SPATIAL TOOLS FOR THE ADMINISTRATION OF MAJOR INSTITUTIONS

Jeffrey M. Young
Program Administration Group
16511 Martha Street
Omaha, Nebraska 68130

BIOGRAPHICAL SKETCH

Jeffrey M. Young was born in Scranton, Pennsylvania in 1954. Mr. Young attended public schools in Scranton and graduated *cum laude* from Lock Haven State College receiving a baccalaureate degree in Geography. Mr. Young continued his education at Arizona State University where he was granted a Master of Arts degree in Geography. While in pursuit of the Master's degree, he participated in the National Science Foundation supported program, "Spatial Analysis of Land Use." Mr. Young is currently a Senior Consultant with Program Administration Group.

ABSTRACT

Administrators of major institutions are seeking new tools to aid in the management of geographically dispersed facilities. Typically these centrally-controlled institutions are a collection of several semi-autonomous units such as state prisons, hospitals, and universities. Traditional information processing approaches for these institutions have relied upon Management Information System (MIS) methodologies. Improved spatial information processing tools provide an opportunity for institutional planners, operators, and maintenance specialists to migrate from a non-graphic MIS environment to a spatially-oriented setting. Both Geographic Information Systems (GIS) and Computer-aided Drafting Systems (CAD) have significant roles in this transition. A model conceptual design of a spatially-related Institutional Information System (IIS) is presented in this discussion. The design is multi-scaled to accommodate the requirements of an institution as a whole, as well as site and building details, for routine operation and maintenance at each location. The IIS conceptual design is structured to support the life cycle of the institutions, i.e. planning, design, construction, and operation and maintenance; including pre-programming, space planning, master planning, resource allocation, staffing, cost analysis, remodeling, rehabilitation, and inventory control.

OVERVIEW

Technology-and-growth enthusiasts would like us to believe that technology and capital can solve almost all problems (Kahn, 1976). The author of this paper does not embrace this extreme perspective. However, the paper is prepared with a spirit of guarded optimism; institutions, such as universities, medical facilities and prison systems, need to prepare for the 1990's and can benefit from expanded use of information technology.

In the context of this discussion, an institution is any organization established to conduct the business and/or operations of a society or association. These institutions may be private in character; designed for profit or publically supported; being operated for the well being of a constituency. Institutions relay heavily upon estimates, projections, and forecasts to evaluate facility conditions and function as a part of normal operation. Institutions are the fabric of our nation. These include schools, universities, banks, religions, insurance companies, health care facilities, prisons, the military, airports, and cultural and historic centers to name a few. We all benefit by well run institutions and, conversely, we all feel the impact of institutions under stress. All institutions have limited staff, funding, and space resources; and some are confined to a cramped collection of buildings, people, and cars with little room for growth. Under these conditions prudent allocations of staff, budgets, and space is of primary concern along with maintenance of existing buildings, grounds, and infrastructure. As a group, institutions are used for diverse functions, however, most have been built from scratch, are long lived, and are surrounded by ever changing land uses and landscapes (Lynch, 1971).

Quality information is required to efficiently plan, design, construct, operate, and maintain an institution. Inadequate estimates or projections have contributed to the failure of institutions (Hall, 1980). The value of map data for facility siting is well established (Williams, 1983). Certainly engineering and architectural drawings and specifications are a prerequisite for design and construction. It is a pity that for most institutions the information gathered during planning, design, and construction has not been effectively integrated into operations and maintenance. Perhaps integration may be too ambitious, but some form of data linkage is appropriate. All too many times a facility manager finds it difficult to answer simple questions such as:

- What is the condition of our buildings, structures, and infrastructure?
- What is the total square feet of our institution?
- What is the total value of our institution?
- How can our functional use of space be improved?
- Where can we build and expand?
- What needs to be repaired, renovated, or decommissioned?
- Have these repairs been completed and, if not, when will they be done?
- What are our operation and maintenance costs next year? ...the next five years?

