LESSONS LEARNED IN IMPLEMENTING SIMULATION-BASED DECISION SUPPORT

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ABSTRACT

The staff of the Chief of Naval Education and Training (CNET) is working to develop and implement simulation-based decision support processes for the enterprise. This capability will streamline critical training support processes and eliminate data redundancy, resulting in improved utilization of resources. This paper will describe the approach CNET analysts have used to improve decision support capability through simulation, data warehousing, and web-enabled technology. This integrated approach provides a standard methodology that can be replicated throughout Navy organizations, improving decision support processes, and reducing future resource requirements.

While great progress has been made in the application of information technology to decision making for Navy training, the implementation of narrowly focused applications has resulted in a whole new set of problems and challenges. Multiple systems, implemented independently, meant data redundancy and lack of integration across the enterprise. Many of these systems contained the same data elements, but with different values, leaving managers searching for ground-truth information for decision-making.

The ability to access quality data is a major obstacle in building simulation-based decision support capability. Since most processes cross functional boundaries, the data required to create simulation models is frequently found in multiple data sources that were never meant to connect outside the application. Other data required for development of business simulations, such as processing times and resource allocations, is simply not captured anywhere. Data warehouse technology became critical for addressing the data migration problem. The challenge was how to seamlessly integrate multiple data sources contained in these many systems.

Through the use of a well-defined architecture, structured methodology, web-based data mart development, and simulation technology, CNET analysts and information technologists are building decision support capability to greatly enhance training support processes and systems. A hybrid approach using structured High-Level Architecture (HLA) data modeling techniques and rapid prototyping provided timely answers while maintaining the necessary structure to capture data for knowledge sharing and reuse. The standard methodology incorporated and lessons learned described in this paper will be beneficial to any organization attempting to build simulation-based decision support capability in today’s dynamic environment.

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LIVING IN A DYNAMICALLY CHANGING ENVIRONMENT

The Department of the Navy (DON) Information Management and Information Technology Strategic Plan "points to the need to reengineer warfighting and core business processes in parallel with technology infusion to maximize effectiveness and efficiency", and "calls for the implementation of strategies that facilitate the creation and sharing of knowledge to enable effective and agile decision making" [Bennet, 2000]. One of today's biggest challenges is integrating legacy systems with cutting edge technology, while satisfying users' ever-increasing requirements for data access, without spending a fortune. However, "…technology alone is insufficient, we need to simultaneously change processes and provide the tools for people to use that technology" [Bennet, 2000].

Both commercial industry and the U.S. Government have expended enormous sums of money on Information Technology (IT) solutions, often realizing less than anticipated results. "There's a belief that the new systems will automatically reengineer your processes. Most people put in new systems with the hope that they will improve productivity and cut costs" [Bartholomew, 1999]. With the dynamic nature of business today, technology improvements cannot afford to ignore organizational processes. However, there is much debate about the success of reengineering efforts. Two primary reasons reengineering efforts fail are "the lack of an adequate business case resulting in unclear, unreasonable, or unjustifiable expectations for what is wanted or expected to result… and the absence of robust and reliable technology and methodologies for performing [the analysis]…" [Mayer, & deWitt, 1999]. This paper will describe the lessons learned in implementing new technology while successfully reengineering processes to provide substantial Return on Investment (ROI) through simulation-based decision support.

Training Business Modeling and Simulation (TBMS) Program

In 1999, Information Technology Program Managers on the staff of the Chief of Naval Education and Training (CNET) began the Training Business Modeling and Simulation (TBMS) program. Two major goals were established under this program:

- To define, prototype, and test a standardized methodology for evaluating and improving business processes. This methodology will provide more accurate and justifiable Navy resource requirements for training and acquisition.

- To define a standardized Manpower, Personnel, and Training analytical framework and architecture to support CNET's decision-making process for delivering quality education and training to the right people, at the right time, at the right place, in the most efficient and effective manner.

