A GRAPHICS ORIENTED COMPUTER SYSTEM FOR HEALTH CARE PLANNING: DESIGN AND DEVELOPMENT PRINCIPLES

James Bohland and Charles Barb
Department of Geography
University of Oklahoma
Norman, Oklahoma 73019
and
Georgia Lundy and Ann Mulloy Ashmore
Oklahoma Health Systems Agency
Oklahoma City, Oklahoma 73120

The health care industry is now one of the largest industries in the United States. Its growth has been accompanied by considerable controversy over the relative roles that the private and public sectors should take in providing health care. Rapidly rising medical costs, inequities in the distribution of health manpower, needless adoption of expensive medical technologies by some institutions, and the absence of any regional coordination of health care services have created an environment that fosters the demand for greater public participation in the operation of the health care industry.

The growing demand for greater public participation has been accompanied by the belief that health care consumers should participate in the health care planning process. Many officials have expressed concern that the medical industry has dominated the planning process to the detriment of consumer groups. The belief is that including users as well as providers of health care within the planning process will create a more integrated and responsive health care delivery system.

To facilitate consumer participation, Congress passed the National Health Planning and Resources Development Act, Public Law 93-461 in 1974. The passage of this legislation provided a legal basis for the establishment of Health Systems Agencies throughout the country. Health Systems Agencies (HSA's) were created to improve the planning process in each state by coordinating the health care

needs of different geographic areas, and developing comprehensive health care plans for their service areas. The policy boards of the HSAs were to include both consumers and providers of health care drawn from the local communities, the majority of which are consumers. In this way consumer participation in the planning process was to be assured.

As envisioned by Congress, the HSAs were to have an important role in developing and monitoring health care policy objectives in a region. To fulfill this role agencies must be capable of obtaining, analyzing and publishing great volumes of information about health status, health manpower, demand for health services and the impact of new services or facilities within specific geographic areas.

In 1978 the authors of this paper were asked by the Oklahoma Health Systems Agency (OHSA) to design and implement a geographic information system to expedite their data management and data analysis functions. Analysis of the agency's objectives and activities determined that a geographic information system would allow them to handle more efficiently their current data functions and to expand their analytical capabilities.

In this paper the design principles of the OHSA geographic information system are described. We do this to inform others who are involved with HSAs of some of the issues one must consider in developing a geographic information system to meet the needs of this type of agency. Although the ideas presented in the paper were developed in conjunction with our work at the Oklahoma HSA, since the structure and activities of HSAs are mandated by law, most of our conclusions are applicable to HSAs around the country.

Although many of the principles and problems associated with developing an information system for a Health Systems Agency are common to other types of systems, certain aspects of an HSA's infrastructureand functions are unique and must be considered in the system design. Failure to consider these can lead to faulty design, ineffectual utilization, and the eventual abandonment of the system. Four aspects of an HSA are particularly important in designing a geographic information system for this agency:

1. the functional objectives of the agency,
2. the administrative infrastructure of the agency,
3. the geographic structure of the information utilized,
4. the data requirements of the agency.

Agency Functional Objectives

Three divisions in an HSA have objectives and functions that could be better served by utilizing a geographic information system. These are review, planning, and implementation.

A primary task of an HSA is to participate in the review of proposed changes in health care facilities or services within their area. This is a time-consuming task that requires collating data from several secondary sources and producing some rather standardized reports. As such, it is a task that is ideally suited to an automated information system.

The review process begins when an institution wished to expand or significantly modify existing facilities or services. This requires approval by a state agency for a Certificate of Need or 1122 review application. The institution originating the application must demonstrate need, cost effectiveness, a reasonable plan for paying for the expansion, and some assessment of the potential impact on other facilities in the service area. In submitting this application they look to the HSA to provide certain baseline information on such items as utilization rates, community socio-economic structure, existing service areas, and future population projections. Although the reporting process can be routinized to some degree, since the requests originate from different geographic areas, retabulation, reaggregation and redefinition of areas must be done for each new request. In a non-automated mode considerable hours are needed to locate and tabulate the information, all within tight time constraints.