Over time, a facility manager can find himself responding to a series of ad hoc inquiries rather than attending to daily needs of the facilities. He may encounter islands of automation in his search for an answer, but in the end some degree of uncertainty and temporal error is present in his response to the questions listed above. The data required to answer those questions may exist, but not in a form for his purposes. Improved information management is now mandated. Long-term institutional data managers, who serve the needs of facility managers and institutional planners, must develop information systems with several attributes including (after Zimmerman, 1987):

- Large storage capacity with minimum operator intervention required
- Accessibility to a wide range of users
- Flexible archiving and networking
- Automated data management
- Responsiveness to long-term growth requirements and technological improvements
- Security

Computer technology to support all aspects of the life cycle of facilities has been improved and refined to a point where implementing an IIS is practical. Presently most institutions possess a disjointed collection of data, procedures, and computer hardware and software which, when approached by facility managers and institutional planners, has been a source of frustration. Database and intelligent graphic-oriented tools may ease the frustration of these users.

This paper presents a definition of an IIS, provides a model IIS conceptual design, and describes IIS implementation steps.

INSTITUTIONAL INFORMATION SYSTEMS

Institutional Information Systems (IIS) comprehensively provide for the collection, data preparation, storage, management retrieval, analysis, synthesis, and display of data on the institution as a whole; campus sites and surroundings; structures and buildings on campuses; building systems; and equipment within each building and structure. An IIS is an organized collection of data, procedures, personnel, computers, software, and communications. Views of the data within an IIS can be tabular, graphic or both. An IIS provides institutional planners and facility managers with a means to receive, sort, retrieve, and transmit information. Information can include region-wide displays with associated data covering several states or detailed inventories of fixed assets within a particular building. Often data on an institution is stored in a variety of media at numerous locations. IIS's can be developed to reduce data lost and unnecessary duplication.

In effect, an IIS is a super-information system which is intended to link or loosely couple several spatial and non-spatial, and, graphic and tabular data handling subsystems which include:

- Administration including staffing, financial, inventory control, and purchasing functions (MIS-based)
- Asset database (MIS-based with a CAD/GIS link)
- Facility database (CAD/GIS-based)
- Infrastructure database (CAD/GIS-based)
- Maintenance management (tabular with a CAD link)
- Environmental compliance (GIS-based)
- Public affairs and relations
- Real estate acquisition and disposal
- Architectural/engineering planning and design (CAD-based)
- New construction and renovation (CAD-based)
- Archiving (tabular)
- Special purpose subsystems (such as statistical mapping and analysis, environmental monitoring, demographic analysis, capital improvement planning, space planning, security, economic forecasting, historical preservation, and litigation support)

MODEL IIS CONCEPTUAL DESIGN

The model conceptual design of the IIS is organized into information tiers (see Figure 1). Each tier is comprised of one or more data element groups which include institution features, building systems, and equipment. This model is intended to be suitable for any of the institutions described earlier. Tiers and data element groups for the IIS are as follows:

Tiers	Data Element Groups
Institution-wide	- campuses - other semi-autonomous locations
Campus Sites and Surroundings	- site features - utilities - structures and buildings - other features
Structures and Building Systems	- operations - HVAC - instrumentation

- plumbing
- power
- lighting
- communications
- other systems

Equipment
- operations
- HVAC
- instrumentation
- plumbing
- power
- lighting
- communications
- other equipment

The Institution-wide Tier contains data of greatest value to institution planners and budget specialists. The Campus Sites and Surroundings Tier provides detailed information on each campus and other semi-autonomous units. This data would provide much needed data to the facility managers at each location. The Structures and Building Systems Tier provides detailed floor plans and characteristics regarding major building systems. The Equipment Tier is the most detailed of all of the tiers in terms of both spatial resolution and associated data on individual pieces of equipment. The associated data for equipment would typically include maintenance cycles, performance standards, description identification number, location, model, type, manufacturer, etc.

