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How to Prevent Logistics Damage to Electronics



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A cell phone, dropped from ear height, can experience an impact of up to 1,000 G's. Even though that phone, like other consumer electronics, is designed to withstand a certain level of impact, it still can be damaged. During shipping, even though devices such as cell phones, laptops, televisions, headphones, video game controllers, etc. are securely packaged, they are still at risk from supply chain mishaps. The damage from these events may go unnoticed, however, unless a package shows visible signs of damage – a crushed corner, for example.

Every electronic component is subjected to unfavorable conditions at some point in the supply chain. Many of these are anticipated. For example, trucks transmit vibrations from engines and irregular road surfaces. Trains experience impacts when cars are coupled and the clickety-clack of vibrations when railcars cross rail seams. Ships pitch and roll in high seas. Planes transmit vibrations from aerodynamic buffeting, which shakes the airframe, as well as the impact of runway touchdowns. Temperatures rise during the daytime and fall at night, and vary – sometimes significantly – between the point of origin and the destination. Humidity changes too, causing condensation within container, which may damage products. Even tilting some items can create stresses that lead to damage. In every case, the potential for damage varies with the item itself.

Cost Concerns

The cost of damage caused by impact, vibration, tilt, temperature, and humidity is exacerbated by a short product life-cycle and the need to contain manufacturing costs. In the U.S., the average smart phone is replaced after 23 months[1], despite a viable product life of nearly five years[2]. For a flat screen TV, the product life cycle is 7.4 years, and for laptops, video game consoles and other electronics, the typical life span is three to four years, but analysts expect that to decrease in coming years… After that, they typically are replaced by newer, more capable models.

Short product life can drive intense price competition, which manufacturers achieve partially by procuring inexpensive, lightweight materials.

Compact designs also increase products' risk of being damaged. To achieve a small footprint, components are placed extremely close together inside products and may collide during impacts. The decreasing pitch of chip scale packages, for instance, allows tiny keypads for ever smaller devices. But the compact size also decreases the size of the circuitry and their solder joints, making products more



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susceptible to damage from impacts and vibrations.

Damage Results

Sometimes the results of supply chain conditions are obvious, but too often damage is hidden inside electronics. In that case, issues are unlikely to be identified before the consumer tries to use the product. Sometimes the damage manifests long after a purchase, when material fatigue accumulates and causes failures. That leaves the consumer wondering why the product broke, and leaves the manufacturer paying for warranty repairs while trying to rehabilitate a tarnished reputation.

Impact - Any jolt an object experiences is an impact, regardless whether it is caused by products striking each other, rail cars coupling, or delivery persons tossing packages. The annual rash of Christmas videos showing delivery personnel tossing packages onto consumer porches and over fences is a good example of simple things that go wrong. For packages of 25 pounds or less, the most likely handling mishap is being dropped while carried, according to the Canadian Conservation Institute. A packed carton dropped from a height of three feet experiences a shock of 113 Gs, which may crack screens and break delicate components on circuit boards. Exposure to that impact level may be acceptable handling for some equipment like

ruggedized handheld radios, but not for more fragile items like computer monitors and game consoles.

Vibration - Simply put, vibration is a series of small impacts. With trucks, for example, vibrations may be caused by the road surface, vehicle speed, suspension type, and structure of the trailer. Although vibrations may not be noticeable, they can cause damage. Throughout transit, items may experience a wide variety of vibrations. Trucks on a highway, for example, transmit vibrations in the ranges of 2 to 10 Hz, although vibrations of 15 to 70 Hz emanate from their suspensions, tires, and chassis. And, the higher a package is placed in the truck, the higher the vibration. A plane's vibrations range from 2 to 200 Hz and stem from the air frame, cargo floor, and touchdowns. If these vibrations are transmitted to the product, they may create a resonance that causes more damage than the initial vibration.

