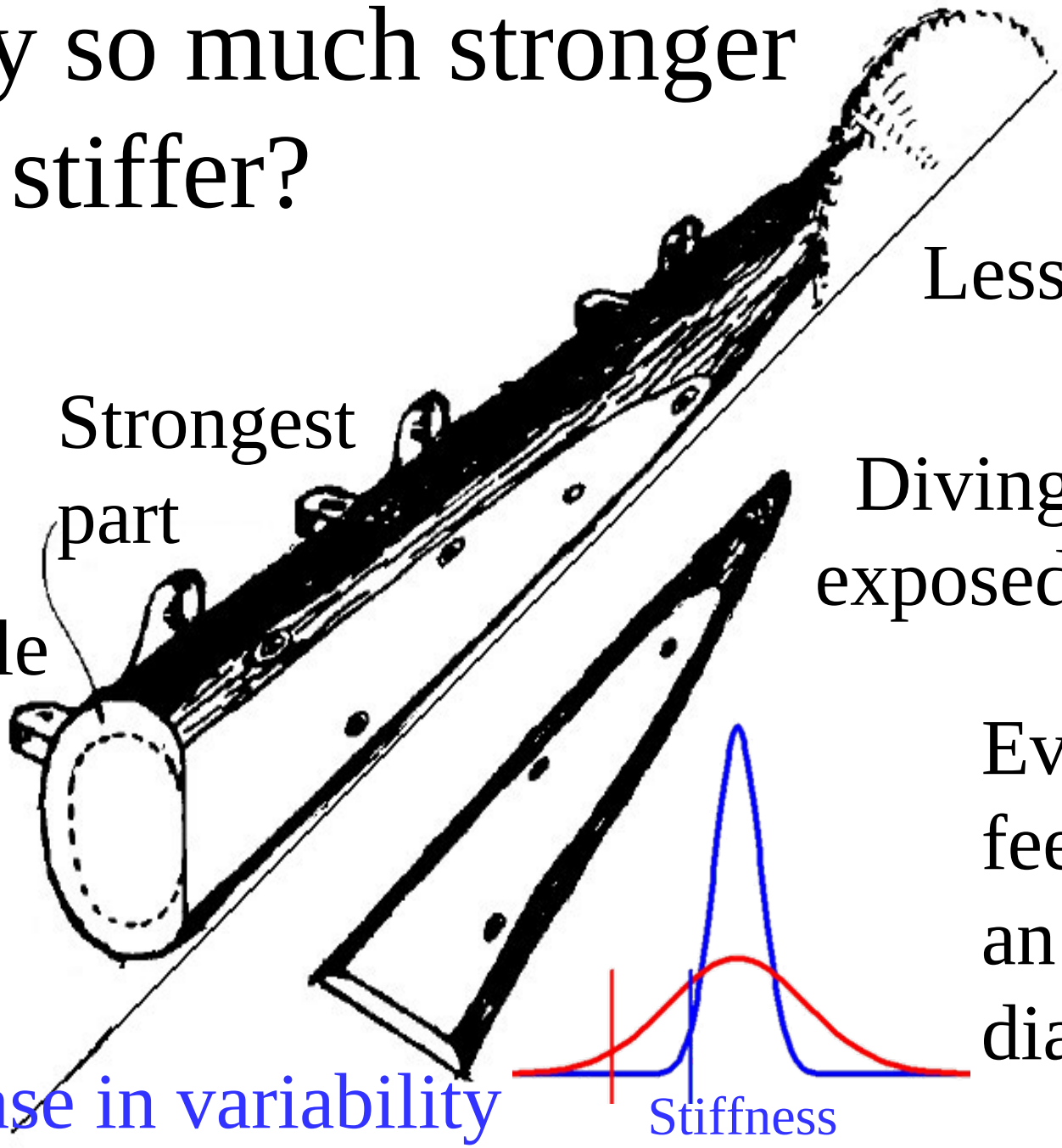
Using Roundwood

At least three times stronger when kept round



At least 2 ½ times stiffer

Why so much stronger and stiffer?



