AD-A250 788

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. AGENCY USE ONLY (Leave blank)	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
	31 Mar 92	FINAL

4. TITLE AND SUBTITLE Application of Expert Systems to Scientific and Technical Information Command, Control and Communication Management, with a Service Organization Case Study

5. FUNDING NUMBERS

6. AUTHOR(S)
Robert S. Soben, Ph.D.
Chief, Total Quality Management Office

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
3246th Test Wing
Total Quality Management Office (CTQ)
Eglin AFB FL 32542-5000

8. PERFORMING ORGANIZATION REPORT NUMBER
TW/CTQ-92-001

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
3246th Test Wing/CTQ
Eglin AFB FL 32542-5000

10. SPONSORING/MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES
To be published in the 3rd Annual "Forum on Artificial Intelligence in Acquisition Management (FAIM)."

12a. DISTRIBUTION/AVAILABILITY STATEMENT
Per DoD Directive 5230.9 (reference (g)) and AFR 80-45, Distribution Statement "A" is applicable.

12b. DISTRIBUTION CODE

13. ABSTRACT *(Maximum 200 words)*

The application of expert systems to Scientific and Technical Information Command, Control and Communication Management ($STIC^3M$) is discussed as it relates to a service organization undertaking the tasks associated with implementing Total Quality Management (TQM). A survey of customer expectations is evaluated as it relates to a Developmental Test and Evaluation environment. An analysis of what specific quality characteristic is important to the customer is also evaluated. The resultant solution to modify the methods with which a specific service organization uses to schedule resources necessary for the conduct of developmental testing is undertaken. The subsequent development of the Resource Scheduling Information Decision Support System,using an off the shelf software package, is highlighted as an example of how an expert system shell can assist in decision making.

14. SUBJECT TERMS Expert Systems, Total Quality Management, Resource Scheduling and Information Decision Support System, and Scientific and Technical Information Command, Control and Communication Management ($STIC^3M$).

15. NUMBER OF PAGES 6

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
UNCLASSIFIED	UNCLASSIFIED	UNCLASSIFIED	UNLIMITED

UNCLASSIFIED

DEPARTMENT OF THE AIR FORCE
HEADQUARTERS AIR FORCE DEVELOPMENT TEST CENTER (AFSC)
EGLIN AIR FORCE BASE, FLORIDA 32542-5000

REPLY TO ATTN OF: PA (Jim Swinson, 882-3931) — 31 March 1992

SUBJECT: Clearance for Public Release

TO: 3246TESTW/CA

The technical paper "Application of Expert Systems to Scientific and Technical Information Command, Control and Communication Management ($STIC^3M$), With A Service Organization Case Study" has been reviewed. Public release is approved.

VIRGINIA N. PRIBYLA, Lt Col, USAF
Chief of Public Affairs

1 Atch
Tech Paper

Accesion For	
NTIS CRA&I	☑
DTIC TAB	☐
Unannounced	☐
Justification	
By	
Distribution /	
Availability Codes	
Dist	Avail and / or Special
A-1	

AFDTC/PA 92-126

92-13714

92 5 22 035 UNCLASSIFIED

UNCLASSIFIED

DEPARTMENT OF THE AIR FORCE
HEADQUARTERS 3246TH TEST WING (AFSC)
EGLIN AIR FORCE BASE, FLORIDA 32542-5000

REPLY TO
ATTN OF: CA

30 Mar 92

SUBJECT: Release of Symposium Paper, Application of Expert Systems to STIC^{3}M, With A Service Organization Case Study

TO: PA

Attached is a paper to be presented at a symposium this week. It is technically accurate and suitable for public release.

