BY ROYAL VAN HORN

Hilliard Elementary School

LAST MONTH I discussed "future-proofing" a school — building it so it will last, technologically speaking. This month I describe the efforts undertaken to future-proof a new elementary school that opened August 21 in Hilliard, Florida.

Hilliard is located in Nassau County in northeast Florida, six miles south of the Georgia border on U.S. Highway 1. Hilliard is a small (pop. 2,452), rural community. The major industries in the county are timber (pulpwood), paper manufacturing, tourism, shrimping, and fishing. The Amelia Island resort area is located on the Atlantic Ocean in east Nassau County. The county has a total of nine elementary schools, three middle schools, and three high schools.

Early Design Considerations

Early in the design process, Hilliard teachers, working with the principal (Linda Morris), county officials, and the architect, settled on a 10-building campus layout with buildings interconnected by concrete walkways with roofs. Essentially all grade levels, the media center, and so on occupy their own buildings. One early step toward future-proofing these 10 buildings was to create an interior data communications room or closet in every building, separate and apart from exterior rooms used to house mechanical equipment. As future demands on the academic network grow, each building/grade level can have its own server; the rooms and network infrastructure are in place.

Another design assumption called for completely *isolated* telephone, intercom, fire, security, energy management, television, and data systems. Five years earlier, the county had built a new high school with an integrated telephone, intercom, fire, and data network, housed in a computerized central console and running over traditional telephone wire. (The high school had its own telephone switch.) The problem with the integrated approach is that a single malfunction cripples many systems, as has happened too often at the high school. Another decision about Hilliard was simple: let the telephone company do telephone switching and run closed circuit television over the traditional, and relatively inexpensive, coaxial cable. Furthermore, let a company that specializes in data networks do the computer network — don't let just any old contractor do it.

The academic data network was to be air-blown fiber to the desktop (i.e., to every single computer). The fire alarm system and the energy management system were to run over a fiber backbone — fiber from building to building, but not within a building.

Air-Blown Fiber

Probably the most significant future-proofing design decision was to use air-blown fiber optic technology. Traditionally, copper wire and conventional fiber optic cable are pulled through conduit from building to building, using pull strings or cords. As more and more separate wires/cables are pulled through a conduit they tend to wrap around one another. Both the pulling and the wrapping (spiraling) of the wires and fibers in the conduit put stress on the glass wires of the fiber optic cable. (You thought all those nice little wires in a conduit ran exactly parallel to one another? Well, they don't.) Air-blown fiber technology solves the pulling and wrapping problem.

Since air-blown fiber is such an ingenious technology, I just have to describe it. The first step in installing air-blown fiber is to install plastic pipe tubes in the conduit. These tubes, often a bundle of six small tubes inside a tough outer tube, form a smooth, continuous, air-tight pathway from place to place in the conduit. The second step is to pressurize the tubes to be sure they are pneumatically sealed. The third step is to mount an ingeniously designed "blowing head" on one end of a pipe tube. The blowing head feeds fiber optic cable into the tube as dry nitrogen gas creates an air stream through the tube. As the fiber is metered out of the blowing head, it rides a column of air from one end of the tube to the other — literally floating on air — no stress here. Believe it or not, fiber can be blown like this for up to a mile. Once the fiber is blown, the tubes have an air-tight end placed on them, and the fiber ends are terminated in a traditional fashion. With air-blown fiber, you install a few spares now, and, if you need more fibers in the future, you just blow a few more from place to place.

Electricity and Future-Proofing

Future-proofing the school's AC electrical systems included placing three flush-mount electrical boxes evenly across the floor in every classroom. These outlets will make it feasible to move toward having a computer on every student desk. AC outlets were also concentrated under a counter running nearly the full length of a wall in every classroom. Fiber optic network "drops" were also installed under this counter. The counter top provides space and outlets (AC and data) for four computers and one printer. An additional AC outlet is high up on a wall behind the classroom television monitor.

The electrical circuits that feed these "data-grade" outlets are all surge-suppressed at the "head end" — at the electrical panel where they originate. Incidentally, electrical outlets should be surge-suppressed only on one end, not both. Adding another surge suppressor on an outlet that is already protected defeats both devices. In addition, the school has an auxiliary generator to provide back-up power for all emergency and data systems. (The school is designated as the local emergency shelter.) The school's main servers are on their own uninterruptible power supplies because it takes the emergency generator 30 seconds or more to start.

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Major Servers

Like other modern schools, Hilliard has more high-tech systems and servers than most people realize. The school has three academic servers, one administrative/student records server, one cafeteria server for cash registers and food service management, one media center server, one energy management server, and one media retrieval system server. (A media retrieval system is a computer-controlled group of VCRs and laser disc players that broadcast programming to individual classrooms.) Now you can see why electricity and surge suppression are so important. It's hard even to buy lunch or check out a library book without electricity.

