

ThinkPad

ThinkPad Quality Design and Packaging



ThinkPad

QUALITY - Design and Packaging



Heat Dissipation Testing

FACT:

Computers produce heat that needs to be dissipated.

TEST:

Attach thermocouples to ThinkPad components. Check for heat dissipation in locations such as Customer access areas. Find ways to improve the cooling of the system, i.e. using Heatpipe technology.

CUSTOMER BENEFITS:

1. Intelligent design and heat dissipation testing reduces internal ThinkPad temperatures, helping ensure dependable operation.
2. The same design and testing provides customer flexibility by enabling use in environments as hot as 95 degrees Fahrenheit.

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Heat Dissipation Testing



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Electromagnetic Compatibility Testing

FACT:

All computers emit electric & magnetic fields which must be contained. Radar and radio frequencies can cause a mobile system to fail.

TEST:

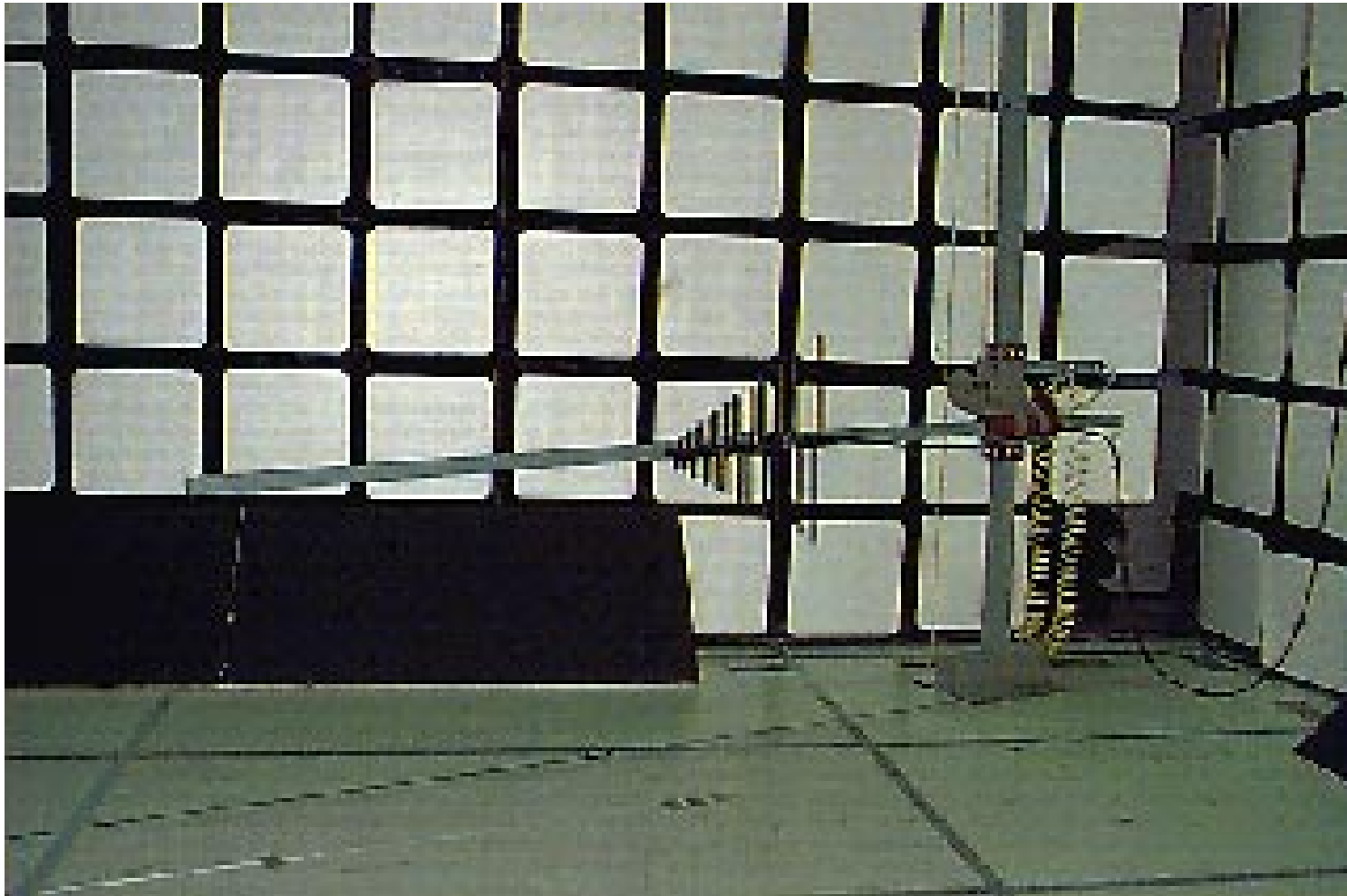
1. Antennas measure ThinkPad electric fields. Objective: achieve worldwide certification for home and office environments.
2. In another test, a room is pumped full of radio and radar frequencies. Objective: ensure the ThinkPad continues to function.

