

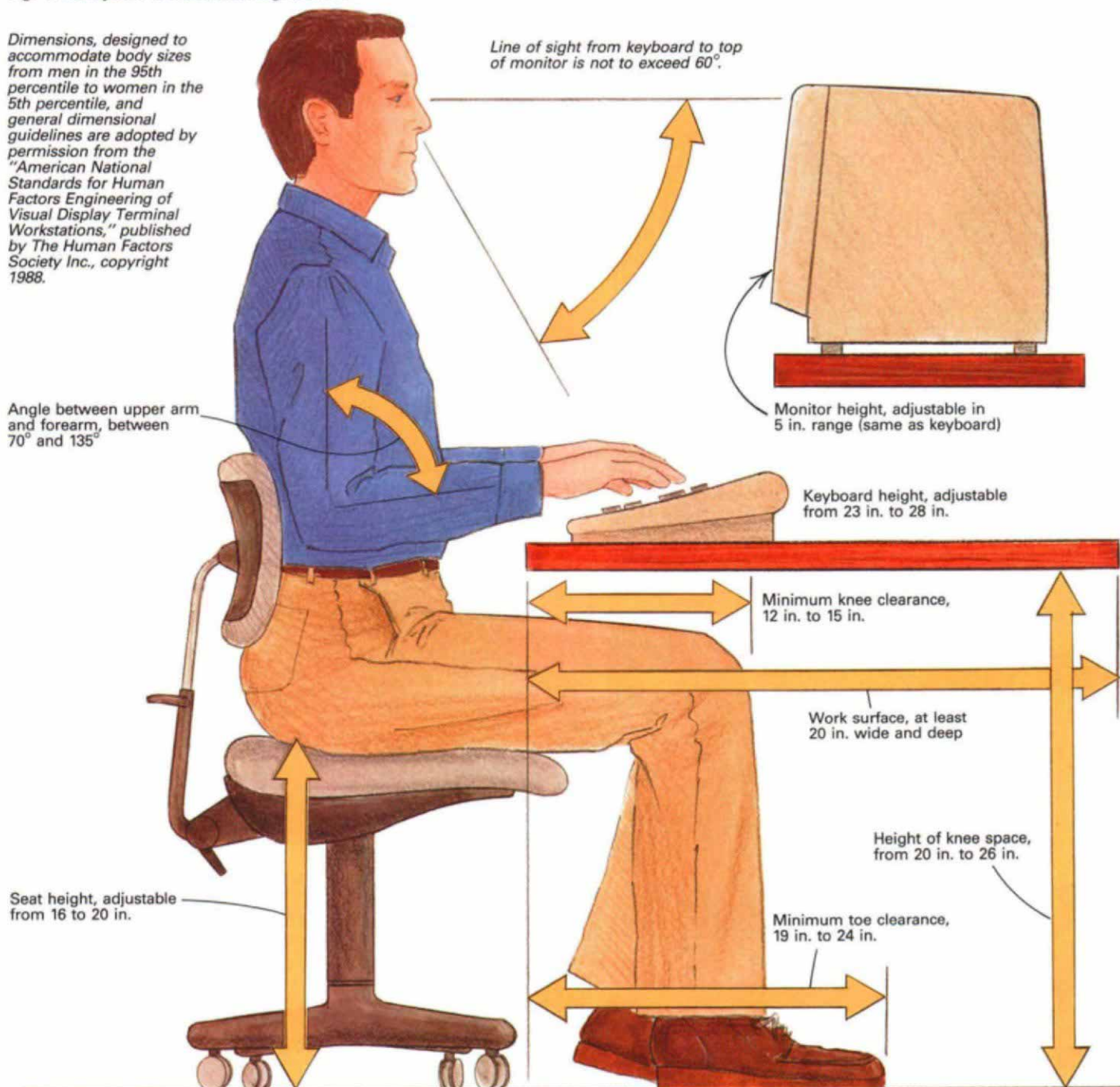
Designing Computer Furniture

Considering components and user comfort

by Sander Nagyszalanczy

Fig. 1: Computer workstation ergonomics

Dimensions, designed to accommodate body sizes from men in the 95th percentile to women in the 5th percentile, and general dimensional guidelines are adopted by permission from the "American National Standards for Human Factors Engineering of Visual Display Terminal Workstations," published by The Human Factors Society Inc., copyright 1988.