The first goal of establishing a standard methodology for evaluating and improving business processes brings structure to reengineering efforts and mandates a clear business case for performing analysis and meeting expectations. It also brings cutting edge analysis tools to better ensure success. Static tools, like flow charts, can only provide one view of how a process could operate, and can only provide limited data on the impact of change in complex systems. However, discrete event simulation (referred to only as computer simulation for the rest of this paper) can quickly provide a comprehensive picture of actual operations, to include productivity levels, cost, staffing analysis, and most importantly, IT change implications. Dr. Profozich (1998) describes this dynamic environment and predicts simulation modeling to become one of the essential tools in ERP implementation, supply chain applications, and any major process improvement endeavor. The second goal of defining a standardized framework to support CNET's decision-making process addresses the Department of Navy's strategic plan of infusing new technology while reengineering processes, and sharing that knowledge. DoDI 7041.3 Economic Analysis (1995) describes a systematic approach to the problem of choosing the best method of allocating scarce resources to achieve a given objective. A sound economic analysis recognizes that there are alternative ways to meet a given objective and that each alternative requires certain resources and produces certain results. The steps for conducting an economic analysis and corollary actions in CNET's business modeling and simulation program are:

(1) Define the objective – mandate clear business case and objectives for the effort

(2) Formulate assumptions and constraints -- collect explicit and tacit knowledge about business processes

(3) Develop alternatives – develop as-is and to-be simulation models of the process

(4) Estimate costs and benefits -- select and estimate key performance metrics

(5) Compare alternatives -- compare to-be models to as-is baseline

(6) Conduct sensitivity analysis – determine key process cost drivers and resource constraints

CHALLENGES IN USING SIMULATION TECHNOLOGY

The Need For Enterprise Technology Improvements

During the mid 1990's CNET and the Bureau of Naval Personnel conceived the Integrated Navy Training Requirements and Planning Database (INTRPD pronounced "Intrepid") strategy (see figure 1) to improve the integration of data for the primary applications used by the Manpower, Personnel and Training (MPT) community to manage the flow of recruits and fleet returnees in and out of training. INTRPD became operational in FY00 and resulted in better interfaces, standardization of data, improved data integrity, reduced awaiting instruction and transfer time and improved seat utilization. Although INTRPD has resulted in many benefits, a number of the systems included in the strategy are older legacy systems that are in need of replacement in order to realize other benefits.

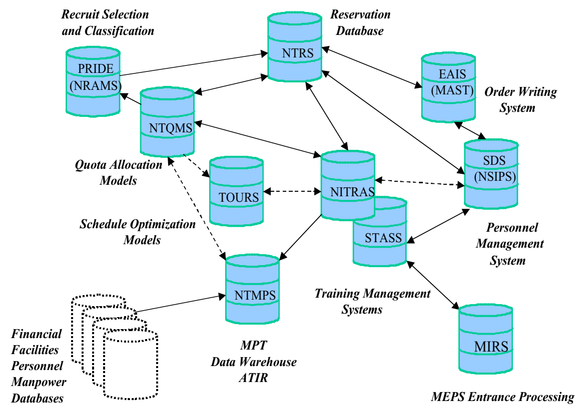

Figure 1: INTRPD Strategy

INTRPD improves the management of the Navy's training seat inventory, however the current architecture restricts comprehensive access to the various types of functional data necessary to support decision-making processes. In addition to the limited access to data in standardized systems, MPT organizations collect, store and use data not captured in a way that it is widely accessible. In today's rapidly changing environment according to theories of Knowledge Management, it is necessary to not only be able to quickly and easily access the explicit knowledge (i.e. the hard data contained in standardized systems), but it is also crucial to capture and access the tacit knowledge (i.e. information existing in people's heads or "intellectual capital") which is not currently captured in any system [Bennet, 2000).

Quickly capturing and using tacit knowledge is not typically a common or easy task to accomplish. However, without the tacit knowledge it is extremely difficult to reengineer processes and gain the full benefit of implementing IT solutions. Eliyahu Goldratt (2001), considered the father of Theory of Constraints, contends the reason we don't see large return on investment in IT solutions is because we neglect to evaluate and change the operating rules that existed before the technology was implemented.

In other words, we had to create rules to deal with the limitations of not having the technology. However, when we get the technology, we do not evaluate the old operating rules and change them to fit the new technology. These "operating rules" are not typically contained in existing systems, but are tacit knowledge.

