Design considerations for an on-line computer system for automated psychiatric assessment

EARL B. COLE, JAMES H. JOHNSON, and THOMAS A. WILLIAMS

*Psychiatric Service, VA Hospital
and*

Department of Psychiatry, University of Utah College of Medicine, Salt Lake City, Utah 84112

The computer-assisted multidisciplinary Psychiatric Assessment Unit at the Salt Lake City VA Hospital required a unique computer system. Design considerations and procedures for development of a Psychiatric Real-Time Information System for Management (PRISM) are outlined. This design is presented as an example for others considering implementing on-line systems. Advantages of the approach are discussed.

Computers are making major contributions in experimental studies related to psychiatry and the behavioral sciences, but they have only begun to be utilized for patient care. At the Salt Lake City VA Hospital, a Psychiatric Real-Time Information System for Management (PRISM) has been designed. This system is used as a base for a computer-assisted multidisciplinary Psychiatric Assessment Unit (PAU) which evaluates all applicants for admission to the Psychiatric Service. Although PRISM is unique and lacks precedent, design techniques developed here may be useful for others considering the implementation of an on-line system. It is the purpose of this paper to describe PRISM systems design as an example of a general philosophy.

DOCUMENTATION SPECIFICATIONS

Before implementation of any computer system, it is necessary to develop a standard outline of documentation. With a standardized approach, systems design is organized, cross-referencing among staff members is facilitated during program development, and systems debugging is made easier.

At the Salt Lake City VA Hospital, the following documentation approach was organized. "Systems Specifications" describe overall job requirements from the user standpoint. This is the basic document for systems design. "Equipment Specifications" describe the equipment utilized. "Functional Specifications" describe a function or an element of the system and are written to be intelligible to a specific user. They describe input, logic, and output characteristics, but do not include hardware or programming details. "Programming Specifications" give detailed descriptions for programming modules. "Data Record, Macro, and Procedure Specifications" describe elements and features that are necessary information for all systems staff. Adherence to this documentation approach necessarily outlines systems design.

SYSTEMS SPECIFICATIONS

The design of a computer system reflects the need of the application for which the system is to be used. The Systems Specifications for PRISM were developed around the computer-assisted assessment of patients at the time of application for care.

Patients applying for admission are referred to the Psychiatric Assessment Unit (PAU). Here the patient is seen briefly by the PAU Coordinator, who determines if there is need for immediate treatment. If so, the patient is admitted to a treatment unit and assessed later. All other patients go through the assessment procedure. Patients to be assessed are met by a receptionist who records demographic data and opens a patient file record via a cathode ray tube terminal (CRT). Patients are then interviewed by the PAU Coordinator making use of a structured mental status examination presented on the CRT. Data obtained during the interview are entered in the CRT by the interviewer. After orientation to self-report test procedures, the patient is presented with a series of multiple choice questions relating to his physical, social, and psychological status on another CRT. The computer analyzes this data. Results are summarized noting unusual clinical characteristics, and printed on a remote printer to form the basis of the patient's medical record. The patient is next seen by a health technician who performs a computer-prompted screening physical examination and enters data into the CRT. The computer summarizes interview information and prints a chart record. The PAU Coordinator reviews results, noting especially positive findings summarized as "exceptions," and briefly reinterviews the patient to complete a problem list. Utilizing all available information, the PAU Coordinator determines if additional consultation is required or the most appropriate treatment disposition.

These clinical specifications lead to several basic

Figure 1. Hardware equipment configurations.

systems requirements. Psychiatric assessment instruments must be administered to patients through CRTs. Data collected from these instruments must be evaluated and interpreted on-line. The interpretation produced must be presented on a remote printer terminal. A large patient-oriented data base must be established and maintained for statistical analyses.

EQUIPMENT SPECIFICATIONS

Computer design follows from the Systems Specifications and begins with the selection of equipment. The equipment necessary to implement the aforementioned functional specifications included a central processing unit with a memory large enough for evaluation programming, direct access storage for patient data, communication equipment for on-line assessment requirements, and unit record devices for system and application program development. A detailed hardware configuration meeting PRISM requirements is shown in Figure 1.

FUNCTIONAL SPECIFICATIONS FOR SYSTEMS PROGRAMMING

Specific objectives for software design also follow

from the Systems Specifications. Objectives describing the specific requirements for PRISM included: (1) Software should support high-level programming languages, i.e., FORTRAN, so that application programs developed are exportable, and so that programs developed elsewhere can be utilized by PRISM. (2) Software should be modular to allow for expansion if new and additional applications are needed. (3) Software must be capable of supporting on-line communication with patient assessment devices. (4) Software should be multi-programmable to allow various applications to be performed concurrently with assessment terminal operations.

