An Automated Decision Support System to Assist with Project Planning and Analysis

1.0 Synopsis

In view of budget cuts and the potential of sequestration, Government agencies and commercial enterprises are in the process of assessing their overall program plans and project priorities. The process requires the associations of numerous dashboards which delineate topics such as schedules, costs, resources, contracts and personnel. Manual procedures and limited decision making software are employed to associate the disparate data sources. Even so, additional decision support capabilities, not currently available for assessment efforts, are desirable to automatically provide management courses of action and a prioritization of projects without disrupting current procedures.

NBS Enterprises (NBS) is foremost in the development of scheduling and management decision aids. For example, if a new project is proposed as an addition to an agency program and no additional funding is available, a manager is interested in the project impact upon schedule, priorities and risk. Answers to this query, by a staff operating without automated decision support, require several days. Similar procedures apply to the elimination of projects that exceed budget constraints.

Once data are available, the NBS decision support system (DSS) associates the dashboards and provides answers within hours or minutes. Further, NBS has developed a set of optimization algorithms that assist with planning, forecasting and prioritization. Because the algorithms are fully developed, their applications produce great savings in costs and assessment times necessary for planning without the necessity of research and development.

2.0 Problem Solution

The NBS Enterprises (NBS) software tool suite provides a decision support system (DSS) that improves the effectiveness of program managers by associating multiple variables and developing courses of action automatically. The DSS is applied in concert with logical and representational software tools, and good data.

The decision-making tools, however, require experience in the building of large scale models that incorporate timing values and other relationships into a computational environment grounded by optimization algorithms.

NBS Enterprises (NBS) develops analytical models that represent an enterprise, systems within an enterprise and their components. The models assess overall performance, provide guidance on system and technology enhancements, and carry out requirements analysis and analytical forecasting to assist with planning for the future.

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sequestration. We provide statistics relative to cost, risk and schedule slip. The "best" means of program reduction are recommended to a user. All assessments are substantiated with quantitative analysis.

2.0 Automation Development

We 1) review and document the specifics of operations, 2) conduct simulations, modeling and optimizations to provide performance statistics of current operations, 3) assess new concepts and technologies and assist with the transition from the current process to a "to-be" environment, and 4) develop a decision support system (DSS) that optimize total systems operations. We accomplish the following:

2.1 Review of Current Operations and Data

We review documents, data and projects. We identify information sources and interpret formats, data fields and content of all data sources.

2.2 Architectural Analysis

We evaluate information processes, review operations and facilities, interview personnel and contractors to acquire an understanding of the current environment.

2.3 Metrics and Measures of Effectiveness

Metrics are obtained or developed which reflect what is to be measured during project evaluations. If metrics appear to be incomplete, NBS supplies additional metrics and measures of effectiveness (MOE).

2.4 Requirements Analysis

Based upon metrics, MOE definitions and interviews, a set of requirements is defined. The requirements indicate the types of information that are most useful to the user and the development of decision support and value analysis.

2.5 Data Structures

Data are selected as appropriate input for optimization and analysis. Using a set of ontologies (business rules), each dashboard is structured into data formats which are compatible for input to the NBS project management tool suite.

2.6 Algorithm Refinement

Although a comprehensive set of algorithms exists for applications of value analysis, issues related to domain specific metrics and requirements must be considered. Any enhancements required for the NBS tool suite will be provided so that specified requirements are fulfilled.

2.7 Incremental Analysis

Because all projects are not interrelated, the entire spectrum of projects might be partitioned. Each partition is assessed separately and value analysis is developed incrementally.

2.8 Decision Support System

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An assessment of projects, their enterprise values and the impact of change with respect to program performance, cost, risk and schedule slip is provided by NBS.

2.9 Reporting

NBS conducts briefings of results as requested by the user. At the conclusion of the effort, a final report and a consolidated briefing is delivered.