The standardized framework to support CNET's decision-making process required structured methods, tools, and techniques that incorporated sound knowledge management practices, cutting edge technology, and innovative analysis. Computer simulation was considered key to providing the required analysis for such complex and dynamic operations, but there were a number of obstacles that first had to be addressed. Five major obstacles were encountered in working to build simulation-based decision support: inconsistencies in simulation model development, obtaining accurate data to build the models, performing model validation, gaining model reusability, and sharing of knowledge.

Development Inconsistencies

A defined, repeatable methodology for model development and analysis must exist to have confidence in the resulting decisions. Computer simulation modeling is still a relatively new player in the business analysis world. Until the 1990's computer simulation was a programming function that required a substantial investment in resources and time. The manufacturing environment was one of the few industries that could afford the investment and quickly reap the benefits. Manufacturing was also an easy starting point because building a simulation model simply meant replicating tangible items in a stable process a person could observe and measure, like an assembly line with moving parts. The structure of an assembly line and the associated rules for routing the parts were clearly defined and easy to capture in a simulation model. Industrial engineers could "walk the floor" of the factory and physically obtain the needed data to build the model through time and motion studies or work sampling techniques. They could also easily validate the model against product attributes like cost and throughput.

Historically, computer simulation development has been applied to only segments of an enterprise and often development was more of an art than a science. This was not a significant problem in the manufacturing environment where model validation was relatively easy, and simulation efforts were limited to specific areas with no requirement for reusability. However, developing enterprise simulation decision support in a service industry involves processes that are not tangible products on a product line, business rules that are not clearly defined, and model validation is extremely difficult. "Simulation of customer service processes presents a unique challenge because both the flow objects and resources are humans. Humans have much more complex and unpredictable behavior than products, documents, equipment or vehicles" [Tumay, 1996].

Although many computer simulation applications define operating rules on how to create an event, resource, or entity in the application, they usually allow great flexibility in how the model is constructed and allow the modeler to define many user-specific parameters, algorithms, and distributions. With recent improvements in hardware and software capability, there are many cost-effective computer simulation tools hitting the market, some even built on existing flow chart tools that are familiar to many managers. This means simulation modeling and analysis is no longer limited to only industrial engineers that have been educated in rigorous development concepts, but is now openly used by many others without the benefit of strong development theory. The flexibility in constructing computer simulation models, combined with the lack of rigorous development techniques, creates large inconsistencies in simulation model development.

Collecting Accurate Data

As we move simulation analysis into the service side of business, we often find the data required to feed a simulation model is not typically the same data elements contained in existing information systems. Traditional information systems are designed to provide high-level data on enterprise cost, throughput, and quality. These systems are usually built by department or function, and not by organizational process. For example, in developing the simulation model to depict Navy berthing, the process for placing Sailors into barracks while they are located at Naval Aviation Technical Training Center (NATTC), we needed some basic information to develop the simulation model. We needed information on barrack capacity, business rules for placement of Sailors into different barracks, length of stay in barracks, and Sailor arrival rates to NATTC. Figure 2 depicts the NATTC Berthing process.