Once data is provided to the applicants, HSAs then assume responsibility for evaluating the application and making recommendations to the state agency. It is this review process which is intended to reduce duplication in health services that may occur because of needless expansion. The evaluation stage of the review process requires verification of the cost effectiveness estimates, demand assessments, and the impact evaluations discussed in the application. In essence the HSA must verify the methodologies and assumptions used by the applicant. Since impacts in particular are differentiated spatially, it is important that much of the information contains geographic references.

The planning division of an HSA is responsible for developing an annual Health Systems Plan (HSP), complete with specifications as to what standards and criteria should be used to evaluate attainment of policy objectives. The Annual Implementation Plan (AIP) establishes the short range objectives for the entire region and for specific sub-regions within the agency's territory. The

objectives may be very general, e.g., reduce the current level of neonatal deaths within the region, or specific to particular topics or areas, e.g., call for the establishment of two new outpatient clinics in a specific county.

Although HSA administrative boards and subarea committees grant final approval to a plan, the planning division is responsible for drafting the document and providing the data and analyses to support each objective. Emphasis is placed on identifying deficient areas in the health care service system, and providing different scenarios for increasing or reallocating resources to eliminate the problem.

Identification of spatial inequities in health care services requires the ability to manipulate geo-coded data easily and effectively. In the analysis phase of the plan development activity, emphasis is given to cartographic techniques and the graphic display of data. Statistical and mathematical models are also used; however, their use has been severely hampered by the absence of accurate geo-coded data and automated analysis systems. For example, the Oklahoma HSA has begun to use minimum path analysis to evaluate accesibility to health care facilities at different geographic scales. Unfortunately, without good geo-coded data, it is impractical to expect the use of this type of modeling to achieve its maximum potential.

All objectives established in the AIP are monitored by the implementation division of the HSA. Since many objectives are specific to geographic areas, the monitoring process has a spatial component. Of the three divisions, however, implementation personnel have less need for empirical data, particularly within a geographic context.

Administrative Infrastructures

The size and infrastructure of the HSA staff possess several problems that must be considered in designing a geographic information system. First, most HSAs are too small to support a technical staff for an information system. Also, limited budgets prohibit the purchase of all but the smallest mini-computer. The Oklahoma HSA utilizes a Tektronic 4051 Graphics Terminal as the basic processing unit. It has 32k of memory and is supported by a tape system, one disk drive, a 132 character printer, and a x-y digital plotter. This configuration cost approximately $32,000, yet it has the technical capabilities needed to meet the agency's demands.

Staff limitations pose a major constraint on the type of informa-

tion system that is feasible. Currently, many HSAs have one person, the data program manager, who is responsible for data management. Unfortunately, this person typically has other responsibilities within the planning division and is unable to devote full time to the operation of the system. For a system to function effectively at least one person from review and planning must be assigned partial responsibility for the operation of the system. Yet, even with this additional staff, it means that no one in the agency can devote all their time to maintaining and operating this system.

The small staff creates still another potential problem. Without adequate staff redundancy on the system, staff turnover can seriously jeopardize its long term success. While staff turnover averages only about 15% a year, the loss of a key individual could seriously hamper the continuity that is needed to maintain a viable system.

Geographic Structure of HSA Service Area

The geographic structure of the HSA administrative organization and the spatial characteristics of the data required for their use is important to the eventual design of the system. The spatial organization of the administrative structure is important because policy formulation is done within the context of this structure, and policy objectives are monitored within the geographic framework. The central office has planning and review responsibilities for the entire service area. In the case of Oklahoma, the HSA service area is the entire state, but in other states, only portions of a state may constitute an HSA.

Oklahoma has six subareas, two metropolitan and four rural. Each subarea duplicates, to some extent, the functions of the Central office, i.e., each has planning, review, and implementation functions. Because of the small staffs in the subarea offices, the central office must assume the data management responsibilities for the subareas. Thus, considerable time is spent by the data program manager in the central office fulfilling the data requests of subarea personnel.

Since the central office serves the data needs of all its subareas a geographic information system must be capable of accessing and utilizing data at five different levels of resolution: 1) the entire HSA service region (typically the entire state; 2) the HSA subareas (aggregates of counties); 3) the county level; 4) functional districts consisting of county aggregates (for example, National Heart Assn. Districts); and 5) county subarea units (for example, census tracts within metropolitan counties).