Less material

Strongest part

Diving grain exposed at cut

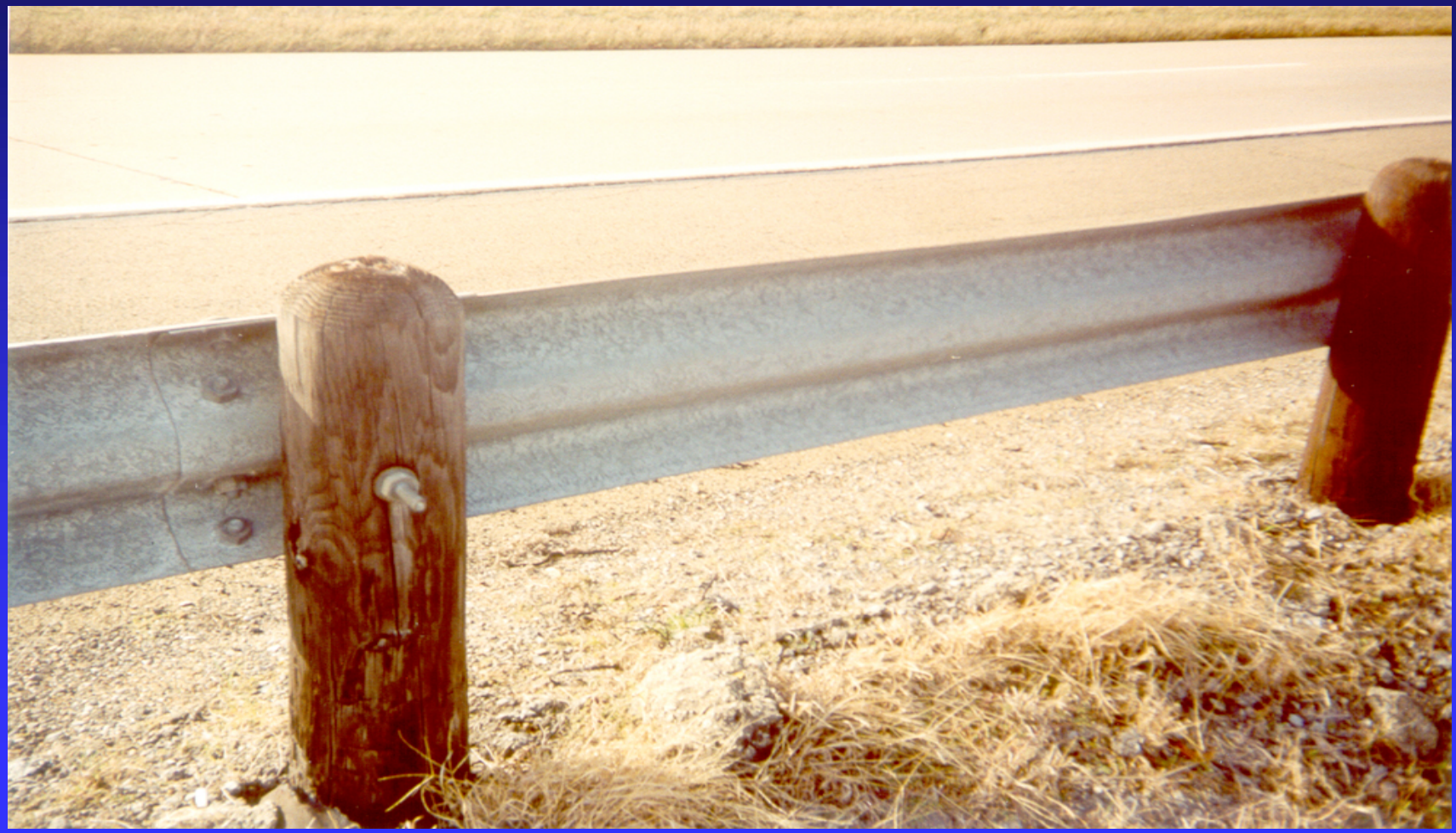
Juvenile wood boxed

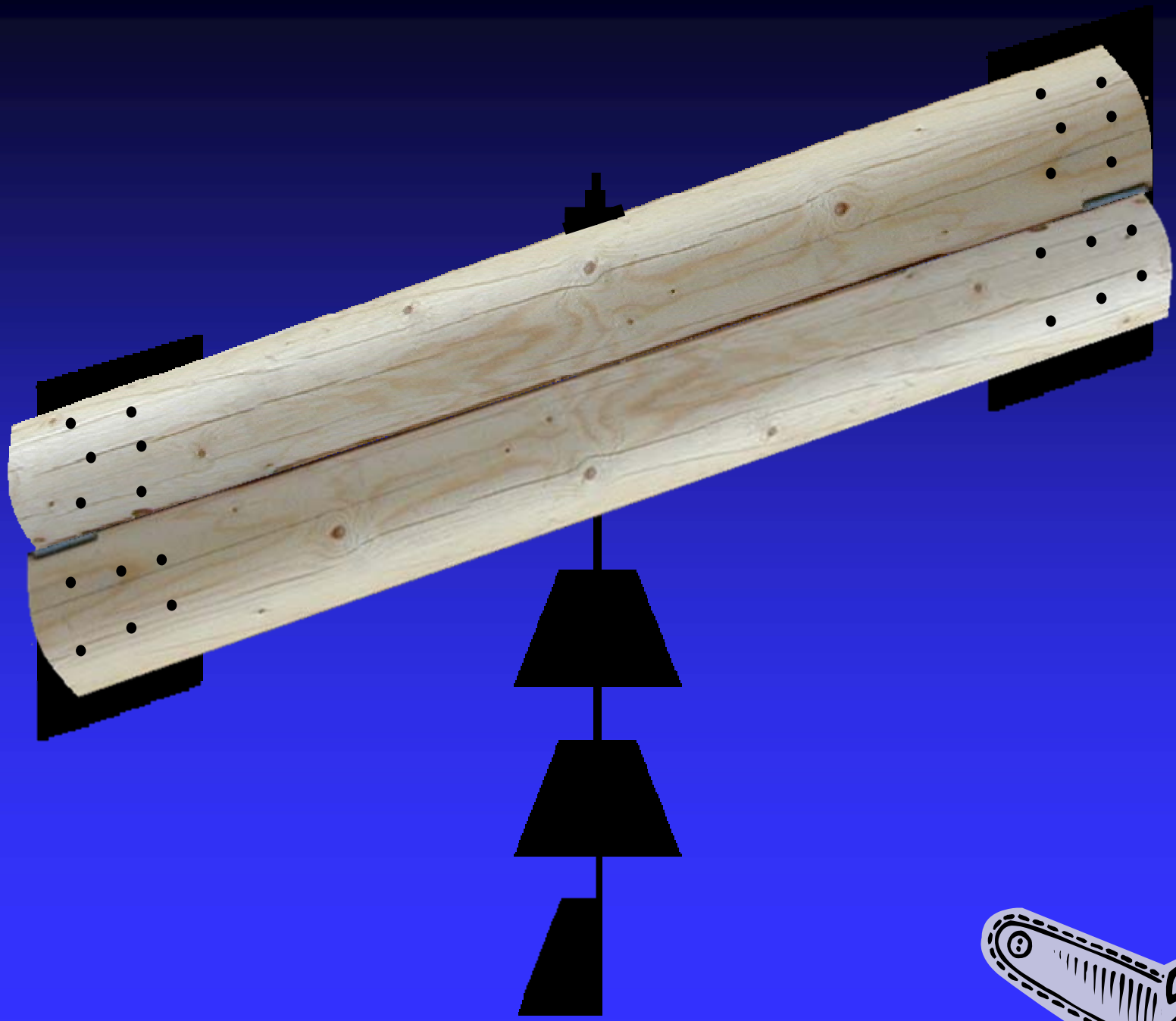
Every 10-15 feet we gain an inch in diameter

