

Product Design of the Model 712 Workstation and External Peripherals

A product design without fasteners and the use of environmentally friendly materials and low-cost parts with integrated functions provides excellent manufacturability, customer ease of use, and product stewardship.

by Arlen L. Roesner

The HP 9000 Model 712 workstation and the three new peripherals that go with the product are an excellent example of computer integration and simplicity. The new workstation, while providing a new class of performance with HP's new PA-RISC PA 7100LC processor, pushed the envelope of product design by using relatively few and inexpensive parts. In addition to simplicity and low cost, the product promotes good product stewardship by making parts easy to identify and recycle. Customers find the hardware easy to manage because there are no fasteners to deal with, and all the components snap or drop into place. The main workstation product is a small compact size that fits easily under a monitor or stands vertically on the desk, and the external peripherals can be positioned on the desktop where they are most convenient to the user. Fig. 1 shows the Model 712 workstation and its three peripherals.

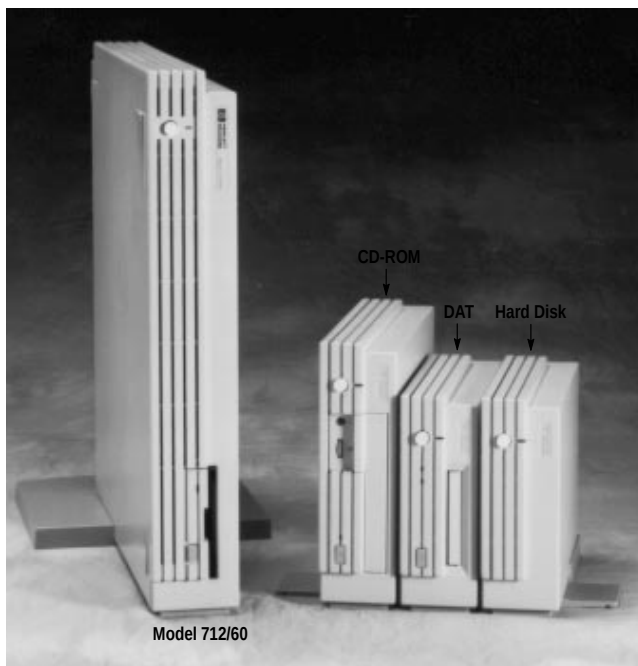


Fig. 1. HP 9000 Model 712 workstation and related external peripherals.

Outward Simplicity

Several assemblies of the Model 712 workstation products have high levels of functional integration. This functional integration tends to make components more complex, but yields an outer simplicity by reducing the number of physical parts and the methods necessary to work with them. Once configured, the only accessible components of the Model 712 workstation include the chassis, system board, option boards (including memory), disk drive, flexible disk drive, and top cover. All of these components are accessed through quick removal of the cover and the manipulation of a few snap or drop-in fits, which require a minimum of time and effort. Fig. 2 shows the workstation and one of the peripherals with their covers removed. Benefits of this resulting simplicity include better manufacturability, easier customer use and configuration, and serviceability.

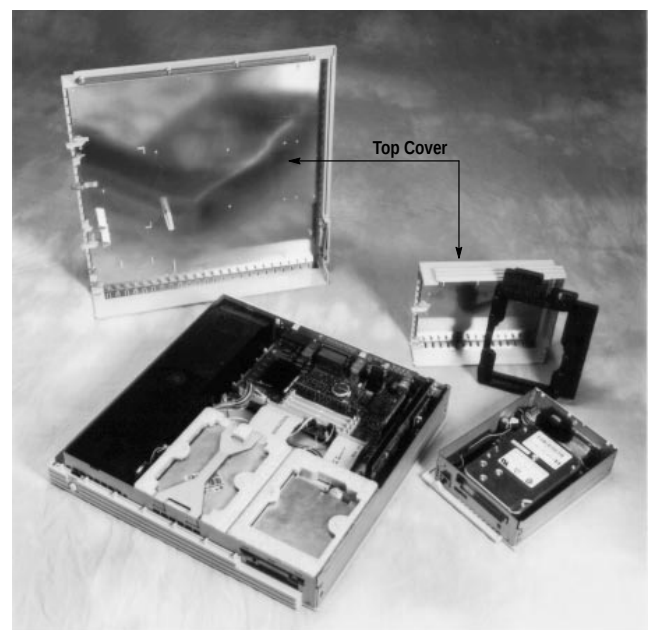


Fig. 2. The Model 712 workstation and hard disk peripheral with top covers disassembled.

