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# MAJOR PROJECT MANAGEMENT: THE YALE TELECOMMUNICATIONS PROJECT

by Michael Grunder, Director of Telecommunications, Yale University

**The large telecommunications project is made up of the most differing, unforeseen, contradictory, ill-assorted things; it is brutal, arbitrary, disconnected, full of inexplicable, illogical and contradictory disasters which can only be classified under the heading of "other news in brief." -- Guy de Maupassant, *Pierre et Jean* (only slightly amended)**

Back in the good old days, when the telephone business was simpler and Saturday night television was worth watching, I can remember Ted Knight the newsman (remember him on The Mary Tyler Moore Show?) looking off into some imagined horizon in the newsroom when asked how he happened to come to his current position. With head cocked upward and his hand clutching his right lapel, he'd start in his deepest, most pompous voice: "It all started in a small, 5,000-watt radio station..."

Around here it all started with a 12,000-line, decade-old Centrex system and a new hospital building going up in the Yale-New Haven Medical Center. Some folks at the hospital who (luckily) knew nothing about the telephone business decided it would be wise to look into owning our own system. This was in early 1980 and marks the beginning of what has now become (unofficially of course) the "Yale Telephone Company."

Things really were simpler then, relatively speaking. The Yale-New Haven Medical Center had about 4,500 telephones in a 34-building complex. Everything was connected by existing tunnel and duct facilities and there were only a few vendors capable of providing a system large enough to fill the bill. After two years of effort, a Northern Telecom SL-1XL was successfully cut over.

Today that system has been upgraded to an XT and is closer to 7,000 lines. (Lesson 1: Never believe growth estimates even when calculated with great vigor by sincere executives in three-piece suits.) In spite of the missed growth estimates and the upgrade, the system has proven itself over and over again in both a financial and technological sense. Perhaps more important (at least for our story here), that experience paved the way for expanding our telecommunications efforts into Yale's central academic campus.

Central campus, as it's called, is located six blocks to the north of the medical center. The majority of it takes up 26 square blocks in the middle of downtown New Haven, Connecticut. There are something less than 200 buildings and, unlike the medical center, a far from adequate duct and tunnel network lies beneath. Most of the buildings are old (but not as old as you might think) with thick, heavy foundations and decades-old wiring facilities. Architecturally speaking, the place is a wonder; mostly Gothic and Georgian with stately spires and beautiful courtyards. It is an inspirational setting in which to live and study. The maintenance and upkeep budgets for these great old cathedrals are also inspiring but in a far more sobering way.

Yale College consists of 5,000 undergraduate students from all corners of the U.S. and throughout the world. Its graduate and professional schools (Medicine, Law, Divinity, Drama, Management and Art and Architecture, to name a few) account for almost 6,000 more students. Funded research makes the place far bigger than its 11,000 students suggest. In an administrative/political sense the first word that comes to mind is "decentralized." To say that authority flows more through consensus than from dictate is more true than false.

## BEGINNINGS

**Langsam's Laws:**
1. **Everything depends.**
2. **Nothing is always.**
3. **Everything is sometimes.**

Yale, contrary to the existence of a first-rate engineering school, a dynamic computer science program, computers everywhere, millions of dollars in scientific research and so on, is first a humanities school. Making a mad dash toward the cutting edge of telecommunications technology was *not* the primary reason for moving forward with the telecommunications project. In fact, it probably wasn't even the second or third reason. In a word, the primary reason was money. Put more gently, "financial considerations." Is it possible that a significant savings can be had over the medium and long term by gearing up and taking control of the institution's telecommunications facilities?

That certainly appeared to be the case in the medical center. Even before that job was complete, we began the initial financial and technical studies to try to answer that question. I can still remember, as if it happened yesterday, one snowy day just before Christmas in 1981. The place had closed early for the first time in 280 years because of a snowstorm. There I sat, all alone in my office, poring over the initial financial runs on the project. (A wolf howled off in the distance.) The numbers didn't look too bad! But are we forgetting anything? What about the cable plant? Is it really possible to install a cable plant this large in the middle of a city and still have enough money left over for a party afterwards?

With the help of our consultant (from the medical center job), a feasibility study was done to determine whether or not cabling the place was a realistic possibility. Conclusions: Yes, there are tunnels. Yes, there is a duct network where the old DC power plant once resided. And yes, the balance could be new construction, probably without breaking the bank. It wouldn't be cheap, but very possible. Also, there sure is an awful, *awful* lot of perfectly good cable and wire out there that could be reused if it could be had for a reasonable price. This last point turned out to be critical.

In conjunction with this cable plant work, a Request for Information (RFI) document was developed. This was a relatively brief paper requesting three pieces of information from as many vendors as we could find to send it to. First, what products are available to serve so large a customer? Second, what is the experience and ability level of each company to maintain so large a system? And finally, what is each company's financial situation? This was sent to 22 vendors and the end result identified 11 possibilities offering eight different switching vehicles.

All of this information, along with some conservative estimates of switch pricing and cost escalation estimates on the current system, were put into a financial analysis. Once again, the numbers came back looking pretty good. Good enough, in fact, to get us some initial seed money to do some staffing and get the consultant on a longer term contract. Keep in mind that at this point staffing means me, an assistant with numerous other responsibilities, a financial analyst from the Budget Office in the same position and a consultant also up to his ears in the medical center cutover.

## THE TEAM

**Loftus' Theory on Personnel Recruitment:**
**1. Far-away talent always seems better than home-developed talent.**
**2. Personnel recruitment is a triumph of hope over experience.**

**MacDonald's Second Law: Consultants are mystical people who ask a company for a number and then give it back to them.**

**Finagle's Eighth Rule: Teamwork is essential. It allows you to blame someone else.**

It's not easy putting together a team of good people for a large project. It is essential, however, and it can be fun if you really put your mind to it. What makes it tough is that the seed money mentioned before wasn't Michael Anthony dropping off a million dollars on the doorstep. It was considerably less than that, if the truth be known. Some creativity and a bit of fast talk was necessary. (In the long haul, a lot of fast talk was necessary.)

A good team is needed for more than the cynical reason noted above by Mr. Finagle. It isn't possible to overestimate the complexity of a project like this. It *is* possible to overspend on a project like this. And it *is* possible to run yourself nuts trying to do too much yourself. A balance has to be struck in order to succeed over the long haul.

The start of the team came by looking within, at existing resources. First, my boss couldn't be accused of being a telecommunications expert but he sure knew the politics of the place. And a more rational, convincing and calming influence never walked the streets of Yale before, at least since I've been here. He put together a small group of higher-level folks through whom the project would be planned and "sold" to the community at large. The two largest computing facilities were represented, as were the library and Yale's Architectural and Engineering Services Department.