Based on these objectives, available programming systems were reviewed. At the Salt Lake City VA Hospital, it was decided that a modification of the MEDLAB Operating System developed by Homer Warner and his staff at the LDS Hospital in Salt Lake City would most nearly satisfy PRISM requirements.

Within the framework of the chosen software, it is necessary to determine a basic design strategy. A number of approaches can be considered in determining an efficient strategy for on-line systems design. Several alternate philosophies exist.

(1) Develop complete self-contained modules, for each assessment instrument, which perform necessary

terminal communications, evaluate responses, and produce necessary reports.

(2) Develop separate modules to: (a) administer each assessment instrument and collect responses, (b) analyze data, and (c) print results.

(3) Establish assessment questionnaire and control information on direct access storage so that one module handles all patient terminal and printer functions. Analysis of the data is then performed by separate evaluation modules after data are collected and before results are printed.

While each approach has advantages, Approach 3 was selected for PRISM because Approaches 1 and 2 require large amounts of computer memory during active assessment and prohibit expanded terminal utilization. Using this systems approach, the following specific modules were outlined to form the "Systems Functional Specifications."

(1) *Executive module*: EXECUTIVE controls allocation of all other modules between direct access storage and core memory, and performs time-sharing functions for the system. Each module executes as needed, but conflicts are resolved based on priority hierarchy. The terminal control module has the highest priority and the analysis module has the lowest.

(2) *Terminal control module*: TERMINAL controls communications with the terminals. Questions are obtained from direct access storage and presented on the CRT. Responses by the patients are collected and resulting reports transmitted to the printer terminal.

(3) *Patient file management module*: FILE MANAGER establishes and maintains patient data files. It places data collected from terminals in the patient file. It also controls access to this data for evaluation programs.

(4) *Assessment evaluation modules*: These modules (EVALUATIONS) perform the evaluations necessary for each assessment questionnaire administered. They score data used to generate reports. One assessment evaluation module exists for each instrument administered.

(5) *Questionnaire and report generation module*: REPORT GENERATOR develops the questionnaire files and necessary control functions used in administering the assessment instruments. It also generates a narrative dictionary file and patient reports which are based on assessment scores received from EVALUATION.

(6) *Terminal print file management module*: Narrative reports produced from the assessment scores are placed on direct access for transmission to the remote printer. PRINT locates available space on the file for report storage and passes this location to TERMINAL for printing.

Execution of the patient assessment process involves controlled operation of each module. This process is described below and shown in Figure 2. A specific assessment questionnaire is selected by entering the

desired assessment name on the CRT. TERMINAL locates the appropriate questionnaire on direct access storage and presents the questions to the patient at the CRT. Patient responses are collected and passed to FILE MANAGER, which places the data in the patient's direct access file. On completion of a questionnaire, TERMINAL initiates execution of an EVALUATION to analyze the data collected.

EVALUATION is initiated by passing the name of the desired module to EXECUTIVE. EXECUTIVE locates the EVALUATION on mass storage and transfers it to core memory for execution. EXECUTIVE controls execution of the EVALUATION to allow concurrent operations of EVALUATION and TERMINAL. The EVALUATION accesses patient data through FILE MANAGER, scores the raw test data, and passes results to REPORT GENERATOR.

REPORT GENERATOR produces reports through the use of a narrative dictionary file. This file contains phrases and sentence structures that are desired in the reports. REPORT GENERATOR selects phrases and constructs sentences based on the scores received from EVALUATION. After the report has been produced, it is passed to PRINT which places the report on direct access storage and identifies its location to TERMINAL for transmission to the remote printer.

DETAILED SPECIFICATIONS

After development of Document Specifications, Systems Specifications, Equipment Specifications, and a general operating system Functional Specifications, planning for detailed Data Specifications as well as Applications, Functional, and Program Specifications follows directly. Specific examples from PRISM are too detailed to be included here, but follow the general format presented above.

DISCUSSION

The major emphasis in developing PRISM centers on coordination of efforts of design and programming. Each module, although independent in functional operation, must interface with other modules and with total systems flow. Because PRISM was designed as a total system prior to programming, it was possible to anticipate problems, for example, the problem of an incomplete questionnaire. It was anticipated that a patient might leave a terminal before completion of a given questionnaire. Before he could return, another patient might have begun testing at the same terminal. TERMINAL solves this problem. It maintains status for each active patient file in the system. If a questionnaire is not completed before another operation is initiated, the outstanding patient file is flagged as incomplete, and TERMINAL continues the questionnaire when that patient file is again activated.