An automated decision-support tool useful for formulating, modeling, and evaluating alternative application software development, operation, and maintenance approaches commonly required when developing HIS plans and implementation strategies is described. Optimizing the selection and sequencing of multiple, often interrelated development projects is an important and challenging aspect of HIS planning. Optimization must consider a variety of technical, managerial, organizational, and financial variables and requires that a large number of feasible combinations of variables -- or scenarios -- be evaluated. Performed manually, these evaluations are time-consuming and costly. Consequently, many organizations that periodically prepare an overall HIS master plan evaluate only a limited number of plan alternatives. This increases the risk of basing the HIS implementation strategy on a suboptimum, high-cost alternative. In the most extreme case, the adopted plan alternative based on limited number of analyzed plan alternatives may be outright unworkable.

sys/PLANR allows the user/planner to formulate and describe a number of plan alternatives, and then submit each plan alternative for evaluation. sys/PLANR analyzes each plan version for its impact on the organization automation objectives as if each such plan alternative was actually executed in the real-world.

INTRODUCTION

From the management perspective, the development and implementation of a multiyear, multiproject HIS plan involves several major issues:

- Identification of high-payoff applications and the formulation of project portfolios that optimize organization's overall expectations from systems automation within the constraints of limited resources.
- Determination of manpower and equipment resource requirements and associated budgets, based on the developmental and operational workloads implied by the selected application portfolio.
- Determination of the effects of different investment levels and resource allocation policies on the rate of implementation and ultimately on the rate of return on investment (ROI) in systems automation.
- Formulation of the resource acquisition and workload management policies best suited to guide the overall implementation of the plan.

A systems plan can be viewed as a set of relevant variables such as, for example, a subset of high-priority projects to be selected from the total backlog of development requests; resources to be utilized for development and operation of HIS; methods of resource allocation and so on. If each such plan variable takes on a specific value, we can refer to such numerical combination of plan variables as a specific plan version or a plan alternative.

An implementation of any given plan version will most likely require some amount of capital resources to be used for process transformation, usually from low to high technology. Consequently, lower system operating cost and other types of tangible and intangible benefits may be realized in different amounts from different projects. One of the primary aims in systems planning is to find the mix of projects which, if implemented, will optimize the benefits to the organization as a whole in relation to the required automation investment.

Contemporary systems planning methods rely on elimination of infeasible or undesirable alternatives early in the planning process. The remaining plan alternatives are then explored by investigating the feasible ranges of values for each key plan variable individually, and by combining the best available choices of values for individual variables with values determined for other variables through a similar process. When all variable values are defined, the resulting plan version is analyzed in terms of its projected overall impact on automation objectives.
This "trial-and-error" approach is generally complicated by a large number of variables and by the need to evaluate a large number of combinations in order to derive an acceptable alternative. Performed manually, analyses of plan alternatives are time-consuming and costly. Manual methods of HIS planning therefore limit the number of alternatives that can be evaluated in an acceptable time frame and thus increase the risk of making a suboptimal HIS decision.

For these reasons, the authors have developed a computer-aided HIS planning tool called sys/PLANR. This tool:

- Identifies high-payoff application portfolios based upon the selection criteria pertinent to the health care organization's set of values and automation expectations,

- Evaluates alternative implementation sequences and resource allocation policies,

- Generates portfolio-level implementation schedules and determines resource requirements, allocations, and utilization for a user-defined set of priorities and resource availability assumptions, and

- Simulates the effect of changes in internal and external variables on schedules, resource demand, cash flow, and ROI.

OVERVIEW OF sys/PLANR CAPABILITIES

sys/PLANR shown in Fig. 1 allows users, through a comprehensive set of parameters to represent the following entities:

- Developmental and operational workloads as portfolio(s) of proposed HIS projects;

- Available manpower and equipment resources;

- Methods for allocating resources to workloads;

- A variety of current and future organizational, technical, and economic environment characteristics.

All of the above entities can be easily manipulated by the user to ascertain the effect of different assumptions (scenarios) on key planning objectives.
sys/PLANR provides the capability to parametrically represent and manipulate:

- Developmental, Operational, and Maintenance Resource Requirements. Manpower and equipment resource requirements can be specified and modified for any, some, or all of the phases in the system life cycle for an individual HIS project, related group of projects or all HIS projects represented in the applications portfolio.

