

# Facilities Automation on a Major University Campus

## Evolution of a Utilities Management System for More than 200 Buildings

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This article deals with the considerations of installing and operating a Facilities Automation System on a major university campus. It addresses a variety of issues, from the basic questions of what the system requirements are, to examples of what was actually done on one campus. This system is used more than a building automation system—it is becoming a *Utilities Management system*.

This article is written from the perspective of the building owner, the facilities management team faced with the challenges of putting an appropriate system in place and then using it to deliver results. It also addresses the reality that technology is advancing, and addresses the transition from a 1970's vintage system to a system that can carry us into the 21st century. It poses issues to consider, and then it uses the actual course of events to illustrate one real world example.

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Where does one start with facility automation? What are the benefits? How does one go about implementing a system?

If you share in the responsibility of operating and maintaining a facility, you probably fall into one of the following categories. You already have some type of facilities automation system, or, you are considering putting one in place. As you may suspect, one size does not fit all. The case study used in this article illustrates one approach to meet the specific needs faced by one organization. Some may find their circumstances very similar, and benefit from a similar approach.

Others may benefit from the questions raised, and use the example to spark thoughts that take them in a very different direction.

## BACKGROUND

The University of North Carolina at Chapel Hill is the oldest public university in the country. The cornerstone of Old East Hall was set in 1793, and the building still stands today as one of over 200 campus buildings in use. It is located in the heart of the picturesque north portion of campus which maintains a classic appearance blending red brick structures with wooded green space. The main campus consists of approximately 700 acres, with over 11 million square feet of campus facilities. The facilities ranging from Old East, originally built over 200 years ago to Lineberger Cancer Research Center, one of the most modern scientific laboratory research facilities which recently completed construction of a new wing. The challenges abound.

The university and the adjoining town of Chapel Hill have grown up together. At one time, the university provided the telephone service, water and sewer, and electric utilities to meet the needs of the university campus as well as the town of Chapel Hill. Following a decision of the state legislature, the university got out of the business of providing utilities services to the community. It does retain a significant responsibility for providing service to the campus itself. This is a major factor in describing the specific, and perhaps unique, requirements related to facilities management of this campus.

## DIRECT DIGITAL CONTROL (DDC)

What are typical needs facing a facility manager? Building controls systems rank high on the list. Of course this can be done in a variety of ways. Tried and true pneumatic controls provide an excellent means of providing control within a building. A facility manager will soon discover limitations to a pure pneumatic system. If the manager has a need to monitor the system remotely, to collect periodic data on system operations, to make changes remotely, or to have the flexibility to reprogram the operation, they will probably be attracted

to a Direct Digital Control (DDC) system.

What are our campus needs?

## DETERMINING SYSTEM REQUIREMENTS

Any comprehensive design approach needs to determine the real requirements. To truly identify system requirements, one has to be able to identify and understand the customers of the system, both internal and external. I contend that one may need to spend a significant amount of time to gain a fuller understanding of who the customers are, and to understand their needs, which may be satisfied by an appropriate system.

In this case, the users of the facilities, as well as those who provide operation and maintenance service, are the primary customers.

The uses of the campus facilities cover a wide range. Academic classrooms, administrative office space, computer centers, libraries, museums and performance arts, dining facilities, retail space, residence facilities, conference and meeting facilities, athletic facilities, research laboratory animal quarters, and clinical patient care facilities comprise this university campus. Many of the facilities have unique needs, again as a reminder that one size does not fit all.

Those providing operation and maintenance support have facilities of their own. The campus is responsible for its own electric distribution system. The campus has a campus-wide steam production and distribution system as well as a chilled water production and distribution system. The campus owns and operates a cogeneration facility, which produces steam, and also has the capability of generating 28 MW of electricity.

### **Facilities Automation Requirements**

From this wide array of customers comes a wide array of requirements:

- Energy savings by turning equipment off during unoccupied times;
- Operational needs to ensure proper equipment operation 24 hours a day;

- Monitoring of critical research material; Comfort cooling,
- Electric load shedding;
- Chilled water load shedding; Steam load shedding;
- Metering;
- Data collection and historical trends; Report generation;
- Global programming;
- Indoor Air Quality (IAQ);
- Changing setpoints;
- Equipment schedules;
- Enthalpy control;
- Economizer; and,
- Integration with other systems.