CUSTOMER BENEFIT:

A ThinkPad that works no matter what radio environment it is in.

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Electromagnetic Compatibility Chamber



Electrostatic Discharge (ESD)

FACT:

Computer systems are susceptible to static discharge which can damage memory, planar, the hard file, and other components. Static discharge can also lock up a computer.

TEST:

The ESD machine simulates static discharge on a ThinkPad.

CUSTOMER BENEFIT:

The ThinkPad is hardened against static discharge which results in increased reliability.

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Power Line Testing

FACT:

All mobile systems are susceptible to power drops. Power drops may shut off a system and cause it not to come back to its previous running state.

TEST:

An instrument simulates power drops below specific levels, and ThinkPad must come back to its previous running state.

CUSTOMER BENEFIT:

Increased reliability

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Acoustic Testing

FACT:

Computer noise is distracting and annoying!

TEST:

The purpose of this test is to measure the noise emitted by the ThinkPad.

The semi-anechoic chamber:

- a. absorbs the sound energy emitted by the machine and
- b. prevents noise from outside the chamber contaminating the noise measurement. Hence, precise and repeatable acoustics data can be collected.

CUSTOMER BENEFIT:

Reduced annoyance! Working with suppliers and package designers, our engineers seek to minimize or eliminate noise to help us produce some of the quietest machines on the market.

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Semi-anechoic Chamber



Packaging Engineering

FACT:

There are vertical & horizontal forces imparted to a mobile system during distribution that could cause damage.

TEST:

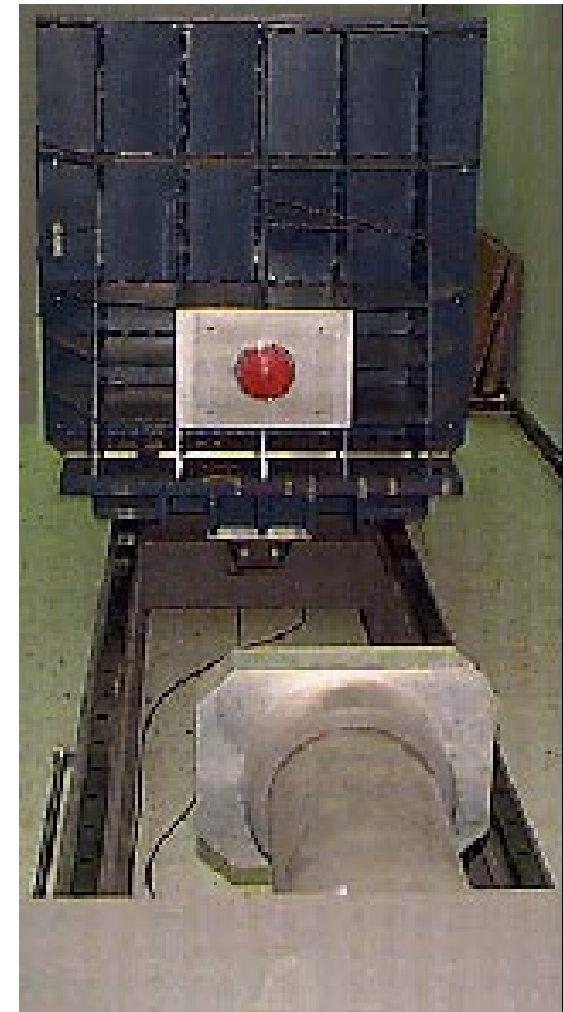
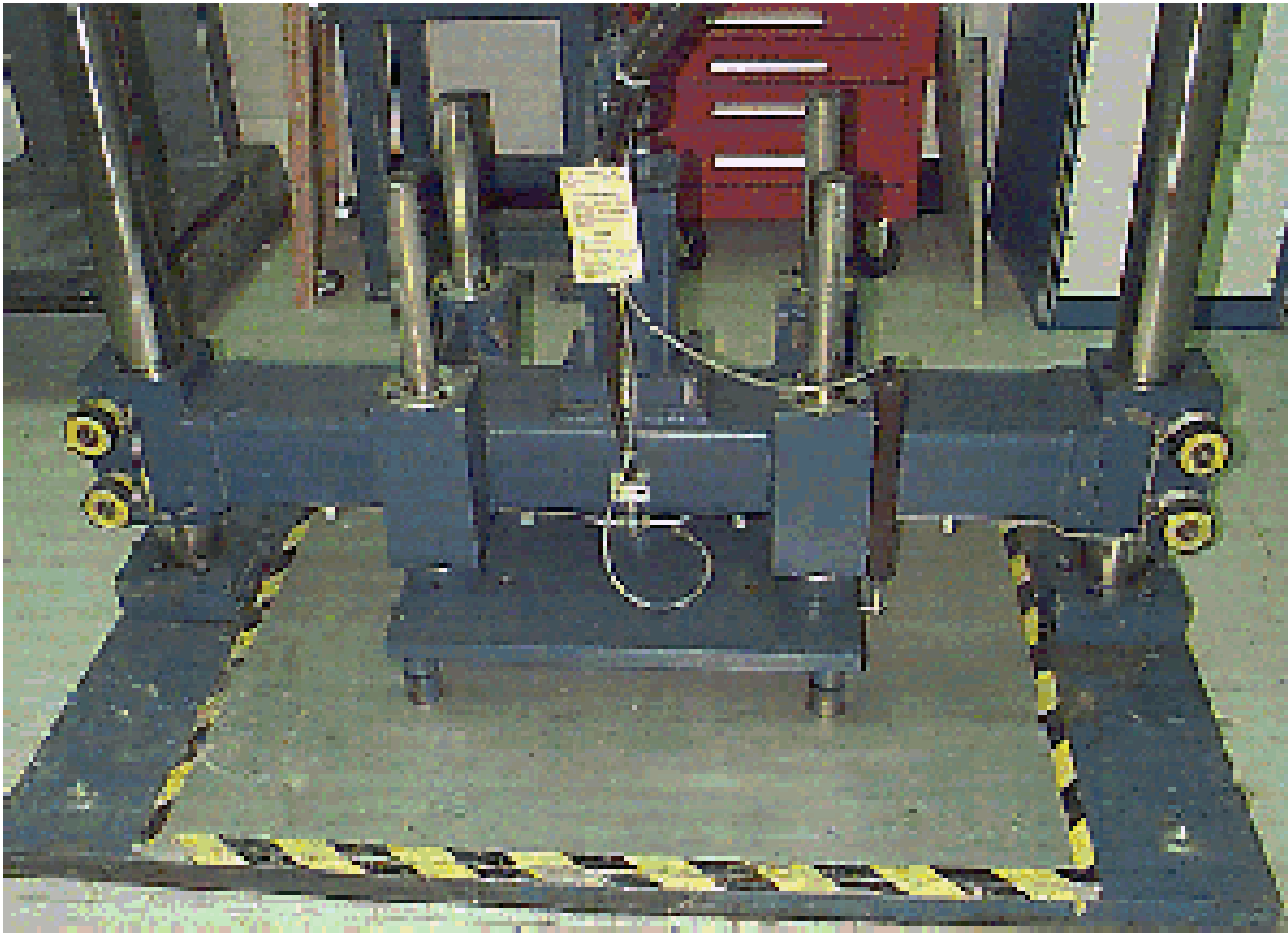
Drop, vibration, and compression tests develop a robustness level for a ThinkPad that is used to design a shipping package.