Decrease in variability

Stiffness

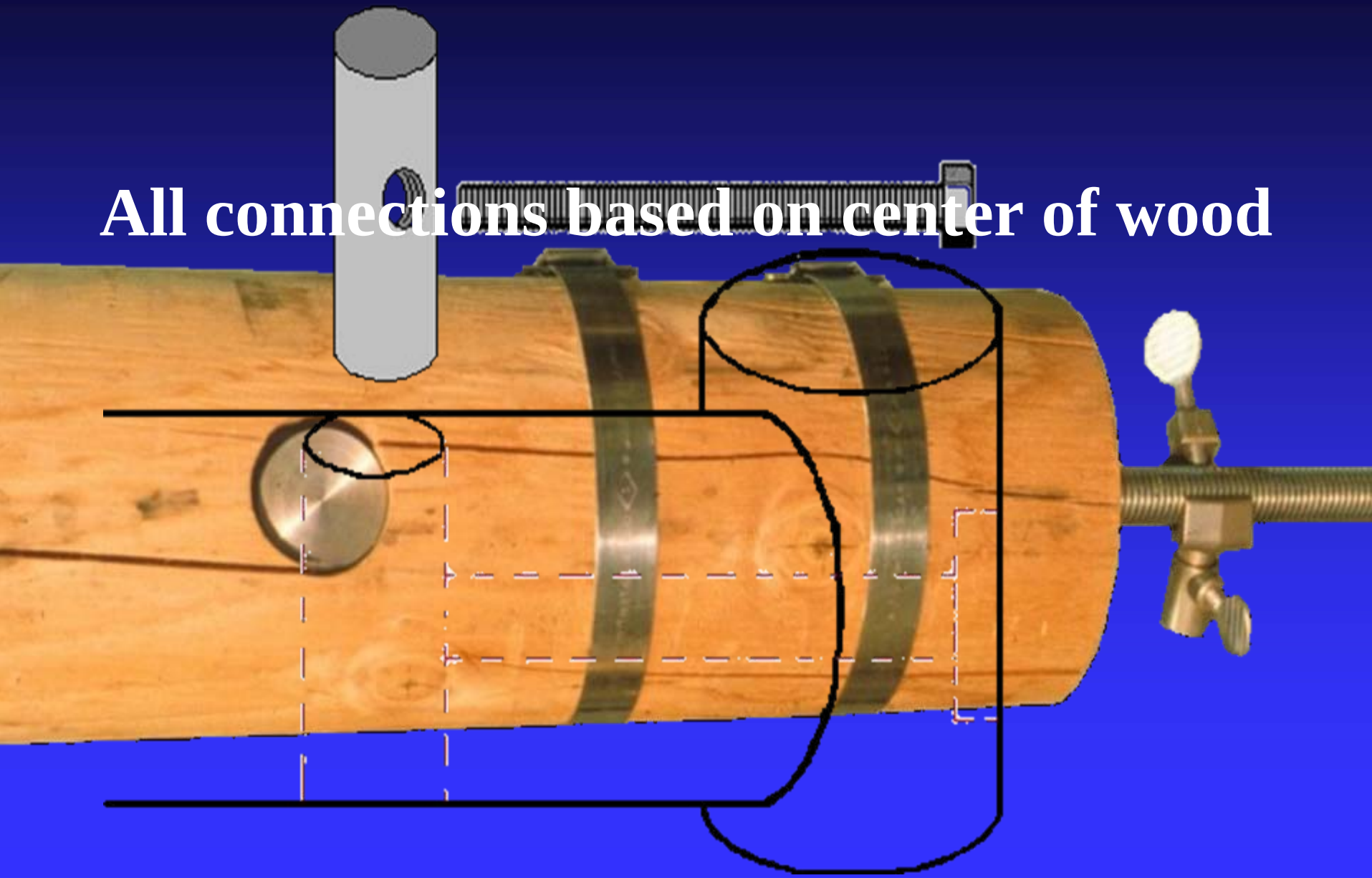
Guardrails
Turned Posts





Roundwood Structures

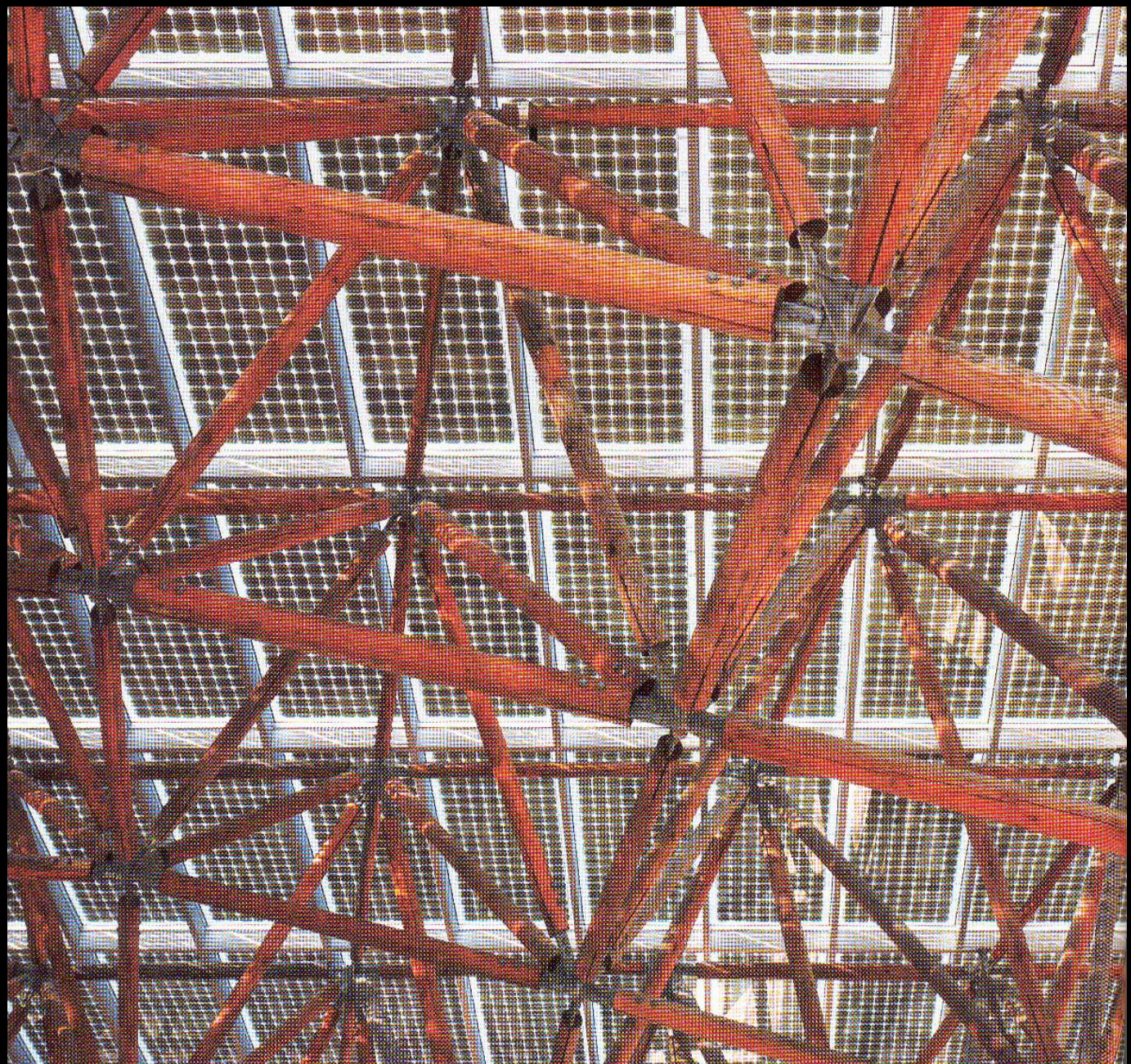
Dowel-Nut Connections



Strong connectors can pull timbers together

Space Frame Structure

Space-frame structure



Westcliffe Pavilion

Townsend Pavilion


01 23 2000

Darby Library

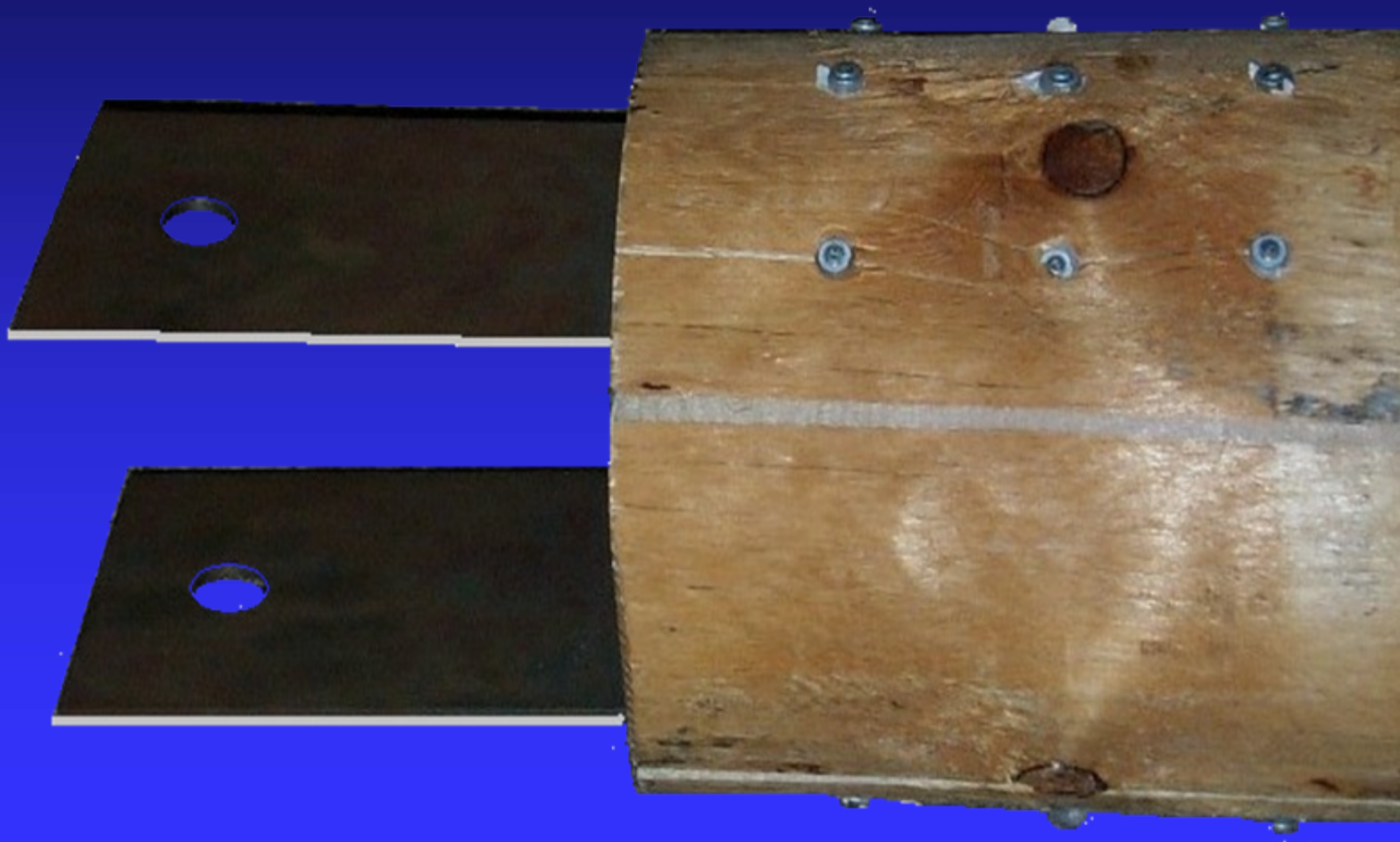
Olympic Kiosks

Welded connectors

Open structure using bracing

Powder Driven Fastener

Mortised Plate Connection



Powder-Driven Nails

Double Shear

Mostly nail failure

Cleavage Failure

Block Shear Failure

Sleeve Connection

Powder-Driven Nails

Single Shear

Single Shear

Mostly wood failure here.