## INTEGRATION

Several control systems exist on campus. The chilled water operation has a control system. The cogeneration facility has a control system. The energy management office has a control system. The cogeneration facility and chilled water operations depend upon their controls systems for plant operations.

This article focuses on the Energy Management and Control System (EMCS). On this campus, the EMCS' initial focus is HVAC systems. The flexibility of this system allows it also to address other systems in addition to HVAC. Even with different control systems that operate independently, there is a need for some level of integration and data sharing. These systems grew up independently addressing different needs. At the time of their inception, each system was not concerned with integrating with the others. Now, however, there is a desire to integrate the systems, to some degree.

## FORESIGHT

Campus facilities managers responded to the 1970's energy crisis. They created the position of energy manager, formed an energy conservation committee with campus-wide representation, and took action to do something to curb increasing energy consumption.

The campus managers had a vision. Their approach was to install an EMCS, which would have a central control room from which any of the buildings connected to the system could be monitored and operated. Using a 1970s vintage mainframe computer, and telephone circuits with communication using modems ranging from 600 baud to 9600 baud, the system was a significant step toward building automation.

Today, energy managers may scoff at the campus' original energy management system designed in the late 1970's, and commissioned in 1982. The vendor is no longer in business, the mainframe on which it runs is obsolete and virtually unsupported, and the software is not Year 2000 (Y2K) compliant.

Today, it is easy to point out the shortcomings of the system. At the time, it took courage, and vision to commit to a campus-wide energy management system. The system is credited with millions of dollars of energy cost reduction over its 16-year service life, yielding a payback within a few short years.

### **Tri-Service Specification**

With an early interest in compatibility and standardization issues, the first generation EMCS on this campus was designed to meet the government's Tri-Service specifications. It is hard for us to believe, as we take this system out of service, how technologically advanced it was when it was placed in service.

## **TRANSITION**

Campus facility managers realized that their original system was not a system to carry them into the next century. But, how does one go about replacing a campus-wide system? To do it right requires a great deal of planning, patience and perseverance.

### **Engineering Consultant**

The university retained engineering consultants to help determine which system to select as a replacement system. Factors they

took into account were current and future system capability, field support life cycle cost, and operational requirements.

The consultant's report recommended a single vendor in order to have a campus-wide system. Interoperability of systems is an issue. Today there are some options for integrating systems from different vendors that were not options at the time.

## PUBLIC INSTITUTION

Public institutions face some challenges that are different from private business and private institutions. The purchasing procedures and budgeting procedures are two examples. As a state university, the organization must comply with requirements applicable to all state agencies in addition to those specific for this institution.

## COMPETITION

Public agencies and institutions, federal and state, must comply with statutory requirements for competition in contracting and purchasing. Clearly, the competitive bidding process is a valuable tool in continuously obtaining competitive prices. Wise purchasing practices are an obligation as stewards of the taxpayers' money. The challenge, then, is to guarantee that specifications adequately communicate all system requirements to ensure that the low price yields material that actually meets the real needs.

Although competition is a useful tool, it also comes with costs. Be aware of the trade-off between sole source and competitive purchasing.

Consider interoperability, training, maintenance and service when evaluating systems. Two controls systems may offer equivalent features, and similar life cycle costs. Each may meet all performance requirements. What could be wrong with installing system A in one building, and system B in the building right beside it?

Life cycle cost must be considered. The facility manager will either operate the equipment with in-house staff, or will have a contract or service agreement. Economies of scale will enable savings, if both

have the same equipment. Having different equipment leads to additional costs for training, for inventory, and perhaps additional staff.

Different equipment requires additional training for operations and maintenance staff. This may lead to situation where certain staff can only work on certain equipment or where an inordinate amount of time is required to train staff on multiple systems, including re-training and refresher sessions. Confusion between systems' operator interfaces may lead to costly mistakes or safety hazards. If there is a need to share information between the buildings, there lies another problem. Rarely will systems be able to operate as well with systems from another vendor as they do with their own system components.

Until recently, there has been little incentive for controls vendors' systems to work seamlessly with other vendors' systems. The norm has been proprietary systems with closely held protocols rather than open protocol. When interfaces between systems were required, they were expensive. The industry seems to be at a turning point moving toward open protocol with the ability to integrate systems for easier interoperability. This article only briefly addresses BACNet and LonMark devices.