CUSTOMER BENEFIT:

Our comprehensive engineering packaging processes help ensure a customer that his system will arrive in a working condition.

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Packaging Testing



Drop and Vibration Testing

FACT:

Mobile systems unsupported by stringent design, manufacturing and packaging processes can fail during transport and handling.

TEST:

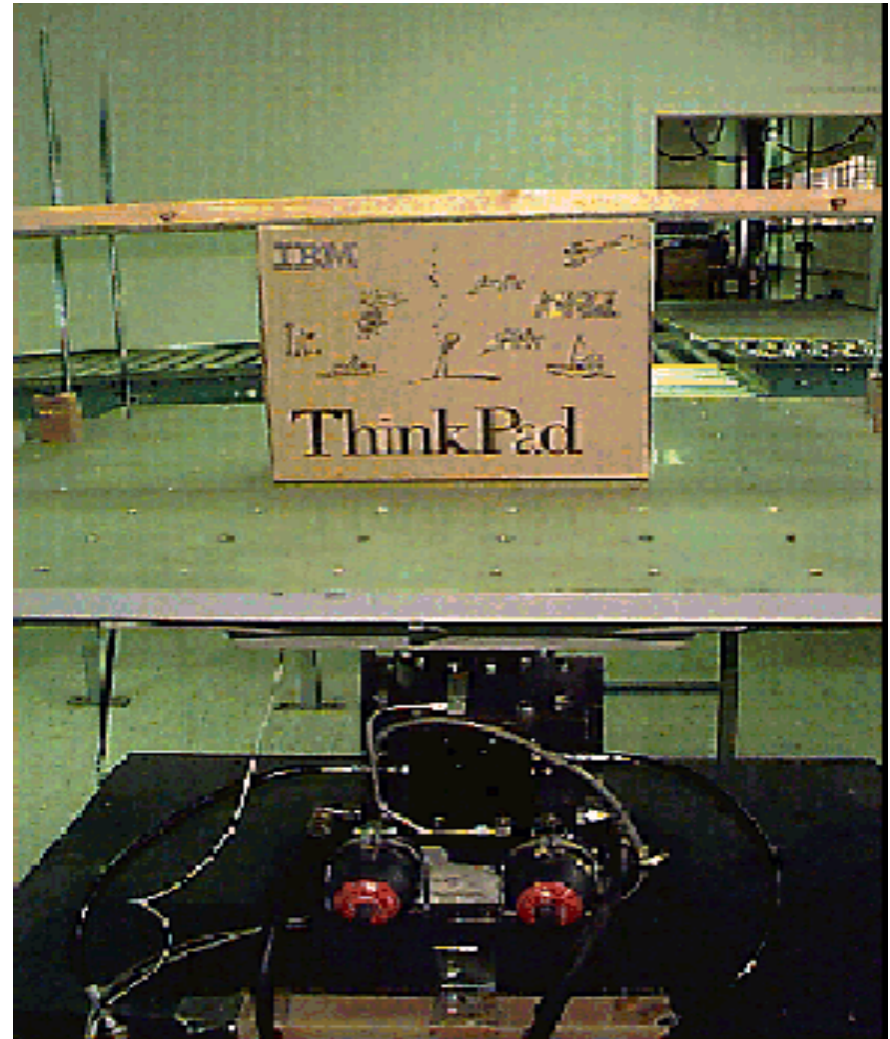
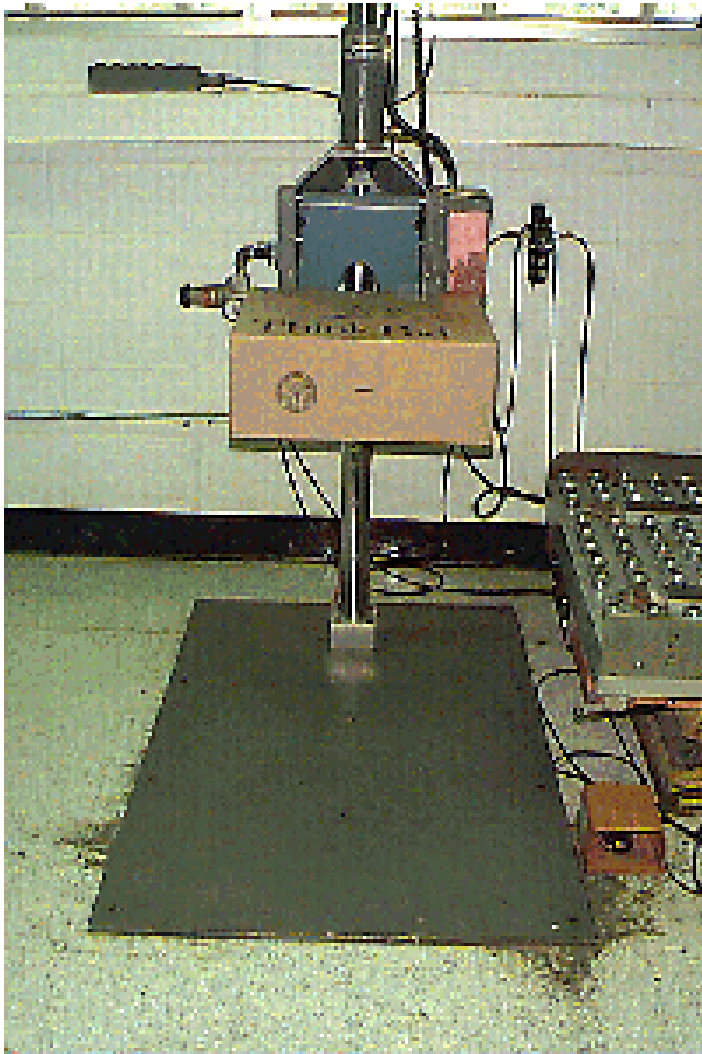
Simulate mechanical stresses during transport and handling

CUSTOMER BENEFITS:

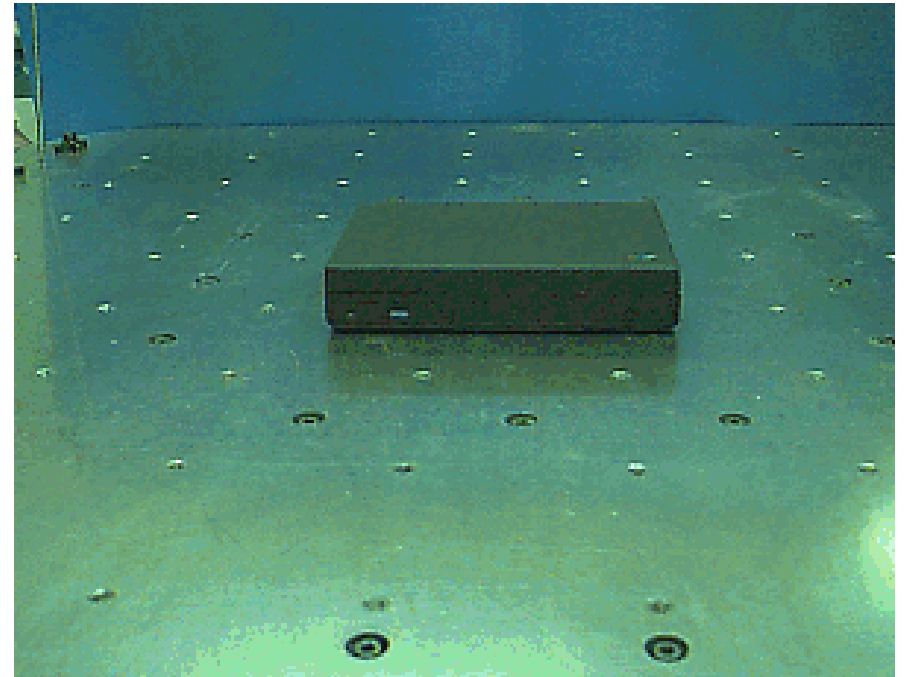
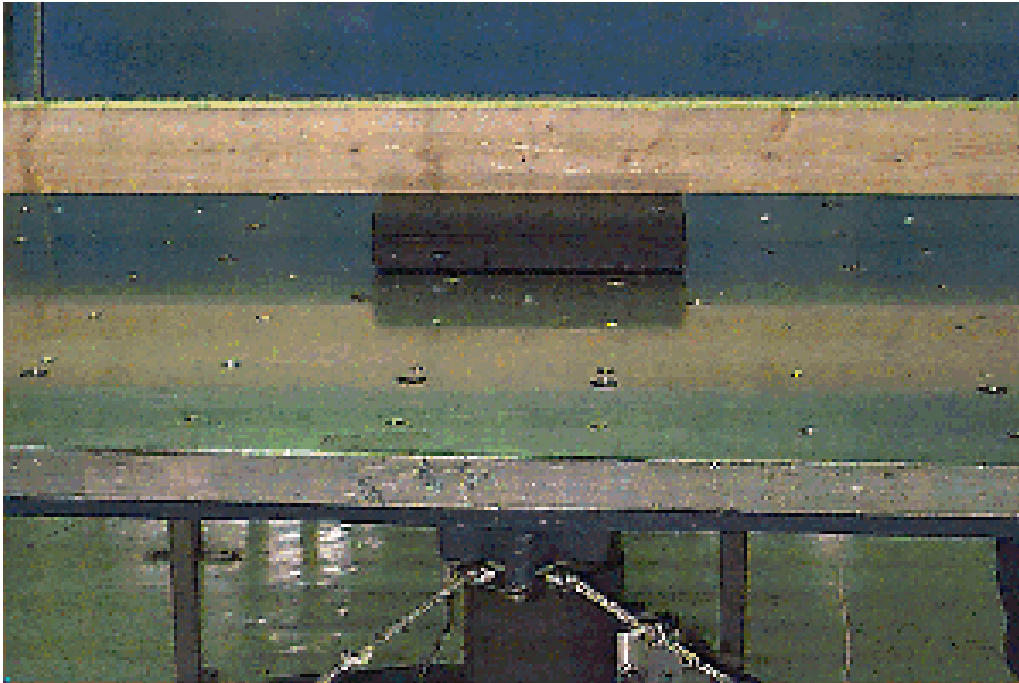
1. Detects potential out-of-box problems before shipment
2. Mobile systems are transported in environments subjected to vibration and shock -- the seat of a car, airplane travel.
ThinkPads are built and tested to perform under these conditions.

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Drop and Vibration Testing



Out-of-Box Vibration Testing



Thermal Cycle Chamber

FACT:

Expansion & contraction of components can damage mobile systems.

TEST:

1. Simulate extreme temperature fluctuations
2. ThinkPads are randomly selected off the assembly line and tested in a chamber that repeatedly cycles at hot and cold temperature extremes.
3. Systems are powered on and off over a 100 times during this test.

CUSTOMER BENEFIT:

A customer can transport his ThinkPad from a hot to a cold environment (and vice versa) knowing that it has been thoroughly tested to work reliably under these conditions.

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Thermal Cycle Chamber



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Elevated Temperature Chamber

FACT:

Heat is the enemy of all computers.

TEST:

1. ThinkPads are randomly selected from the assembly line.
2. Diagnostic software is run on a ThinkPad for many days in a chamber in elevated temperatures.
3. Software executes cycles of tests that checks memory, hard drive, diskette drive, etc.

CUSTOMER BENEFIT:

Increased reliability

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ThinkPad Quality
Procurement



Centralized Procurement

FACT:

1. A centralized procurement organization streamlines consolidation of worldwide demand.
2. It presents a single set of supply requirements to suppliers.

CUSTOMER BENEFITS:

1. Improved negotiating power enables us to pass on the benefit of lower parts prices to our customers.
2. Buying from the best suppliers improves product quality.
3. If the marketplace demands a certain commodity, and we cannot find it within IBM, we will obtain it for our customers wherever we can.

Technical Partnership

FACT:

1. A technical partnership between procurement and development facilitates:
 - greater emphasis on defect prevention
 - reduced dependence on manufacturing processes to catch defects
2. Procurement has expertise to identify technology, price, and availability trends to product development.