Example data profiles for the Campuses Group, Site Feature Group, HVAC Systems Group, and HVAC Equipment Group have been prepared to further explain the content and level of detail of each tier (see Figures 2, 3, 4 and 5). Each profile defines the graphic and non-graphic characteristics of the data element group being portrayed including a definition of the data element group, data types included, a representative plan view, and a listing of typical non-graphic associated data.

IMPLEMENTATION STEPS

Implementation of an IIS requires the execution of several activities which would likely be conducted over a period of months and, in some cases, years depending on the size and physical extent of the institution. A pilot should first be conducted prior to institution-wide implementation. A six phase prototypical implementation approach is described below.

Phase 100-IIS Conceptual Design

The identification and evaluation of user requirements and data sources currently in use will form the foundation for an IIS. The tasks to be conducted during this phase are:

Task 110 Document IIS user requirements
Task 120 Review IIS data sources
Task 130 Design a conceptual IIS database

Task 140	Define conceptual applications modules
Task 150	Design a conceptual computer configuration
Task 160	Recommend an IIS organizational framework
Task 170	Evaluate costs

Phase 200-Computer System Selection and Acquisition

Computer hardware and software will be selected and acquired during this phase. After acquisition of computer components from vendors, an acceptance period will provide the institution with assurances that the selected system will fully support their requirements. This phase will require the execution of six tasks:

Task 210	Establish functional requirements
Task 220	Prepare a computer vendor solicitation
Task 230	Issue solicitation and receive responses
Task 240	Evaluate responses and select vendor
Task 250	Acquire and install computer hardware and software
Task 260	Evaluate performance and accept equipment

Phase 300-Detailed Database Design

The IIS database design will be based upon the physical requirement of the computer configuration selected under Phase 200 and the functional requirements identified under Phase 100. The physical design of the database will describe keys and links to various applications. The tasks for this phase are as follows:

Task 310	Specify database
Task 320	Test database design
Task 330	Finalize database design

Phase 400-Data Conversion

A digital database for the institution will be created during this task. Prior to conversion, data standards will be established to provide guidelines for data input, format and structure; accuracy and precision requirements; and performance schedules. The tasks which will be addressed in this phase are:

Task 410	Establish data standards
Task 420	Select conversion vendor
Task 430	Test data quality and compatibility
Task 440	Convert data

Phase 500-IIS Operations

The IIS will begin routine operation during this phase. Successful operation will require clearly defined organizational roles and responsibilities. Some staff training is anticipated. This phase contains several tasks:

Task 510	Define organizational roles and responsibilities
Task 520	Select staff
Task 530	Train staff
Task 540	Operate the IIS
Task 550	Provide technical support

Phase 600-Applications Development

Applications will be developed which employ the previously designed database and acquired computer configuration. Initial applications development will concentrate on those applications which will serve a wide range of IIS users, although some applications will meet specific user requirements. These applications will include space planning, code compliance, infrastructure management, inventory control, environmental monitoring support systems, capital improvement planning support, and incidence mapping. The phase involves five tasks:

- Task 610 Select candidate applications
- Task 620 Design selected applications
- Task 630 Test applications
- Task 640 Implement applications
- Task 650 Provide technical support

SUMMARY

An IIS is a set of human and capital resources which provides information to institutional planners and managers. Successful implementation requires the cooperation of all levels of an organization. However, please remember, technology alone solves nothing.