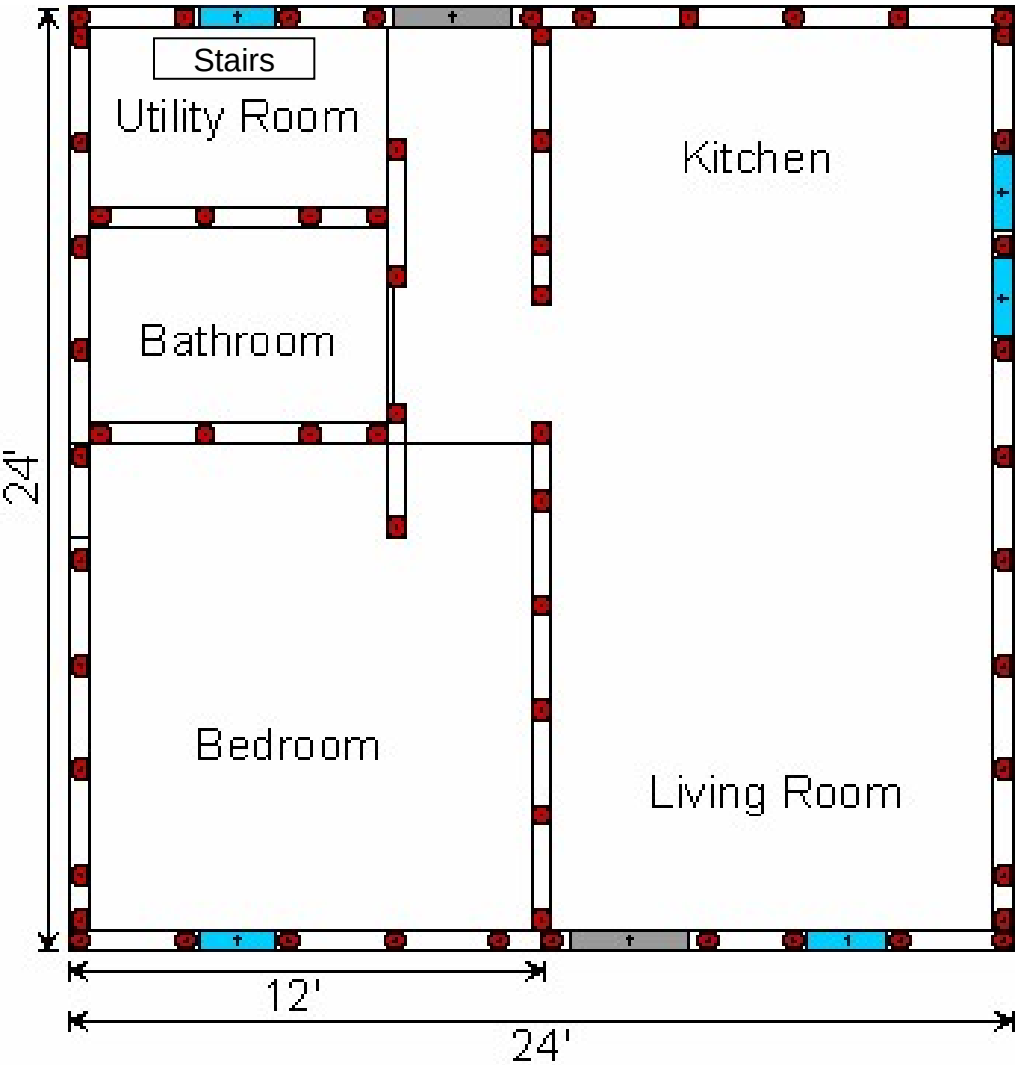

Key

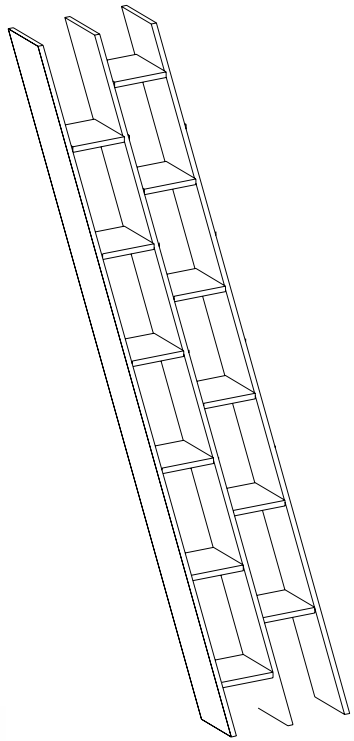
Beautiful connectors

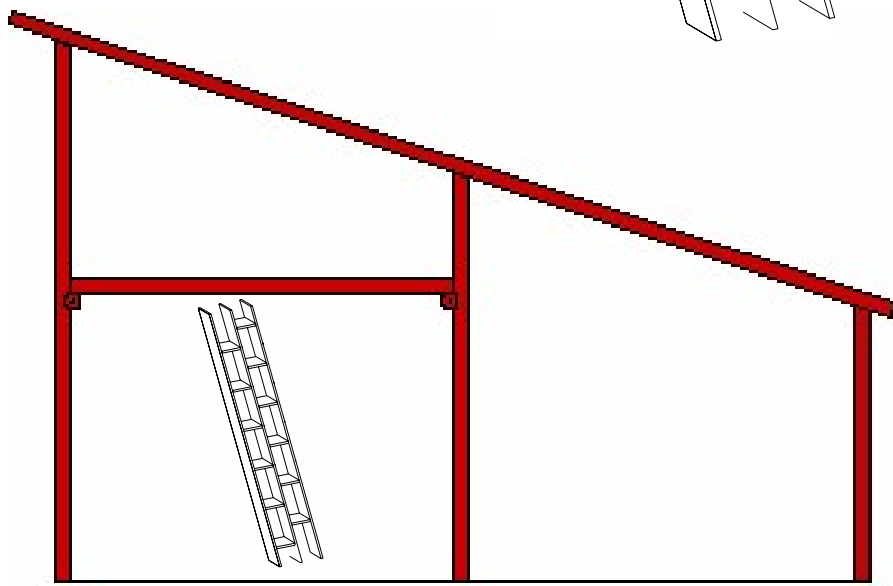

Turned logs
Coped ends


Peeled logs
Flats cut

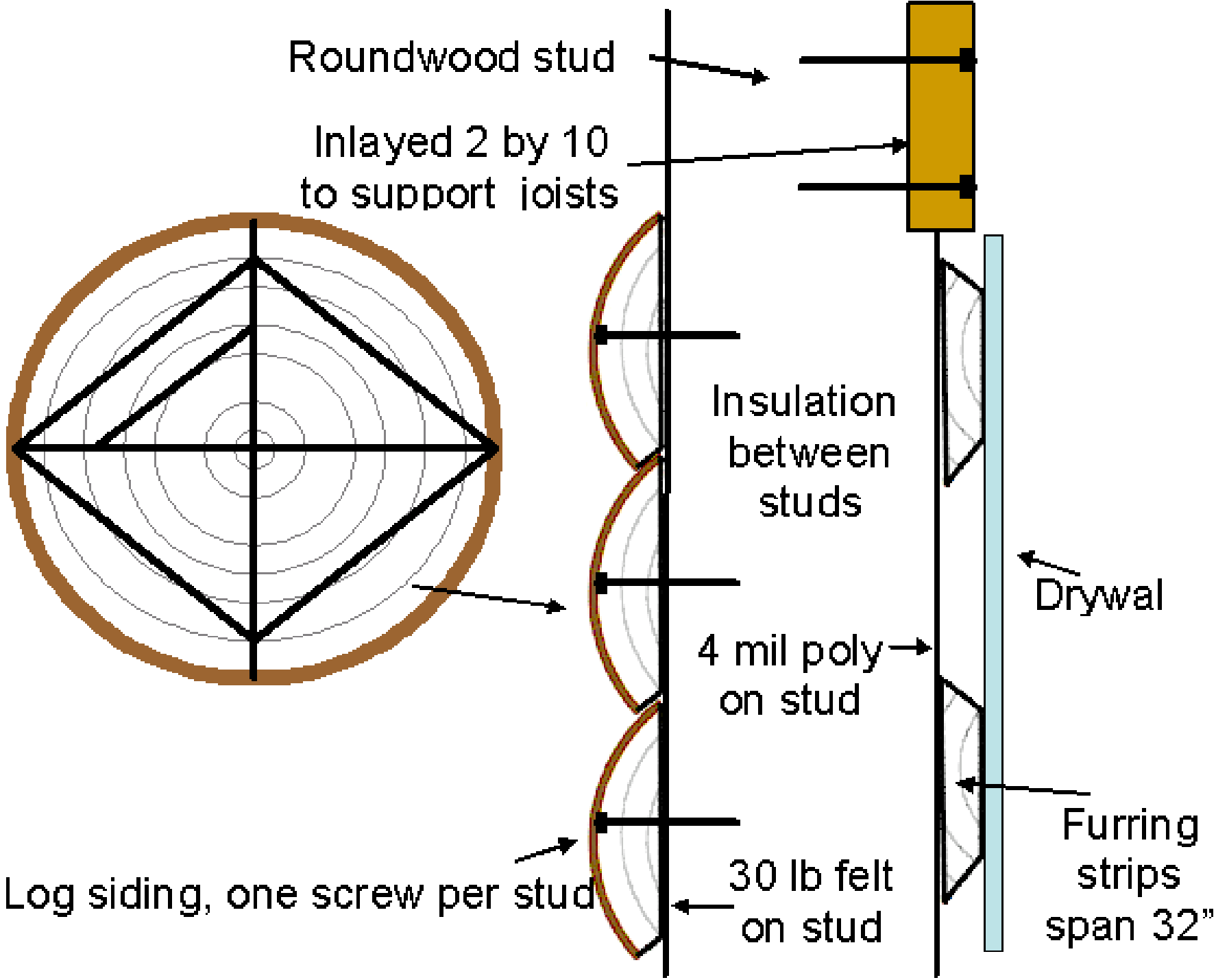
Habitat for Humanity half duplex

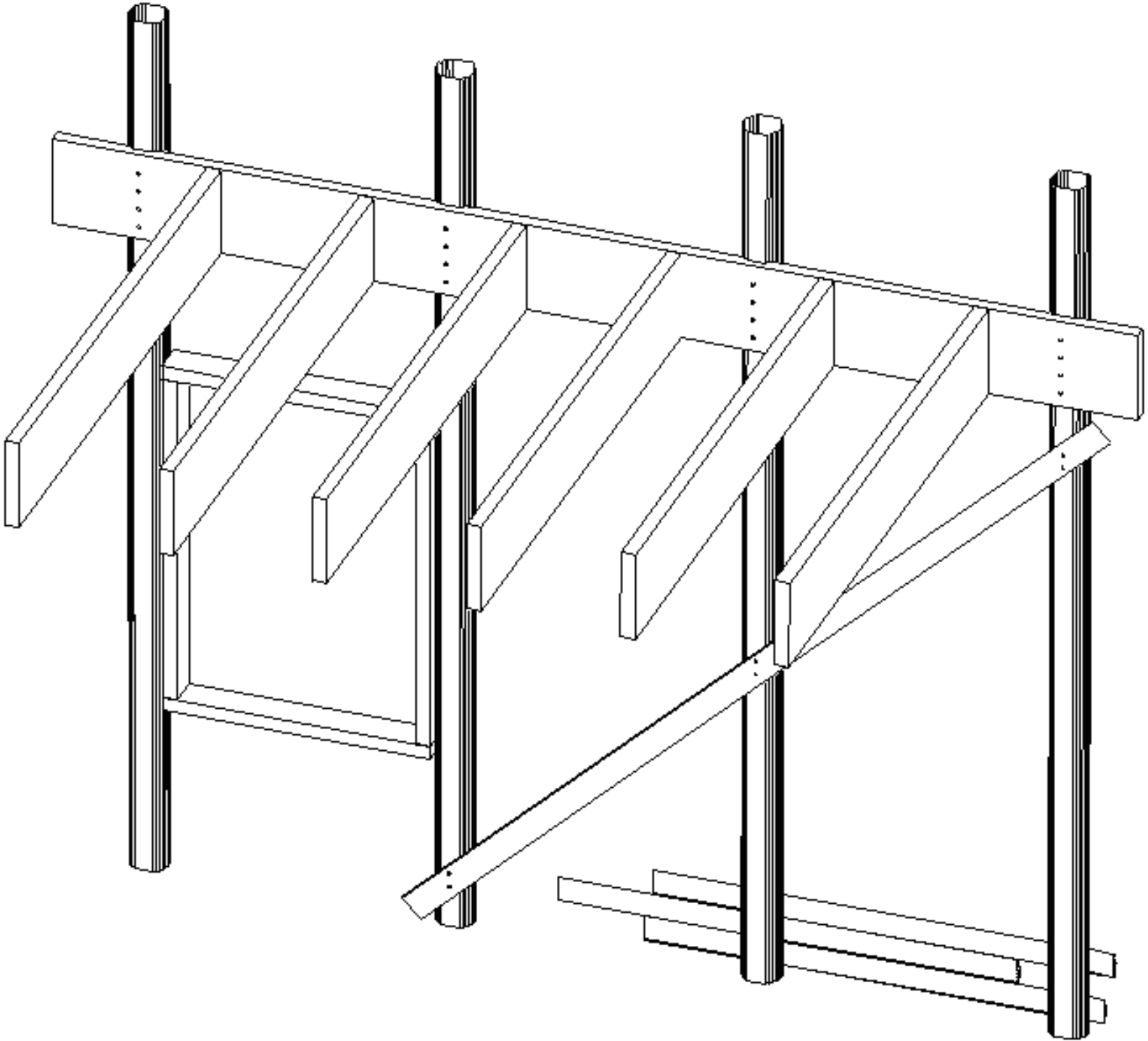




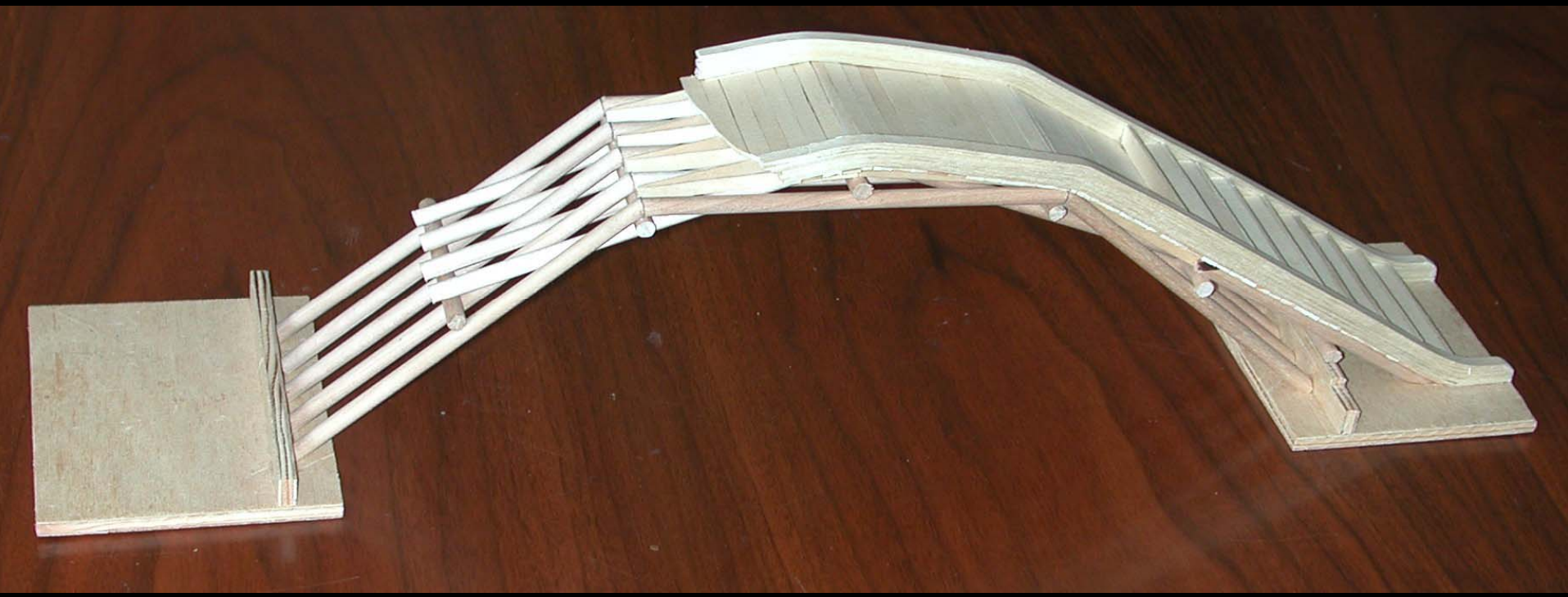


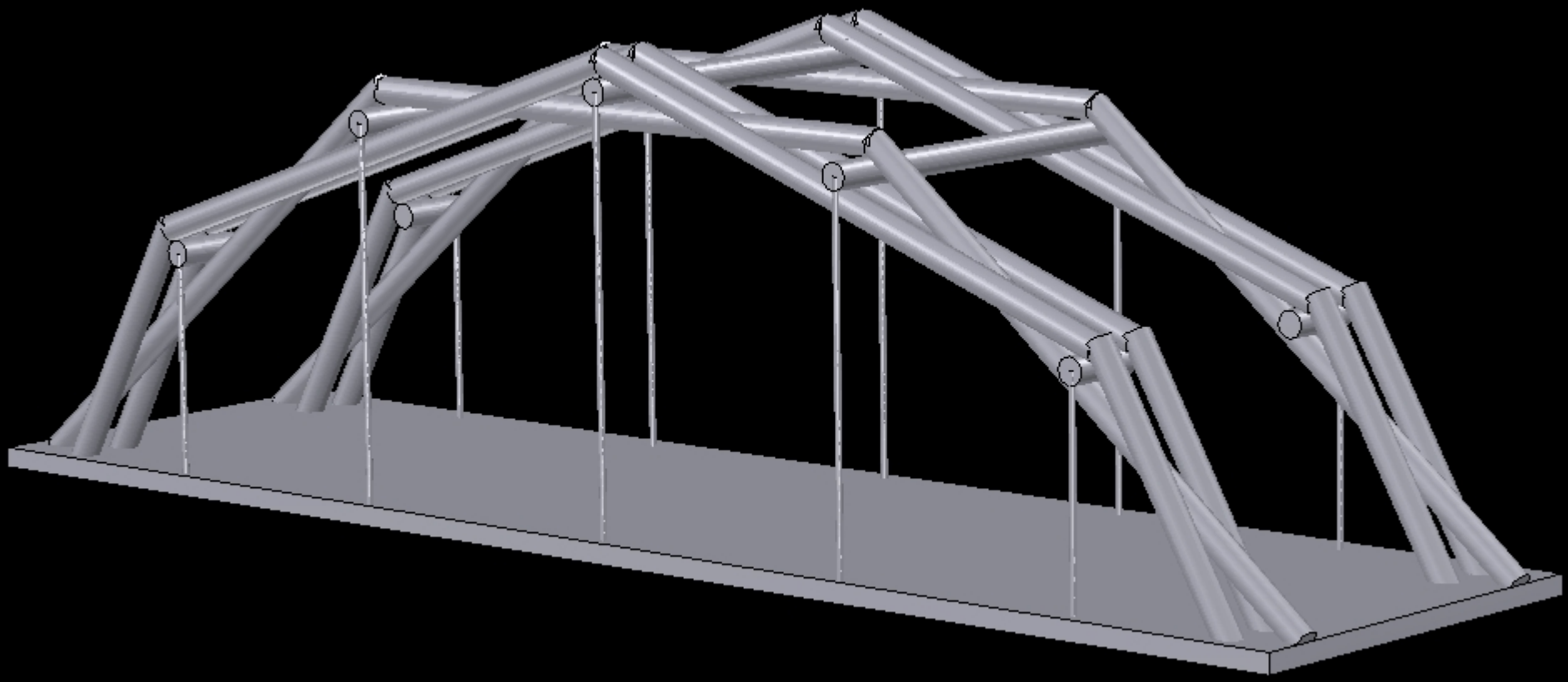
Studs are 32" on center, where possible
Windows are 24" wide, Doors are 36" wide


Roundwood stud
Inlayed 2 by 10
to support joists
Insulation
between
studs
Drywal
4 mil poly
on stud
Furring
strips
span 32”
Log siding, one screw per stud
30 lb felt
on stud



Rainbow Bridge





40ft Pedestrian Bridge

80ft Suspension Bridge

Privacy Fences

- Use 2 to 3 inch roundwood
- Develop landscape designs
- Needs marketing effort
- Wide use in Europe

www.elwdsystems.com

Energy

Lowest Value

Demand Exceeds Supply

Biomass Power

Combined heat and power plant in St Paul, MN

25MW of power

District heating and cooling to downtown

Fuel is urban wood waste less than 25 miles

MN has two more 25MW plants (2007) Mandate = 125MW

Biomass Power

Combined heat and power

5KW of electrical power
Heat for space and water

That's 1/5000 the size of St Paul

Today, the average house uses less than 1kw (average)

Biomass Energy

Power modules from 5 to 50 kWe using agricultural and forest residues

(still lowest economic value of wood)


BioMax 15/35
Gas Production Module
BioMax 15/35
Power Generation Module
GENERAC
POWER SYSTEMS