RONALD A. JACOB
Technical Advisor

1 Atch
Symposium Paper

UNCLASSIFIED

Application of Expert Systems to Scientific and Technical Information Command, Control and Communication Management (STIC^{3}M), with a Service Organization Case Study

by: Dr. R.S. Soben, Ph.D., 3246th Test Wing, Chief, Total Quality Management Office, Eglin AFB, Florida
32542-5000; DSN: 872-3616; (904)882-3616

Introduction

President Bush, on September 29, 1989, in an attempt to spur American competitiveness in the US and foreign markets, launched a campaign to implant management practices that replicate the Total Quality Management philosophy, fashioned by Dr. W. Edwards Deming. The President stated: "Reasserting our leadership position will require a firm commitment to total quality management and the principle of continuous quality improvement...Quality improvement principles apply to small companies as well as large corporations, to service industries as well as manufacturing, and the public sector as well as private enterprise."[1] Also, in 1989, Air Force Systems Command began an endeavor to instill this philosophy, as a business practice, in the acquisition process. Subsequently, the Air Force Development Test Center and the 3246th Test Wing, located at Eglin AFB, Florida, adopted the Systems Command thrust into the daily process of Research, Development, Test, and Evaluation (RDT&E) of nonnuclear munitions and advanced development weapons systems testing, conducted to support the Life Cycle Cost acquisition activities. Such testing encompasses the pre-/post-developmental evaluation of such weapon systems as: bombs; missiles; avionics systems and systems associated with advanced development of global navigation; plasma energy devices and infrared sensors; perimeter security systems related to intrusion detection and personnel identification checking systems; and a host of other systems that are difficult to test. These require multiple testing methodologies that are costly to the government, but are paramount to national/global security.

As part of the endeavor to propagate a new management style that would foster improved work productivity, efficiency and effectiveness, the 3246th Test Wing conducted a Customer Satisfaction Assessment to determine what was important to the customer (without second guessing them) and to determine their likes and dislikes of the Wing's capability to meet requirements and expectations. The 1991 customer survey results became the guiding principles by which the Test Wing conducts business and were integrated into the organizations strategic business plan, which is maintained by its Total Quality Management (CTQ) Office.

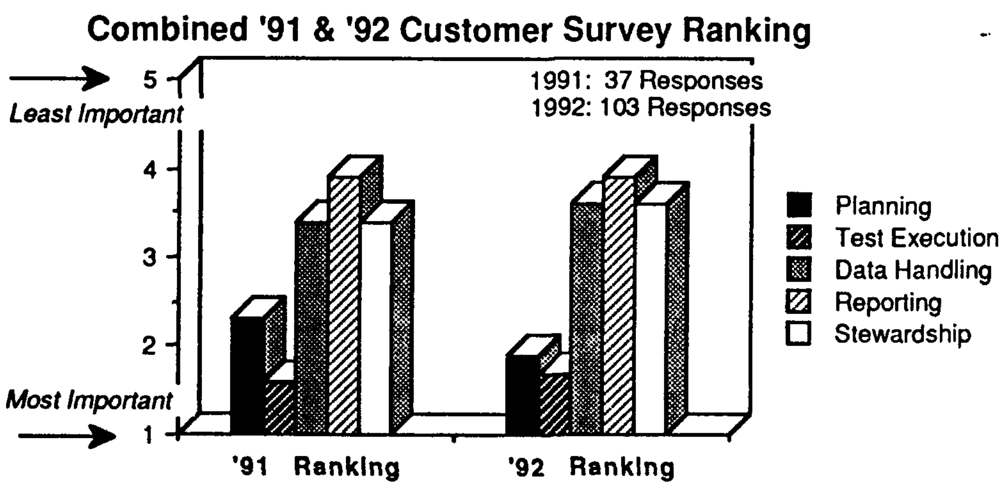

Figure 1

Figure 1 depicts the composite results obtained for years 1991 and 1992. The customers include other U.S. and foreign government agencies and the Department of Defense (DoD) who are also attempting to instill the "Deming Philosophy" of management practices within their own service organizations. It is readily apparent, from Figure 1, that customers have ranked, over the past two years, the Test Execution Process as the most important aspect of work conducted on the Eglin complex. And, given that the ratings over the last two years have not changed dramatically, nor are they pegged at the Very Satisfied level, the Wing still has some work to do.

One of the major aspects concerning the Test Execution Process of RDT&E scheduling is resource scheduling. Within the Test Wing, this involves the utilization of scientific and technical information of test resources, test item capabilities, etc., such that properly scheduled missions will result from accurate resource requirements interpretation and testing limitations. This is an area seen by the customer as needing improvement. In this light, Scientific and Technical Information Command, Control, and Communication Management (STIC^{3}M©)[2] can be viewed as a field of study, occupying the space where management and technology overlap. STIC^{3}M technologies, used in conjunction with Artificial Intelligence/Expert Systems are today not only impacting the processing of data, but also influencing: (1) the way people work at their jobs, (2) the quality of products, (3) how decisions are made, and (4) the manner in which many organizations compete.