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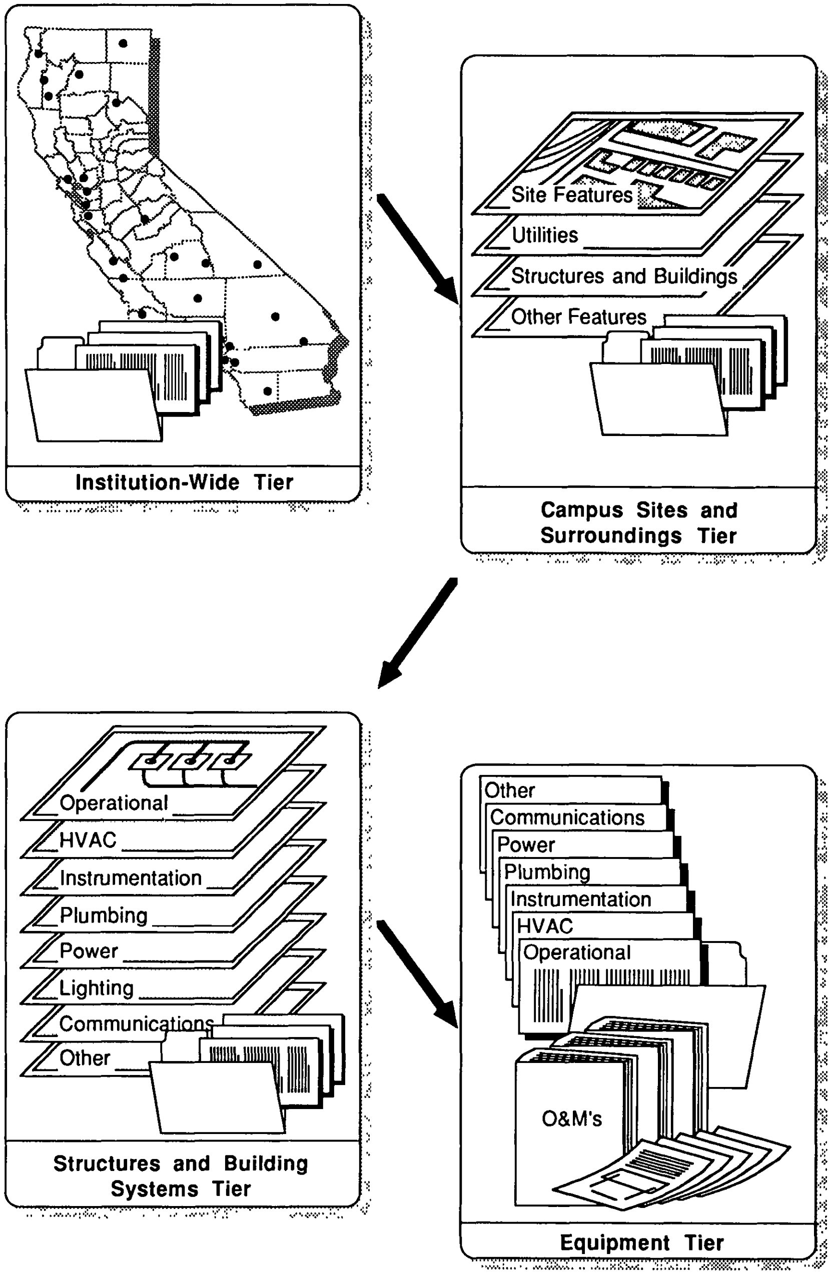


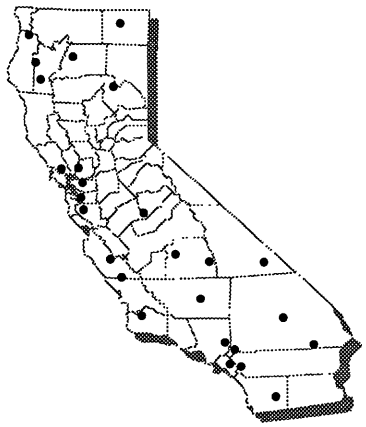
Figure 1. Institutional Information System Model Conceptual Design

Tier:	Data Element Group:
Institution-wide	Campuses

Definition:

Campuses: Semi-autonomous contiguous areas with infrastructure, natural features, structures and buildings associated with an institution. Institutions are typically comprised of multiple semi-autonomous campuses.