## SOLE SOURCE—SINGLE VENDOR

There are clear advantages to having a single system. The most obvious are system-wide compatibility and the simplified training needs addressing only one system.

The engineering consultants recommended a single system. That recommendation has been used as justification to purchase controls from a sole source over the entire course of the transition from the first generation EMCS to the current system.

## GLOBAL SYSTEM

Ideally, the EMCS would have a global campus system, with the ability to monitor and control all connected building systems from a single seat. This is not an ideal world, and a truly global system does not currently exist on this campus. We do have an EMCS control

room, providing one central location for all EMCS systems.

Although the sole source justification enabled the campus to use a single vendor for all existing controls, it was not seen as sufficient justification to limit competition for new construction and major building renovations. We have attempted to stress interoperability by specifying use of BACNet communication at the front end, and LonMark compliant devices in the buildings.

As a result of our design decisions and our purchasing and contracting actions, instead of having a single system operating in the EMCS, there are multiple systems represented. The systems include: the original system, currently being replaced and phased out; the one recommended by the engineering consultants; two other vendors' systems each connected to only one building on campus, and a newcomer with promises to integrate in accordance with our new specification.

### **Original 1970's Vintage EMCS**

What were the advantages of having an EMCS control room when the first generation EMCS system was installed?

- Ability to monitor building equipment;
- Ability to program equipment schedules;
- Ability to change operation from a central location;
- Limited ability to change set points; and,
- Some graphic displays.

The system provided a means for turning equipment off. Typically, the system would allow command of either Off or Local. The local command would allow the equipment to operate in a local mode with a pneumatic receiver controller.

### **Original Limitations**

What were some of the limitations of that first generation system?

- All processing was done at the host computer. Loss of communication meant loss of control in the building;
- On/Off control of air handling units rather than full analog control;





- Cumbersome user interface; and,
- Cumbersome database manipulation.

## REPLACEMENT SYSTEM

What are some improvements with a new generation DDC system?

- Ability to take full control of equipment with the use of analog output;
- More flexible graphic user interface;
- PC-based host server system;
- Capability for processing to reside in panel;
- Multiple client workstation capability;
- Multi-tasking.

What are some limitations of the new generation DDC system?

- Proprietary system causes hurdles in integrating with other systems;
- Limited number of client workstations;
- Required resources to maintain database.

## EVOLVING TOWARD UTILITIES MANAGEMENT

The expense of a centralized global campus system would probably be difficult to justify, if it only incorporated typical building automation functions related only to HVAC.

A major feature of this campus's facilities automation comes from the ability to act as a utilities management system. Presently, this capability is not fully in place, but it is growing in that direction.

### **Single Phase Incident**

One way to illustrate the benefit of this system is to relate a recent incident on campus. The local electric utility was performing work on circuits affecting campus. Due to a problem at the electric

substation, a portion of campus was subjected to a single phase power situation, potentially disastrous to three phase equipment.

### **Developing the Picture**

It is always difficult during an unusual event to fully assess the situation. Most parties involved only see a portion of the picture.

In this case, the EMCS operator was aware of a power outage, and was able to alert other parties of the situation. Some of the others already were aware of certain aspects of what was going on. The operator, knowing that some buildings had lost power, and ascertaining that equipment was subjected to a single-phase condition for an undetermined duration, took further action.

The event occurred at the end of the regular day shift, when most of the maintenance personnel leave for the day. The standby personnel consist of individuals responsible for specific trades. The EMCS control room became a communications center for the activity to follow. From that vantage point, the operator had access to building information, a view of circuit information from the electric substations, and availability of radio and telephone communications.

The fire department was called to a half dozen sites responding to reports of burning smells. Those were among the first locations the maintenance crews were dispatched as well. Fears of finding burned-out motors and pumps were the major concern. The area effected has approximately 22 buildings containing major scientific research buildings, computer centers, and computer tabs.

### **Control Center**

Once normal power was restored to the area affected, the EMCS operator could monitor building equipment. Eighteen maintenance personnel were called back to campus to respond to the crisis, including HVAC mechanics, maintenance mechanics, and electronics technicians in order to assess the condition and restore operation of mechanical equipment.

Eight hours later, a few hundred pieces of equipment had been restored to normal operation. Those that had not yet been restored had been identified and actions taken to schedule the necessary work. By using the EMCS as a communications center, we knew where to send the field personnel. We were able to prioritize the areas needing

attention, similar to medical triage, taking into account the severity of the problem, the estimated length of time to bring the equipment back into service, and the criticality of the need for the equipment.