The Academic Network

Now to my favorite subject, the academic network. I will describe the network from a single workstation to the Internet. Every classroom and resource room has four student computers, which are Apple PowerMac 5200/75 LCs with 16 megabytes of memory, 500-megabyte hard drives, CD-ROM drives, and Ethernet cards. Originally, we ordered Apple LC 580s, but Apple had manufacturing problems and shipped us PowerMacs instead — thanks, Apple! Most software has trouble running on Macs with just eight megabytes, and a lot of software is delivered only on CD-ROM — thus the above configuration. Every teacher and staff member has an identical computer.

One student computer in every classroom has video output that can be shown on the classroom's 25-inch, wall-mounted TV. Every classroom has a Hewlett-Packard HP 660C color and black-and-white ink-jet printer. Individual computers have a fiber optic transceiver Velcroed to the back, which is connected to a fiber network outlet. The fiber runs to the data communications closet in each building, which contains the building's fiber network hubs/concentrators. These hubs can be managed from a remote location. At the building level, the hubs are connected to the campus backbone (a logical and physical star) that head-ends at a 15-port Ethernet switch in the server room in Building One.

Incidentally, you need an Ethernet switch for a network like Hilliard's because a regular hub/concentrator simply divides the bandwidth too many times. Networks are like lawn sprinkler systems. If you put too many hubs in a network, it's like putting too many sprinklers on a water hose. The network solution is to put in an Ethernet switch, which is analogous to a sprinkler system's controller that sends water to where it is needed.

The school has two Macintosh 9150 120-megahertz custom-built servers with impressive stats: one MB fast cache, 72 MB main memory, two 2GB RAID drives, internal CD-ROM. One server has tape backup. With the workstation count in the school as high as it is (225 computers), you have to have capable servers.

At present, one academic server is the teacher/staff server, running AppleShare and First Class E-mail. First Class not only provides for today's E-mail, but it can also be used in the future to provide dial-in by students and parents. You can set up bulletin boards with First Class, and it is capable of supporting a Wide Area Network. Other software includes Claris FileMaker Pro server database software, and ClarisWorks 4.0 for word-processing functions. The student server runs a variety of primary and intermediate level software, with one hard drive for primary and one for intermediate programs. If the load gets too heavy on one server, some users and/or software can be moved to the other server. In addition, a configuration involving two servers gives you the desired redundancy.

The servers are connected to a Telebit Net Blazer communications processor that has two modems connected to two telephone lines that will soon connect the school to the Internet. The Net Blazer also has two spare high-speed ports that can be used if the district ever installs a Wide Area Network — more future-proofing.

A third, small academic server also exists as a backup to the two larger servers. This third server is used for network management and is capable of assuming the E-mail task should the teacher server ever go down. I am sorry that there isn't space here to discuss software and the training of teachers, other staff members, and students — even more important issues.

But I must say a few words about the dedicated professionals who helped future-proof Hilliard Elementary School. Nassau County School Board members were forward-thinking enough to augment the construction budget with the funds necessary to help future-proof the school. John Ruis, the superintendent, and Fred Pike, the assistant superintendent, provided the necessary leadership — often running interference and doing all kinds of mediation. Cris McConnell, the director of maintenance (physical facilities) for the county, provided all kinds of savvy and, best of all, was driven to "do it right the first time." Don Jacobs, the CEO; Dave McCurdy; and Don Mills of Commercial Communications Systems, Inc., of Orlando helped ensure that the fiber optic network was well designed and installed. Of course, without the hard work, dedication, and drive of Linda Morris, the principal, and of the excellent faculty and staff, the whole project would have been impossible. I count myself fortunate to be working with such fine people.

> *Believe it or not, fiber can be blown for up to a mile.*

Now for the answer to last month's trivia question, What is so unusual about Category 5, 10Base-T Ethernet wire and why is installing it trickier than most people realize? This wire, which usually consists of four pairs of wire, is unusual because it is manufactured with each pair of wires in the outer jacket having a different twist applied to it. Some pairs have a tight twist; some have a loose twist. In addition, the twist on any given pair of wires changes every so many feet as the pairs go from one end of the wire to another.

The wire is tricky to work with for two reasons. First, no more than 25 pounds of force should be used to pull the wire through a conduit. Second, when a pair of wires is attached to a connector, the loose or tight twist of the wire should be maintained. Loosely twisted wires need a loose twist to the connectors, and so on. If you see Category 5 wire connected in such a way that every pair has a tight twist going to a connector, it has not been installed properly; it will look nice but work poorly.

This month's trivia question: Why might a computer need to know where it is located on Earth? (The article above contains a hint.) K

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