STIC^{3}M can be conceptualized as an antecedent to how managers and executives should view their tasks of manipulating and using data/information for quantitative and qualitative analyses in decision making. Information when visualized as a key resource that should be managed strategically (as other resources through STIC^{3}M manipulation available for everyday operation), can be facilitated by expert systems to assist in the data analysis required for decision making and strategic planning. This paper is written in hopes of enlightening those managers not familiar with the strategic importance of information as a resource and the methodologies, like expert systems, available to them for use to enhance their decision making, through a STIC^{3}M example case study.

Case Study

Test Wing Core Purpose

The Wing's core purpose is to "satisfy customer needs with world class test and evaluation of armament, electronic combat, guidance, and other specialized DoD systems." The tenet here is the organization will efficiently and cost effectively evaluate each system and subsystem to determine weapon system capability, reliability, and maintainability. Also, RDT&Es major thrust is to detect (and report to the customer) early deficiencies; requiring system design changes, and to determine preparedness for production.

Problem Definition

A major portion of the support required to conduct the RDT&E mission is the scheduling of resources essential to the management of the test and evaluation. One of the problems associated with the scheduling of resources (to conduct individual test mission objectives) is how to optimally schedule the maximum number of missions and only those test resources essential for an effective evaluation. This problem is further compounded by the fact that there are 50-60 missions per day bidding for those same resources and all tests are on "critical path time-lines," due to future production and budgeting constraints, that require expeditious scheduling and objective accomplishment, .

The test scheduling cycle is accomplished via a dynamic computer programming model, developed in-house, to equitably schedule all missions that can optimally run at the same time and utilize only those resources necessary to accomplish their specific task; thus, leaving the under utilized resources for lower priority test missions. This program is referred to as the Resource Scheduling and Operations Management System (RESOMS). Unfortunately, situations dictate that lower priority missions, or missions with special emphasis, must be infused into the daily schedule, such that, the reliable completion of some specific "special" tasking can be accomplished. This situation occurs approximately three to five times per day, requires approximately 2-hours of research per mission (which takes Test Wing Deputy Commanders and Staff out of pocket to do the research), and, due to time constraints, must be completed before 1500-hours for inclusion in with other RESOMS test project requirements.

As a result of this perturbation of the previously established schedule (normally a 5-day time-line), other missions may be jeopardized by the loss of essential resources or could be totally eliminated, to allow for the incorporation of this so called "blackboard" (BB) mission. (NOTE: origin of the term "blackboard" is unknown, but is assumed to mean the bleak attitude associated with having to change a daily schedule.)

The problem for management is that accurate decisions are essential for determining if a BB mission should be scheduled into the daily activity (either allowing the BB to ride on its own precedence level or by receiving management emphasis to be scheduled "at any cost").

Management decisions are based on the timely analysis of which resources are needed, which resources are being used by previously scheduled missions, the engineer's interpretation of the criticality and future testing direction, and what probable productivity can be expected by the mission being considered versus missions established in the schedule. (The probable productivity being based on such "fuzzies" as: weather, anticipated test item operation, resource reliability and availability, etc.)

GURU® Selection

The selection of the expert system software shell GURU®[3] was made since it offered an environment for building different expert system applications, the ability to retrieve and present data through natural language processing, and the key essentials for contemporary business computing (i.e., graphics, word processing, data processing, statistical analysis, etc.). GURU allows the user to create rule-sets related to certain topics and during consultation GURU surveys one or more of these sets to make the proper recommendation. Should additional information be necessary to provide an answer, GURU asks for it and can explain why it was needed.