Some areas in critical need were ones housing research animals and ones containing major computer systems, to preclude overheating which could lead to irreversible damage.

### **Valuable Tool**

The account of this incident illustrates that the EMCS system, on this campus, is a valuable tool.

### **EMCS Operators**

The EMCS operator, also is a valuable part of the response effort. The EMCS operator needs to be familiar with the facilities and the critical needs of each.

## **LOAD SHEDDING**

In addition to performing building automation functions in individual buildings, the EMCS serves as a campus management tool. One of the most important operational features for this campus is the ability to perform load shedding from the EMCS control room.

### **Not Just for HVAC Anymore**

Usually the topic of load shedding centers around electric load shedding to avoid setting a high peak kWh demand. Typically, a demand charge can be very significant. Not to downplay that aspect of load shedding, but this campus views load shedding in a broader sense. This university campus differs from some large facilities due to the diversity of uses across the collection of facilities during the course of each day.

Take, for instance a hospital or large manufacturing plant. Those facilities can be very large, but typically have a few buildings with what can be a homogeneous profile of activity. There may be many "units" within the complex, which look much like the other units. As the diversity of the units increases, the more opportunity to benefit from the types of load rolling described here.

### **Sharing Available Resources—Load Rolling**

In short, our concept of load rolling is a means of sharing the available resources. The resources include steam, chilled water, and electric power. This campus operates with the concept of central production and distribution of these utilities. Although some package boilers serve some individual areas, most facilities are served by the steam distribution lines, supplied by central steam production at the cogeneration facility, or by the hot water loop, in turn fed by the steam distribution system.

The cogeneration facility has two large boilers, each with a capacity of 250 M-lbs/hr, and a smaller backup boiler, with a capacity of 150 M-lbs/hr. These boilers undergo planned outages for maintenance, and occasionally are taken out of service for unscheduled maintenance.

The campus has three electric distribution substations. One of these connects the output of the turbine generator to campus. The peak demand for this campus in 1997 was 55 MW. The capacity of the turbine generator is 28 MW.

The chilled water operations operates three major chiller plants, two of which have a combination of electric centrifugal chillers, and steam absorption chillers. These three chiller plants can be configured to feed the campus chilled water distribution system with approximately 24,000 tons capacity of chilled water.

The number of buildings served by the central system is increasing as the number of buildings with stand-alone chillers is dwindling. The hospital, located amidst health affair buildings on campus, operates its own chilled water system. The hospital is a major customer of the campus steam production. The steam is used for sterilization to support surgery and other procedures, for the burn unit, for heating, and for the hospital's absorption chillers.

The campus can operate its utilities more efficiently as a result of central production and distribution. As you can imagine, the campus facilities have a complex interrelationship. This requires sharing information and coordinated operation.

The campus benefits from the efficiencies. The facilities also compete for the available resources. When campus demand exceeds available supply, a central control system allows a decision of which facilities receive the resources. Refer to Table 1, Campus Utility Components for a summary of campus load and production capacity.

**Table 1**  
**Campus Utilities Components**  
*University of North Carolina at Chapel Hill*

Utility	Production	Connected Campus Load	Peak Demand	Diversity =Peak/Connected Load
<b>Chilled Water</b>	<b>3 Chiller Plants</b> 24,000 Tons Capacity • 7,000 Absorption • 17,000 tons centrifugal.	<b>31,603 tons</b>	<b>21,655 tons</b>	<b>68%</b>
<b>Electric Utility</b>	<b>3 Substations</b> • Manning 46 MVA • Cameron 44 MVA • South 46 MVA (Rated values)	<b>-100 WA</b>	<b>65WA</b>	<b>65%</b>
<b>Steam Utility</b>	<b>3 Boilers at Cogen</b> 2 @ 250 M-lbs/hr 1@ 150 M-lbs/hr		<b>&gt;454 M-lbs/hr</b> 50 M-lbs elec gener 400 M-lbs campus loads	

## DEMAND MANAGEMENT

### **Steam Load Shedding**

When the cogeneration facility is unable to operate one of its large boilers, it may be able to meet only a portion of the entire steam demand of the hospital and the campus. Although the cogeneration facility has a control system dedicated to operating the production of steam, the capability of managing the campus load lies outside of their system's capability. They control the valves at the supply, and have the capability of dispatching personnel to manually close steam valves on campus.

