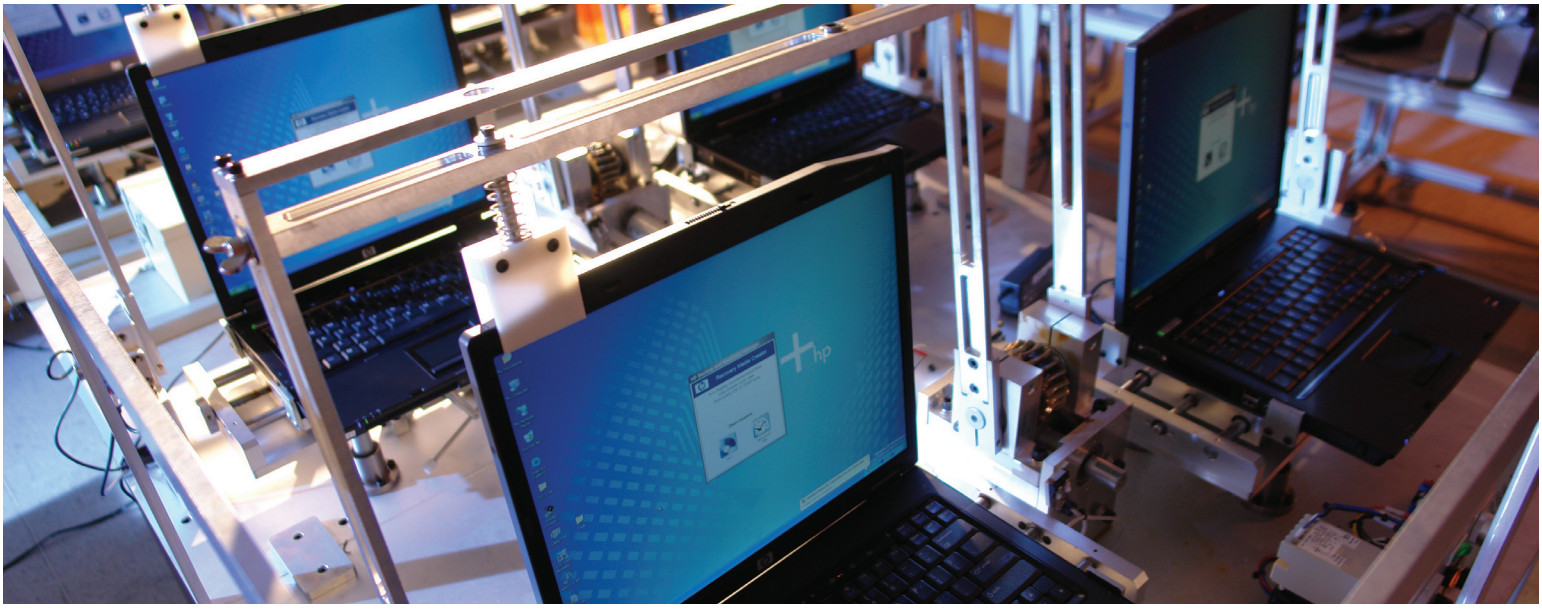


# HP BUSINESS NOTEBOOK QUALITY SYSTEM WHITEPAPER

Driving Higher Standards
Precise attention to detail. Uncompromising quality.

## Table of contents

# The HP Notebook Quality System involves a continuous program of systematic process improvement.

## Introduction

The HP Notebook Quality System involves a continuous program of systematic process improvement. From the earliest design stage through product testing, manufacturing, service and support, and eventual end-of-life, we remain alert for new opportunities to improve our products, our services, and our relationships with our customers.

The HP Notebook Quality System offers many benefits:

- Stringent component quality standards drive suppliers to improve quality and processes over time.
- Comprehensive product design and development process have quality control built in.
- Exhaustive lifecycle testing validates product quality and ensures interoperability.
- Routine and random audits are performed throughout development and manufacturing to ensure that our rigid quality standards are maintained.
- Early warning and detection systems contain and resolve potential issues, often before they affect you.
- World-class, award-winning service teams and service partners deliver prompt, professional support with minimal impact on your business.
- Fundamental, quality-driven processes ensure rapid escalation and resolution. Field findings are then incorporated to the process, delivering continuous improvements to all aspects of the HP Notebook Quality System.