GURU's reasoning power can use forward-chaining to discover the logical outcome of a situation, or backward-chaining to investigate a specific possible outcomes. Numerous search strategies can be used to determine which rules should be considered for firing, how hard GURU should work to find values for unknown variables, and has the ability to deal with uncertainty and fuzzy variable situations. Rule sets can incorporate these "questionable accuracies," which enhances GURU's ability to make realistic recommendations from available information or data from internal or other external databases. Plus, GURU has the ability to help check the validity of its conclusions by explaining its reasoning process step-by-step.[4]

Resource Scheduling Information Decision Support System Development

The Resource Scheduling Information Decision Support System GURU prototype, developed by this author, referred to as RESIDS, will support the timely analysis of the BB situation, assist management in making accurate decisions given specific information on resource status and mission requirements, decrease the likelihood of error, facilitate the BB process (by taking the tedium out of the task associated with the analysis of alternatives), and allow the test engineer greater involvement in the BB process and greater input to future testing.

Prototype Development and RESIDS Analysis

Figure 2 depicts the critical BB premise elements, variables and associated databases, and represents the dependency diagram initially visualized as the developmental tool for rule-sets and for analysis of the overall goal attainment. The critical elements, for the BB goal, requiring analysis are: Range(s)/Resource(s), Test Item Status, Scheduler Capability to manipulate the RESOMS program, Test Project Information, RESOMS Status/Forecast of prior and future testing activities for the BB mission, Weather, Management Action (for special emphasis), and Aircraft Requirements.