Whether we like them or not, computers have become integral parts of our lives, and they're here to stay. Computers handle our finances, connect our phone calls and teach our children. And while we can't ignore computers, few people seem concerned about furniture for them. Some folks think any object can be transformed into a piece of computer furniture just by setting a computer on it. I've seen one digitally possessed person pecking away on a keyboard set on an old orange crate, watching a monitor propped up on the floor by a carton of cigarettes—Neanderthal furnishings for high-tech tools.

Fortunately, more suitable furnishings for computers do exist. There are many commercially available workstations made from metals and plastics. However, the warmth of wood provides a pleasant contrast to the high-tech austerity of computer components, and many people are willing to pay for well-designed, custom-built units to harmonize with other furniture pieces in their homes and offices. In researching this article, I visited with more than a dozen cabinetmakers and furniture makers who built pieces to house personal computer systems. While the work pictured here and other pieces I saw generally were attractive and well built, I was surprised at the small amount of wooden computer furniture being built, considering the proliferation of computers.

Part of the reason may be complexity: Though not nearly as complex as microchips and computer software, designing a good piece of computer furniture can be as demanding as developing the most sophisticated desk or cabinet. A well-designed computer workstation—the modern equivalent of a desk—needs to fulfill an impressive set of requirements. The equipment itself has specific needs: Components must be accessible to a seated worker, and they must be well ventilated and easily wired together. In addition, the workstation must accommodate a comfortable seat. Most workstations also serve as regular desks for paperwork. In an office in which several persons share the same computer equipment, a workstation must be flexible enough to be adapted to different people, as well as provide room for future additions to the computer system.

These diverse requirements don't mean you have to be an engineer or a magician to build a first-class workstation that's functionally and ergonomically suited to your needs. There are few restrictions on the construction methods or joinery; workstations don't require special abilities outside the realm of basic woodworking skills. This article will outline how to design and build a piece of computer furniture, as well as provide general dimensions for a typical workstation. A description of the most common computer components and hints on accommodating them in your furniture piece are provided in the sidebar on pp. 35-37. First, let's examine a few different kinds of furnishings that can function as computer workstations.

Types of computer furniture—While many people think computer furniture should look as if it came off the bridge of the *Starship Enterprise*, a functional workstation actually may resemble a conventional piece of furniture. Practically any desk, hutch or cabinet can be adapted to fit the needs of a computer user and to harmonize with the rest of the furniture in the room. For instance, the "Motus" workstation, shown in the top photo at right, designed and built by Emeryville, Cal., furniture maker Dean Santner, is based on the modular furniture seen in modern offices: The workstation has ample surface area for computer components or paperwork (and file space), it's adjustable to fit different-size people and it can be expanded with optional work surfaces, shelves or accessories.

But computer furniture doesn't necessarily have to be part of a true workstation made for full-time computing; the furniture may be used to hide the computer most of the time. Cabinetmaker Frank Klausz of Pluckemin, N.J., built a computer cabinet for executives



Dean Santner uses mahogany lumbercore plywood covered with plastic laminate for the surfaces and shelves in his "Motus" modular furniture system. The leg columns, which are painted with a tough acrylic finish, allow the height of each work surface to be adjusted independently for user comfort.



