Main Topics

- Physical distribution environment and distribution hazards
- Mathematical model and theory of protective packaging system
- Product (shock) fragility and vibration sensitivity
- Cushioning materials and properties
- Compression issues
- Protective packaging development process
- Packaging for perishables and temperature sensitive products
- Package testing methods, standards, and systems

Physical Distribution Environment

**Warehouse and Handling**

- Walkie Truck
- Reach Truck
- Forklift

**Package Sorting and Handling**

Physical Distribution Environment – continued

- Manufacturer self operated distribution system
- Common carriers
- Third party logistics

Shipping Quantity

- Container load
- Truck load
- Less than truck load
- Small parcel/express

Distribution Efficiency

Transportation Mode – Ocean

Transportation Mode – Rail
Freight Train

Transportation Mode – Truck

   Trucking
   Forklift

Transportation Mode – Air

Transportation Mode – Mixed

Physical Distribution – Examples

• Buy a SONY DVD player from Best Buy store
• Buy a coffee maker from Wal-Mart store and JIT logistics
• Order a computer from Dell Direct over the phone or from the Internet

Distribution Hazards

- Mechanical Hazards
  - Shock/impact/drop
  - Vibration
  - Compression
    
- Climatic/environmental Hazards
  - Temperature (high, low)
  - Humidity
  - Atmosphere pressure
  - Light
    
- Biological Hazards
  - Microorganisms
  - Insects
  - Mites
  - Rodents
    
- Contamination Hazards
  - By materials of adjacent packs
  - By leaking contents of adjacent packs
  - Radioactivity
    
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Distribution Measurement and Analysis

What’s Distribution Packaging?

Different Levels of Packaging

Three Areas Related to Distribution Packaging

• Physical distribution environment and associated hazards
• Product sensitivity characteristics
• Available packaging materials/structures/methods/techniques

Product Package System

Mathematical Model of Product Package System

The Physics of Impact/Shock

Product Fragility

A Shock Machine
Data Acquisition System
The Shock Pulses
Damage Boundary Curve

Mechanical Vibration

Free Vibration
Forced Vibration
Model of Product and Cushion on Vehicle
Sine Vibration vs Random Vibration
Vibration Simulation Testing
Sine Test or Random Test?

Cushion Materials and Properties

Cushioning Material in General Term
Common Cushion Materials
Dynamic Cushioning Curve
Vibration Transmissibility

Protective Packaging Development

5-Step Distribution Packaging Development Process
Computer Aided Packaging Development
Computer Simulation Based Distribution Packaging Development Process (Example)

Cushion Structure Examples

Compression Issues

Compression in Distribution Environment
Static Compression vs. Dynamic Compression
Protecting Product from Compression Damage
• Strong outer container
• Inner packaging materials/structures
• Product support

Corrugated Board and Shipping Container

Other Shipping Containers

Packaging for Temperature Sensitive Products

Package Performance Testing

QUESTIONS?
THANK YOU!