Building Intelligent Buildings

You May Be Asked To Build the High-Tech Office Of The Future

By Jeffrey L. Beard

Telecommunications. Modems. Microcomputers. Three buzzwords of today’s electro-tech society. Technological breakthroughs in data storage and retrieval over the past 20 years are profoundly affecting the way we work and live—from the desktop computer and printer in the modern office to the computer-controlled environment in a state-of-the-art condominium.

New construction materials and methods to accommodate the information age. Today’s buildings are designed and constructed in congruence with the need for low and high voltage distribution/delivery systems in automated offices. The requirement for interconnecting computer and telephone communications forces building planners to incorporate construction products which adapt well to wiring, cabling, connecting and sometimes even the cooling of advanced electronic equipment.

Owners of buildings involved in the service and communications economy are insisting that their work places have the capacity and flexibility to handle information needs from micro scale to macro scale and back again. To explain further, here are some definitions.

• Micro-level — individual work station typically equipped with an el-shaped desk, ergonomic chair, terminal/CRT telephone, printer.
• Intra-building communication conveyance systems. Intra-building components include underfloor duct, cellular steel floor, access floor, flat wire and fiber optic cable.
• Inter-building communication conveyance systems. Inter-building components include telecommunications—metallic cable, microwave antennae, satellite dish and fiber optic cable.
• Macro-level — storage devices located in corporate headquarters or lesser divisions/profit-center (mainframe at the “home office” or newer computers with large capacity integrated chip for information storage).

H.H. Robertson Co. cellular/composite steel floor system is comprised of a trench header (main trunk line) feeding cellular deck (distribution branches). Composite system is designed for steel frame construction. Photo courtesy of H.H. Robertson Company.
Naturally, contractors are most concerned with the communications and equipment conveyance systems integral to their clients’ buildings. The more commonly used building construction components, which are reviewed in the following section, have been developed in response to owner/user demands for comprehensive communications systems.

The following sections describe basic intra-building communications components.

Underfloor duct. Embedded within a concrete floor, underfloor duct systems are comprised of enclosed gauge metal raceways, usually placed four or five feet on center in all future office work areas. Cable is pulled through the duct from power/communication closets and vertical chases, and is fed to individual work stations by inserts placed either prior to the concrete pour or core-drilled as needed after the concrete is placed. Duct systems usually require a separate above-the-floor outlet for each service (e.g., power, telephone, computer wiring—three services, each with their own monument outlet.)

Contractors are familiar with the problems presented by underfloor ducts—“floating up” of the duct if not properly attached to the form work, difficulty of placing reinforcing around the duct, concrete intrusion into duct voids where cuts are not adequately covered, and maintaining schedules with custom-designed duct systems (coordination of engineering approval/delivery/installation).

Some of the newer duct systems feature vast improvements over their predecessors—single pre-set outlets for three services, well-machined activation hardware and easily-fastened and adjustable raceway support brackets. Although underfloor ducts may have a relatively high initial material and installation cost, the life-cycle cost for building owners is relatively low.
“Flat cable is ideal for older buildings where cellular floor or underfloor duct is non-existent, where poke-through is unacceptable, and where ceiling height and existing door openings will not permit installation of raised access flooring.”

because of inexpensive floor-outlet activation procedures.

**Cellular steel floor.** Manufacturers of composite steel deck created cellular floor systems for office buildings as early as 1935. Since that time, architects and engineers have greatly expanded their use of structural/electrified deck—now incorporating the system in a majority of the high-rise steel framed office buildings being constructed.

Cellular floor is fed from a header duct into two- or three-inch deep cells. These cells run parallel in groups of two or three approximately five feet on center. Preset inserts are normally placed in the low flutes between the cells, providing access to high tension wiring on one side and low tension services on the other. Pre-set outlets are often placed every five feet, although specifiers and users indicate this rigid placement can be a problem for interior designers. There are two field solutions to the problem of unacceptable outlet locations: 1) drill into the cell for placement of a monument outlet, or 2) run “flatwire” under the carpet from the pre-set function box or to the desired location, then install a compatible outlet fixture.