CUSTOMER BENEFITS:

1. A quality strategy that prevents defects is intrinsically better in protecting the customer than a "reactive" strategy.
2. Technical partnership helps guarantee the latest available technology.

Supplier Report Card

FACT:

1. Feedback is provided to our suppliers on their quality performance:
 - on-time delivery
 - responsiveness to problems
 - defect-free products
 - flexibility to changes in volume and changes in schedule
2. Suppliers must demonstrate and maintain high quality standards.

CUSTOMER BENEFITS:

A high level focus on supplier quality leads to a higher quality product:

- in the initial receipt of the product
- in long term reliability and performance

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ThinkPad Quality
Manufacturing

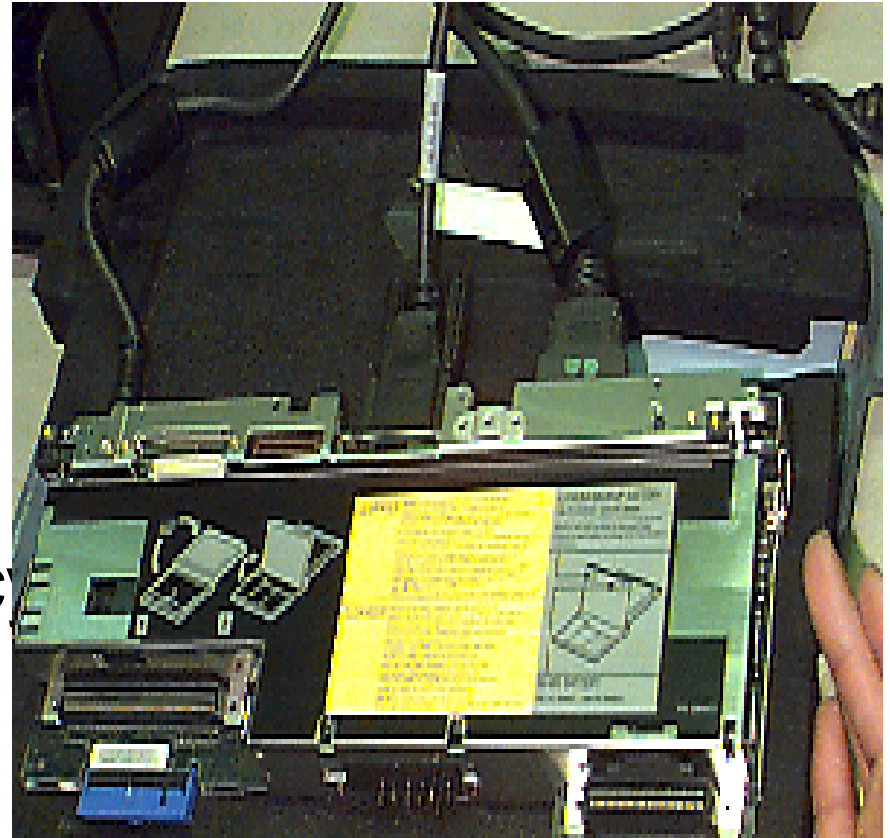


QUALITY - In Manufacturing



Planar Sub-Assembly

- CPU, planar, video, audio, and power card assembled
- All assembly operations are tracked and tested
- Parts are scanned for accuracy



LCD Sub-Assembly

- LCD panel is assembled and tested for vivid, bright colors.
- Protective film protects panel against scratches
- Audio is tested



Keyboard Sub-Assembly

- Keyboard card and speakers are attached
- Keyboard, speakers, and LEDs tested
- LCD must display "PASS"

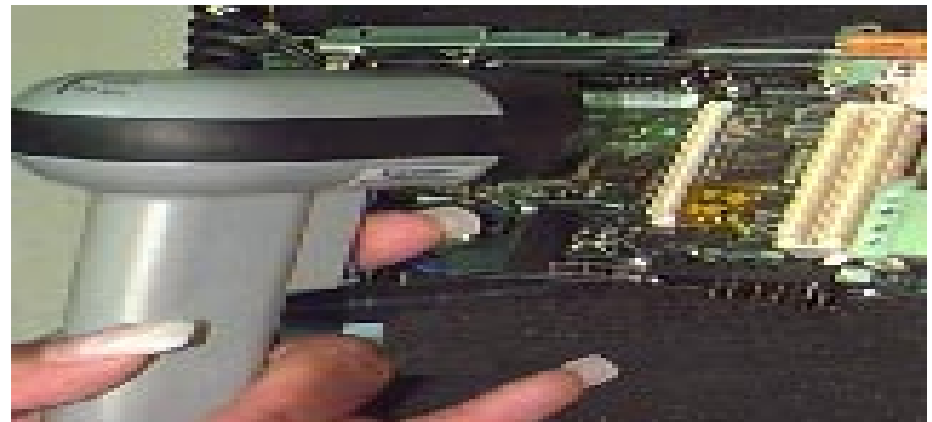


Components Added

- Hard file, diskette drive, and memory are added
- Diagnostic programs loaded. Multimedia functions checked