For financial analysis we brought in the Budget Office (again) so our financial studies were never looked at as the work of amateurs. Financial credibility is important. Gaining community-wide consensus is probably even more important, but it must be controlled wisely.

Within the Communications Department we developed and hired a new position called "project administrator." This person would be 100% dedicated to the project, unlike most of the rest of us. Also, a long distance network analyst was hired to take full control of our "Watsbox" long distance system. This would free up my assistant to spend a larger part of his time on the project. An accountant was also added to oversee the department's books and to assist in tracking project spending (which by the way is no easy trick).

And then there was the consultant. Do you really need a consultant? Aren't we all professionals? If we didn't know the business, how could we have gotten this far? The answer to the second question is yes, we are professionals. And to the third: "We got this far by being a lot more than just telecom professionals." We got here by being politicians, financial wizards and psychologists, with at least a little bit of born-again preacher thrown in. Only a fool, however, thinks he knows all the answers in this business. And like it or not, talent from out of town always looks better than the local kind. A good consultant not only brings credibility, but fresh perspective and usually a broader range of specific, project-related experience. Also, when the going gets tough, the consultant can bring some extra staffing for the trenches. The answer to the first question is yes, by all means, a *good* consultant is needed. No doubt about it.

In our case we hired two consultants. First, the good guys from the medical center job. This gave us credibility and that fresh perspective. We also got lucky and found a contract engineer that had over twenty years of experience in the interconnect business and cable plant design. The weakest link in our internal talent pool was cable plant design and the construction and duct systems necessary to accommodate the cable. We learned the hard way that electrical engineers are not necessarily telephone engineers. The rules for pulling and accommodating for telephone cables are much different than the rules for electric cabling. (Telephone manholes are different than electrical manholes, too. Better check that one out.)

Meanwhile in the medical center, the cutover had occurred and a management office was set up to oversee that new enterprise. I mention this because it was critical to the central campus project that the medical center be managed effectively for two reasons. One was the credibility it would give us as the central campus project went through the various approval stages. Second, and equally important, the medical center couldn't be allowed to become a management time drain on the resources of the central project. So in a sense, the good people running the medical center were a key part of the central campus project.

## THE RFP

**Knagg's Derivative of Murphy's Law: The more complicated and grandiose the plan, the greater the chance of failure.**

The project team would change as the project wore on and circumstances changed. Various players would come and go, and in the long haul the entire complexion of the department would change as we turned into our own telephone company. For now, however, this was the team that would develop a detailed Request for Proposals (RFP) document and take us to vendor selection and contract negotiation.

And what a process the RFP writing would be! We were (still are) a pretty confident bunch. Our plan was to create the magnum opus of all time. The ultimate document to ensure the acquisition of the ultimate system. We would do this with minimal help from our consultant. No preprinted, boiler-plate-riddled, dust-covered job pulled from an old file drawer for us. Ours would be different.

Well, I don't know how different ours turned out, but if blood, sweat and tears (and heartache and frustration) are any indication of success, then we succeeded famously. Our first version was way too complex. Version number two was way too simple. We finally got it right on number three. Ultimately, the effort we spent was worth it in that we learned a tremendous amount about this place and the process we were going to have to go through. We learned a lot about ourselves, also. All good stuff, but it could have been easier.

My advice: let the consultant do most of the work. They've done it all before and a little dust never hurt anybody. Your big effort, and it's important, is to control the process and make sure the thing is written in your institution's image. Make sure it really reflects the reality of your place and your philosophy. You edit and you structure. Let the consultant write.

As for RFP parts: write a section of business terms and conditions in a way that will allow them to easily become part of your contract. Enter a new team member: the lawyer. Run this stuff by the legal folks quickly. It'll save some time and trouble later.

The technical specifications should be detailed and well thought out. Again, if done correctly, a lot of it can go into the contract, or promises made in the RFP can be used during contract negotiation.

The financial section should be structured so the numbers can be easily plugged into your financial analysis software and easy "apples to apples" comparisons can be done between the various systems.

Finally, the cable plant. We used a connect-the-dots approach that allowed the vendors to be creative in relation to the architecture of their particular system. This is very important, unless you happen to have perfect knowledge of every system out there.

Our final RFP product went out to 11 vendors. Walk-throughs were held and meticulous effort was put into being fair and aboveboard with everyone. We wanted to play the competitive game to the hilt with no accusations of unfair treatment. All questions were answered to all vendors, all changes were made clear to all at the same time and everyone played to the letter of the rules. A hustle for one became a hustle for all.

The analysis of the RFP consisted of several things. First, an overall review of the document by the entire project team. The first vendor cut came based on obvious financial and technical shortcomings. The survivors were then each invited in for formal, technical presentations. Again, rules were defined and everyone was treated the same and given the same opportunities and time. After each presentation an immediate "post mortem" was held in private to discuss the pros and cons while it was still fresh. Detailed notes were kept so the losers could be given specific information as to why they weren't selected. We weren't going to tolerate any end runs or leapfrogs by anyone up to a higher level of authority within the University.

Our final selection was based on a combination of things. Financial considerations of course head the list. The technical aspects of the system and our comfort level with the vendor's ability to install and then support so large a system were close behind in importance. Finally, gut feelings come into play. These are the intangibles that are hard to define but shouldn't be neglected. Your stomach as well as your brain has a role to play in this.

## THE CONTRACT

**Todd's First Financial Principle: No matter what they're talking about, they're talking about money.**

Our RFP evaluation process got us down to three finalists. Contract negotiations were begun with finalist number one, while numbers two and three waited in the wings (just in case). I could write a book (a short one anyway) about this. Fascinating stuff! There are dozens of things to keep in mind during the process. I guess the first one on my list is to be patient and meticulous and don't be afraid to develop your own, unique contract document. In fact, insist on it. Never again will anyone love you like they love you now.

Our contract negotiation team was a smaller version of the project team: me, my technical assistant, the project administrator and our consultant. We left the lawyers at home but at the ready, and we kept them plugged into the process. Great pieces of the RFP were

employed in the document which made life simpler but brought out, in many instances, the complexity of some seemingly simple promises made in the heat of the RFP process.

Ultimately we succeeded at hammering out a contract because we were meticulous and patient and fair. And we had a healthy and realistic respect for our importance as a valuable customer with great future marketing potential for our vendor. Everyone needs to develop and promote their own unique potential as an important customer.