Cellular floor is the most widely used electrical delivery system in owner-occupied office buildings, largely due to its overall capability as a structural floor (average spans of eight to 16 feet with live load capacities in the 150 to 200 psf range) and its proficiency as an organizer and conductor of high and low voltage wiring. It is also cosmetically appealing, with all services hidden within the floor. And because the system is based upon composite steel decking, building contractors are quite familiar with its installation.

**Access floor.** Raised access floor components include adjustable support pedestals, two feet by two feet floor panels and a square carpet wearing surface. The square panels may be removed individually or in groups to facilitate access to enclosed raceways and conduit (high tension), or to power trays and covered cable (low tension). Raised floors normally provide six-inches to 24-inches of plenum area creating plenty of space for connector blocks and interface devices required by baseband, broadband, and fiber optic networks. However, unless the electrical and equipment subcontractors impose organization and discipline by careful layout and installation, spaghetti-like masses of wiring can result and capacity is effectively squandered.

Originally, access floor was developed for computer rooms. The large capacity solved both the cabling and cooling dilemmas of the early machines. Access floors have recently been added to general office areas of buildings, as owners have recognized their high utility value (accessibility for frequent wiring changes) and depreciation potential (faster write-off because access floor is considered equipment and not a permanent part of the real property.

Contractors need not hard trowel concrete floor surfaces in areas to receive access floor pedestals, which can provide some savings in time and
labor costs. However, the surface must be level, since pedestal adjustment is only about one and one-half inches. Other potential trouble spots occur where the raised floor meets openings at the building core (elevators, lavatories). The openings/thresholds can present field problems if not accurately aligned with the plane of the access floor system.

**Flat Cable.** Flat conductor cable was first developed in the 1950s by NASA engineers intent upon saving space and weight within the Mercury program rocket capsules. By the 1970s, the concept was adopted and refined by electrical manufacturers for use in flexible “open” office designs. Manufacturers now produce a variety of cable options: three, four or five conductor configurations, 12 AWG and 10 AWG. Cable fittings are designed to permit power, telephone and communications outlets to be housed in a single floor monument.

“Flatwire” is protected from traffic by carpet overlay, and any subsequent work station relocations will require 1) pulling up the carpet and 2) reinstallation of the cable, the outlet and the carpet. In addition, the system’s capacity for computer cabling is somewhat limited. There are many benefits to counter the detriments of this undercarpet wiring system: concrete leveling and finish quality are not critical; outlets can be installed precisely where they are needed, and flat cable is ideal for older buildings where cellular floor or underfloor duct is nonexistent; where poke-through is unacceptable; and where ceiling height and existing door openings will not permit installation of raised access floor.

**Fiber optics.** The fiber optic cable consists of a bundle of hair-thin glass strands carrying pulses of light from a source to a receiver. Analysts in the fledgling fiber optics industry predict that more than a million miles of fiber optic cable will be installed by 1986. The majority of it will be placed outdoors and underground along railroad and utility rights-of-way. However, many newer office buildings are certain to be recipients of the fiber optic rather than coaxial cable for their communication needs.

Fiber optics systems use computer technology to convert sound, data and even images into simple numeric expressions, which lasers transmit through the tiny glass fibers at blinding speeds. For example, a fiber optic cable connecting two computers 100 miles apart could transfer the entire Encyclopedia Britannica from one to the other in two seconds. The speed with which fiber optic technology is evolving is nearly as impressive. The price of the fiber itself has dropped from a level of eight dollars per meter a few years ago to less than fifty cents today. AT&T now manufactures strands that bundled together can carry nearly 1.8 million phone calls simultaneously—36 times the capacity of the first commercial fiber optics system announced in 1979.