Parts scanned into Data Base
Floor Control System



Power Management Testing

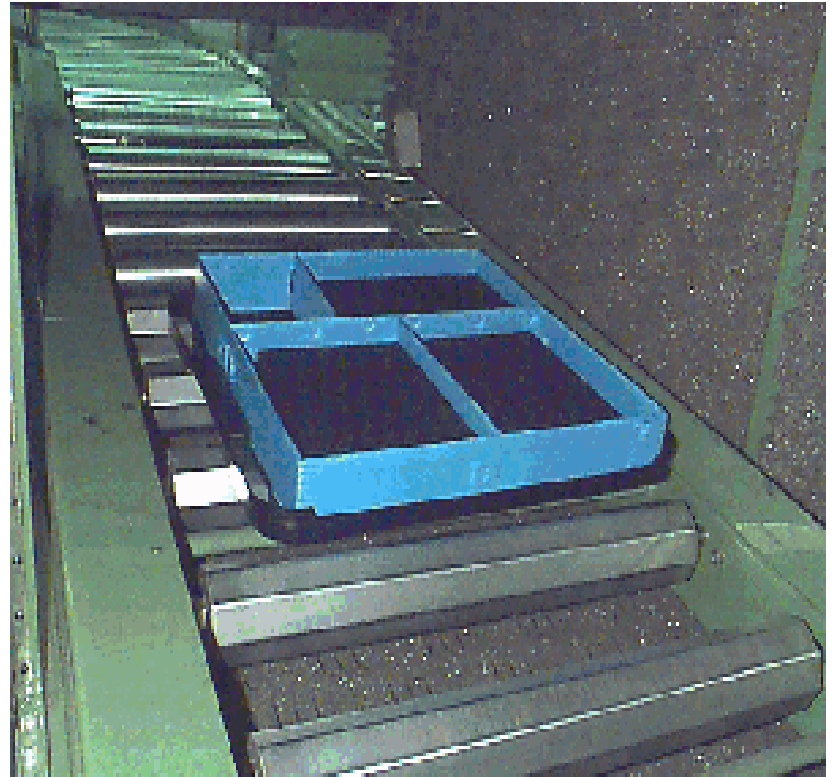
- Battery tests:
 - charge
 - discharge
 - suspend/resume

- External monitor displays "PASS" after tests complete successfully.



Shake and Vibration Conveyer

- Simulates truck travel and handling
- Conveyer vibrates ThinkPad systems for 10 seconds
- Detects loose soldering joints and cable connections



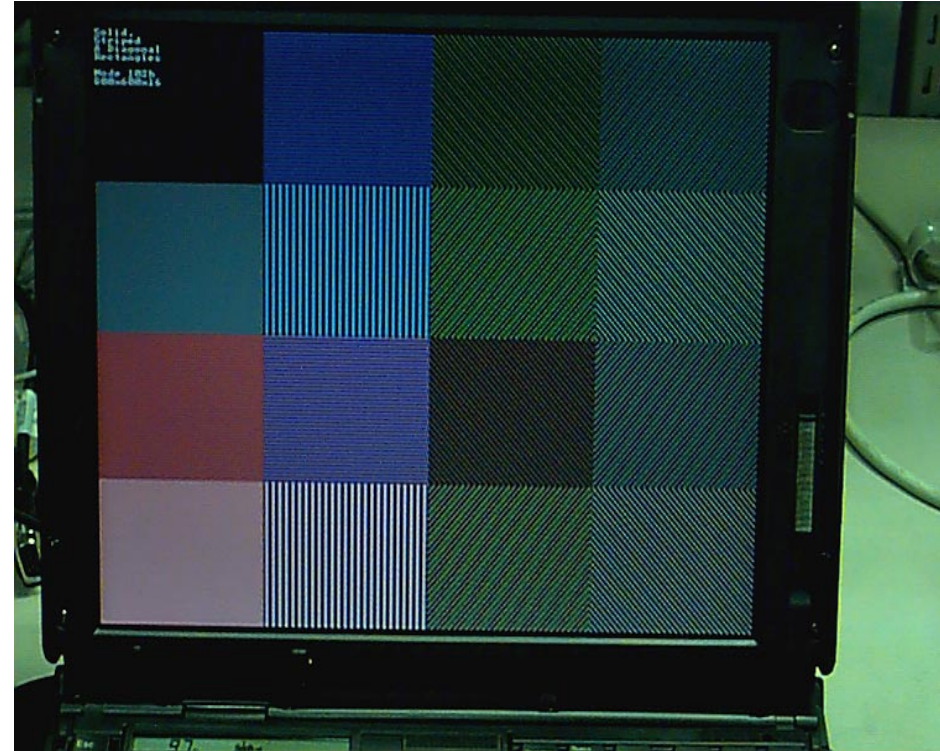
Elevated Heat Chamber Testing

- Diagnostics test all ThinkPads for 12 hours at 95 degrees Fahrenheit.
 - Hard Disk
 - Diskette Drive
 - Memory
 - Display
- Errors logged to diskette. Root cause determined.