A couple of interesting side notes: in the contract, we negotiated some free fiber optic cable in addition to the fiber that would be used to connect the two switches. Our vendor was making a name for itself in that business and was desirous. We thus designed a network to connect the two switchrooms to five buildings housing our biggest computer centers. It was just for the future, there was no definitive plan. (As it turns out we hardly had the stuff in the ground and we had an application.) Also, we negotiated the immediate installation of a small version of the PBX in our building. In this way we could have over a year of experience with it before ours came on-line. This turned out to be a good move on everyone's part and a relatively modest investment for our vendor.

## SOME MORE TEAM

**Lerman's Law of Technology: Any technical problem can be overcome given enough time, money and people.**

**Lerman's Corollary: You are never given enough time, money or people.**

The RFP and contract negotiation processes resulted in a detailed financial analysis that ultimately got us approval to continue and the necessary funding to proceed with implementation.

Our contract called for a detailed implementation schedule to be developed by a specific date after contract signing. It also had the vendor's project team clearly defined along with a detailed implementation plan. (Another thing it had was a relatively easy method for changing the contract when things like schedules and plans hit hard times.) For our part, we had opted to provide the free and ready access for the entire system, so we had a large construction design project before us. Not only did switchrooms need to be designed and built, but the method for running all the cable and the subsequent construction had to be planned.

The overall project team had by now changed and expanded rather dramatically. I hired an assistant who would ultimately be put in charge of construction management and financial supervision. My previously noted technical assistant was put in charge of switch design and installation and data communications applications (he also became our chief diplomat/glad hander out in the street with our user community). Our long distance network analyst was put in charge of managing the old system, along with adapting and developing the various computer management systems we would use for order processing, billing, inventory and long distance applications. The project administrator, which by now was a different person, would be in charge of training, directory services, departmental systems design and the installation program to hang all 8,000 telephone sets on schedule. Our "project engineer" (the second of our two consultants) would be in charge of cable plant and switchroom design. (Our other

consultant had primarily helped with the financial analysis and in providing an "expert witness" during the approval and funding stages of the project.

Additional internal Yale personnel resources included an electrical design engineer and various other architectural and engineering resources brought in as needed (these included consulting architects and engineers from outside as the pressures of other Yale projects dictated). Construction management personnel were brought in to oversee (with help from my assistant) the various construction projects. Our primary contractors for the different construction projects and their foremen also became part of the team, depending on the phase of construction.

The vendor brought in the troops also. First, a project manager with overall authority for vendor performance came on board. One of his key early responsibilities was the creation of a computer-based scheduling system. (A good tool but one that can be an awful time sink if not done with good software and then kept up religiously. That can be a very difficult trick when so large a project heats up. There is something to be said for flying by the seat of one's pants in some instances.)

The vendor also provided two cable plant engineers, staffing for departmental systems design work and training and assistance with telco order writing for the removal and addition of trunkage and long distance facilities.

## IMPLEMENTATION: CONSTRUCTION

**Benedict's Principle: Nature always sides with the hidden flaw.**

Before we could install the system we had to provide the free and ready access for the cable plant and build two switchrooms (loop length limitations on the digital telephone sets caused a two-switch configuration). We divided the campus into two logical parts. The north end (or science area) would be served by the smaller of the two systems (about 25% of the total). The larger portion would be located to the south and we put that switchroom, luckily, just about on top of the point where existing duct facilities cross. I say luckily because the search for a switchroom location turned into an incredibly complex, political drama. I don't believe we are unique on this one. Everyone seems to struggle with it. My advice is to plan on taking just short of an eternity and bring your sense of humor.

While the search for the switchrooms progressed, design was begun for the cable plant construction in the science area. Plans were formulated, drawings completed, bid specifications developed and the bids let. When the bids were returned, it was back to the drawing boards because they all came in too high. This was the first in a long line of missed estimates (I believe it was Willie Nelson who sang, "Mother Don't Let Your Baby Grow Up To Be An Estimator").

It was cut and slash from here and we got quite good at it. We rethought runs, we cut down on the use of reinforced concrete surrounding the ducts, we went aerial in some locations, we piggybacked onto telco and power poles, we went through sub-basements in spots instead of digging. It's amazing how things can be refined when you have a large enough financial incentive to do so. This proved true also in switchroom design. Never assume that a vendor's first design is the best and only way. Forced creativity builds character. I believe we actually have a better system because of the struggle we went through to stay on budget.

A word about switchrooms. We ultimately ended up in some pretty dreadful space in the larger of the two switching locations. But it was centrally located and it was pretty much dead space that would never have a good academic use. Beware of several things: old mechanical systems that must be moved and probably rehabilitated (very expensive); make sure the full extent of building codes and what must be done to comply is understood up-front; and don't *ever* believe what an "as-built" drawing shows you. They are *never* correct. Always expect the unexpected. (This is also true of outside construction, especially street-crossing excavation.)

In sequence, we designed the science area duct construction and cable plant. Then we designed the science area switchroom. This was followed by the same process in the central area: duct construction and switchroom. We had multiple projects going at once. Before it was over we also had the vendor's subcontractor pulling, splicing and terminating cable as we dug and laid pipe. A scheduling feat of the first order!

## IMPLEMENTATION: SYSTEM DESIGN

**Hardin's Law: You can never do just one thing.**

Meanwhile back at the ranch, a scheme was being devised to inventory existing station equipment and design the systems that would take the place of the old telephones. Yale has about 200 departments, so it was no small task.

To accomplish this we developed what was called the telephone coordinator program (we had done the same in the medical center job with good success). From each department we requested that one individual (more than one in the larger departments) be assigned to help us with the design of their system. We had meetings to explain what we were going to do and then gave basic training so it could be done. We started with an inventory of existing equipment. This allowed us to clean up our billing records, and it taught the telephone coordinators how their telephones were set up and how they related to the business-day process.

Once this was done and we had the smaller of the two switches partially on-line, we held an afternoon demonstration to show how the new system worked and how the various features would be used to replace key equipment. Instructive handouts were distributed, refreshments were served and a drawing for a couple of free telephones was held. We had a full house.

Along the way we developed a mailing list of the coordinators so we could stay in relatively easy touch as time went by. It was important that we be in regular contact with these folks because they were our primary contact in each department and their help would be critical in "selling" the new system throughout campus. No system, regardless of its sophistication and ease of operation, will work if the users don't want it to.

Our project team for the entire design effort consisted of three Yale people, three vendor representatives and two people from our consulting firm. We kept very tight control of the process because we wanted the system to be used in a predetermined manner and not necessarily how the vendor would have done it. For example, our financial model called for digital sets to be kept to 25% or less. More than that could have potentially spelled financial disaster.