Despite its advantages, the technology still has its shortcomings. If the cable is damaged or cut, splicing fine glass threads is much more difficult than repairing severed copper wire.

In addition, bending fiber optic cable at a sharp radius can reduce its light transmission capability. The resultant requirement for a large bending radius could cause problems in confining duct systems where there simply is not enough room to curve the cable from the raceway up into the floor outlet.

On the positive side, glass fibers
conduct light, not electricity, so they can be laid in the same trench or duct as power cables, thereby saving time and money at the construction site.

**Other information conveyance/distribution components.** Poke-through wiring systems allow through-the-floor wiring to be accomplished by installation of conduit and cabling in the space between the underside of the concrete floor and the ceiling of the floor immediately below. Core drilling for single service or dual service outlets is necessary for all activations. Initial costs of a poke-through system are low—little or no work is done until the tenant/user occupies the space; yet capacity is limited because the UL fire-code limits outlet placements to one per 65 square feet. Other disadvantages include limited flexibility for adapting to new equipment/cabling and high costs for new or relocated outlets.

Manufactured wiring/cabling systems consist of flexible metal clad cables with built-in connectors. The pre-engineered cables are designed for use in ceiling plenums or in raised access floor plenums, where light fixtures, floor outlets, service poles, partitions and other office furniture can be pre-wired to receive the cable connections. Manufactured wiring systems are intended to simplify installation. Field labor and total installed cost are thereby reduced, as components simply plug together. The system is uni-dimensional, however; it does not adequately provide for telephone and data service distribution.

Overhead track and service poles are especially useful in buildings where a retrofit application of electrical distribution is specified. Service poles are simply metallic ducts suitable for interior placement. They contain multiple power outlets and can accommodate moderate amounts of communication cabling. Unfortunately, office aesthetics can be reduced by the cluttered effect of a “forest” of power poles.

Components used in inter-building communications systems are:

**Wirepair and coaxial cable.** Standard metallic cabling is the workhorse of long distance transmission, carrying analog signals (continuous range of frequencies 300-3400 Hz) along copper conductors of various configurations. A device called the modem permits communicators to convert digital signals (stream of on-off pulses) into analog messages that can be sent over the telephone company’s analog channels.

Cabling is either placed in trenches or carried overhead on towers or poles. There is a limited market for specialty contractors installing low voltage communication systems. Most contractors, however, are merely concerned with locating and protecting existing wiring during the construction phase of a project.

**Microwave towers.** Microwave transmitters are dependent upon “line-of-sight” for signal purity, and consequently are erected on mountain summits, on the roofs of high buildings, or on man-made towers. Trees, nearby buildings and other large objects—airplanes or cooling towers, for example—can seriously degrade the transmission and reception capability of the system.

Microwave transmission seems particularly suited to special use communication, and may be much more
economical in remote areas as opposed to constructing a continuous coaxial or fiber optic cable network. A microwave tower is susceptible to high wind loadings, often requiring a heavy concrete foundation and a specially engineered and fabricated superstructure.

**Satellite systems.** The key component for receivers of information via satellite is the earth station. A 10-foot dish antennae and accompanying hardware purchased at a cost of $15,000 in the late 1970s is now priced at $3,000. Made of fiberglass, spun aluminum or metallic mesh, the dish has become the new symbol of the corporate rooftop. It is not unusual to find roof-mounted dishes sheltered from wind and view by extended parapets. Ground-mounted dish antennae are protected by earth berms, landscaping or chain link fences.

Satellite communications are only as good as the inaccessible satellite itself—the system is prone to solar disturbances and electrical problems—but the technology is rapidly improving due to active participation by the National Aeronautics and Space Administration through its space shuttle program.

**Fiber optics.** Fiber optic cables are the circuits of the future carrying high speed light pulse streams of voice, television, facsimile and data in a uniform manner by digital encoding. The advantages of glass fiber information transmission are many:

- high bandwidth—information carrying capacity is excellent.
- clear signal—repeater stations continue signals without distortion or reduction in quality.
- digital system—20 times more information can be sent over a digital line compared with a comparable analog line.