The EMCS, however, has capability of influencing, and to some extent, controlling the steam demand on campus.

The Cogeneration Systems, Chilled Water Systems, and EMCS need to work closely to coordinate campus operation. The Cogen Facility requests cooperation in operating the appropriate number of absorption chillers to match the steam production. For instance, when more steam is produced to generate more electricity, the absorption chillers can use the steam in the production of chilled water.

If the campus experiences a sudden loss of steam pressure, the EMCS can respond by shedding the less critical steam load.

The high priority customers for steam are the hospital and the research animal quarters areas. Under certain weather conditions, pre-heat for outside air to avoid freezing coils and resultant flooding is a concern. Comfort heating falls much lower on the scale. If all loads continue to call for steam, there simply will not be enough steam to go around.

The EMCS can play a vital role in stabilizing the situation. By shedding all unnecessary steam load, the Cogen Facility is able to return to stable operation more quickly. Service can be maintained, or restored quickly to the most critical areas. If demand continues to surpass the supply, the EMCS is able to use a load rolling scheme.

## LOAD ROLLING

While maintaining steam supply to the most critical loads, the EMCS can apportion the remaining supply to the remaining loads.

This, again, requires a comprehensive knowledge of the campus facilities and their needs.

If a steam shortage occurs during the academic day, and there is not enough steam to supply to all the academic buildings, they may be cycled to share the burden. Steam valves in one set of buildings will be closed using the automation system. After a period of time, perhaps an hour, the operator will shed steam load from the next set of buildings and restore the steam to the first set. This sequence proceeds until the steam pressure available is sufficient to meet all the campus demand.

### **Chilled Water Load Shedding**

Typically, the chilled water plants prefer that the EMCS not shut off a chiller, unless extreme conditions warrant it. The EMCS tends to again work with the demand side of the issue, as the preferred approach.

The global programming capability allows the EMCS to have automated programs that can increase cold deck discharge temperatures across several buildings simultaneously. This change in chilled water load is seen at the chiller plant shortly thereafter.

One area where the chilled water systems and building automation systems come together is at the chilled water bridge. Our facilities are being designed with a chilled water bridge to operate between the chilled water distribution system and the building load. When operating correctly under low to moderate loads, it allows the building to recirculate chilled water to increase the chilled water return temperatures.

In doing so, it allows the chillers to operate more efficiently. When the bridges are not operating correctly, a building can bypass large quantities of chilled water causing low return temperatures, and reducing the efficiency of the campus chilled water systems.

With the overlap of the two systems, the chilled water bridges are operated by the same controls systems as comprise the EMCS. Although vital to the operation of the chilled water production and distribution, the chilled water bridges are closely coupled with the individual buildings' operations. Sharing information is essential. Our current system allows us to place a workstation in the chiller plant to enable their operators to view how the bridges are performing.

### **Electric Load Shedding**

Similar to the situation with steam and chilled water load shedding, the electric load shedding follows the same theme. With three substations operating, the campus has plenty of capacity to provide the needed service. If a major outage occurs, rendering a substation or several circuits out of service, the available capacity needs to be managed to carry the load.

Although switching the load from one circuit to an alternate is not done by the EMCS, the system provides a window into the data useful to those who do perform those switching operations. The EMCS operator can monitor circuit load, and can manage the building mechanical equipment accordingly, to work as a team member with those restoring normal service of the electric systems. The energy management system and EMCS operator can monitor circuits, amp readings and alarm on overload conditions.

### **Profile**

Each campus facility has a predictable profile for use. The academic classrooms and office spaces are most heavily used from 8:00 a.m. to 5:00 p.m.; the dining facilities follow a predictable pattern around meals; the residence halls have demand for domestic hot water in the mornings; and, the patterns go on.

The operator's knowledge of the critical needs on campus, and the patterns of campus needs goes a long way in helping to manage the utilities when demand exceeds supply. One key is knowing how each facility's needs shift.

## **AUTOMATION**

Many programs are resident at the building. The building controller actually contains the database, including programs tailored to the specific needs of that building. The great advantage is that the programs will operate regardless of the ability to communicate with the host server. As long as the programs are properly written, the building can operate on its own.