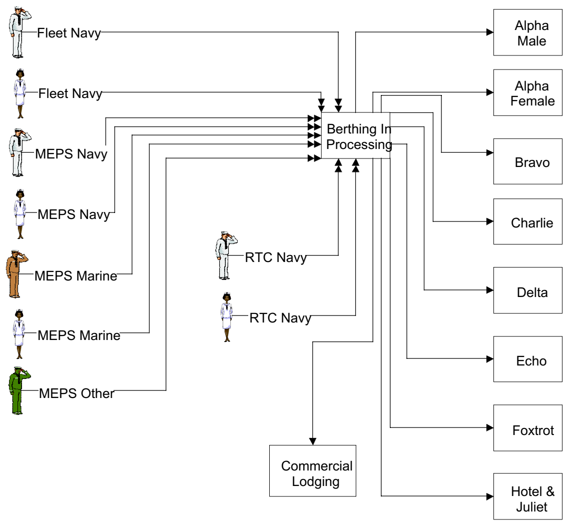

Figure 2: NATTC Berthing Process

Although we could easily extract data from existing MIS systems to provide high-level information on the total number of Sailors that occupied NATTC berthing, it required additional analysis to extract the specific numbers broken out by category and place of origin. We needed Sailor arrival rates broken out by Navy, Marine, and other service; further broken out by male and female; decomposed by origin (Fleet or Recruit Training), and further decomposed by Rating (career field). Once this data was captured, an off-line statistical program was used to derive the average length of stay each rating spent in the barracks. Other pieces of required data, like the business rules for placement of Sailors into different barracks, and barrack capacity was not captured in any MIS system and had to be obtained from personnel who managed NATTC berthing. Interviews with berthing personnel captured this tacit knowledge to build the models. Although building the model only took a few short weeks, capturing accurate data to input into the models and validate results took several months and was labor-intensive at times.

Conceptual Model Validation Difficulties

"Conceptual validation should be the foundation for simulation credibility. Validation of results from simulation testing and use can determine how well the simulation performs for specific test cases, but without validation of the concepts and algorithms of the simulation, one has no basis for judgment about how well the simulation can be expected to perform for any other conditions" [Pace, 1998]. Simulation models do not easily lend themselves to conceptual validation from the user community (i.e. those who perform the processes but are not simulation modelers). Each computer simulation product uses its own ontology and the modeler has great latitude in how to construct a simulation model. For example, the simple process of customers ordering a product can be modeled two totally different ways in the same vendor package. Figure 3 shows 2 types of requests arrive (80% of requests are simple, while 20% are complex), a staff member reviews the request, and a worker processes the request (a complex request takes longer than a simple one), and ships the product.

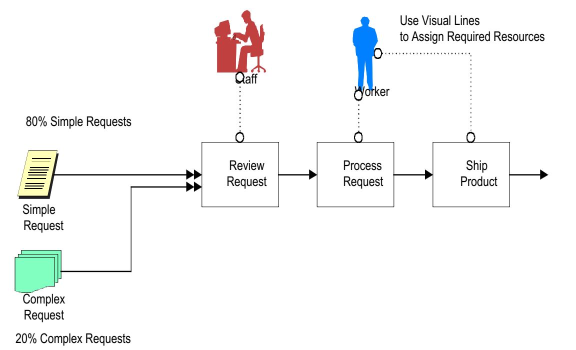

Figure 3: Model 1 of Customers Order a Product

The very same process can be modeled differently both visually and in the code behind the scenes in the same vendor package and produce identical results. Figure 4 shows the same process, only all requests arrive together and are split into simple and complex after arrival, the resources are assigned using simulation code vice visual lines, and the last 2 steps of processing the request and shipping the product are combined into one box.

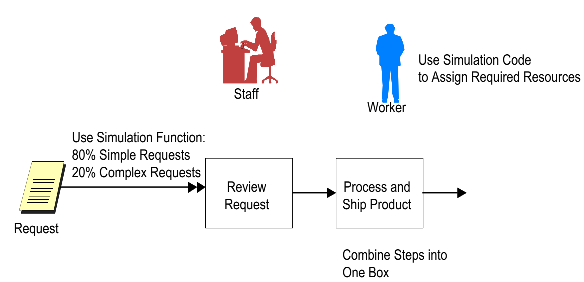

Figure 4: Model 2 of Customers Order a Product

Although this latitude in model creation is a benefit many modelers enjoy, it greatly hinders ease of conceptual validation from the users. That difficulty only increases with multiple vendor products. Although many of the simulation products export data to a spreadsheet, each product formats the data differently and uses their own nomenclature. The user is left with either learning the vendor package to work through the model item by item for validation, or leaves the validation to the modeler, who is probably too close to the model development for an objective view and does not understand all the nuances of the operations to catch all modeling errors. Unfortunately, this stumbling block is the primary reason models are created but not properly validated, which leads to inaccurate results and decisions – and often frustration in trying to use something more advanced than spreadsheets and databases to analyze complex problems.

Model Reusability – Non-interoperable Tools

Throughout the Navy, there are multiple organizations using simulation technology to analyze and solve inefficiencies. The challenge is figuring out how best to reap the benefits of these efforts without putting unnecessary constrains on each organization. Unfortunately, most Commercial Off The Shelf (COTS) simulation tools on the market today are stand-alone in nature and do not interoperate with other vendor packages. The Navy could consider standardizing all simulation efforts on only using one specific vendor product, but this would severely limit the organization's flexibility in using the best package for the organization's specific needs, hinder competition, and stifle innovation.