Fast as a blink; safe as a sandbox— that is the beauty of fiber optics. Thousands of miles of fiber optic cable are being placed along railroad beds and in utility easements, where it serves the multiple communication needs of industries, businesses and homes simultaneously. Trenching and boring subcontractors, along with electrical contractors, have garnered much of this cable installation work.

**Contractors are re-positioning for the service/communications economy.** Author John Naisbitt places the accelerating pace of technological change at the very top of his list of *Megatrends* “The United States is rapidly shifting from a mass industrial society to an information society, and the impact will be [farther-reaching] than the nineteenth century shift from an agricultural to an industrial society,” he says. The implications of this information revolution for the construction industry are positive:

- new markets to pursue (as older structures are rendered inefficient by new accounting or production equipment);
- better communication networks among international design/construct firms that can maintain satellite or microwave communication networks;
- improved data bases of material
and manpower costs for estimating and control purposes;
  • increased installation of micro or mini-computers at construction sites
    for engineering or scheduling problems; and
  • improved home-office functions such as accounting systems or
    computer-aided design drawing.

In 1984, 74 percent of America’s work force was employed in the service sector—approximately 68 million
people. The information storage and forwarding networks of modern communications technology appear to be
freeing employees from the constraints of time, just as telephones helped relieve workers from the separations of
physical distance.

The key to today’s technology is simple. Any type of information can be rapidly transmitted in either an
analog or digital form. The origin and destination may vary:
  • Desk-to-desk transfer—text, data and information.
  • Electronic mail—stores mail until recipient is ready to receive and answer.
  • Data Communications—machine-to-machine communication links.
  • Video text—two-way messages with information retrieval and display.
  • Interactive CATV—broadcast network with answer-back capability.
  • Teleconferencing—conferences communicate from specially-equipped
    rooms with continuous presence full motion video transmission/reception
    systems.

The information processing industry will grow from $268 billion in annual revenues during 1983 to $1 trillion in
annual revenues in 1990. That’s not exactly exponential growth, but unmistakable evidence of a shift in the
economy. Clearly, those contractors having experience and know-how with
specialty building materials and components needed for constructing efficient communications systems could
have a market advantage in the information age.

Editor’s Note: This article is reprinted with permission from the February, 1985 issue of Constructor, published by the Associated
General Contractors of America. Jeffrey L. Beard is a staff writer for Constructor.

Power, Lighting, Electronic, Communication Systems For
Today’s Office Buildings: (PLEC) Distribution Evaluation Summary *

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<th>Design Criteria Systems</th>
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<td>Corporate office with high flexibility and high capacity requirements.</td>
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<td>Access (Raised) Floor</td>
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<td>E</td>
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<td>E</td>
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<td>F</td>
<td>Renovations where alternative system is not available.</td>
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<td>Floor Boxes</td>
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<td>Mtd. Wiring Systems (power distribution systems only)</td>
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<td>E</td>
<td>As building having open areas and accessible ceilings.</td>
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<td>Overhead Track Systems</td>
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<td>G</td>
<td>For high capacity requirements where data and communication cables must be enclosed in a metal raceway and PLEC system was not designed into building.</td>
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<td>Service Poles</td>
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<td>G</td>
<td>Good system for offices in which PLEC distribution systems were an afterthought</td>
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<td>E</td>
<td>F</td>
<td>F</td>
<td>For low capacity requirements with good access to service feeds; limited flexibility requirements.</td>
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<tr>
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<td>G</td>
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<td>F</td>
<td>F</td>
<td>Retrofit applications where extensive raceway work is not contemplated and walls are available. Also for perimeter feed in new construction.</td>
</tr>
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</table>

Key: E Excellent G Good F Fair P Poor NR Not Relevant

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