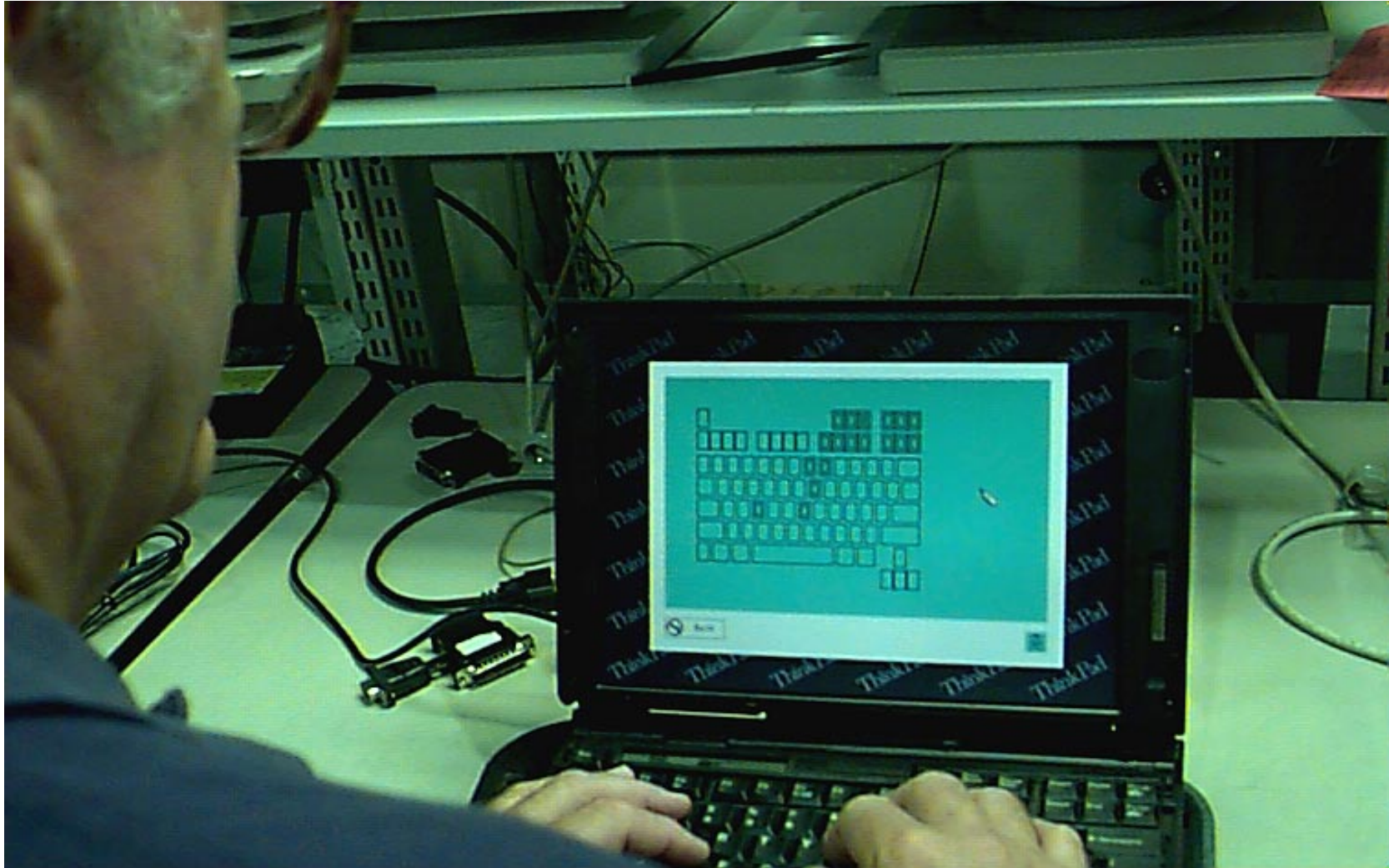


Extensive Diagnostic Testing

- Additional testing ensures ThinkPads operate properly
- Stringent LCD panel tests
- External ports, hard file, diskette drive, memory, CD-ROM drive are tested



Extensive Diagnostic Testing



Software and Final Packaging

- Operating system and application software down-loaded to hard file via PCMCIA LAN adapter
- Final packaging and visual inspection
- Data Base Floor Control System monitors all processes to ensure high quality

Data Base Floor Control System



Out-of-Box Inspection Station

- Reaching for the very highest quality in mobile manufacturing
- All ThinkPads are re-tested
 - CPU
 - Display Panel
 - Planar
 - Storage Devices
 - Memory