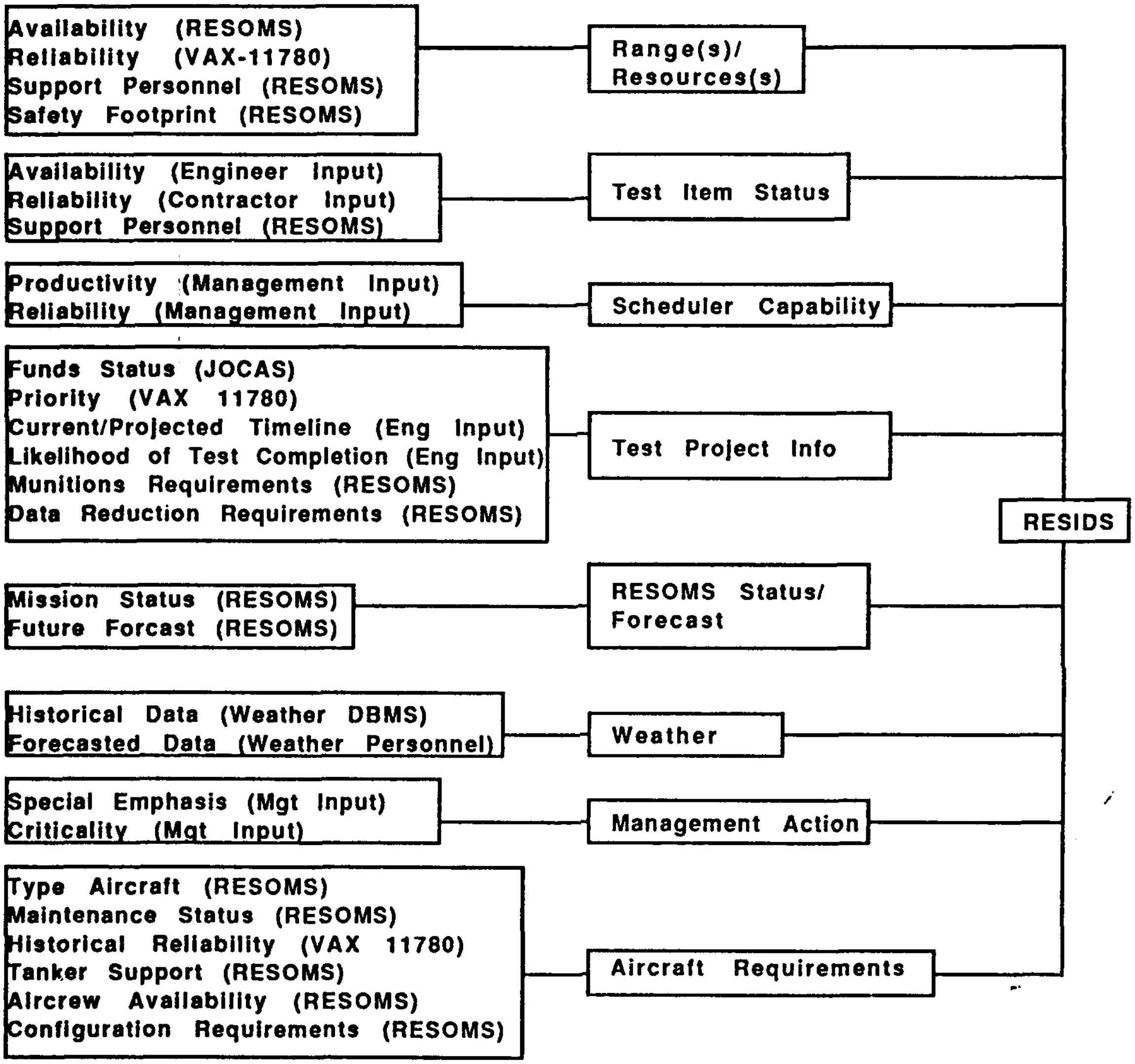

Figure 2

CRITICAL BLACKBOARD PREMISE ELEMENTS

As can be seen, sub-elemental inputs to each of the primary blocks are also depicted. For example, sub-elements for the determination of aircraft support are: the tanker aircraft support requirements, for added fuel not normally available to limited range fighter aircraft; maintenance support availability and maintenance status of the aircraft; reliability analysis to determine aircraft capabilities to perform specific types of missions; and pilot availability (to include pre-/post-mission crew rest, certification in type aircraft, and turn-time to/from other mission activities).

Only partial development of the BB system was pursued beyond prototyping, due to lack of GURU shell documentation for password protection/cluster interface, and database development delays for such uncertainties as weather, aircraft and instrumentation reliability, etc. The RESIDS menu options will support BB input forms and it is anticipated that other capabilities such as resource status analysis, creating and updating BBs, evaluating Wing goals, projecting daily and monthly activity rates can be implemented.