Later, when we began the user training program and when we needed to hang the 8,000 new telephone sets on a tight schedule, these same telephone coordinators would again play a

critical role in scheduling and providing access. The telephone coordinator program still exists, with the coordinators now providing ongoing assistance in order processing and so on.

## IMPLEMENTATION: TRAINING

**Meyer's Law: It is a simple task to make things complex, but a complex task to make them simple.**

You can't train people too much in how to use a new telephone system. It's impossible. Training is not only the most important thing in the whole process, it's also the most difficult. Most people, especially people with advanced degrees and people in high places, all too often aren't about to be bothered with such a mundane thing. Mustn't insult anyone's intelligence, dontcha know.

With that in mind we tried to make the process as intriguing as possible. We developed, in-house, a multi-machine slide show of about 12 minutes on each of the two kinds of sets. We billed the new system as exactly what it was--a computer (a friendly one)--and we challenged people to come and try it. Eye-catching handouts were also developed and professional trainers provided by the vendor were the instructors. Again, they trained to our specifications on standard feature packages we had developed.

With an aggressive scheduling process, good publicity and an interesting show we managed to train almost 4,000 of our users. We often had standing room only and people often stayed over and went immediately into the other class, even when not scheduled. On one occasion the Provost (Yale's chief operating officer) attended class in a show of support that enhanced attendance overall. Just as you can't train people too much, you can't ever get too much high-level support.

For those working odd shifts we also scheduled late night training. And for those requesting it, we took the training on the road and went right into departments to special faculty and staff meetings. You *can't* train people too much.

## THE CUTOVER

**Evan's Cutover Law: If you can keep your head when all about you are losing theirs, then you just don't understand the problem.**

Everything associated with the project came together in August, 1986. The cable pullers were pulling cable directly behind the construction crews. The main switch was being installed as the switchroom was being completed. Training was happening as sets were being installed. University directory information was updated with all the new numbers and telco intercept was ready. Just to insure maximum interest, our vendor had a strike. Management people were brought in to carry on.

As part of the final deal, we had purchased all of the existing station, riser and interbuilding cable from the telephone company. The wiring scheme called for a minimum of 50% growth in each building and in each cable run. Double two-pair jacks went into each telephone location. Where possible, existing cable would be rehabilitated and reused. Where

not possible, new cable would be run. Centrex dial tone was not going to go away when a new phone was hung out. Rather, the new system would work in tandem with the old until two weeks after the final sets were installed (October 31).

In early August the switches were brought to life for good. First the police, all our emergency phones, the student health center, the administrative offices in the residential colleges and all the departments in our building were put into service. In effect, the cutover had happened. From here the set hanging began in a tightly scheduled manner from the north working south. The deadline for completion was October 17. In late August the students started coming back to campus. They were put on the new system as they signed up for service. (Double two-pair jacks were used in every possible location for student residential service, and a line card termination was dedicated regardless of whether the student signed up or not. In this way, activating their phones merely became a software exercise.)

Through some perverse twist of fate (and an awful lot of good work), the last telephone did in fact get installed on October 17. The new system was alive and complete and working with the old. Of most significance on that day, we cut the old long distance network dead (the Watsbox) and shifted all the remaining facilities to the new network. New dialing instructions and new toll authorization numbers were needed. Our publicity and our efforts at getting the new information into everyone's hands apparently worked as there was very little trouble.

One week later one more significant event occurred. We removed the ability for people on the new system to easily call the old system. Rather than a five-digit number, they now had to dial 9 plus seven digits. (The old system was always set up this way.) This was another break from the past and forced people, more or less, to use the new system. Again, no complaints. (In truth we had received some complaints from people wanting the old phones removed. They were in the way.)

One more week later, at midnight on Halloween, Centrex dial tone was removed. We were ready for the worst, but it never came. This didn't surprise us. It did surprise some people who had experienced large system conversions of this nature before.

I believe our success had to do with not only a first-rate installation job by all involved, but also with the fact that we knocked ourselves out during the entire process advising people of what was going on and what to expect. Also the slow, 10-week installation and keeping the Centrex alive while it was happening made the change much easier for people to handle. When in doubt, that good old black rotary dial job was still there to hang onto.

The next step after the Centrex was turned off was to remove the old station equipment as soon as possible and do a quick, first-round cleanup of the idt's and old, unused station wire. This had all been pre-planned to start right after November 1st. Along with it would be an updating of all the floor plans in relation to jack locations and jack markings. The entire process took about three months.

## MISCELLANY

**Berman's Corollary to Roberts' Axiom: One man's error is another man's data.**

We're almost at the first anniversary of the cutover and the project is still not 100% complete. Granted, all of the public stuff is done. As far as our users are concerned we're

finished. But the cable plant isn't completely rehabilitated yet and various construction items are not quite finished. There are various punch lists to develop and see to and final inspections to do. Our plan is to cut all telco feeds from our buildings (except five) and route any outside services through our switchrooms. Full clean-up of the idt's and complete documentation of the cable plant is progressing, but slowly. These are not small tasks and we underestimated their complexity. It seems that the last 5% of the project just may take as long as the first 95%.

**Data--Plan B:** Try as we did in the early days of the project to get some consensus on a unified data communications plan, we never succeeded. The place is just too diverse with too many kinds of computers and too many different applications and standards. In light of that, we developed and implemented what became known as Plan B.

Plan B said we would have data-handling capability as one of the higher priorities in our switch selection criteria. It said we would cable not only for the telephone system and its growth but also for current and future support of the Gandalf PACX data network in use on campus. It said we would put in extra ducts wherever we dug to accommodate future data communications (and security, energy management and CATV) needs. And finally it said we would negotiate some extra fiber optic cable just for the future. Plan B succeeded famously, I'm happy to report.

**Miscellaneous circuitry:** Where "Plan B" was a great success in the general sense, the area of security and energy management circuitry became a problem in a much more specific sense. Not only does our cable plant support voice and data communications applications, it is also used for hundreds of burglar, fire, refrigeration and energy-management alarms throughout campus. Beware. We didn't forget that these things had to be cut into the new cable plant. We did underestimate the effort and time it would take to accomplish this. And we also underestimated the dreadful condition that the circuit records were in and the inhospitable locations of a great deal of the equipment.

**Budgetary considerations:** As noted previously, financial considerations were of extreme importance in the approval process, and a great deal of effort went into financial analysis and ensuring that this really was an attractive alternative. A great deal of effort also went into setting internal rates and trying to make the new system as "budget neutral" as possible for our customers. We had always charged departments for their telephone service. This was done on a pass-through basis, using the standard Centrex rates that we were charged for service. We didn't want to cause a huge number of budget problems for departmental business managers throughout the University by drastically changing rates. We did, however, have to recover all of our costs, and it was our strong desire to simplify and clean up the many discrepancies in our old billing system.