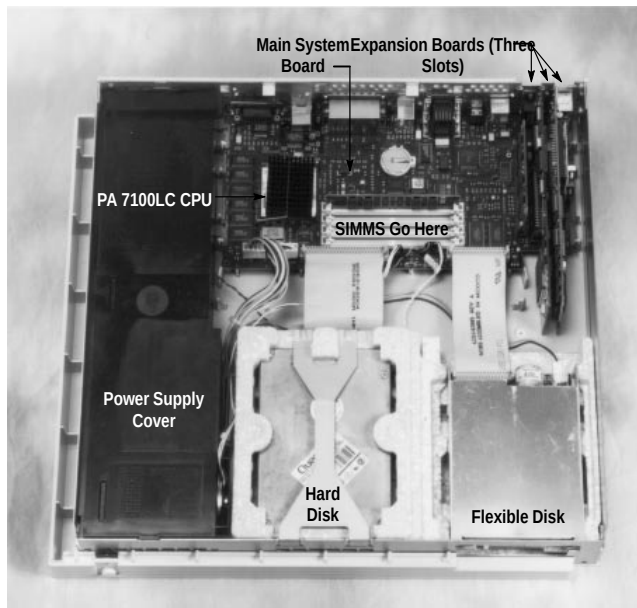


Fig. 3. Top view of the Model 712 without top cover.

Electronics

The system electronics is the place where integration is most likely to be first noticed in the Model 712 product. Electronic assemblies consist of one main system board, a power supply, three optional circuit boards, and up to four memory SIMMs. The main system board is relatively small, and all of the core electronics is incorporated onto this board through integration of functionality into relatively few VLSI components. (Fig. 3 in the article on page 9 shows the main system board). The main system board uses dual-sided surface mount construction, with I/O connector space being provided mostly by double-high (stacked) bulkhead connectors. Optional boards are provided for telephony, extra I/O, and high-resolution graphics. Compared to today's personal computers, the Model 712's system board functions are usually found on a personal computer's motherboard, backplane (if any), and two to three expansion boards. This level of integration on the Model 712 exceeds the density of personal computer functionality, while providing current workstation performance.

Chassis

The chassis assembly consists of a plastic base, a metal chassis, a metal liner for EMI containment of the rear I/O connectors, and a plastic rear dress panel (see Fig. 4). The dress panel includes silkscreened graphics to identify the connectors and state necessary regulatory information, eliminating the need for information labels. The chassis has a variety of holes and embossments to assist in joining the plastic parts to it. The plastic base provides outer air venting and cosmetic appeal to the product while also containing several snaps and guides for mating parts. The metal liner provides EMI finger contact to all connectors in one part, whereas previous products often required many different clips for such functionality. Held together via plastic heat stakes, the plastic base, the metal chassis, the metal liner, and the plastic dress panel make up the main assembly chamber of the product. The main circuit board, power supply and cover,

disk brackets, and top cover all snap or drop into this chassis. Option boards are also easily installed into the chassis on top of the main system board, with integral bulkheads that mate vertically to chassis cutouts (also without fasteners).

Power Supply Cover

The power supply cover is another example of integration. Many parts were "designed out" by this single plastic part that performs six functions. The main function is to protect end users from dangerous voltages by shrouding the exposed power supply. The cover snaps into the chassis from front to rear and is removable only by using a screwdriver to disengage the snap that holds it in place. In addition to shrouding the power supply, the cover secures the power supply board in place, houses the fan and speaker, channels air flow, and provides structural support for the monitor. The fan simply snaps down inside the cover and seals to the sides and top of the cover. The speaker slides down and press fits into a simple pocket, which provides acoustic baffling. After the cover is installed, cables from these devices are routed to the main system board for electrical connection.