The host also has the capability of running programs. The host-level programs are typically the utilities management programs. They

are global in nature, addressing more than one facility. They do require communication with the individual controllers across campus. Programs can be set up to run on predetermined conditions, or they can be run with the operator in the loop.

## HOURLY PRICING

Due to the university's cogeneration capability, and the ability to manage utilities across the campus, the administration was able to enter into a desirable rate plan with the local electric utility. In anticipation of changes related to possible deregulation of electric power in the state of North Carolina, many alternatives were explored. The university currently is in an arrangement where it has agreed to purchase a block of power daily. Any additional power purchased from or surplus exported to the power company is exchanged at a published Hourly Rate (HR). The hourly rate is set by the power company and published before the end of the business day preceding the day for which the rates are effective.

The cogeneration facility generates steam to meet the campus demand for steam. In addition, it has the capability of generating up to 28 MW using a steam turbine generator. The campus calculates the marginal cost for condensing, and the marginal cost for absorption, and makes its decision about how much electric power to generate, accordingly.

This creates the need for a cooperative relationship between campus utilities to coordinate steam production and absorption chillers. When the hourly rate quoted by the power company exceeds the marginal cost for generating our own electricity, it is economically expedient to generate as much as possible. The duration of the high price is also considered as a factor in the decision whether to generate at maximum capacity.

Instead of viewing the bill from the power company as our total electric bill, we instead look at the combined cost of purchasing and producing electricity. We may produce less and purchase more than we did prior to the hourly rate agreement, but our overall cost for electric power should be lower. This results in a win-win situation. The electric power company has created an incentive for the university to generate during periods it is most beneficial to both parties.

### **The Race is On**

Under the current rate structure, we are not as concerned about the peak demand. With our current campus load, we have a bit of a buffer before we incur any significant penalty due to exceeding our current kW peak demand. As more facilities come on line, the campus load increases, and our peak goes higher. We are in a race to get our system in a position to be the tool that is needed to manage peak kW demand.

### **FIVE-YEAR TRANSITION**

Changing from one campus-wide system to another is not easy. It requires a good plan to use as a road map. It requires commitment of resources, including the budget across the fiscal years required to maintain progress through completion.

### **Chasing Technology**

Technology continues to change. We live with yesterday's decisions, and we make more decisions today which will take us to tomorrow. One of the most difficult challenges facing us is anticipating where technology will go, and trying to make the right decisions.

### **CHOOSING A VENDOR**

Some of the major factors in selecting a vendor for a campus-wide system were the operating system's ability to handle multitasking, and the vendor's ability to provide continued system support.

At the time of the selection, the OS/OS2 based system offered what appeared to be the best package for multitasking. The availability of a factory regional/branch office offered the best option for continuing support.

### **PARTNERSHIP**

We consider our relationship with our controls vendor as a partnership.

## COMMUNICATION

The original EMCS system relied upon direct connection with building panels. Most of these connections were made using four wire leased line circuits through the telephone company, and the remainder were made by installing our own wire from point to point. The annual telephone bill for connections made over leased lines is over \$50,000.

The current system uses a combination of dial-up telephone connections, direct connection (most using leased lines), and Ethernet using the main campus backbone network. The campus made a major investment to install a fiber optic network on campus, providing service to all departments with a variety on information system needs. The EMCS is attempting to take advantage of the availability of the campus network by converting as many controllers to Ethernet as possible, thus reducing the expense for leased telephone lines.

### **Network Traffic On A University Campus**

Many controls vendors have products with network communications capabilities, such as Ethernet. Most of those systems work well on a dedicated network. I suspect that most were not designed to operate in an environment as intense as a shared network on a major university campus. With thousands of students, faculty, researchers, and staff using the same network for myriad purposes, the network traffic is not always friendly. Broadcast traffic seems to be our major nemesis, so far. With a spirit of partnership, we are working with our campus information technology personnel and our control system vendor to improve our performance on a busy network.

## PHILOSOPHY

On our campus, the facilities services organization is responsible for operation, maintenance and repair of the buildings mechanical systems, including the DDC systems. Most of operation and maintenance of the energy management and controls systems fall under the HVAC Systems group, and are performed by staff employees.

Our philosophy is to be as self-sufficient as possible. We aim to

retain a well-trained staff, familiar with all our systems. This requires continuous emphasis on "On-the-job training" (OJT), as well as strategic formal training as required.