To do this we devised a simplified rating scheme that came as close as we could to being budget neutral for the largest number of departments. We worked closely with the central budget office to devise a strategy and policies to deal with problem areas. And we talked with departments that were having trouble with the new rates. We bent and compromised when we could and we hung tough and blamed it on the budget office when we couldn't (and they did the same). It was no easy task.

**Running the new "telco":** Perhaps the most interesting, and at the same time the most frustrating part of our post-cutover work has been setting up all of the procedures and

standards necessary to successfully integrate and manage all of our new systems. There are dozens of things to consider: billing, order processing, long distance network maintenance, toll fraud investigation, telephone repair, cable plant documentation, capital planning and budgeting, system upgrades, customer relations, proper staffing levels and salary administration, to name a few. Perhaps the most critical and most complex is on-call scheduling and emergency procedures. What to do when it hits the fan, especially afterhours.

Our switchrooms are a great deal more than just places where the PBX sits and hums. They are high-tech structures of the first order with security and redundant support systems that rival the telephone switch in complexity. In our first year of operation we have had more problems with mechanical support systems (air conditioning, sprinkler, Halon, burglar alarms, moisture detectors, smoke detectors and so on) than we've had with the telephone system.

Don't underestimate the effort that goes into stabilizing these systems in the first months after cutover and in developing standards and procedures that will quickly mobilize a wide variety of technical staff from throughout various trades in a real emergency.

## POSTSCRIPT

**The Fundamental Theorem of Job Security: New systems generate new problems.**

If any single thing caused us to succeed with this project and live to tell about it, it was (and still is) humor. (Some will say it was the chocolate chip cookies at our project meeting lunches, but they're wrong.) Don't forget to laugh once in awhile. It's important. And don't forget to give credit where credit is due. In this case, Murphy's Laws as seen here are the work of Arthur Block from his book *Murphy's Law Book Two*, published in 1980 by Price/Stern/Stern, Inc. Thanks, Arthur.

# THE COMMONS SWITCHROOM TOUR

**by John Meickle, Associate Director for Planning and Technical Development**
**Yale University Telecommunications Department**

The Commons Switchroom is the largest of two telephone switchrooms built as part of the Central Campus Telephone Conversion Project. The second switchroom is located in the basement of the Kline Biology Tower, on the north end of the central campus. A third switchroom, built as part of the telephone system installation at the Yale-New Haven Medical Center, is located in the basement of the Laboratory for Clinical Investigation.

The Commons, which functions as the main dining hall for freshmen, was built beginning in 1870 and construction is said to have continued over a period of 30 years. Its foundation consists of "blue stone" (a quarried igneous rock), rubble, and brick and in spots is over four feet thick. The switchroom was built in an area that over time has served as a boiler room, a coal bin and a storage area. It is currently surrounded by mechanical and utility systems that serve both the Commons itself and a large portion of the campus. Those systems include high-pressure steam, chilled water, ventilation and electrical service.

To protect the telephone system from the environmental hazards presented by the utilities, a strategy of "a building within a building" was utilized. The roof of the switchroom consists of four inches of steel-reinforced concrete and the walls are made of concrete block. Every planning effort was taken to minimize risk and to promote survivability of the system while attempting to maintain a reasonable budget. Some safety/survivability features include redundant A/C power, dry pipe sprinklers, Halon fire suppression and extensive alarm points.

On the following pages are a floor plan of the room and a brief description of the systems that are in place. The complex covers approximately 2,900 square feet of floor space and cost about $1,400,000, which includes extensive renovation to mechanical systems, the adjacent kitchen and removal of asbestos.

## Systems and Equipment in the Commons Switchroom

1. FIRE ALARM - The fire alarm acts to monitor the Halon system as well as control the sprinkler system. In a normal state the pipes in the switchroom are dry. When a sensor reaches 135 degrees the pipes are flooded, but water will not be released until an individual sprinkler head reaches 165 degrees and melts. The system reports alarms to the Campus Police Dispatch Desk.

2. HALON SYSTEM - The Halon system is used only to protect the switching system because of the sensitive nature of electronic components and the cost of Halon. It is a two-zone system that requires positive input from two ionization sensors before triggering. The system is tied back into the fire alarm system and will activate the alarm.

3. WATER SENSORS - Because the basement of the building is below the water table (and possibly below sea level) the entire complex is dotted with active water sensors, 20 in all, that report back to one panel. An alarm tone and zone annunciation is provided locally and a single alarm message is sent to Yale Console Operations, which is staffed 24 hours a day, 365 days a year.

4. AIR CONDITIONING - The room where the telephone switch itself is housed is the only room actively air-conditioned. The room is designed with two "load sharing" air conditioners that will provide sufficient cooling for a maximum size NEAX 2400. The load sharing aspect of the design assumes that one air conditioner can fail and the other air conditioner can maintain a stable air temperature until the faulty unit is repaired. Alarms off the air conditioners are sent to Console Operations. The room temperature is also monitored by a thermostat connecting to an alarm that also goes to Console Operations.

The remainder of the rooms are cooled by the building's chilled water system as a cost-saving option since the environmental criteria for those rooms are less stringent than the PBX room.

5. THE SWITCH - The NEAX 2400 PBX consists of 17 racks and currently serves about 6,000 stations. In its present configuration it can be expanded to 10,000 stations without additional cabinets. The switch can be expanded to its maximum size (22,000 ports) without any disruptive construction.

6. MAINTENANCE AND ADMINISTRATIVE TERMINAL - The MAT is a personal computer used to assign system features and line features and for diagnostic purposes. System data is also backed up on floppy disk for off-site storage.

7. "THE GAME SHOW DOORS" - Three doors on the west wall were designed with growth in mind and will permit access to and egress from the PBX room as new rows of cabinets are installed.

8. THE FRAME - The Frame carries 21,000 pairs of distribution to the southern three-fourths of the campus (the northern quarter of the campus is fed from the switch at the Kline Biology Tower). All distribution is located on one-half of the frame and all "dial tone" (line port appearances) are located on the other side.

9. FIBER OPTIC CABLE - On the north wall of the alcove are some of the terminations of the optical cable that was installed as part of the telephone installation. The fiber specified is 62.5/125 micron cable with biconic couplers. The class of cable is AT&T Grade M, the lowest loss multimode cable available. Besides connecting the two central campus telephone switchrooms, the cable system connects the computer rooms of Computer Science, Management Information Systems, the Yale Computer Center and the Sterling Memorial Library. Present applications on the fiber system include connecting the two nodes of the telephone system and provision of backbone facilities for an expanding, campus-wide high-speed data communications network.