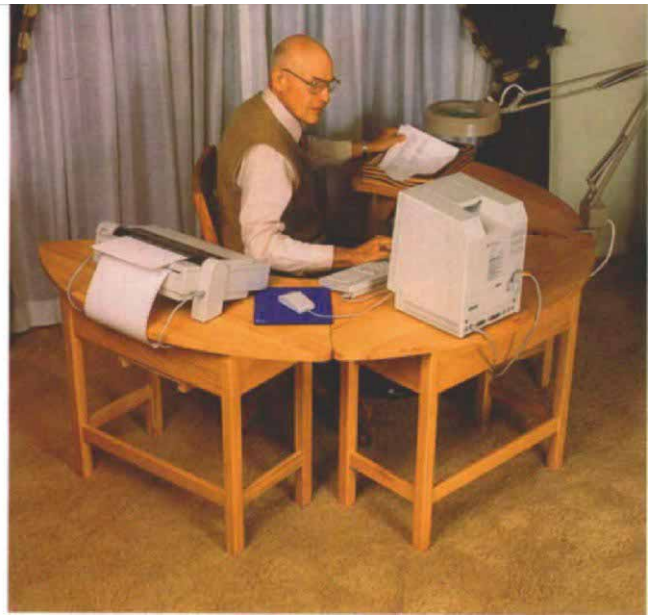
Frank Klausz does the final drawer adjustment on a computer cabinet he designed for an executive's office. The mahogany cabinet has bi-fold doors that conceal a pull-out keyboard and a two-tier printer drawer that has one slot at the front for loading paper, and another slot at the rear for paper to feed up to the printer.

who don't require full-time computer access. It's designed to match the existing furniture in an executive's office and to hide the keyboard and printer behind bi-fold doors, allowing them to be pulled out when needed (shown in the bottom photo, above). In many situations, a computer is only an incidental part of the furnishing. Furniture designer/craftsman Glenn Gauvry, who owns a company called Heartwood in Philadelphia, Pa., says he isn't commissioned to build computer workstations as often as he's asked to accommodate computers in the desks and cabinets he has always built. When I visited Heartwood, its employees were working on a reception desk for a hotel built in what Gauvry described as "cleaned-up Victorian" style. The desk's counter had a recessed cubby in the top to house a computer monitor and keyboard, so a clerk could easily check room reservations.

Work surfaces, storage and lighting—While a workstation may be just a single, flat table, Dean Santner says that a more functional computer workstation should have three separate levels: one to hold the monitor at eye level, one for the keyboard at a comfortable typing height and one for a regular writing surface. Despite a computer's electronic medium, computer work always involves paperwork as well. Therefore, a good workstation needs to function as a regular desk, if only to provide places to put copy while typing. If you are



This computer workstation, built from cherry wood by Hugh Foster, features a retractable keyboard drawer, a raised shelf for two monitors, a drawer for floppy discs and two mechanical-arm lamps on wooden bases that can be moved to give light where needed.



E.D. Groves sits at his workstation built from solid oak. A swivel chair and the round design of the top allow the user to reach all work surface easily. Each of the three segments has a hinged top that lifts up for loading paper or supplies.

going to use a rolling "mouse"-type computer control, there should also be some flat space at desk height near the keyboard.

In addition to filing drawers for documents and other papers, the workstation must include a safe, clean place to store floppy discs and prevent their magnetic messages from being scrambled. Many computer-desk makers prefer drawers with built-in dividers to organize floppy discs. Just be sure to find out what size discs fit the computer before making the drawer; discs are typically either $3\frac{3}{16}$ in. by $3\frac{3}{4}$ in. or $5\frac{1}{4}$ in. square. For paper storage, a regular file drawer is useful, as well as a pencil drawer for assorted office supplies.

Lighting is a particularly tough issue with computer workstations: The trick is to keep glare off the monitor screen, yet have plenty of light available for illuminating the keyboard or writing surface. In offices with ambient light or with desks located near windows, glare can become a real problem. Monitors can be fitted with anti-glare filters over the screen (see monitor section of sidebar) or perhaps a recessed compartment can be designed into the workstation to shield the screen.

Another solution to lighting problems is to outfit the workstation with one or more adjustable lamps that can provide lighting only where it's needed. Any adjustable desk lamp is capable of giving this kind of task lighting, but architect's mechanical-arm lamps are popular because of their long reach and wide range of adjustability. Hugh Foster of Manitowoc, Wis., employs a pair of these lamps on his cherry computer desk, shown in the left photo, above. The lamp stems fit into holes in round wooden bases, which allow the lamps to be set up wherever needed. Santner's modular workstations have special fittings that will hold an architect's lamp. These fittings are designed to mount anywhere on the leg columns.