Woody Biomass Energy

Can help reduce dependence on foreign oil

Help provide outlet for thinnings from hazardous fuel treatments

Reduce cost for hazardous fuel treatments

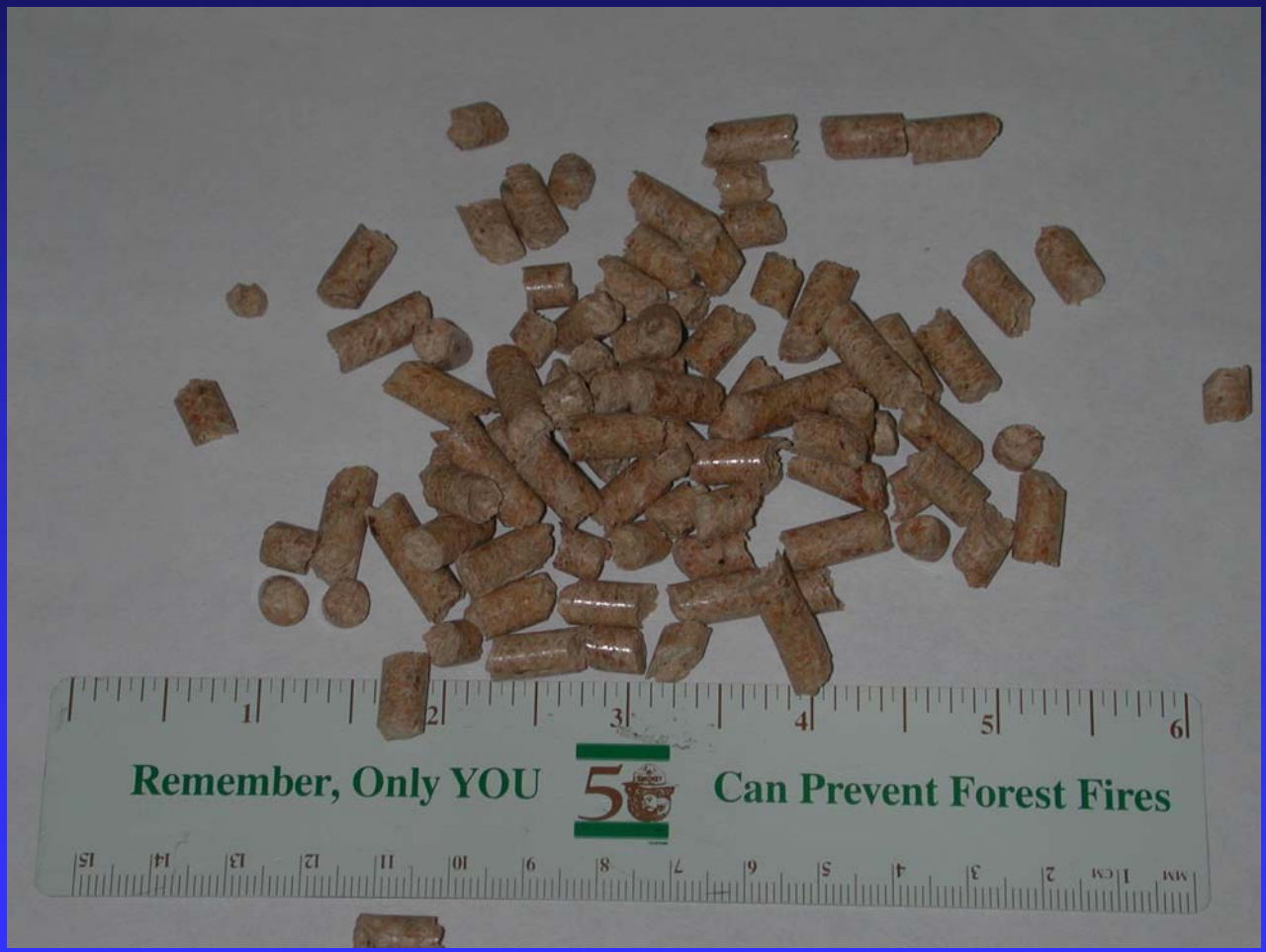
Can be cost effective alternative

Electricity generally costs eight to ten times more per unit of energy than wood chips; oil and natural gas cost roughly two to two and one-half times as much as wood chips

Calculator

f: g:

Wood Pellets



- Sawdust
- Large export market
- Shortage
- Hit 1 million tons production
- Bagged or bulk
- Pellet furnaces

	1 TPH	2.5 TPH	4 TPH
Hammermill & Feeder	$40,644 30 hp	$43,114 75 hp	$56,007 150 hp
Air assist discharge system	$20,373	$21,480	$23,804
Pellet Mill, Conditioner, Feeder	$119,613 100 hp	$178,570 250 hp	$277,519 400 hp
Cooler, Air system	$45,949	$45,949	$45,949
Rotex Screener	$7,831	$9,554	$13,999
TOTAL	$234,410	$298,667	$441,082
Electrical cost (max)	$9.70	$24.25	$41.00