Appendix A Project Management

Conditions

An effective assessment solution includes more than integrated commercial off-the-shelf tools (COTS). Additions must be made in the form of metadata processors and algorithmic manipulations.
Namely, analytical capabilities for existing database management systems are restricted to linear and inaccurate solutions to user queries. For example, resource leveling addresses projects that have more work than people. These tools simply extend a schedule to make all work possible in an expanded time frame. The tools provide a visual display and an experimental approach to a program solution. Given that resources are fixed, personnel and physical assets are switched from current projects to the new start by inspection. A Critical Path Method (CPM) is run subsequently to quantify the impact of change relative to a selected measure of effectiveness (MOE). The assessment process is iterative, time consuming and complex. A more useful decision support system (DSS) provides an automated means of deriving optimal solutions. Answers are produced in minutes rather than hours with minimal human oversight.
Once a new project is defined, changed or deleted under conditions of limited resources, personnel and assets are removed from current projects and assigned to new projects so that a program impact is minimized. An MOE might be schedule, costs, values and priorities of projects, or program risk. In addition to optimization, the DSS provides sensitivity analysis, impact analysis, and "what-if" experimentations.

Requirements

The rationale of planning and architectural analysis is to produce data structures that support the DSS. An understanding early on of what needs to be represented is critical to costs and performance of decision support tools. A solution indeed requires tools which extract and transition data, but simple displays of contracts or schedules in and by themselves do not address queries. Metadata tools need to either be purchased or developed that produce a "virtual database", which not only represents descriptions of program categories (schedule, resources, contracts), but also the associations between segments of the disparate sources of data. Further, a collection of relationships is necessary to conduct trade-off and sensitivity analysis. An example is the change in schedule duration for a project with respect to the skill levels and quantities of personnel. Data are converted to models that when exercised respond to queries and assist with the selection of courses of action.

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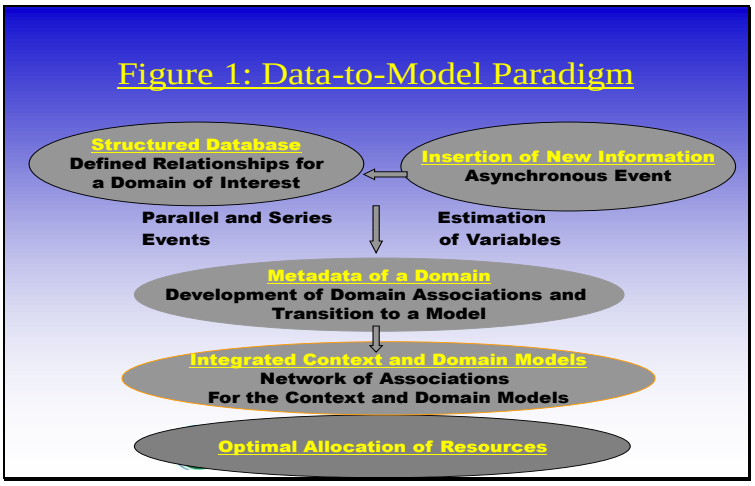
A DSS application must be thoroughly planned so that the contents of a database not only comprise category extractions, but also the metadata to feed a DSS. Without planning, a solution is incomplete and many revisions to data structures become necessary later in a planning phase of project additions and deletions.