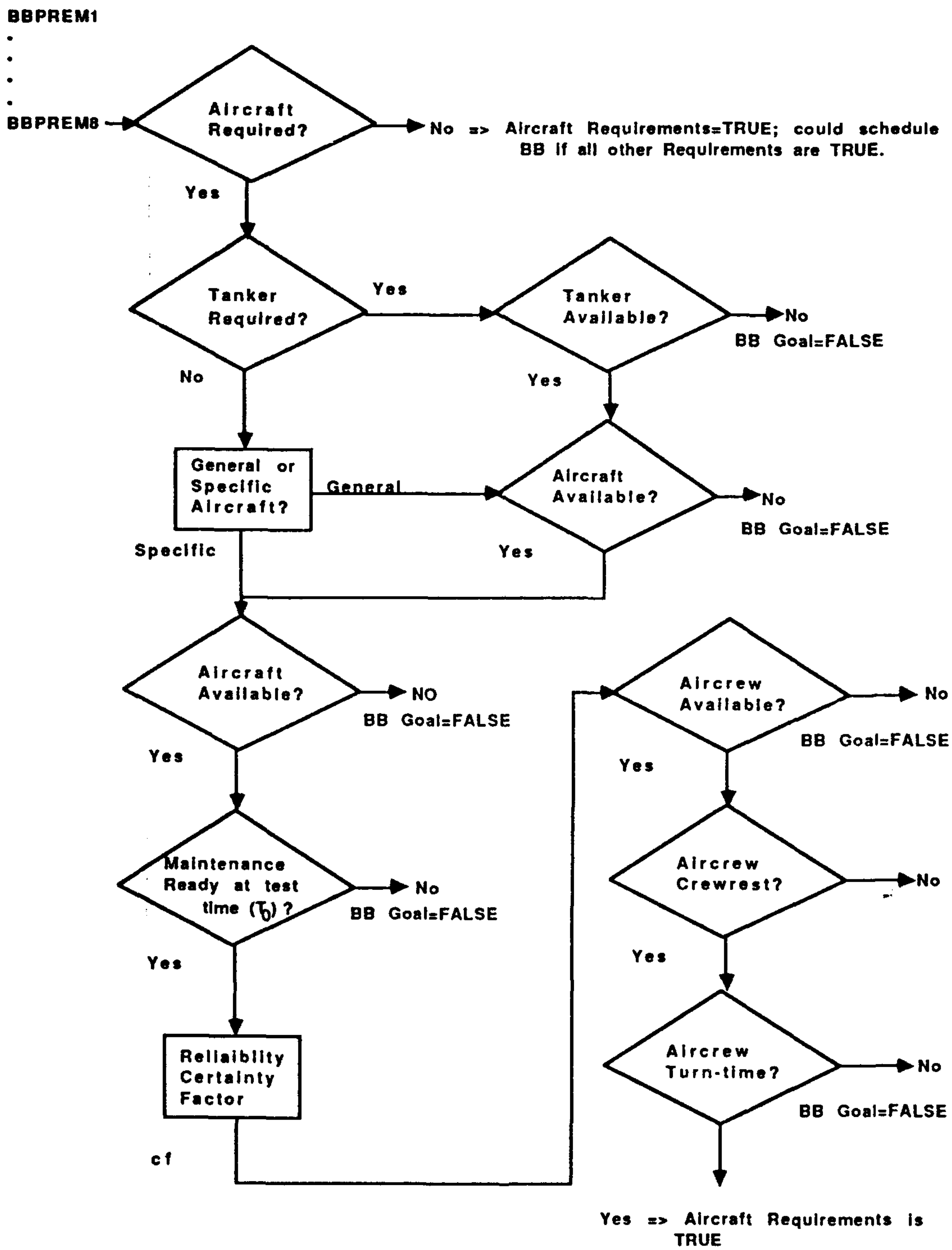

Figure 3
EXAMPLE FLOW CHART

Rule-Set Development Example

Figure 3 depicts an example flow chart used in rule set development for the RESIDS goal of including BBs into the RESOMS scheduling process. [NOTES: (1) BBPREM is the "coding" word for "blackboard premise." (2) The flow chart depicted was used versus the decision tree GURU produces, for ease of presentation in this paper. It represents only one elemental branch of the RESIDS model -- BBPREM #8 -- and includes only those rules and certainty factors applicable to Aircraft Requirements determination. (3) BBPREM1-BBPREM7 are not discussed.] The flow chart is easy to follow but of special note is the Aircraft Reliability Certainty Factor (cf) is included to tag with the remaining determinates. Also, note certain occurances of a "NO" will still lead to a "TRUE" for the BB Goal. This situation will occur if an aircraft is not required since the mission may be a ground test and not an airborne test.

Case Study Conclusions and Recommendations

The practice of submitting BBs to accomplish "special" taskings will not disappear; however, it is reasonable to assume the use of RESIDS will alleviate some of the burden. It is anticipated that the implementation of RESIDS will assist management by decreasing the time required to research and analyze BBs being submitted to them for consideration. In fact, it is anticipated the time required to perform the review/pre-approval functions of BBs can be cut in half, saving approximately 3-5 hours per day. Further, once the uncertainty and fuzzy variable databases are on-line and accessible to RESIDS, the time required for analysis will be substantially reduced. Finally, by using RESIDS to expedite/expand decision making capabilities and to develop scheduling consistency (through the eyes of the customer), the likelihood of customer satisfaction may facilitate return business.

STIC^{3}M-oriented firms who view information as a major economic resource that is a desirable investment rather than as merely a necessary expense can far exceed their competitors in the market. Not only will they be leading the pack in growth, they will be utilizing advanced technological developments that will assist with future visioning. Thus, managers, by studying the processes that cause information to be needed, gathered, manipulated, stored, communicated, and used (from a STIC^{3}M perspective), can develop strategies and tools (such as expert systems) to make themselves or their organizations more effective, efficient and productive in producing the quality products their customers desire.

Bibliography

[1] Criteria and Scoring Guidelines: The President's Award for Quality and Productivity Improvement; W. Diefenderter and C.B. Newman; Superintendent of Documents, US Government Printing Office, Washington, DC, 1990.

[2] STIC^{3}M™ is a Copyrighted Trademark of Organizational Communication Management (ORCOM™), 1301 Windward Circle, Niceville, FL 32578.

[3] GURU™ is a Copyrighted Trademark of Micro Data Base Systems, Inc. P.O. Box 248, Lafayette, IN 47902.

[4] The Manager's Guide to Expert Systems Using GURU™; C. Holsapple and A. Whinston, New York, NY, Academic Press, 1986.