2.5T x 8 hr x 5 day
x 50 week x $200
= $1 million
- $50,000 electrical

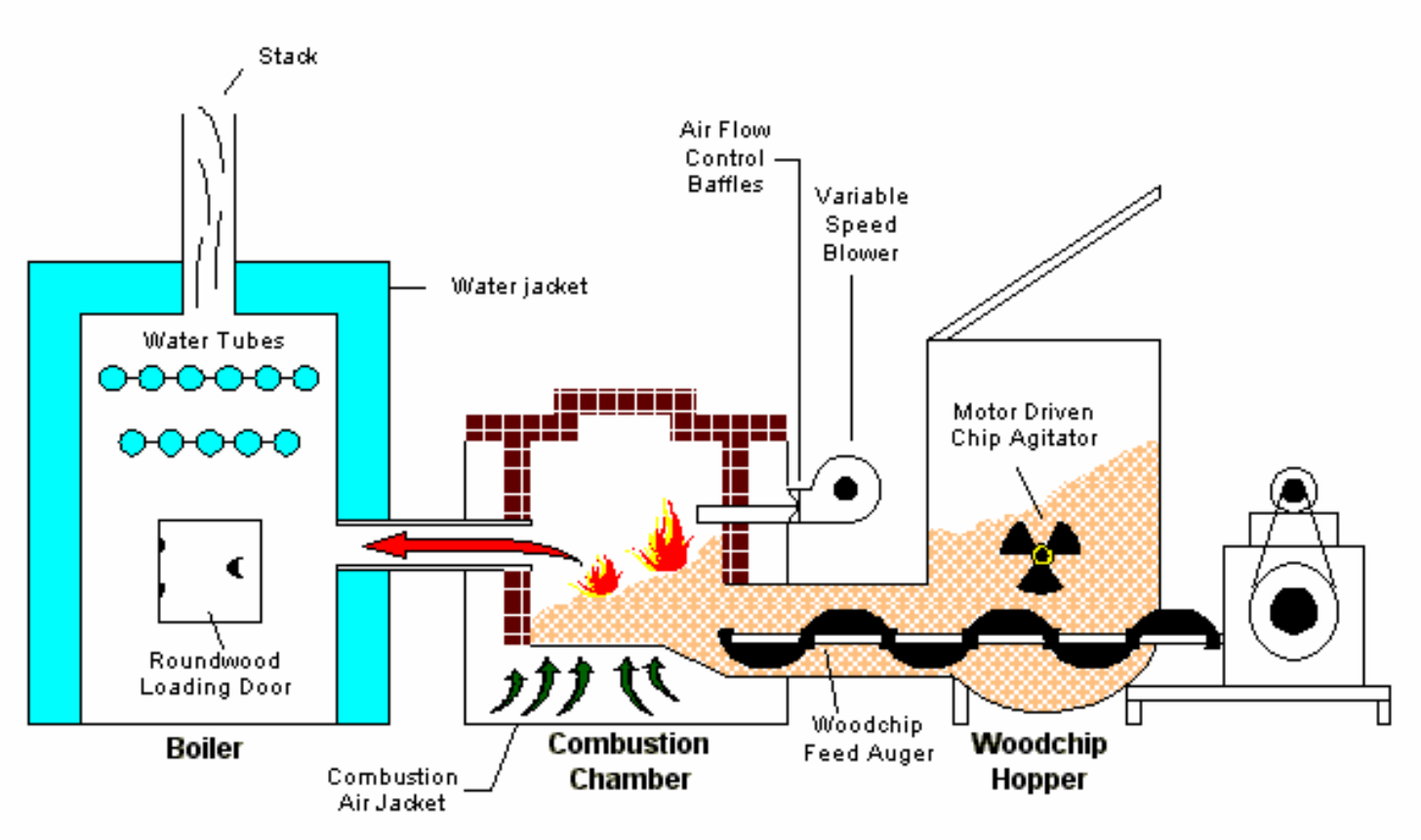
Free wood

School Heating System

Fuels for Schools - Institutional Heating

Darby, MT

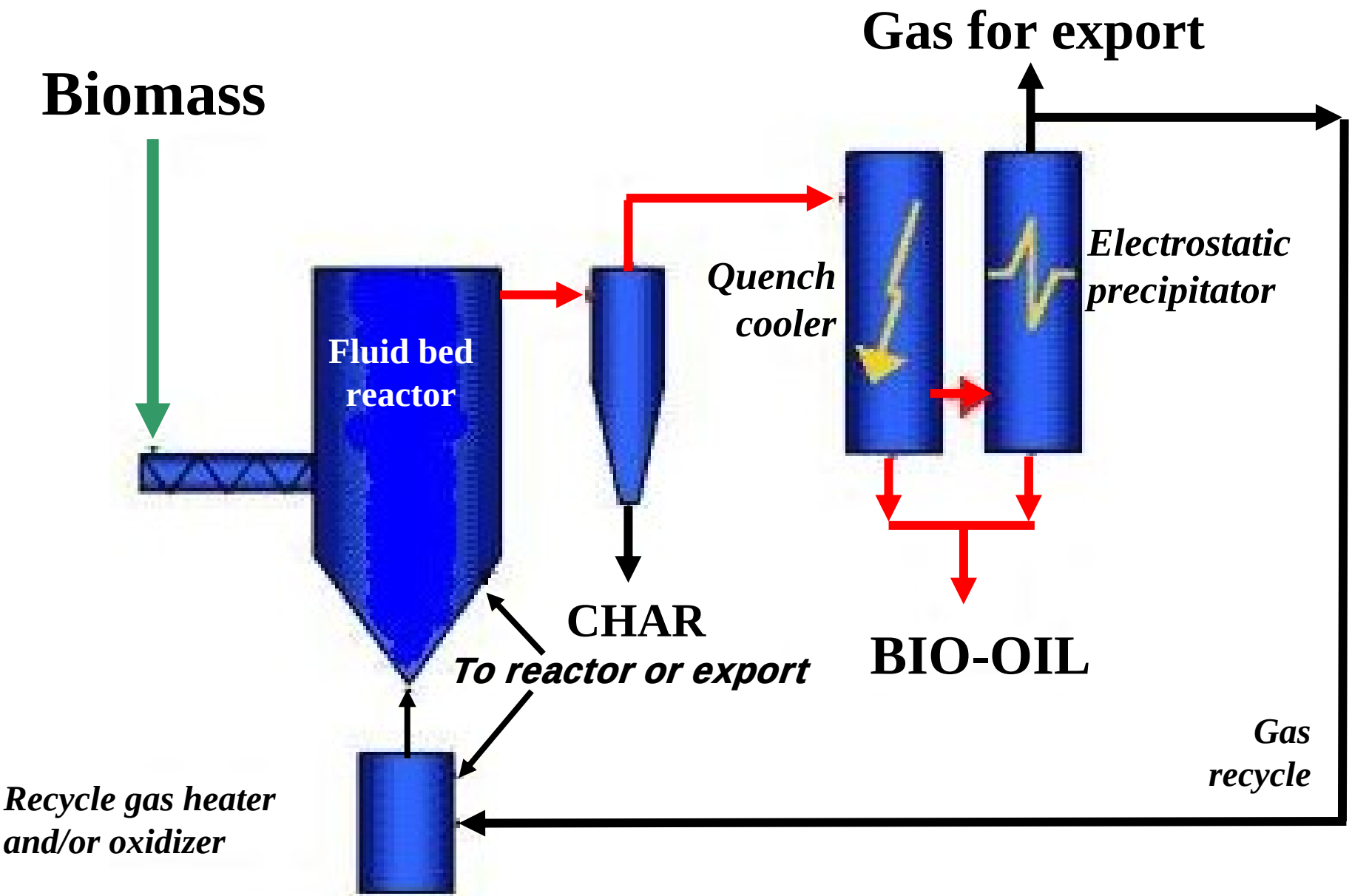
Small Commercial Bioenergy System



Ethanol From Thinnings

- Ethanol can be produced from many different feedstocks
- Polymers are enzymatically hydrolyzed to make sugar
- Still costly to make ethanol from wood
- Growing interest and investment in ethanol as biofuel
- Elimination of MTBE from gasoline

Bio Oil


Gas for export
Biomass
Fluid bed reactor
Quench cooler
Electrostatic precipitator
CHAR
To reactor or export
BIO-OIL
Gas recycle
Recycle gas heater and/or oxidizer

Useable Energy Forms

- Electricity
- Heat (steam, exhaust gas, hot water)
- Cooling (air-conditioning)
- Producer (wood) gas (crop drying, duel-fuel)
- Bio-fuels
  - Bio-ethanol
  - Bio-oil
  - Bio-methanol
  - Bio-diesel

Ethanol - Fermentation

- Mostly made from corn
- Current yield 65 gallons/bone dry ton
- Steps include:
  - Pretreatment of chips
  - Enyzmatic treatment
  - Fermentation
  - Distillation
- Yield to 80% with enzymes for 5-carbon sugars

Ethanol - Thermochemical

- Thermal treatment to produce a synthesis gas
- Fischer-Troph reaction with catalyst
- Convert low BTU gas into methanol, diesel, gasoline, etc
- Not commercial, pilot plant stage in US

Current status for ethanol commercialization

- Market exists for ethanol
- Ethanol blended fuels represent more than 12% of the U.S. motor gasoline sales
- Ethanol production has a net positive energy balance (1.34)
- The balance is significantly higher from wood or agricultural residues than from corn

[1]USDA: "The Energy Balance of Ethanol: An Update." National Agricultural Statistics Service, USDA. Wang, Shapouri, Duffield, Aug 2002

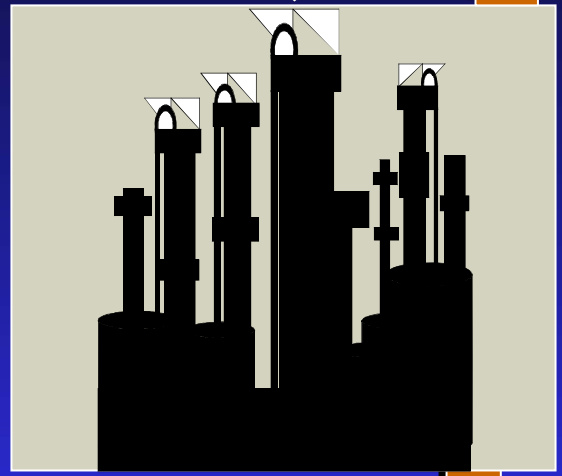
[2]Argonne National Laboratory: "Effects of Fuel Ethanol Use on Fuel-Cycle Energy and Greenhouse Gas Emissions," Wang, Saricks, Santini, January 1999.

66 x 10^6 MT CO_2

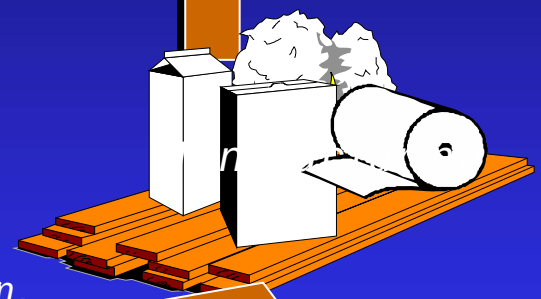
O_2

Syngas

Power Export
$3.8 Billion
or
Liquid Fuels/Chemicals
$5.5. Billion



Black Liquor
& Residuals



➥Extract Hemicelluloses
➥New Products
Chemicals Polymers
$3.3 Billion

➥BL Gasifier
➥Wood Residual Gasifier
➥Combined Cycle System
➥Process to Manufacture
Liquid Fuels and Chemicals

Steam, Power & Chemicals

➥Pulp
$5.5 Billion

The Forest Biorefinery

Net Revenue Assumptions:

Acetic Acid - $1.73/gallon	Purchased Electricity - $43.16/MWH
Ethanol - $1.15/gallon	Exported Electricity - $40.44/MWH
Pulp - $100/ton net profit	Renewable Fisher Tropsch Fuel - $57/bbl

Mark Knaebe
Forest Products Technologist
S&PF Technology Marketing Unit
Located at the Forest Products Lab
USDA Forest Service
One Gifford Pinchot Drive
Madison WI 53705-2398

608-231-9422
fax 231-9395
mknaebe@fs.fed.us
http://www.fpl.fs.fed.us
http://www.fpl.fs.fed.us/tmu