## Commitment to quality from the start

Our development process involves every major function of the company: supply chain, marketing, design, engineering, service and support, and more. We want our products to provide the consistency and stability that you require. Our attention to detail in the design process, combined with the highest-quality materials in production, has created a line of some the most durable business notebook PCs in the industry.

### Certified strategic suppliers

HP Business Notebook PCs use only the highest-quality materials. Throughout product development, every aspect of the components and products are tracked and closely monitored. We maintain deep, long-standing relationships with our suppliers, and we work closely with them to drive ongoing quality improvements over time. Toolmakers, molders, sheet-metal vendors, and other sub-suppliers must meet the strict requirements of our approved vendors list (AVL), and stringent quality controls ensure that they continue to meet them.

For additional quality assurance, we have supply chain engineering staff at the manufacturing sites tasked with closely monitoring sub-suppliers. They are responsible for component audits and for ensuring all inventory parts meet our stringent quality controls. They also ensure that design upgrades are effectively implemented on sub-assemblies, appearing exactly how the design team envisioned them. We track failure data by component and supplier in an effort to use only the highest performing parts and suppliers to help drive continuous improvement.

## Precise attention to manufacturing

Large-scale manufacturing entails numerous quality check points and standardized production metrics. Operator error is removed from the notebook quality check equation by reconfiguring the manufacturing floor using advanced robotics to help identify any issues. Key mechanical features in the notebook are tested to ensure proper functioning. Simulating the end-user experience, these robotic test fixtures are vital because they provide a standardized assessment that ensures every batch of notebooks meets the standard.

As an example, all HP EliteBooks undergo manufacturing quality assurance inspections–meeting the HP EliteBook quality standards–before shipping:

- The entire notebook is examined prior to shipment to ensure precise fit and finish. Hinges, keyboard, touchpad, seams, and even docking hooks, are examined with precision gauges to ensure all meet exacting standards before they leave the manufacturing floor.
- Stringent component level quality control is also applied to sub-assemblies including objective pass/fail criteria to ensure every component is manufactured to HP standards.
- Automated testing devices test every HP EliteBook to ensure perfect display latching/unlatching– and perfectly smooth docking/undocking–every time. These precise testing devices ensure that each HP EliteBook measures up to the same exacting standards–every time.
- Each HP EliteBook is measured for outstanding precision. The system is placed on a flat surface to ensure it is correctly leveled. Measurement gauges are used to ensure the palm rest area, keyboard keys, and other surfaces are flat and smooth.
- HP has a senior level engineering executive attend every development build to ensure that all these exacting standards and quality measures are achieved. The senior executive inspects the notebook as it comes off the manufacturing line to ensure the finished product meets the quality and finish that earns the HP EliteBook badge.

## Engineered for quality

Months before any HP EliteBook is ever manufactured for a customer shipment, the notebook design engineers work in conjunction with the manufacturing engineers to optimize the design for production in a way that ensures extremely high quality. Line operators are provided with extremely detailed instructions describing each and every step of the process.

Once all the assembly steps are clearly defined and documented, the team then moves to executing a series of small development builds for each notebook model. With each small build, design improvements will be noted and implemented on the next round of the development build to improve the quality, precision, and aesthetics of the notebook. Any given HP EliteBook design will go through multiple small builds to fine-tune the design for optimal quality and manufacturability before the design is finalized.

HP EliteBooks are subject to multiple design enhancements prior to our first production build to ensure that the final design–the one you buy–is as finely built as was originally envisioned by the design engineer. Whether you buy thousands, hundreds or only a few, you get a business notebook you can depend on with consistent quality.

# Designing for quality

**Battery construction and design**

HP has developed and continues to develop technologies to help further improve battery safety (patents pending). Battery packs are robustly constructed with multiple redundant safety designs:

- Insulating safety wrap encloses battery cells.
- Fire-retardant casing conforms to rigorous safety standards.
- Barrier walls provide a liquid and thermal barrier between the battery cells and the Printed Circuit Assembly (PCA).
- Conformal coating on the PCA helps protect circuitry from potential shorts.
- Flexible circuit interconnects are designed to prevent pinching and potential short-circuits.