10. FIBER OPTIC MODEMS - Mounted in the equipment rack are three Canoga Perkins optical modems. Each modem supports four T-1 connections. The digital trunkage between the two nodes of the telephone system is equivalent to 288 four-wire E and M tie trunks. All interswitch calls are routed over the tie lines as are all DID, DOD and long distance calls from the PBX at the KBT switchroom. Tie line operations and feature transparency are provided by Common Channel Interswitch Signaling software and hardware. The modems are configured to use 48-volt DC power, so power is uninterruptible.

11. MEDICAL CENTER FIBER OPTIC CONNECTION (MED-LINK) - The Yale-New Haven Medical Center, which is made up of the Yale-New Haven Hospital and the Yale Schools of Medicine and Nursing, is located six city blocks from the central campus. Served by a Yale owned and

maintained SL-1XT system, the Medical Center shares the University's Long Distance Network (YALENET). The combining of traffic results in significant cost savings.

The telephone system on central campus is "consoleless." All operator services are provided by Console Operations staff in the Medical Center, a 24-hour/365-day-per-year operation that provides faculty, staff and student directory assistance, patient information, overhead and radio paging services, a doctors' answering service and alarm monitoring services. Provision of all these services between the two campuses, as well as high- and low-speed data communications services, are accomplished by an 18-pair, multimode fiber optic cable leased under special contract from the local telco. This facility replaced multiple, leased copper pairs that were originally used. The fiber cable is far more reliable, has far greater capacity and is much cheaper than the copper cable it replaced. Fiber optic multiplexing equipment replaces multiple tie line packs and related equipment in each switchroom.

12. ALARM MULTIPLEXER - Through the alarm multiplexer, 14 discrete alarms are sent to Console Operations from the two central campus switchrooms. These include Major Switch Alarm, Water, High Temperature, Air Conditioner Alarms and Power Transfer. These alarms are an integral part of providing security and protection to the telephone system, and any alarm initiates a documented procedure that causes Yale staff to investigate the situation regardless of the time of day. Yale management is on a rotating "on call" schedule 365 days a year.

13. POWER TRANSFER - The complex is fed by two AC current feeds from the local electric utility. In case of failure of the primary feed, the secondary feed is automatically cut in to provide power.

14. ASTRA TOLL SYSTEM - The Station Message Detail Recording device is an NEC Astra 370 minicomputer that receives the toll record from the telephone system, assembles it into a record, purges non-billable calls and prices billable calls. It also provides management information statistics on the long distance network and provides query capability on completed calls. Yale currently captures call records on 400,000 toll calls per month.

To provide redundancy, the toll system is powered by the uninterruptible power supply (115 volt) and is backed up by a standby Astra 215 microcomputer, as well as the memory buffer of the telephone system itself. If all else fails, the vendor can provide SMDR collection and disk restoral services via the public telephone network.

15. FACSIMILE SERVICE - Repair and Service Order documentation is passed from the Telecommunications Management Office (which resides at a different location) to the Commons switchroom via fax.

16. PREMISE BURGLAR ALARM - The entire complex was planned to provide physical security for the telephone system. This planning includes not only the alarm system, but a review of windows, doors, air vents and other access points as well as lock-and-key control procedures.

17. FAN ROOM - As part of the renovation needed to install the telephone system, the ventilation of the main dining hall noted earlier had to be reworked. An out-of-service ventilation fan was removed and the room was renovated to provide work space for telecommunications technicians.

18. STORAGE ROOM - The storage room presently provides secure warehousing for wire and other ancillary devices. Higher value and/or more sensitive equipment such as switch cards or digital phones are kept in the frame or switchrooms.

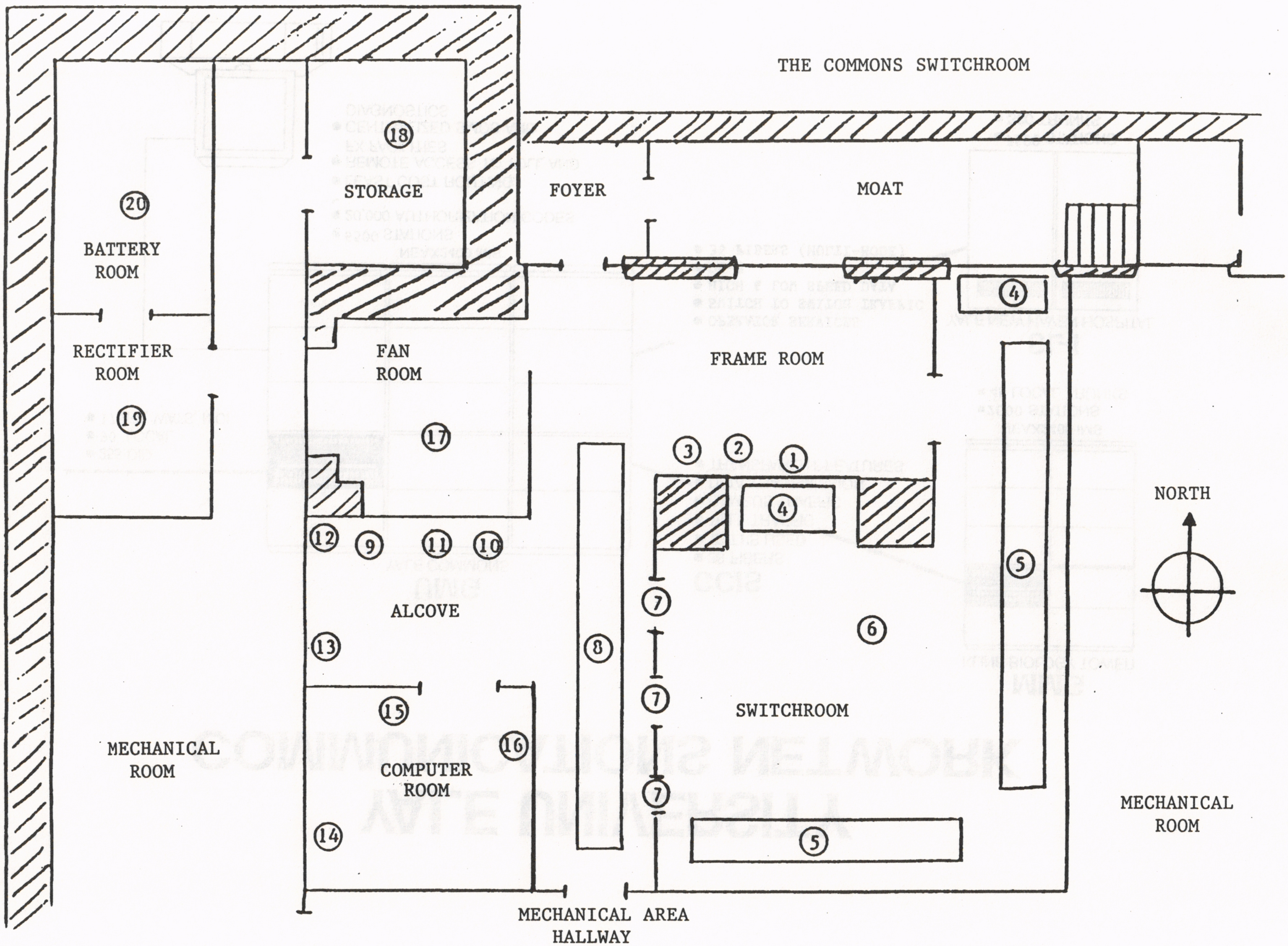
19. RECTIFIER ROOM - AC power fed from the power transfer panel (see item 13) is fed to the rectifier where it is converted to DC (direct current) at 48 volts. The DC current is provided directly to the batteries, to the telephone switch and to various devices that use direct current.