Dimensions and adjustability—Like chairs and other furniture that must provide user comforts, workstations must be designed ergonomically, which means taking into account factors such as how far the user can reach comfortably to open drawers and operate components, and what are comfortable heights for keyboards and writing surfaces. E.D. Groves, a retired professor of vocational education and technology at Mississippi State University in Starkville, Miss., tackled the problem of putting all computer components within reach (as well as within view) by making a circular workstation, shown in the above photo at right. Groves' workstation

is made up of three segments, which allow portability and flexibility in arranging the workstation to suit the user's individual needs.

Work surfaces must be at comfortable heights, so tailor them to fit your needs or the comfort of your client. For instance, to find the best keyboard height for his workstation, Foster sat down at his partially completed desk and measured where the keyboard felt comfortable, something he's concerned with since he's a professional writer. His rule of thumb is "the closer the keyboard is to your lap, the faster you'll type." If you're designing a workstation that must accommodate a range of different-size people, you may want to take a more scientific approach. The ergonomics of computer workstations have been studied by The Human Factors Society, which sells a book called "American National Standards for Human Factors Engineering of Visual Display Terminal Workstations" (available from The Human Factors Society Inc., Box 1369, Santa Monica, Cal. 90406; 213-394-1811). While the book goes into great depth on specific issues, like what kinds of casters are most efficient for workstation chairs, the book shows a few critical dimensions to use as a starting place in workstation design: keyboard height, knee space, monitor height, size of work surface area, and seat height and angle. A drawing that includes both general guidelines for determining dimensions and a range of dimensions designed to fit most people can be found in figure 1 on p. 32.

Santner, who has built workstations for hundreds of different clients over the past 10 years, takes exception to the idea of plotting workstation dimensions from an ergonomic chart. He says, "When you try to create a single, rigid design that'll fit anybody, you're bound to miss-fit almost everybody." Santner's solution to the dimensions dilemma is adjustability: The leg columns on his modular workstations are drilled with adjustment holes that allow the user to change the height of all work surfaces independently, at increments of $\frac{1}{8}$ in. up or down. This allows the keyboard, monitor and writing surface to be optimally located. Interestingly enough, laws in Europe already mandate adjustability in workstations, and many people expect similar laws to be passed in the U.S.

Adjustability is also an important consideration when enclosing computer components in cabinets or cubbies or on multiple shelves. This is because component sizes aren't standardized—even for the same kinds of components (you encounter a similar

dilemma building a stereo cabinet). Adjustable shelves allow you to tailor spaces to existing component sizes, as well as add many new components and accessories in the future.

Construction and materials—The kinds of construction techniques for building a computer workstation are as limitless as they are for building most furniture. Popular systems include plywood carcasses, solid-wood frame-and-panel constructions, or veneer- or plastic-laminate-covered particleboard. The main concern is strength; computer components can be extremely heavy: CPUs, monitors (especially some of the newer, large-screen models) and laser printers can weigh 35 lbs. to 75 lbs. or more. Workstation tops, drawers and shelves must support this weight, as well as the weight of someone who may sit or lean on the piece. For instance, if the component is placed on a shelf, the span should be short—about 24 in. maximum for $\frac{3}{4}$ stock—or the shelf should be reinforced with battens glued to the underside. Otherwise, the shelf may sag or even break. If you want to gain greater strength in shelves or carcasses without having to build a workstation that weighs as much as a Sherman tank, you can use torsion-box or honeycomb-core panel construction. By gluing two skins over a thin inner lattice, the resulting panels will be strong, yet very lightweight (for more on honeycomb construction, see Scott Peck's article in *FWW* #76, pp. 76-78). Because cabinet backs are often left off workstations, for ventilation or access to wiring, it's a good idea to add glue blocks or bracing on the inside carcass corners to prevent the case from racking. As an alternative, cabinetmaker Klausz used a pegboard back on his computer cabinets, like the one shown in the bottom photo on p. 33. The pegboard prevents racking while the holes allow ventilation.