# Early warning and detection systems

The HP Notebook Quality System employs numerous improvement initiatives that help provide early warning and detection of potential troubles, contain any problems that do occur, and deliver consistent quality improvements over time:

- **Early detection.** We impose strict controls on our components and materials, ensuring that they all meet our rigorous standards, and we conduct exhaustive product testing during the development phase. As each new product enters the field, its performance is carefully monitored from every angle to identify and correct any unanticipated issues that may arise.
- **Rapid response.** Sales and service personnel respond rapidly and positively to any concerns that customers may have with a new product, no matter the cause, and support calls are quickly routed to dedicated specialists who are uniquely qualified to diagnose and resolve problems.
- Containment. If a consistent failure point reveals a weakness in a product design, immediate steps are taken to identify the problem and devise a solution.
- **Prevention.** Service personnel are equipped with effective solutions to known problems, and programs are in place to proactively distribute updates and patches to those with affected products, often before they know a potential problem exists, minimizing the impact on business resources.
- **Improvement.** We welcome customer feedback at every stage of the product lifecycle, because new opportunities for improving quality can be found anytime, anywhere.
- **Implementation.** Continuous quality improvements are constantly being applied back into the HP Notebook Quality System, from beginning to end.

# Measuring results

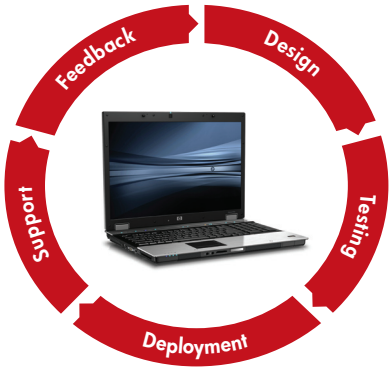
HP takes a hard-line approach to measuring quality. We're completely committed to producing the best possible technology and providing the highest levels of service, so we hold ourselves to a very high standard. We relentlessly scrutinize our business practices and development processes for potential areas of improvement. We think the end results speak for themselves.

HP uses two key quality metrics to set and monitor goals for continuous improvement:

- The first metric is the **Annualized Service Event Rate (ASER)**, which notes measures how often products are serviced during their warranty period. A service event occurs whenever a notebook PC is serviced while under warranty due to a hardware or software issue, regardless of the reason. This includes true component failures as well as those caused by the environment or user error.
- The second metric is the **Annualized Failure Rate (AFR)** which measures how often products fail for hardware related issues during their warranty period. In this context, a failure is defined as a failure where physical part of the notebook PC requires repair or replacement. AFR is a subset of ASER. While ASER covers both hardware and software issues, AFR only captures events that involve hardware failures.

ASER scores for HP Notebooks have improved by 30% since 2004 demonstrating our long term commitment to quality improvement.

**Figure 1**. The HP Quality Improvement Cycle




**Continuous improvement**
We systematically capture feedback to optimize future development and improve specifications.

**HP Total Care**
We offer a wide variety of services designed to meet diverse customer needs in 143 countries.

**Design and engineering**
Reliability is engineered into our products, with the highest-quality components in the right arrangements.

**HP Total Test Process**
Over 100,000 hours of extensive testing and validation ensure that our designs, materials, and components meet the highest standards.

**Total Customer Experience**
From product selection and installation to preventative issue resolution, HP is focused on customer needs.

# HP continuous quality improvement for business notebook PCs

HP's continuous quality improvement process for business notebooks helps ensure quality across the product lifecycle and beyond—throughout design, development, manufacturing, and the service and support processes. The result is higher-quality products, solutions, and experiences for our customers.

## Design: Higher quality features

HP designs and builds our Business Notebook PCs to deliver a superior experience with quality improvements and features based on years of direct customer feedback and exhaustive development, testing, validation, and analysis. For example, the HP EliteBook utilizes HP DuraCase, a full-metal case with a display latch that engages the top and the bottom of the notebook for enhanced impact protection, HP DuraKeys keyboard protection, scratch-resistant HP DuraFinish, HP Panel Protection system, and a spill-resistant keyboard with drains. HP Business Notebook PC s have won numerous design awards, including the IF (Industry Forum) product design award in 2003, 2004, 2005, 2006, 2008, and 2009.