The room also contains an Inverter which, as illogical as it sounds, converts 48-volt DC current back to AC current at 120 volts. The reason for this is that if the main AC current fails, we will be able to provide battery power to various devices that require alternating current power. The instruments using the inverted (or uninterruptible) AC power include the Maintenance and Administrative Terminal (MAT), the Astra toll system, emergency lighting and several data communications devices. Due to their electric current requirements, the air conditioning units are not on the UPS system. The rectifier room is protected by Halon and sprinklers.

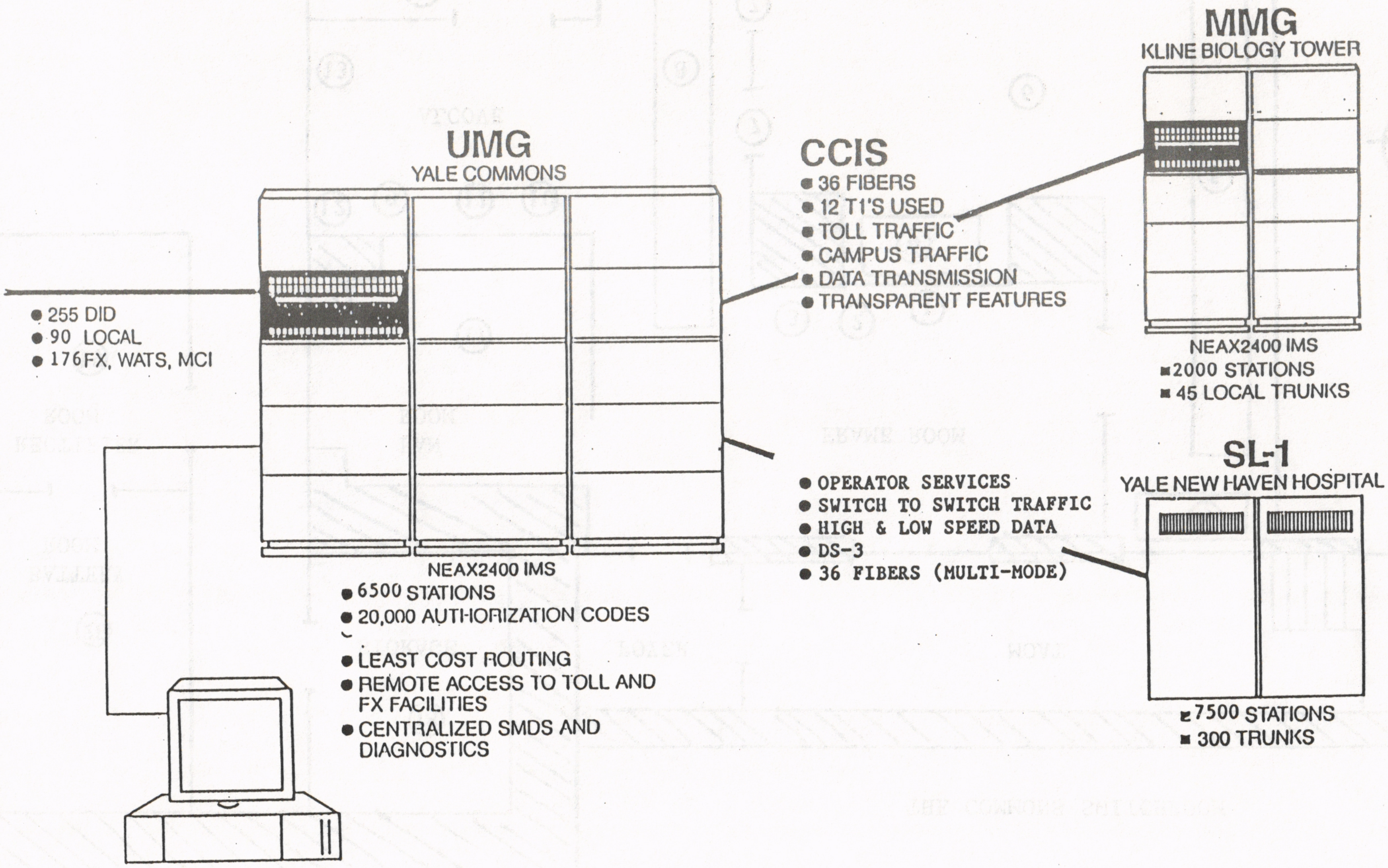
20. BATTERY ROOM - Connected to the rectifiers and the telephone system at all times are the batteries. They act to filter the power to the system by absorbing power fluctuations and as a reserve supply of power to the telephone system and to the Inverter in case of total power failure. The 10 tons of batteries (lead/acid type) have been tested to provide more than four hours of service to the switchroom.