Joinery for workstations depends mostly on the materials and the design; Foster used mortise and tenons and dovetails to join the frame members on his solid-wood computer desk. However, exposed dovetails would be inappropriate in a modern-style, laminate-covered desk, in which biscuit joints or dowels are most commonly employed. Drawer construction depends on the materials and the load the drawer will carry. Like regular file drawers, pull outs or drawers meant for heavy components should be mounted on full-extension metal drawer slides rated to carry at least as much weight as the components. For keyboard trays, choose drawer slides that will lock in the extended position. Accuride series 3037 full-extension slides and series 322 slides, for heavy drawers and pull-out shelves, as well as series 2008 keyboard-tray slides are available from The Woodworkers' Store, 21801 Industrial Blvd., Rogers, Minn. 55374; (612) 428-2199.

Finishes—Work surfaces should be finished to withstand abrasion, so treat these as you would any other desktop, applying several coats of a durable finish. While traditional lacquers and varnishes are acceptable, finishes like catalyzed lacquers and polyurethane are even more wear-resistant. Some makers have even resorted to "industrial-strength" finishes: Gauvry's Philadelphia, Pa., shop was commissioned to build a set of computer cabinets for an insurance company and chose a paint called "Plextone" as a finish. Though the product was originally designed for auto luggage compartments, Plextone can be sprayed with regular spray equipment modified to handle the viscous mixture. Gauvry sprays the Plextone on the carcass surfaces, as well as the rounded-over edges of his cabinets. It is highly resistant to abrasion, and is also anti-static—an added benefit when working with floppy discs that can be ruined by a single jolt of static electricity. (Plextone is available in 5-gal. cans from the Plextone Co., 2141 McCarter Highway, Newark, N.J. 07104; 201-484-4443.) Plastic-laminate surfaces are easy to keep clean, and are popular for office furniture that doesn't get much maintenance. Santner's workstation has plastic laminate applied over lumber-core hardwood plywood, which he uses because it's stronger than regular veneer plywood. Both sides of each panel are covered to prevent warping, the same reason you should veneer both sides of any panel.

Seating—Since practically all computer work is done while seated, the choice of the chair used with a workstation is as important as the rest of the setup. While workstation seating is the subject of an entire article in itself, it's important to choose a computer chair that's truly comfortable: Compared to a regular dining chair used during a two-hour meal, a computer chair used in an office situation must keep the user comfortable all day long. Design-wise, this is no small feat.

I talked to Richard Schultz, a freelance contract furniture designer in Barto, Pa., about workstation seating he's designed for the contract furniture industry. Schultz says that an individual's own definition of comfort changes during the course of a workday, and the chair should, ideally, adjust to accommodate a range of different seating positions. On many modern office chairs, a host of levers and knobs allows adjustment of height, angle, rotation and even firmness. Contrary to a high-tech approach, Schultz says a rocking chair might be a good solution to allay fatigue at the workstation. That strikes me as a nice balance; front-porch comfort on the edge of the technological frontier. □

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Accommodating computer components

The components of a typical personal computer system are a CPU (central processing unit), one or more computer disc drives, a monitor or CRT (cathode-ray tube), a keyboard and a printer. The CPU, a metal box that contains the computer's central "brain," is connected to all the other components. The system's one or more disc drives load and store information on magnetic floppy discs. The monitor is similar to a television set and displays the words, numbers or graphics being processed by the computer. The keyboard resembles a typewriter keyboard: In addition to the usual

letters and numbers found on a typewriter keyboard, a computer keyboard has a cursor (a flashing spot on the screen that shows you where the characters you type will be entered) and function keys that let you control various computer operations. A printer produces paper copies of your on-screen work.

Computer accessories commonly found in a simple home/office computer system include a mouse, a palm-size control unit that rolls on a flat surface, controls the cursor and performs some other keyboard functions; a power strip, an extension cord

with multiple outlets designed to protect equipment from electrical surges and to provide a convenient central location for switching everything on and off; a modem, a device that allows computers to transmit information over phone lines; and a "hard" disc drive, which, like a floppy disc drive, stores information.