## Testing: HP Total Test Process

Every HP Business Notebook PC is subjected to the HP Total Test Process (TTP)—a minimum of 100,000 hours of rigorous tests that help ensure superior quality and reliability in a wide range of applications and operating environments. Our testing process is constantly reviewed and enhanced to meet evolving customer and market needs.

Areas of testing include:

- **Mechanical tests.** As part of our mechanical testing, we simulate opening and closing the notebook 10 times every day for 6 years (25,000 cycles), as well as 7 years of keyboard usage (10 million keystrokes).
- **Accessory tests.** Key accessories such as internal and external batteries, memory, and AC adapters are subjected to extensive notebook testing processes. New accessories (keyboard, mice, hubs, external hard drives, optical drives) are tested with each new and current notebook to confirm full compatibility.
- **Software and system integration tests.** HP Business Notebook PCs undergo approximately 20,000 hours of comprehensive system level integration testing, involving more than 30,000 steps and 240 industry-standard hardware and software products per operating system.
- **Business rugged tests.** Most HP EliteBooks are designed to meet the tough military standards (MIL-STD 810G)[i] for drop, vibration, dust, humidity, altitude, and high temperature. For instance, the HP EliteBook 8440p has been tested at extreme temperatures over 60 °C/140 °F and below –29 °C/–20 °F as well as, high humidity, altitude, bumps, and vibration. It was dropped 26 times on each side, edge, and corner; and it was exposed to vibration levels simulating being transported 1,000 miles inside a truck and extreme conditions such as high humidity, dust, and 15,000 feet altitude.

## Deployment: Total Customer Experience

As part of our quality processes, early-warning programs have been statistically proven to effectively identify and help address issues:

- **Customer installations visits.** A completely free early-warning program where teams audit our effectiveness in configuring and installing products.
- **Out of box audits.** After a customer installation visit, the out of box audit tests 50-100 units for a full week.
- **Rapid detection and resolution.** This program directs all initial new product calls to dedicated specialists who monitor and improve quality and customer experiences.
- **Call-center data trend analysis.** Our own call data is regularly mined for analysis and identification of possible trends.
- **Data driven solutions.** For the few technical support cases that escalate to the top, our Customer Data Drive Solution identifies potential trends and drives rapid resolution.

## Support: HP Total Care

Within the HP Total Care portfolio, HP Support Services offers extended service contracts that go beyond standard warranties. These services cover needs at every stage of the technology lifecycle to help maximize the initial return on investment and reduce loss of productivity:

- One and three-year standard warranties on HP Business Notebook PCs
- Care Pack on-site hardware support services
  - Choice of flexible coverage levels
  - Easier and faster problem resolution with minimal downtime
  - Simplified administration through a single point of contact
  - Convenient up-front payment and preset pricing
  - Support in more than 143 countries
  - Extensive choices of maintenance and implementation services
- HP Mobility and Wireless Services
  - Custom engagements to solve business needs

### Industry Leadership

Our highly talented and diverse product design team is extremely active in industry-wide associations and committees. Many of our engineers participate in or even lead groups that drive industry-standard goals and initiatives. These are just a few examples:

- **SFF Committee.** HP personnel defined the Serial ATA (SATA) connector for hard drives and optical drives, and we played a key role in the SATA steering committees responsible for getting these requirements into the Small Form Factor (SFF) standards.
- **T13 Committee and VESA.** HP pioneered the mechanical and electrical standard for notebook LCDs that the Video Electronics Standards Association (VESA) uses today.
- **IEEE 1625.** HP was part of the industry group that collaborated on safety standards for notebook PCs.
- **JEITA.** HP actively participates in discussions with other PC companies through the Japan Electronics and Information Technology Industries Association (JEITA).
- **BAPCo.** HP is a member of the Business Applications Performance Corporation (BAPCo), a non-profit consortium of industry leaders gathered to develop objective performance benchmarks based on industry-standard applications and operating systems.

