Pallet Industry in the U.S.

- 1.9 billion are in use in the U.S. each year.
- Solid wood pallets are 92% of the market.
- 441 million new wooden pallets were manufactured in the U.S. in 2006.
- 321 million pallets were recovered/repaired/remanufactured in the U.S. in 2006.
Common Pallet Sizes in the U.S. (2011)

<table>
<thead>
<tr>
<th>Pallet Size (in.)</th>
<th>Annual production (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>48X40</td>
<td>24.4</td>
</tr>
<tr>
<td>42X42</td>
<td>4.8</td>
</tr>
<tr>
<td>40X48</td>
<td>2.8</td>
</tr>
<tr>
<td>48X36</td>
<td>1.5</td>
</tr>
<tr>
<td>36X36</td>
<td>1.8</td>
</tr>
<tr>
<td>48X48</td>
<td>3.8</td>
</tr>
<tr>
<td>44X44</td>
<td>3.0</td>
</tr>
<tr>
<td>800 x 1200 (Euro)</td>
<td>0.7</td>
</tr>
<tr>
<td>Other</td>
<td>57.1</td>
</tr>
</tbody>
</table>
2 way

Partial 4-way

Full 4 way
Unidirectional Base

Perimeter Base

Unidirectional Base

Cruciform Base
Solid Wood Pallets
(79% of market demand and 92% of the users use it)

**Advantages**
- Inexpensive
- Easy to prototype
- Strong
- Stiff
- Recyclable
- Can be designed using PDS
- Existing equipment and packaging is designed to the performance of wood pallets

**Disadvantages**
- Fasteners
- Can harbor bugs
- Splintering
- Gaps between boards
- Give off moisture
- Variation between pallets
- Different lumber specs for different locations
Plastic Pallets
(11% of market demand and 37% of the users use it)

Advantages
• Bug Free
• Durable
• Washable
• No fasteners
• Weather resistant
• Design Potential
• Custom colors

Disadvantages
• High purchase price
• Expensive to prototype
• Low Friction
• Low Stiffness
• Fire safety rating
• Not repairable
• Slower production times
Composite Pallets
(18% of the users use it)

Advantages
• Smooth deck
• Dry
• Bug-free
• Good product protection
• Durable
• Design flexibility
• Can be designed with pallet design software

Disadvantages
• High purchase price
• Expensive to repair
• Splintering
• Less recyclable
• Less water resistant
• Fasteners
Paper Pallets
(11% of market demand and 8% of the users use it)

**Advantages**
- Lightweight
- Ergonomics
- Smooth deck surface
- Recyclable
- Lower freight cost
- Dry
- Bug free

**Disadvantages**
- High purchase price
- Susceptible to moisture
- Poor performance with flexible loads
- Not durable
- Less product protection
## Metal Pallets

(0.8% of market demand and 7% of the users use it)

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Strong and Stiff</td>
<td>• High purchase price</td>
</tr>
<tr>
<td>• Durable</td>
<td>• Weight</td>
</tr>
<tr>
<td>• Recyclable</td>
<td>• Sharp edges</td>
</tr>
<tr>
<td>• Fire Resistant</td>
<td>• Low friction</td>
</tr>
<tr>
<td>• Bug free</td>
<td>• Susceptible to rusting</td>
</tr>
<tr>
<td>• Sanitary</td>
<td></td>
</tr>
<tr>
<td>• Dry</td>
<td></td>
</tr>
<tr>
<td>• No Fasteners</td>
<td></td>
</tr>
<tr>
<td>• Impervious to extreme</td>
<td></td>
</tr>
<tr>
<td>temperature</td>
<td></td>
</tr>
<tr>
<td>• Excellent product protection</td>
<td></td>
</tr>
</tbody>
</table>
Fundamental Pallet Design Parameters:

- **Strength**
  - Racking
  - Static (Floor Stack)
  - Dynamic (Fork tine)

- **Functionality:**
  - Stiffness
  - Durability
  - Size
  - Weight

- **Cost!!!!!!**
PALLET STIFFNESS
Cost breakdown of packaging within a typical unit load

- Stretch wrap: $1.80
- Pallet: $8 - $9.00
- Corrugated cases: $45.00
- HDPE 32 oz bottles: $324.00

- Stretch wrap: $1.80
- Pallet: $8 - $9.00
- 3 ½ gallon pails: $210.00
Buckling in walls of plastic pails
Pail failures during storage
Best Practices for Stiffness

• Always know the stiffness of your pallet design.
• Measure the increase in stress distribution before you make a decision.
• Consider the stiffness change of the pallet before modifying the support conditions.
• Stiffer is better!!!!!!
Durability

- Life of a pallet specified in Number of Trips
- Expendable pallets need to last 1 trip
- Reusable pallets are designed to last for more than one trip.
- Don’t design for more than 10 years.
- Don’t design for longer than you can retain ownership of pallets.
Pallet Durability

Lead-edge board failure

Splits

Fastener Failure
Pallet Fasteners

- Helically Threaded Nail
- Twisted Square Wire Nail
- Annually Threaded Nail
- Plain Shank Nail
- Round Wire Staple
Measurement of Fasteners

- **Helically Threaded Nail**
  - Head Diameter
  - Shank Diameter
  - Thread Crest Diameter
  - Pitch
  - Thread Length (perpendicular to the Flute)
  - Thread Angle
  - Flute
  - 6 Helices / Length
  - Fastener Length

- **Annularly Threaded Nail**
  - Head Diameter
  - Shank Diameter
  - Thread Crest Diameter
  - Pitch
  - Thread Length (perpendicular to the Flute)
  - Fastener Length

- **Rectangular Wire Staple**
  - Crown Length
  - Wire Thickness (perpendicular to the Wire Width)
  - Wire Width
  - Fastener Length
  - Fastener Length
Fastener Bending vs. Splitting
Effect of Thread Press-Out
Effect of Helix Angle

\[ P = 14.7 \theta_A + B \]

Average adjusted maximum withdrawal resistance as a function of thread press-out for 11 gauge 0.120 in. wire diameter helically threaded nails from red oak (assembled green - tested dry).
Potential Durability Improvement

- 5-6% increase in the number of fasteners → 56% improvement.
- Butting lead-edge deckboards → 38% improvement.
- Split-inhibitors in leading-edge deckboard → 48% improvement.
- Use dense hardwood instead of medium density hardwood → 38% improvement.
- Use dense hardwood instead of Douglas-Fir → 165% improvement.
- Use air-dry pallet instead of green → 43% improvement.

Source: White and Wallin (1988) Pallet and Container Laboratory Bulleting No. 8
Technology to Improve Durability

- Pallet protector attached to fork tines
- Distributes the load on a larger area

- Pallet protector attached front of the pallet
- Reduces the severity of impacts on blocks and stringers and lead-edge boards
Best Practices for Durability

- Use butted double nominal 6in boards as lead-edge boards.
- Use hardwood boards for the lead-edge of the pallet.
- Use BETTER nails.
- Protect the lead-edge and blocks or stringers from impacts.
- Don’t design for more than 10 years.
- Don’t design for longer than you can retain ownership of pallets.
For More Information:

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Website: www.palletpointguard.com
Or visit ProMat 2015 Booth 676