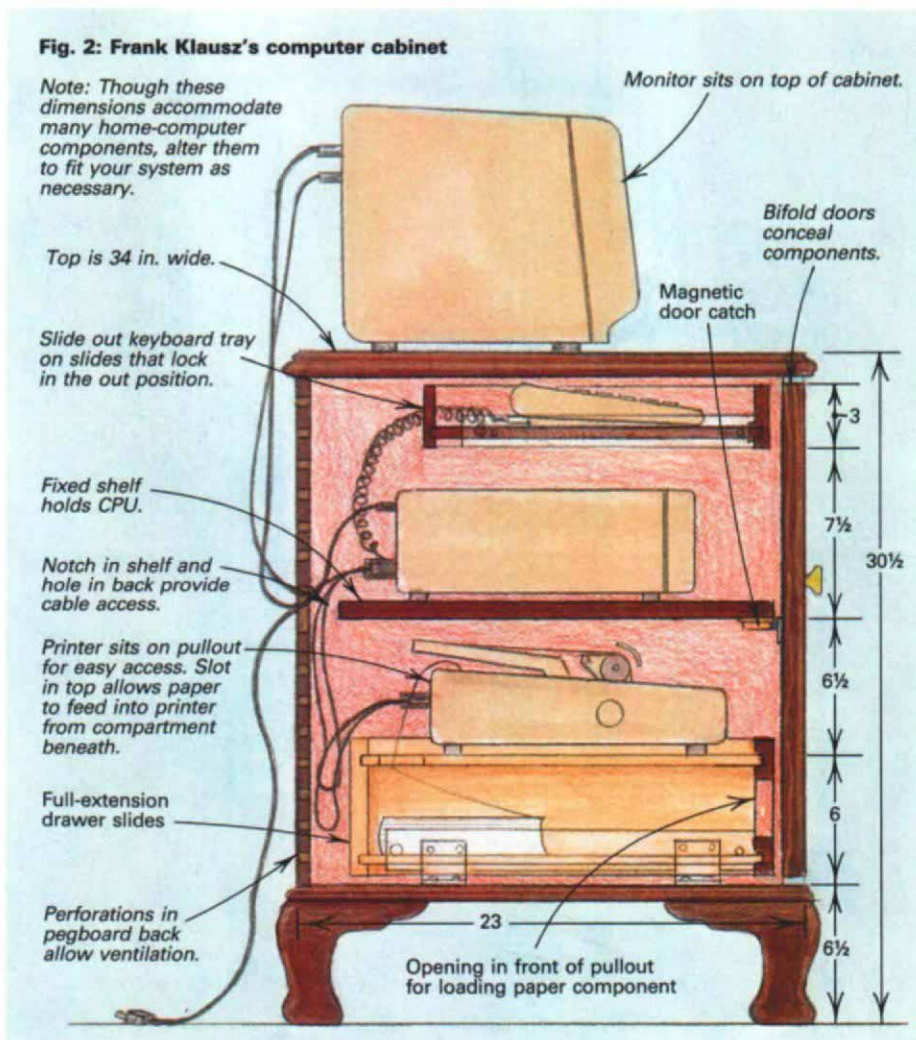
On the next pages are descriptions of the characteristics of individual computer components you should consider before designing any piece of computer furniture. In addition, a discussion on wiring and ventilation is provided.



Covered in bandsawn and slip-matched Honduras mahogany veneer, the executive desk by David Welter features a pivoting drawer, that swings around to hide the keyboard and make the desktop an uninterrupted surface. The far end of the cabinet has a compartment that houses the computer's central processing unit (CPU).

Keyboard: Unlike a regular typewriter, a computer's keyboard is most often a detached, separate unit that connects to the CPU via a coiled cord. The keyboard can be used on your lap or on a table or desktop. However, typing with the keyboard too high can be uncomfortable and can even lead to wrist problems, like carpal tunnel syndrome. Many computer desks employ a pull-out drawer or tray that's mounted under the desktop. This lowers the keyboard and allows it to be rolled out of the way when not in use. David Welter, a cabinetmaker and instructor at the College of the Redwoods in Ft. Bragg, Cal., designed a more novel way to hide a keyboard in his computer desk, which is shown in the photo at left. Mounted to a pivoting tray, the keyboard flips over when not in use to return the desktop to an uninterrupted surface. Aside from the addition of a keyboard tray and a compartment for computer components, Welter's executive desk is a typical desk. Welter's reasoning behind designing a hide-away keyboard is that an executive uses a computer occasionally.