Active involvement in these and other industry organizations is another way of proving our commitment to consistent quality improvement. Not only does it keep our staff fully informed on the latest trends and technology developments, it enables us to drive higher standards throughout the industry, improving the overall quality of the customer experience.

## Feedback: Continuous improvement loop

At every step—from design and development through production and testing and on into the workplace—HP is alert for any opportunity to improve quality. Everything we learn goes into making the next generation of HP Business Notebooks the best it can be to deliver the highest-levels of quality and best customer experience. At HP, we:

- Systematically compile results from surveys, customer advisories, research, resellers, sales, and service across the globe
- Share findings among all pertinent divisions/workgroups
- Develop action plans based on information received
- Optimize future designs and enhance the relevant feature set in the next generation of products
- Improve specifications over time, source more parts from the top quality component suppliers, and enhance product testing procedures

# Relentless improvement and commitment to quality

HP has a long history of continuous improvement in quality across products, solutions, and experiences. For more than 20 years, HP has been making advances in next-generation computing and emerging mobile computing technologies. We operate in 170 countries, with strong sales, service, and support capabilities around the globe. Our current patent portfolio now stands at about 32,000—one of the largest in the world—and every year, we spend $3.5 billion in research and development, improving the overall quality of our products and customers' experience.

Relentless improvement is the driving force behind our products, our process, and our business. At every step—from design and development through production and testing and on into the workplace—we're alert for any opportunity to improve quality, and everything we learn goes into making the next generation of HP Business Notebooks the best it can be.

# Examples of the HP Total Test Process

The HP Total Test Process consists of a minimum of 100,000 hours of rigorous tests that help ensure superior quality and reliability in a wide range of applications and operating environments. A sampling of the tests include:

- Drop, shock, and vibration testing
  - Verifies full system functionality in several scenarios
  - Performed on both unboxed and boxed (packaged) systems
  - Shock tests in both operating and non-operating modes
  - Monitors critical components both independently and as part of the system
- Hard drive testing
  - Shock transmission tests ensures the effectiveness of the shock-resistant hard-mount design of HP 3D DriveGuard
  - Active testing verifies the effectiveness of HP 3D DriveGuard
- Keyboard and button testing
  - Verifies functional and mechanical performance and life of keys
  - Applies 10 million keystrokes to validate mechanical, electrical, and cosmetic properties
- Display panel testing
  - Scuff testing verifies the effectiveness of the HP Panel Protection System
  - Display hinge clutches tested to 25,000 open/close cycles
- Electrical testing
  - Verifies performance of local and wide-area wireless connectivity
  - Confirms that the battery and battery charger meet expectations
- Mechanical testing
  - Applies transverse force to the power cable from eight directions
  - Simulates normal stresses on the enclosure to ensure that internal components are sufficiently protected
  - Evaluates panel and surface wear from the display assembly and keyboard/palm rest being pressed together
  - Performs multiple thermal tests, totaling 2400 test hours
- Environmental testing
  - Assesses the ability of a system to withstand the nearby presence of RF transmitters such as mobile phones, emergency personnel radios, and wireless cards
  - Subjects notebooks to extreme temperature and humidity, simulating operation in harsh environments
- System-level integration testing:
  - More than 30,000 steps and 240 industry-standard hardware and software products per operating system.
  - Approximately 7,000 total docking tests are performed on each platform to ensure quality and reliability throughout the lifecycle.
  - Wide Area Testing (WAT) validates HP hardware as well as industry standard hardware and software in typical customer environments.
  - Software Integration Test (SIT) verifies a quality interaction among drivers, apps, OS, and ROM and helps ensure software image quality and stability.
  - Windows Hardware Quality Lab (WHQL) verifies component and system compliance with the Microsoft Windows Logo Program.
  - The OS Integration Test (OSIT) validates new operating systems and service pack updates for compatibility.

(Endnotes)

1. Testing was not intended to demonstrate fitness for DOD contracts requirements or for military use. Test results are not a guarantee of future performance under these test conditions.

Learn more about HP Business Notebooks and our commitment to quality by visiting **www.hp.com/go/notebooks.**



February 2010