When an electronic package is dropped, it experiences an initial shock followed by post-shock vibrations, similar to the ripples that form when a rock is tossed into the water. When impact or vibration occurs to electronics, any problems that result tend to be hidden damage – a loosened screw, a disconnected socket, or a broken solder joint deep inside the product. To put this into context, although office equipment looks sturdy, it is comparable to glassware or unfired clay in terms of its ability to withstand vibration, according to the Canadian Conservation Institute.

Regardless what packaging is used, one of the challenges is ensuring the package design doesn't amplify shipping vibrations. For more sensitive electronics, such as components in stationary consumer electronics, packagers may need to design packaging systems that actually dampen vibrations by decreasing their frequencies.

Tilt - The dangers of tilting cargo during shipment often is overlooked, but can put undue stress on certain products. Flat screen TVs, for example, are designed to mount vertically. Tilting them beyond about 10 degrees – including laying them flat – puts undue stress on the thin glass of the screen that may result in damage... Tilting also may damage other products or components by putting pressure on elements not designed to bear the object's weight.

Tilted products also are more likely to fall during shipping. A 27 inch flat screen TV, for instance experiences up to 240 Gs when it tilts, falls, and hits the floor. In tests performed by the Consumer Product Safety Commission, the average force was below 2,100 pounds upon impact – easily enough to cause damage.

Temperature - Virtually everyone knows not to leave electronics in car trunks or on sunny dashboards during summer heat waves, but heat dangers aren't always adequately considered when shipping electronics across the country or across the world. Even on mild days, the heat trapped inside covered pallets on a tarmac can be significantly higher than the ambient air temperature and, therefore, damage electronics. For example, one particular shipment sat on a tarmac in 25°C temperatures, under a clear plastic pallet cover airlines use routinely to protect cargo from weather and abrasion. The temperature underneath the cover was above 50°C, thanks to the greenhouse effect.

Resultant damage may include shorter battery life as well as warped or even melted components or cases. Extreme cold is a danger, too. Although most laptop hard drives, for example, have a non-operating temperature range of -40° to 70°C (-40° to 158°F), extreme winter temperatures throughout the U.S. and Canada sometimes reach such extreme levels. At low temperatures, hard drives can freeze, losing data, including factory-loaded programs. Plastics also are more likely to crack.

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Either hot or cold temperature extremes can dramatically shorten battery life.

Humidity - This is an obvious threat. When humidity is too low, static electricity builds up, and can result in damage due to static discharge. Conversely, too high humidity may penetrate seals and condense, beginning a corrosion process that may not be discovered for months or years.

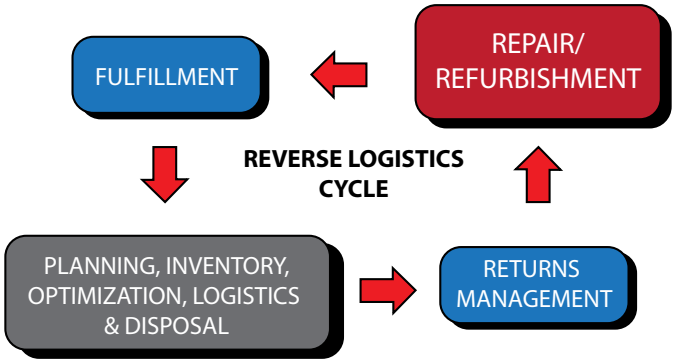
The act of moving cargo between notably different environments may cause condensation when humidity is significantly different. The issue is important enough that some electronics manufacturers build in humidity sensors so the devices cannot be operated until a safe humidity is reached.

Lab Testing

Packaging engineers work to mitigate damage from environmental conditions, using increasingly sophisticated tests and simulations. Results depend heavily upon test design, so shippers must ensure the testing engineers understand the relationship of the test to the component being tested.

