DISTRIBUTION PACKAGING
SYMPOSIUM

ASTM Meeting, Anaheim, California
7th April 2007, Monday 10 am – 12.00
University Liaison Committee
(Cal Poly, MSU, RIT Packaging Programs)
Agenda

- Hazards in distribution
- Single Parcel Shipping Environment
- Transportation Vibration Measurement
- Dangerous Goods Shipments
Dangerous Goods Shipments
Hazards in Distribution
Physical/Transportation Environment

- Refers to the freight movement activities and the hazardous incidents and elements occurring during these activities.

Hazards experienced in a simple shipping scenario:
- Impact
- Stacking
- Vibration
- Impact
- Stacking

- Visual inspection, incubation and other testing
Physical/Transportation Environment

- Annual damage to consumer products ~ $10 billion in the U.S. due to transportation and handling
- Led to “Shock & Vibration” area – PACKAGING DYNAMICS
- Shock – instantaneous, drops, ↑ F
- Vibration – continuous, vibration, ↓ F
Global Supply Chain

Blood Red Strawberries
Height of Summer

Salinas, CA
Buenos Aires, Argentina
Helsinki, Finland
Tokyo, Japan
Seoul, Korea

19 HOURS
Distribution Hazards

- Following are some dynamic forces encountered by a package during distribution:
  
  **Manhandling**: dropping, throwing and other abuses applied by the manual loading, unloading and movement of packages.

  **Warehouse handling equipment**: stresses applied by mechanical handling equipment such as forklifts, conveyors, etc.
Distribution Hazards

- **Vehicle impacts**: starting, stopping and other jolts due to the movement of trucks, railcars, ships and aircraft

- **Vehicle vibrations**: naturally occurring vibrations resulting from the motion of engines and moving contact of the vehicle with highway and rails
1. Single Parcel Shipping Environment
The past decade has shown a great increase in the number of direct to consumer shipments of products and packages. Using various modes of transportation, these packages are routed between destinations after being sorted using hub and spoke models.
A Hub-and-Spoke System

Carrier drop location – drop box, mail store or post office

Shipper takes parcel to drop

Local pick-up vehicle

Origin hub or terminal

Lines haul (truck, rail or air)

Origin – shipper’s premises

Intermediate hubs

Destination hub

Local delivery vehicle

Receiver picks up parcel

Carrier pick-up location – mail store or post office

Destination – receiver’s (consignee’s) premises

A Hub-and-Spoke System
Package Delivery System
Over 30 major studies completed with major carriers for US and Europe

There is a continuous need to quantify what happens to these packages as they are handled both manually during collection and delivery and on large high speed conveying and sortation equipment at hubs.

The dynamic events during these moves can cause damage.

The information collected for the hazards experienced in route by the packages is useful in designing protective packaging.
Single Parcel Shipping Environment Comparison Study

- Objectives:
  - To characterize the dynamics of the second-day air express environment for small (7.75” × 7” × 5.75”) and lightweight packages (less than 5.5 lb) shipped by USPS, UPS, FedEx and DHL within the US.
  - To provide recommended test levels for drop testing packages of this size and weight for the single parcel shipping environment.
Examples of Transportation Recorders
Instrumentation

- Lansmont model Saver 3X90 and IST EDR 3C
- Internal tri-axial accelerometer that records:
  - Drop heights
  - Impacts
  - Vehicle motion
  - Vibration
  - Temperature
  - Humidity
  - Duration of 90 days
TEST PACKAGE SHIPMENTS
Test Package
Shipping Routes

Shipping Routes of FedEx
Shipping Routes of UPS
Shipping Routes of USPS
## Results

<table>
<thead>
<tr>
<th>Drop Data</th>
<th>Carrier</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>USPS</td>
</tr>
<tr>
<td>Number of Drops</td>
<td>49</td>
</tr>
<tr>
<td>Maximum Drop Height (in)</td>
<td>136.86</td>
</tr>
<tr>
<td>Drop height at 99% occurrence (in)</td>
<td>59.42</td>
</tr>
<tr>
<td>Drop height at 95% occurrence (in)</td>
<td>44.26</td>
</tr>
<tr>
<td>Drop height at 90% occurrence (in)</td>
<td>38.12</td>
</tr>
</tbody>
</table>
Results
## Results

<table>
<thead>
<tr>
<th>Drop Height (in)</th>
<th>USPS</th>
<th>UPS</th>
<th>FedEx</th>
<th>DHL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Highest</td>
<td>136.86</td>
<td>74.49</td>
<td>74.69</td>
<td>131.84</td>
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<tr>
<td>2nd Highest</td>
<td>59.42</td>
<td>52.20</td>
<td>72.59</td>
<td>68.30</td>
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<tr>
<td>3rd Highest</td>
<td>44.26</td>
<td>48.73</td>
<td>71.36</td>
<td>66.20</td>
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<tr>
<td>4th Highest</td>
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<td>41.56</td>
<td>51.48</td>
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<tr>
<td>5th Highest</td>
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<td>25.90</td>
<td>50.76</td>
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<td>6th Highest</td>
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<td>22.79</td>
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<td>7th Highest</td>
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<td>8th Highest</td>
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<td>17.93</td>
<td>31.95</td>
<td>40.14</td>
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<tr>
<td>9th Highest</td>
<td>28.94</td>
<td>15.44</td>
<td>31.57</td>
<td>36.63</td>
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<tr>
<td>10th Highest</td>
<td>28.17</td>
<td>13.30</td>
<td>31.45</td>
<td>35.30</td>
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</tbody>
</table>
# Results

<table>
<thead>
<tr>
<th>Carrier</th>
<th>Orientation of Drops (%)</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Face</td>
<td>Edge</td>
<td>Corner</td>
</tr>
<tr>
<td>UPS</td>
<td>19.36</td>
<td>36.62</td>
<td>44.02</td>
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<tr>
<td>USPS</td>
<td>8.17</td>
<td>57.14</td>
<td>34.69</td>
</tr>
<tr>
<td>FedEx</td>
<td>13.95</td>
<td>44.26</td>
<td>41.79</td>
</tr>
<tr>
<td>DHL</td>
<td>20.59</td>
<td>28.43</td>
<td>50.98</td>
</tr>
</tbody>
</table>
Results

- The typical number of drops according to ASTM and ISTA test methods range from six to ten to twelve.
- Select optimum number of drops for lab simulation of shipping environment.
- Creating lab test depends on looking up the values in the provided tables:
  - Drop height based on Assurance Level for product
  - Orientation %


MSU CDP Published Studies