At all five levels, both area and point location data are required for both review and planning functions. The areal data are usually county unit information reported by either the census bureau or some state agency. Facility information is recorded geographically as point data. Detailed information for all hospitals, clinics, or nursing homes is used in both planning and review. This data must be geo-coded at the individual facility level.

Data Requirements

HSAs are prohibited by law from collecting primary data. The agency must rely totally on secondary data, and consequently, they have no direct control over the content or structure of the data. HSAs obtain data from a variety of sources, and in many different formats. Data from some agencies is already in automated form, but it is not always machine compatible, particularly when a small micro-processor is the host machine. Also, usually an HSA is not interested in all information on a data file and the geographic reporting units are not always consistent with HSA needs.

Most data entry, therefore, will require manual operations. Since the staff is limited, this can pose a major problem. It is essential that data entry be simplified so that clerical staff can be utilized.

Difference in temporal sequencing of data must be considered when constructing data files. The review process requires current data. However, great discrepancies exist as to what is "current". For some information, the 1970 census is "current", while others, such as vital statistics, are reported monthly by the state health department. While the review function requires current figures, planning requires historic files for time series analysis. In some instances, the temporal sequence for a current file is different than that for time series and temporal aggregations are required. To meet the needs of the different activities within the agency, different temporal structures for data files are required.

System Principles

We have reviewed very briefly the functional and structural aspects of an HSA that are important to the design of a geographic information system. Based on our experience with the Oklahoma HSA certain design principles can be established to serve as guidelines for developing such a system. These principles were formulated after carefully considering the objectives of the agency, the geographic structure of their information needs, their administrative

structure, and their data requirements.

General Principles

1. Emphasis should be placed on maintaining quality data in terms of accuracy (verified where possible), timeliness and geographic comprehensiveness.

The credibility of OHSA to its various user groups will, in the long run, be based on the extent to which the information provided by the agency is valid and reliable. OHSAs should strive to gain the reputation as the agency with the most accurate, most current and most comprehensive data related to health issues. To insure quality, control over data entry must be centralized under the responsibility of the data program manager.

2. Emphasis should be placed on maintaining a fundamental, simply structured, readily understandable and usable, adequately documented system which is well within available staffing resources.

Given the substantial data needs of OHSA and the limited resources which are available to support a system on a continuing basis, it is essential that the system should not become too complex or cumbersome. A potential user should be capable of learning the system quickly, and the operation of the system should not be confined to a small cadre of highly trained technicians.

3. End user support should be decentralized to the maximum extent.

While data entry and quality control should be centralized, access to data through the system should be decentralized wherever possible. Within the central office, each division should have at least one person designated to operate that portion of the system which is applicable to their needs. This type of user network not only provides a more effective means of system utilization, but it also helps reduce the impact of staff turnover.

Data Base Development and Maintenance Principles

1. Initial development of data files should proceed upon the following priorities.

   a. Health facilities and services,
   b. County demographics and health status
   c. County health manpower,
   d. Annual implementation objectives and status.

2. Data will be collected and stored for both areal units (counties) and point locations (facilities). Geocodes established for the system will permit areal aggregation and the combining areal and point information into temporary data files.

3. Current year data files should be systematically updated and maintained for trend analysis.

4. Historic annual data files should be developed and maintained for trend analysis.

5. Data files should include automated internal documentation of data variables and full external documentation of data variable sources, availability and technical characteristics

Software Development and Maintenance Principles

1. Priorities in the development and maintenance of systems soft ware should be:

   a. data acquisition/storage and retrieval (including standard data listings);
   b. simple statistics and graphics summarizing data distribu tions;
   c. simple map graphics of the data which has geographic distributions; and
   d. elementary analytical models relevant to health systems planning.

2. All software should be developed using pseudo language planning/ program documentation, structured programming and user prompting techniques.

System Staffing Principles

1. Emphasis should be placed on developing a close working relationship with subarea staff to:

   a. enable delegation of user data assistance to subarea staff;
   b. elicit subarea staff assistance in routine data file verification and collection of adjunct data; and
   c. obtain timely definitions of subarea data needs to support local implementation or planning activities.

2. De-centralize data development and reinforce a working liaison between the data manager and central office section staffs.by appointing a system user from each section.