New testing models can incorporate both random and sine wave excitation and enable the use of detailed distribution shapes that closely mimic real-world conditions. Impact and vibration tests may be based upon certain conditions – a shaker may mimic road vibration, or a system may replicate the acceleration of a truck suspension on a bumpy road, for example. Temperature testing can follow anticipated shipping lane temperatures. Although these tests are realistic, they may not expose the product and its packaging to all the conditions experienced during an actual shipment. The only way to get that information is to monitor real shipments.





Reverse Logistics Visibility

Mobile electronics are especially vulnerable during daily use. A survey by Corning (makers of Gorilla Glass) shows that 85 percent of cell phone users have dropped their phones at least once a year, and 55 percent have dropped them more frequently. The impact a phone experiences when dropped, for example, can break internal electronics. The phone may break immediately or the drop may stress internal components and contribute to material fatigue. Either way, the product may be returned for warranty repair.

To better understand the root cause of warranty repairs, manufacturers may consider adding small impact indicators inside consumer electronics. A small impact indicator draws no energy and fits inside even small devices, providing additional insight that can help manufacturers reduce costs and improve quality. Because it is inside the actual device, it can provide objective evidence that shows whether the product was dropped at sufficient force to cause damage. Then manufacturers can decide whether to repair the product under warranty or take other action. If the indicator doesn't show an impact occurred, the manufacturer knows to investigate other causes, such as material fatigue or materials substitution by suppliers.

Best-in-class companies take steps to understand the underlying need for the repairs and incorporate that information into decisions affecting product design and materials sourcing. For example, when analyzing repairs, one equipment manufacturer found the bulk of its repairs involved one particular component supplier. With that knowledge, the company was able to remedy the situation. In fact, the ability to recover costs from the suppliers responsible for product failures is one of the hallmarks of best-in-class reverse logistics operations, according to The Aberdeen Group. It points out that, while visibility into the return cycle is growing throughout most organizations, the extent of that visibility is one of things that sets best-in-class companies apart from their competitors.

Next Steps

Part of that visibility is provided by monitors and indicators attached to products or pallets as they move throughout

the supply chain. By tracking and analyzing the data from these sources, companies can reduce overall costs and catch problems before they become consumer problems.

Monitoring conditions throughout the supply chain is one part of a robust product protection and loss prevention program. It should be deployed especially for high-value products with long or complicated transit routes, and also for lanes or carriers experiencing problems. Routine use, even among top carriers or lanes, can provide insights into the actual conditions products experience during shipping. That enables shippers to develop strategies to further improve the supply chain.

Consumer electronics are becoming increasingly rugged, but they are not impervious to supply chain conditions. Contact SpotSee to learn how supply chain monitoring can cut your warranty costs, help you increase your products' reliability, and improve your reputation.



SpotBot Cellular

A standalone device that delivers tri-axial impact monitoring and live tracking through cellular connectivity. It features real-time visualization through the SpotSee Cloud, a web based platform. SpotBot features best in class impact monitoring, generating accurate data on impacts up to 65G which is four times (4X) the range of the next best competitor.



SpotBot BLE

The device was created in partnership with Bosch to make the supply chain transparent. Once attached to the shipment, the SpotBot BLE measures and records temperature, humidity, tilt, and shock, with the data visualized through the SpotBot BLE app. The limits of each parameter can be individually configured, and any violation is traceable and assignable.



ShockDot

These tamperproof indicators turn red when a potentially damaging impact occurs. Each indicator is serialized and ensures the user that the device has not been switched during transport.



TiltWatch XTR

A single-use tip indicator used to monitor goods that must remain upright. Once applied to the packaging, the TiltWatch XTR will provide evidence of mishandling if the shipment is tipped. However, the tilt indicator remains unaffected by movement resulting from normal handling conditions.

Speak with a local SpotSee logistics expert about your supply-chain and explore our best-in-class logistics devices.

Sources

1. Armstrong, Martin, and Felix Richter. "Infographic: Smartphone Life Cycles Are Changing." Statista, 2 Mar. 2017, www.statista.com/chart/8348/smartphone-life-cycles-are-changing/.
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