CPU: The CPU location depends partially on whether it also houses the system's disc drive. Most home-system CPUs have at least one drive that's accessed through a slot on the front. This should be accessible to the user since discs need to be inserted and taken out often. The CPU can rest flat on a desktop or shelf, or can be enclosed in a cabinet or drawer; in any instance, it can be mounted either horizontally or vertically (check the computer's manual before doing the latter). If the CPU sits in a tight space, make sure there's clearance at the unit's intake and exhaust ports for ventilation, as well as clearance to get at the unit's on-off switch (you can also plug the CPU into a power strip, described later). Also, your design should permit the CPU to be removable, both for service and for access to the plugs and wiring on its back or side panels.



Monitor: A computer monitor should sit on the workstation so that the top of the screen is at or below eye level, with the viewing angle between monitor and keyboard not exceeding 60° (see figure 1 on p. 32. Many people put the monitor on top of the CPU, but this isn't always an attractive or a functionally desirable arrangement. If you provide a special shelf for the monitor, you also free up space below the screen for paperwork. Computer monitors are often deeper than regular TV sets of the same screen size; so make the shelf deep enough to hold the monitor without too much overhang. If the monitor is enclosed in a hutch or wall unit, leave at least a couple of inches of space around the monitor for ventilation. Extra clearance at the top also allows the monitor to be used on

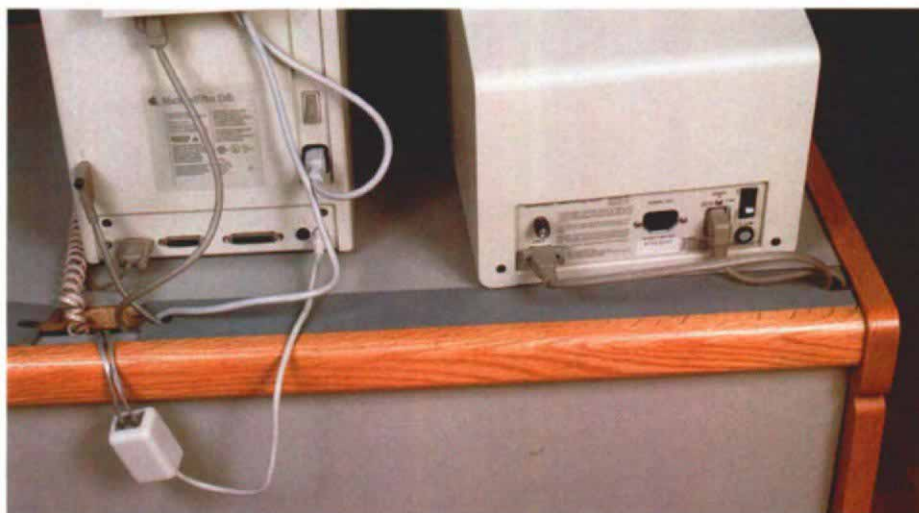
top of a tilting-and-pivoting monitor stand, a device that allows the user to position the screen for the best glare-free viewing. Monitor stands, as well as copy stands, anti-glare screens and other accessories, are available from Misco, One Misco Plaza, Holmdel, N.J. 07733; (201) 946-3500.

Printer: In offices, several individual computers may be connected to a single printer, housed in its own stand. A home computer setup, on the other hand, usually has a printer directly connected to the CPU. Printers will work on any flat surface, but can be fitted into all manners of compartments, drawers and pullouts. Because printers are noisy, some people prefer to enclose them entirely inside a cabinet or drawer. Cabinetmaker Frank Klausz's computer cabinet, shown in the bottom photo on pg. 33 and in figure 2 on the facing page, features a pull-out printer drawer with a built-in paper compartment. Phil Smith, a Long Beach, Cal., woodworker and contractor, built a hinged cover on a printer stand he was commissioned to build to reduce the printer's noise. The cover had a slot at the back for the paper to exit, and was lined inside with thin, dense-cell foam (available as sleeping pads from outdoor supply stores) to muffle the printer's noise.