For example, at the individual application level, the user can specify and modify the number of manyears required to maintain the software and the type and amount of hardware resources required to develop, test, and operate the system. Daily production workload requirements, expressed in terms appropriate for each resource required (e.g., number of CPU instructions per time period), can be specified for each application. Where appropriate and meaningful, the hourly distribution of this workload can also be specified and subsequently modified, if necessary, to facilitate the hardware capacity planning activities at macroscopic level.

- Manpower and Equipment Resource Pools. For each class or type of shared resource, (e.g., manpower, hardware) the user can specify and modify the quantity initially available, its utilization level or unused capacity, the cost of acquisition and cost of continuing use of each resource type under several alternative methods, (e.g. buy, lease, or rent; hire or contract). Future infusions of additional, shared or project-specific resources, their quantity and timing can also be represented and user-manipulated.

This capability of sys/PLANR allows the user to evaluate the cost tradeoffs of different resource acquisition policies; the timing of required manpower and equipment upgrades; the rate at which projects can be implemented; and the effects of changes in resource availability on automation objectives.

- Resource Management Methods and Project Priorities. For each class or type of resource, the user can represent the resource management policies within his organization which best reflect the existing methods of resource use, organization, allocation, consumption, and replenishment.

For example, sys/PLANR can allocate manpower resources to projects based upon the following criteria:

- Management- or user-specified priority;
- Project value calculated by sys/PLANR, based upon user-defined value attributes and project ranking against these attributes;
- Relative risk rating;
- Any other criteria or combination of criteria, e.g., value combined with some high-priority projects.

Additionally, users can specify logical precedence relationships among different projects to reflect perhaps the logical dependencies implied by the direction of information flow in the organization, technical constraint, or some other sequencing constraint. For such situations, sys/PLANR will adjust resource allocation and project scheduling accordingly.

sys/PLANR supports the simulation of management policies designed to allocate or restrict the use of manpower resources according to a number of user-controlled criteria:

- Technical specialty;
- Functional specialty;
- Team or application group, or
- Non-specific, fully flexible classification (e.g., resource pool)

Personnel requirements for each candidate project in the portfolio are defined accordingly. Projects are scheduled only if sufficient resources of the required type are available for the assignment.

- Resource Replenishment Policies. sys/PLANR supports several different development manpower resource replenishment policies, such as:
  - An initial, (i.e, one time) infusion of development manpower at the start of the implementation period
  - Infusion at a user-specified amount per period or at selected points during the simulated implementation period,
  - Replenish when and to the extent the development manpower is reduced by the amount of resources permanently tied-up by the maintenance activities of newly developed HIS application,
  - Replenish when and to the extent necessary to maintain concurrent development of at least n- applications,
  - Replenish at a specified percentage of the prior period's budget.

- External Environmental Factors. A great many external factors which may affect planning objectives can be represented and manipulated. Included are external factors related to the economy, technology, and manpower productivity.

For example, user can specify through interactive dialogue entries plan scenario parameters such as cost of money, software useful life, prevailing or expected trends in cost of hardware, time-sharing services, or personnel; trends in hardware cost/performance; and different rates of inflation applied to potential labor savings and other tangible benefits.
Once sys/PLANR has been initialized, it is possible to define virtually unlimited number of hypothetical planning scenarios; execute them; and assess their relative performance in terms of cost, risk, and benefits. Selection of a preferred HIS plan alternative to consider for implementation would then depend on the relative importance the organization places on each of the different plan performance criteria.

The current design of sys/PLANR has been structured to support generic "What-If" capabilities implemented through the "trial- and-error" method. In these types of experiments, a hypothetical situation (i.e. plan scenario) is formulated, represented in the sys/PLANR's temporary working copy of data base, and executed. This process can be repeated for all plan alternatives considered, with the resulting output being saved in temporary report libraries. The merits of any given scenario can then be compared side-by-side against other scenarios, using the Comparative Plan Analysis facility of sys/PLANR. Based upon user-specified weights attached to plan performance measures such as ROI, scheduling efficiency, plan completion date, and other plan performance measures, sys/PLANR can also recommend the plan version with the highest performance score.

Under development is the Plan Optimization Support option of sys/PLANR. This option is expected to be offered in the second quarter of 1984. This feature could be used to directly identify near-optimum configurations of applications, resources, and resource management methods.