Plan View



Associated Data

- Functional Uses
- Year Constructed
- Total Acres
- Acres Developed
- Gross Floor Area by Function
- Road Length/Area/Media
- Generalized Utility Information
- Design Capacity
- Total Number of Users
- Total Number of Staff
- Climate/Meteorology
- Seismic Zone
- Surroundings
- Land Use
- Other

Figure 2. Campuses Data Profile

Tier:

Campus Sites and Surroundings

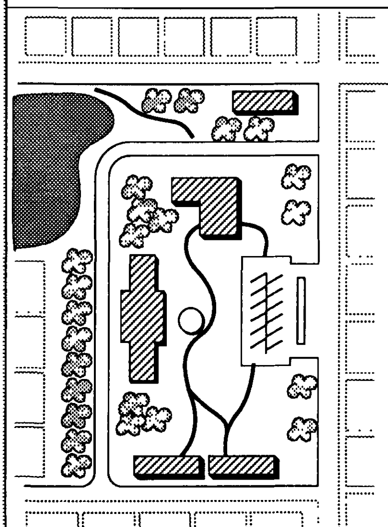
Data Element Group:

Site Features

Definition:

Site Features: Natural and manmade components of a campus site and surroundings including hydrography, pavement, roads, paths, property, boundaries, sidewalks, and vegetation.

Plan View



Associated Data

Description
Location
Size Dimensions
Materials of Construction
Year Constructed
Inspection Interval
Last Inspection
Staff Requirements

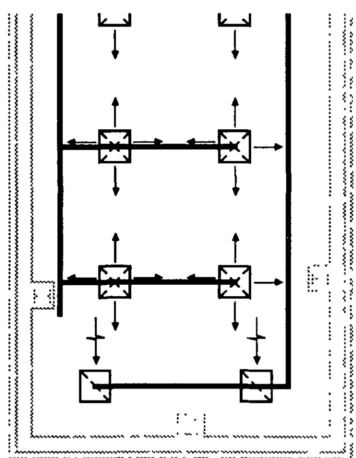
Figure 3. Site Features Data Profile

Tier:	**Data Element Group:**
Structures and Building Systems	HVAC Systems

Definition:

HVAC Systems: Integrated system of piping, ducting, and equipment required to support heating, ventilation and air-conditioning of a building or structure.

Plan View



Associated Data

- Description
- Location
- Rooms Served
- Capacity
- O&M References
- Shop Drawing References
- Specification References
- Inspection Interval
- Spare Parts
- Staff Requirements

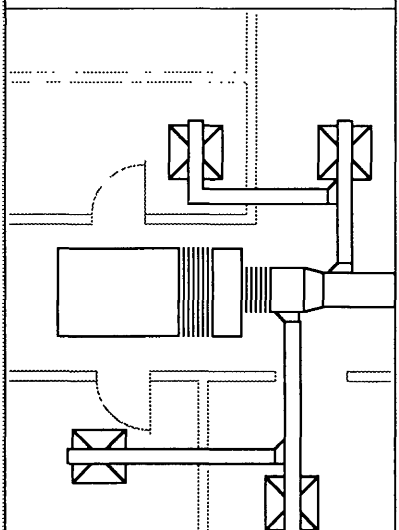
Figure 4. HVAC Systems Data Profile

Tier:	Data Element Group:
Equipment	HVAC Equipment

Definition:

HVAC Equipment: Piping, ducting, and equipment required to support heating, ventilation and air-conditioning including air conditioners, air handling units, boilers, compressors, exhaust fans, furnaces, heat exchangers, heat pumps, humidifiers pumps, unit heaters and ventilators.

Plan View



Associated Data

- Description
- Number
- Location
- Model Number
- Vendor
- Manufacturer
- Capacity
- O&M
- Shop Drawing
- Specifications
- Date Installed
- Spare Parts
- Inspection Interval
- Last Inspection
- Staff

Figure 5. HVAC Equipment Data Profile