**Yale Installation System Statistics**

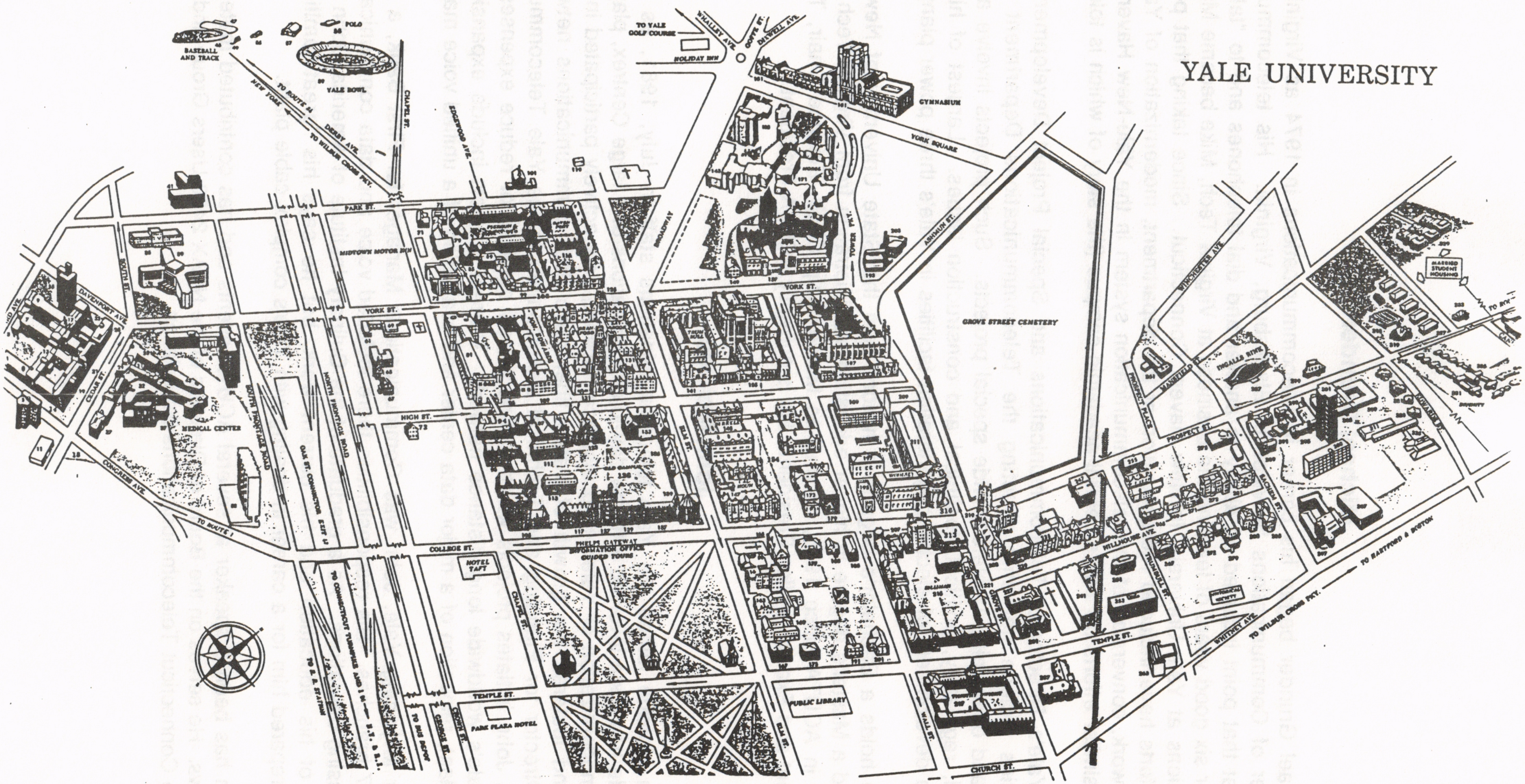
| | |
|---|---|
| System size | 8,000 lines at cutover (administrative and residential) |
| Total system capacity | 33,000 lines |
| Cable plant | 36,000 copper cable pairs |
| Fiber optic cable | 387,000 feet |
| Intermediate dist. terminals | 1,000+ |
| Data terminals served | 1,200 |
| Local area networks served | 25+ |
| Security applications served | Hundreds |
| Switchrooms constructed | 2 |
| Environment | 170 buildings, 26 square blocks |
| Trenching | 1 mile |
| Duct/conduit installed | 19 miles |
| Manholes | 16 |
| Street crossings | 23 (11 new construction) |
| Railroad crossings | 1 |
| Aerial (telephone poles) | 19 |


THE COMMONS SWITCHROOM
STORAGE
FOYER
MOAT
BATTERY ROOM
RECTIFIER ROOM
FAN ROOM
FRAME ROOM
ALCOVE
SWITCHROOM
NORTH
MECHANICAL ROOM
COMPUTER ROOM
MECHANICAL ROOM
MECHANICAL AREA HALLWAY

# YALE UNIVERSITY COMMUNICATIONS NETWORK



# YALE UNIVERSITY



## Michael Grunder

Michael Grunder began his career in telecommunications in 1974 as Virginia Tech's first Manager of Communications Services in Blacksburg, Virginia. His telecommunications experience at that point included an ability to answer and dial telephones and to "talk a good game." After six good years of learning the business at Virginia Tech, Mike became Manager of Communications at Yale University in New Haven, Connecticut. Since taking that position in 1980, his efforts have included reorganization of the department, modernization of Yale's long distance network, conversion of the telecommunication system in the Yale-New Haven Medical Center and similar efforts on Yale's central academic campus (the story of which is told here).

As Yale's Director of Telecommunications and Special Project Development, Mike's responsibilities include not only directing the Telecommunications Department but also overseeing and developing University-wide special projects. Such projects involve a complex mix of legal, regulatory, political, technical and construction issues. Largest of his current efforts is the development of electric cogeneration facilities in Yale's three power plants.

Mike holds a Bachelor's degree in history from the State University of New York at Fredonia and a Master's degree in higher education administration from Virginia Tech. He has been active in ACUTA since 1975, serving as Membership Chair, Finance Chair, Treasurer, Vice President and Executive Vice President. He is currently ACUTA President.

## John Meickle

John Meickle joined the Yale telecommunications staff in July, 1981, as Assistant Manager. He has been involved with the day-to-day operations of a large Centrex, played a key role in the modernization of Yale's long distance network, *very* actively participated in the story told here and fostered the growth of Yale's fiber optic data communications network. As Associate Director for Planning and Technical Development in the Yale Telecommunications Department, John initiates projects which introduce new services or reduce expenses, and he oversees Yale's worldwide long distance network. Current projects include expansion of the fiber optic plant, relocation of a major data center and evaluation of a unified voice mail system.

Prior to joining Yale, John was Communications Manager for First Bank, a statewide bank with 37 branches. His responsibilities there included voice and data communications and word processing operations. As a graduate of the Culinary Institute of America, John notes the incongruity of his education and his current work, but he says his "great familiarity with spaghetti" prepared him for a career in dealing with Yale's complex cable plant.

John has been a speaker at several ACUTA events and has contributed material to the *ACUTA News*. He serves on the Board of Directors of the NEAX 2400 Users Group and has been active in the Connecticut Telecommunications Association.