Our partnership with vendors is a vital part of our striving for self-sufficiency.

Our staff includes HVAC mechanics, building automation specialists, EMCS operators, and electronic technicians.

### **Responsibilities**

- Installation
- Commissioning
- PM
- Calibration
- Database maintenance
- Programming

The EMCS operators are responsible for daily operation of the system. In addition, they are programmers and system administrators. Our system allows much flexibility. With the flexibility comes the need to design, program and customize the system to fit our campus needs. We can accomplish these efforts through contracted efforts, or with our in-house personnel and resources. We realize that we will make some mistakes, and have committed to learn from those mistakes.

The responsibilities we have taken on with our EMCS require a commitment of resources. Some organizations may desire more canned programs available off the shelf. They may not need as much customization, or they may choose to have all their programming done by contracted effort. With fewer needs to perform system administration, one can get a simpler user interface. These decisions depend on the specific facility's needs and the organization's resources.

### **AUTOMATION FEATURES**

- Load shedding
- Alarming
- Scheduling

- Proportional/Integral/Derivative (PID) Control Loops
- Initiate programs on specified conditions.

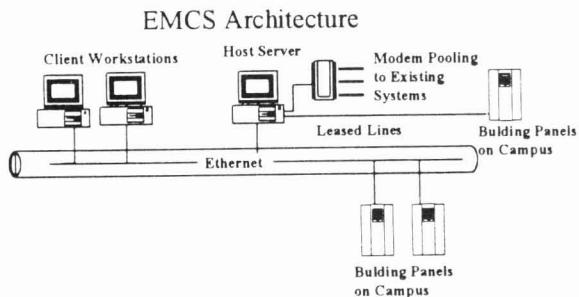
## BRANCHING OUT

The campus energy management system started out with operator view available only in the energy management control room. As users needs and system capabilities have changed, this system has expanded, allowing more users to have a view of real time data through workstations connected to the host-server in the energy management office. Currently workstations already are installed or will be added in these locations:

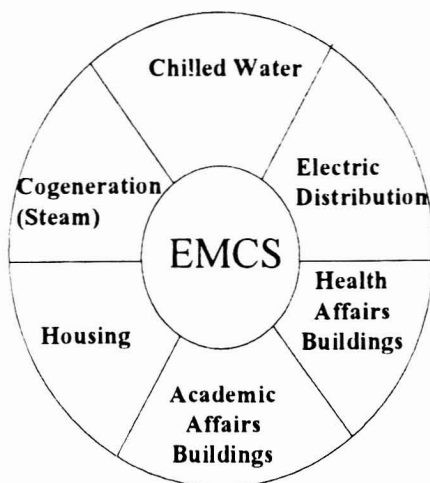
- Cogeneration Operators Control Room
- Electric Distribution
- Chilled Water Operations
- Housing Support (Residence Halls)
- Health Affairs Buildings
- Academic Affairs Buildings
- Energy Manager

## LAPTOP COMPUTERS

Current systems allow direct connection to building panels with the use of a laptop computer.



**Figure 1. EMCS Architecture.**



**Figure 2. Interrelationship of Energy Management Systems.**

## BACNET AND LONMARK

Anticipating the future is extremely difficult. For new construction, we must specify the controls systems which will be installed sometimes years after the specification is written. We are encouraged by the move toward open protocol in the ASHRAE standard, BACnet. That standard is changing and evolving, making it difficult to anticipate future changes. LonMark also has attractive features of interchangeability of particular devices.

For new projects, we have specified a hybrid approach to take advantage of LonMark controllers within campus buildings, and use BACnet as a means of communication with the host computer. Again, we are relying on the partnership with one controls vendor to provide a front end that will allow us to communicate with our installed equipment, and accommodate other vendors' BACnet systems.

## CHALLENGES ABOUND

We are successfully concluding the five-year transition from our original EMCS system to a modern DDC system. Our journey is not

over. We continue to expand the system in facilities on campus, and incorporate controls in new construction.

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#### ABOUT THE AUTHOR

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Mr. Taylor holds a B.S. in electrical engineering from the University of Mississippi, and an M.S. in engineering management from the University of Southern California. Before moving to North Carolina, he served 9 years in the U.S. Air Force, and has a background in project management, systems engineering, process improvement, and energy management.

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