But before deciding to enclose the printer, you should consider how the printer will be used. Printers that are manually fed or are only used to print a few sheets at a time may be located on a desktop or shelf, within easy view and reach. If the printer uses a continuous paper-feed mechanism, the cabinet should provide a way for the paper to enter and exit the machine without jamming. If the printer is in the middle of a table or large desk, you can cut a slot in the surface and feed the paper up from a storage area underneath the work surface.

Disc drives and accessories: Even a simple computer system may incorporate extra drives or accessories, and you may wish to plan extra shelves, compartments or drawers to accommodate them now or as they are added in the future. Unlike regular disc drives, the memory-powerful hard drives don't use removable discs, and don't need to be located within close reach. Hard drives can be housed practically anywhere in the workstation, and can be remotely switched on and off from a separate power strip. Most other accessories can be housed on shelves, in little cubbies or in a single hutch or pullout. Some of these accessories (or peripherals as they're known) need easy access; so again, locate them within reach.

Wiring: Besides the usual Ac-power cords, computer systems involve a series of cables



Bill and Jim Kochman's computer workstation is a prototype for a line of computer furniture the brothers were considering manufacturing in their partially automated cabinet shop. A removable plastic strip at the back of the top reveals a raceway for computer cables, which allows a userfull access to the cables while keeping them neatly hidden.

connecting all the components. While wiring a computer system usually isn't more complex than wiring a stereo system, there are several points to consider. Computer cables tend to be thicker than stereo wires, and their clutter can be just as unsightly. Therefore, a well-designed workstation should provide some way of containing these cables, yet allow the cables to be easily removed and rerouted if components are added, serviced or relocated. Two different approaches to wire management can be seen in the workstations designed by cabinetmakers Bill and Jim Kochman, of Kochman Woodworking in Stoughton, Mass., and Emeryville, Cal., furniture designer/builder Dean Santner. The Kochmans provide access to the cables by creating a wire trough or raceway fit along the back edge of the desktop. The raceway is concealed by a removable cover, as shown in the photo at the top of this page. Santner's modular workstation holds the wires in hook-and-loop fasteners suspended underneath its shelves and work surface. Both of the systems allow wiring to be changed instantly.

Where wires pass through tops or carcasses, holes or slots must be made large enough to pass not only the cables, but end connectors as well. Proportional to cable thickness, these holes can be surprisingly large. One computer-desk maker told me he had to painstakingly remove a 50-pin connector from the end of a cable, then solder all 50 wire connections back on because he failed to make a large enough opening to pass the connector. But instead of leaving gaping holes in your workstation, you can buy wire grommets, which reduce holes and slots down to wire-size openings. Wire grommets, as well as plugs for as-yet-unused holes, are available from Doug Mockett & Co., Box 3333, Manhattan

Beach, Cal. 90266; (213) 318-2491. Also, when sizing compartments for components, leave enough room for protruding connectors, plus extra clearance for cables that must turn a corner before being routed through a raceway or passage hole.

Ventilation: All computer components (except keyboards) need ventilation. If they're enclosed inside a cabinet, consider leaving the cabinet's back or bottom open to avoid obstructing the component's cooling vents. Though a CPU can create a fair amount of heat, the unit's built-in fan will usually cool it, provided you leave an opening in the case or drawer at least equal in size to the component's ventilation port. If you are in doubt or if the unit seems to get too hot inside the cabinet, you can always install a "muffin" fan (a 3-in. muffin fan is available from Radio Shack, part #273242). This is a small, flat Ac-power exhaust fan that mounts over a hole in the cabinet and circulates cooling air.

Unlike other sensitive electronic gear, most computer components aren't particularly susceptible to dust problems in the average home or office environment. Unless you want to close a workstation with doors or with a tambour roll top to keep out kids, to ensure security or to cut down on visual clutter, there's no reason the components can't sit out in the open. -S.N.

EDITOR'S NOTE:

Relatively few woodworkers today are building computer furniture, but as computers proliferate, hopefully we'll see a boom in computer furnishings as well. If you've designed a piece you're pleased with, send a slide or transparency along with a description to: *Fine Woodworking* magazine, The Taunton Press, 63 S. Main St., Newtown, Conn. 06470. We'll consider the best submissions for future publication.