HP-PAC Disk Brackets

The disk brackets are made of HP's newly patented HP-PAC material.¹ This material is made of expanded polypropylene beads, and is used most often to produce shipping carton cushions for many types of products. Instead of placing this material around a finished product to cushion it in a shipping carton environment, it is instead formed to fit inside a product with integral recesses to embed internal components. For the Model 712 workstation, the HP-PAC material is used to hold the hard disk and flexible disk mechanisms in place. The HP-PAC used in the workstation consists of three parts: a bottom shell which provides a recess for both flexible and hard disk, and two separate top pieces for covering each disk mechanism (see bottom portion of Fig. 4). Because of the cushioning properties of the HP-PAC material, the disk drive mechanisms benefit from reduced shock and vibration levels. The HP-PAC material also provides integral air channels for inlet air to be drawn across hot areas of the disk drive mechanisms. The interesting feature of HP-PAC is that no screws are needed to install the mechanisms. The devices simply drop into recesses inside of the cushioning material, and cables can be connected directly to the embedded mechanisms. Once in place, the chassis enclosure then retains the top and bottom shells of HP-PAC around each device.

Top Cover

The top cover includes a configurable bezel for the flexible disk area, a plastic top shell, and a thin metal liner to complete the EMI enclosure. The liner is held to the cover via plastic heat stakes and has a series of fingers on each side of the cover to contact the chassis and contain EMI radiation. The flexible disk bezel is designed to snap into the front of the cover, which then configures the frontal appearance of the product. The cover assembly drops vertically onto the chassis and then slides rearward until alignment hooks and snaps in the cover engage to hold the cover in place.