EXAMPLES OF PLANNING EXPERIMENTS

The following experiments are representative of the types of questions a user may pose, and for which sys/PLANR can provide appropriate responses. In most instances, responses are gene-rated in about thirty seconds or less.

Examples of Application Selection Analyses

Given the existing backlog of application development requests, organization's project selection criteria, management- and externally-imposed priorities, and the available resources, assemble a subset (portfolio) of projects that represent:

- the best overall balance between the cost, benefits, risk, and externally imposed reporting requirements,
- all projects with the investment payback period three years or less,
- the projects with the greatest overall impact on health care delivery, and so on.

Examples of Resource Requirements and Allocation Analyses

Given a portfolio of HIS applications ordered in priority sequence, with defined resource requirements, and precedence characteristics, how many applications can be developed and maintained if a total of 'x' additional personnel are acquired at the beginning of the implementation cycle?

What is the best resource addition policy? Should the needed personnel be hired all at once at the beginning of the implementation period or should resources be added gradually, on "as-needed" or some other criteria?

If the gradual resource built-up is preferred, when and in what amounts should resources be added?

What will be the effect of increasing the number of development or maintenance personnel on the CPU load? Will there be sufficient number of terminals, computing power, and disk test space to assure that the newly added staff is productively utilized to its fullest extent?

What would be the effect of investing in programming productivity tools? What will be the effect of these tools on number of needed programmers, CPU load, implementation schedule?

Examples of Financial Analyses

For each scenario or plan version, what is the corresponding future and discounted cash flow, rate of return on investment, payback, and required development and operating budgets?

Would projects that have been included in the HIS plan on the economic basis be still viable, if the cost of money increased by 'x' percent?

PLAN IMPACT REPORTS

sys/PLANR data base supports generation of wide variety of HIS planning reports. These reports can be produced both as screen displays and as hard copy output. Displays are available in color graphics and numerical formats.

The following is a brief description of a sample of key planning reports:

Implementation Schedule. For the selected set of portfolio applications considered in a given scenario, sys/PLANR indicates which applications could be scheduled during the planning horizon given the resource availabilities specified at initialization. Scheduled applications are represented graphically in a Gantt- chart format and show the time periods in which systems development and production begin. It is also possible to represent individual phases of systems development cycle. Alternative
methodologies i.e. for in-house development, package modifications or substantial application redesign can be defined and are taken into consideration during resource allocation and project scheduling.

Cash Flow/Budget Reports. sys/PLANR produces projections of future cash flows and calculates the return on investment and payback for each application successfully scheduled. While sys/PLANR does not capture nor processes cost items such as, for example, data processing supplies, light, rent, and so on, all of the major cost elements (manpower, hardware, and software) are being supported. The resulting cash-flow projections can therefore be used for first-cut budgetary estimates and cash flow requirements forecasting. Financial analyses and projections are available for the individual HIS applications as well as for the entire portfolio of applications.

Resource Utilization Report. sys/PLANR reports too the projected utilization of pooled manpower and hardware resources. For each class of pooled resource, sys/PLANR indicates the resource demand, level of resource utilization during implementation period, and computes the residual resource availability.

Manpower Hiring and Equipment Acquisition Schedules. The quantities and corresponding dollar values of project specific resources, required vs. available in each time period are reported and potential resource shortages or surpluses are identified. Resources can be manpower, CPU's, DASD, channels, CRT's, terminal printers, controllers, space or other resources specified by the sys/PLANR's user.

CONCLUDING REMARKS

Employment of tools such as sys/PLANR can be of considerable value to systems planners in health care organizations with large backlogs of systems development requests and diverse user groups vying for limited development resources. Tools like sys/PLANR allow to evaluate a considerably larger number of plan alternatives in the same time frame, and increase the probability of developing better HIS plans. Subsequent HIS plan maintenance iterations required perhaps because of changes in project priorities or new technology developments can be accomplished at practically no cost.

sys/PLANR is now offered commercially by System Research Services, McLean, Virginia as a fully-supported program product implemented on the IBM-Personal Computer.

Enhanced capabilities of sys/PLANR are planned as well as an interface with a detail project management system, also based on the Personal Computer. Additional information is available from the authors.

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