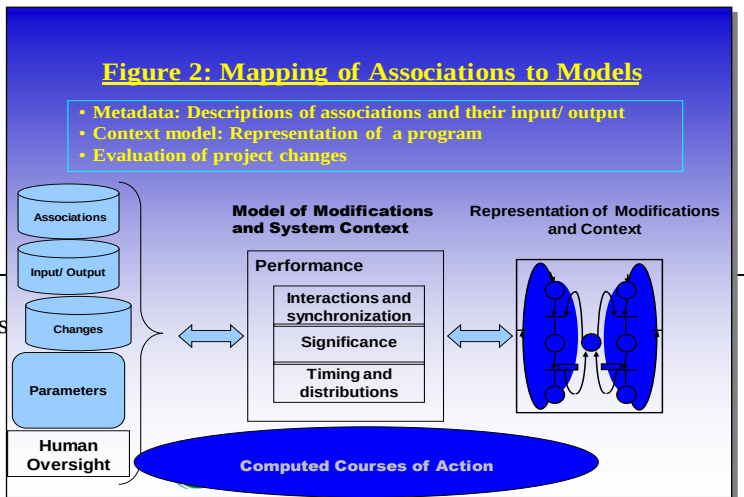
Process Model for a DSS

Fundamentally, many structured databases are aligned that represent singular topics such as resources, technology and schedule. The databases are not mapped to a composite data warehouse; rather each feeds a domain specific set of metadata representations that produces associations of events, their inputs and outputs (I/O), and probabilities and times to accomplish the events. Associations are further mapped to a context model that is executed to compute performance statistics. Figure 1 displays a flow diagram of a process that when implemented produces responses to queries based upon relationships between disparate databases.



Metadata

An extractor produces structured databases, which are transitioned by metadata to a definition of associations. The associations are further transitioned and positioned within a program context model that feeds analytical equations or a simulation of a program. By exercising the model, performance statistics are derived which encapsulate actions initiated by an asynchronous situation, as well as the context model, which represents an entire program. Figure 2 shows a mapping for an instance of contract modification.



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General Purpose Problem Solver

The backbone of the DSS and a system representation is a general purpose problem solver (GPPS) that employs one network representation to permit semantic net associations, performance computations and optimization. The primary representation of the existing tool suite is a rule-based encapsulation of a network or any complex system. Optimization is always accomplished in the context of a systems model. Only one measure of system effectiveness can be optimized while all system variables are balanced to best achieve an objective. The variables represent competing measures of performance such as minimum cost versus schedule to maximize the effectiveness of an agency program. Further, impact, sensitivity and what if analyses are achievable for any proposed project changes. A myriad of algorithms orchestrates the optimization and performance analysis procedures.
One representation scheme encapsulates all facets of associations-optimization-performance capabilities.

Concept of Operations

A concept of operations for an automated decision support system is outlined below. A context model is prepared for an agency program. Many facets might be included in the context model such as resources, contracts and schedule, as well as technologies and costs. A data extractor transitions disparate data to structured databases while domain specific metadata interface with each database. Given that a new set of data is obtained, which represents a program change; associations are formed within the appropriate metadata and mapped to the context model. The context model is expanded to include the additional information and is exercised to display the impact of the change.
A scenario is presented whereby a manager requests an answer to a program issue, which must be addressed by the staff.

1) Program Manager issues a request (e.g., what is the impact on the agency program for the addition of a new project without the availability of new resources?).
2) Identify all relevant data from disparate sources (resources, contracts, schedule).
3) Extract and display relevant data,
4) Transition relevant data to metadata format (dependencies on existing projects (I/O), resources, and contract timelines).
5) Define the requirements for the new project: e.g., personnel, resources, dependencies, desired time of completion).
6) Apply metadata to develop associations: if-then-else, distribution functions for the new project timelines).
7) Insert the associations into a context model of the entire program: position the new project within the context model.

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8) Develop and retrieve relationships for all contracts: e.g., change in a project schedule when personnel are extracted or resources are delayed, cost of contract changes.
9) Impose all constraints: e.g., some contracts cannot be changed.
10) Define a measure of effectiveness (MOE): e.g., schedule delay, program cost, risk.
11) Exercise the context model using a simulation tool (GPPS) to assess program performance with and without proposed project insertion.
12) Optimize the agency program, using GPPS, in response to the desired MOE: minimize the impact of switching resources from existing contracts to the new project.
13) Isolate problem areas: e.g., no resources available, explosive cost overrun, unacceptable schedule delay.
14) Using GPPS, conduct trade off, sensitivity and impact analysis.
15) Report recommended course of action with supporting analyses to the Program Manager.

Project deletions are addressed using procedures similar to those noted above.

Benefits of Automated Decision Support

The benefits of the NBS decision support system are:

a) Automated processing and association of disparate data sources.
b) Rapid response to queries
c) Courses of action
d) Impact analysis, work flow analysis, risk assessment, and prioritization
e) Analytical forecasting

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