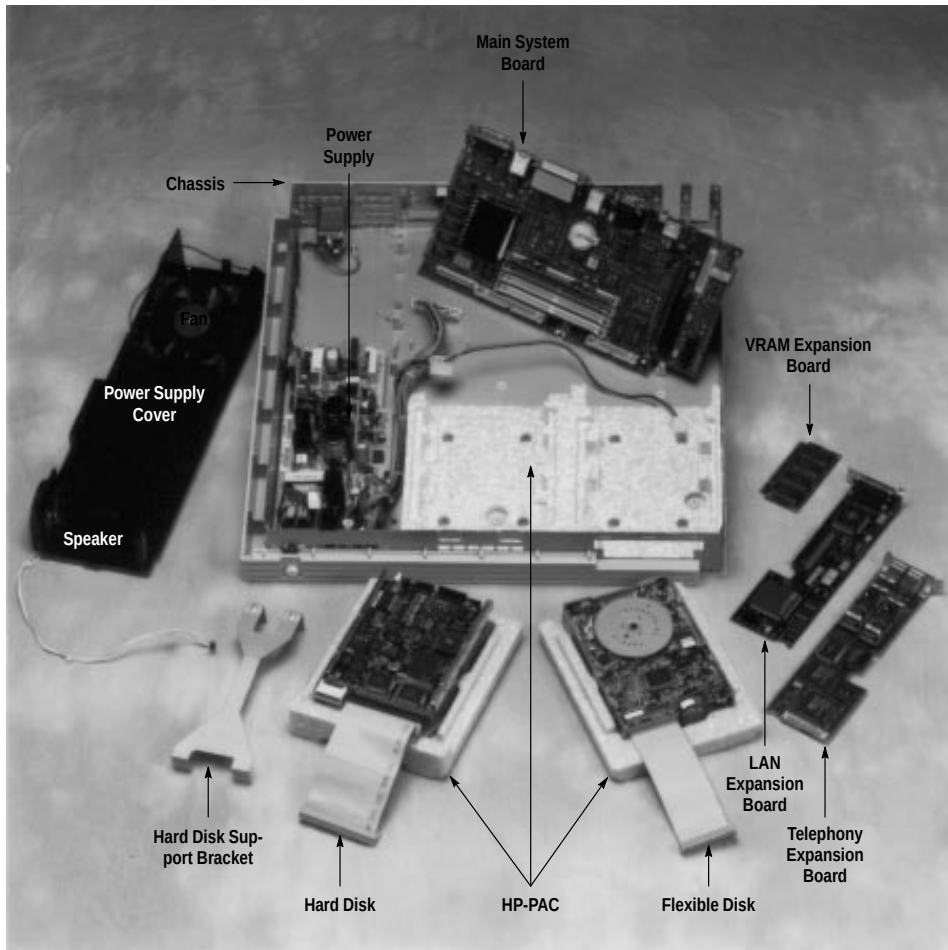


Fig. 4. The Model 712 workstation showing components disassembled from the chassis.

External Peripheral Products

The product design of the three external peripherals also includes a large degree of functional integration. Each of these boxes is designed as a miniature Model 712 workstation, with HP-PAC cushions providing location and support for the drive mechanism, a printed circuit board (for power conversion), power switch plunger, and cabling. The plastic cover for each product includes any necessary doors, light pipes, and buttons. The chassis assembly of each product integrates a plastic base, metal chassis, spring clip, dress panel, and SCSI signal cable (attached with screws by the vendor). Thus, final assembly parts involved in the manufacturing of the box include only the chassis assembly, internal power cable, printed circuit board, plunger rod, HP-PAC, disk mechanism, and top cover. Like the workstation, there are no fasteners for manufacturing or the customer to deal with, and the top cover snaps into place to retain all parts inside.

Low Cost for Entry-Level Pricing

To command lower material costs for mechanical components, all custom plastic and sheet-metal parts were hard-tooled for mass production. The chassis of each product was designed with a minimum of folded features to reduce part complexity and the cost associated with that complexity. All major sheet-metal parts use progressive tooling for the lowest price.

To reduce the amount of final assembly time (and labor costs) involved in the product, components were designed

with a high degree of functional integration. Integrated components (such as chassis or top cover assemblies) are assembled by vendors, placing the burden of labor on these non-HP processes and thus achieving lower pricing of the final product. This functional integration of components also lowers cost by reducing part count and related inventory management.

Because of the no-fastener design, final assembly takes under four minutes for the workstation product and comparable times are achieved for the external peripherals. This ease of manufacturing lowers manufacturing costs because of reduced assembly time and overhead costs. It also makes the product much better suited to indirect market channels, which prefer to configure products themselves and often do this at the last possible moment before shipment.

Environmentally Friendly

The Model 712 workstation and peripherals also conform to HP's new guidelines for product stewardship. Virtually every component of the workstation and peripheral products can be easily disassembled, identified, and recycled. Each plastic part contains engraved information that identifies the type of plastic used, and only four different types of plastic are used within the entire family of products. To assist the disassembly process, the products use plastic heat staking to join parts together, which can easily be cut away during the disassembly process. The new HP-PAC material can be recycled as well, either by grinding to pellet size and reusing in other shipping cushion parts, or by melting the material

down to solid plastic. And again, because there are virtually no fasteners to deal with, disassembly is quick and thus more parts are given to recycling. Materials with bromide compositions have been avoided, except for the HP-PAC parts, which require a bromide flame-retardant treatment to meet safety requirements.

Other product stewardship features include:

- No painted components (all plastics with molded colors)
- No plated plastics
- No adhesives
- Required labels can be recycled along with plastic base material

- Reusable aftermarket components (flexible and hard disk, power supply, CPU, and fan)
- Bulk packaging of final assembly components implemented on larger parts (reduces manufacturing waste)
- Printed circuit boards built in approved non-ODS (ozone-depleting substance) processes
- Embedded fan (low acoustic noise).

Reference

1. J. Mahn, et al, "HP-PAC: A New Chassis and Housing Concept for Electronic Equipment," *Hewlett-Packard Journal*, Vol. 45, no. 4, August 1994, pp. 23-28.