There are some COTS simulation products on the market today that are capable of object-oriented, fully interoperable source code and data. Regrettably, they usually require a steeper learning curve and additional resources and time to get good return on investment. In fact, those who are using object-oriented technology find the trade-off for long-term interoperability can be very costly upfront. For example, in object-oriented development it is critical to correctly define the classes and inheritance during the requirements analysis phase. Since most object-oriented software development efforts are iterative in nature, errors or imperfections in the simulation specification resulting from inaccurate data or evolving tacit knowledge are very costly. If requirements engineering does not do a good job in this area, the rework required to fix the errors is substantially more than traditional development efforts [Polen, 2001]. Until object-oriented simulation tools become as understandable and easy to apply as many non-object-oriented simulation tools, organizations will continue to use traditional stand-alone computer simulation products.

With today's proliferation of business simulation software products, the best answer is to allow organizations to choose the best simulation product for their specific needs. However, it is undesirable to conduct one-of-a-kind simulation studies and continually recreate the wheel in analysis efforts. So how do we gain the benefits of interoperability without using interoperable tools? We instead focus on methods and tools to permit reuse of the data elements and business rules that feed these simulation models and accompanying analysis.

Sharing Knowledge – One Time Use Case

Analysis efforts typically follow a one-time use case, as illustrated in figure 5. A crisis comes up, a snapshot of the situation is taken, analysis is performed, action is implemented to solve the crisis, the analysis report is placed on the shelf, and it is rarely, if ever referred to again. [Aust & Dunlap, 2000].

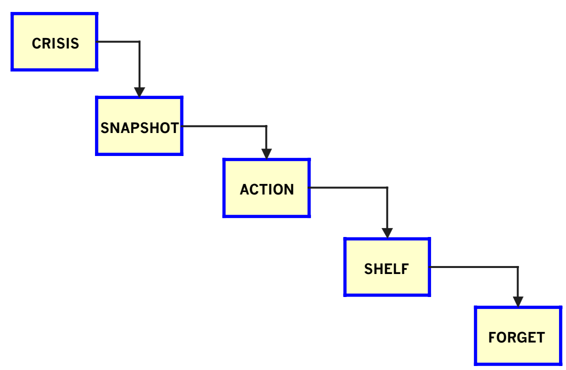

Figure 5: One Time Use Case

Part of the reason for this continual "recreation of the wheel" is because previous analysis efforts are not publicized or located in an easy to access location. In order to decrease rework and increase reusability, it is necessary to first share the knowledge. However, as stated earlier, when you consider sharing analysis from simulation modeling efforts, the models and resulting analysis can look very different. A major challenge for CNET analysts was defining a common way to share simulation model analysis efforts without limiting organizations in what simulation tools they choose or stifling innovative modeling techniques.

CONSTRUCTING THE SIMULATION-BASED DECISION SUPPORT FRAMEWORK

All of the before mentioned challenges required a comprehensive approach that integrated knowledge management practices, a structured methodology for developing simulation models and performing conceptual validation that could generically apply to most simulation tools, an avenue to easily share analysis and lessons learned, and an approach to promote model reusability and decrease analysis rework. CNET analysts determined a web-enabled Business Modeling and Simulation Resource Center (BMSRC) was the best choice to overcome current challenges and meet the Department of the Navy's goals and CNET's objectives.

Using A Standardized Methodology To Reduce Modeling Inconsistencies

Although simulation-modeling tools allow great flexibility in model development, a common methodology for capturing data and developing the models could be developed which did not limit modeling creativity or application desired, but did provide structure and better development consistency. At a high-level, this methodology can be described in four major phases: knowledge acquisition, knowledge engineering, conceptual and results validation, and redesign.

Knowledge Acquisition is gathering the right data, from the right data sources for the objectives at hand. Process diagrams are developed depicting the process flow, and the required data elements are gathered to feed to simulation model. *Knowledge Engineering* transforms the data from Knowledge Acquisition into computer simulation models for analysis. Once these models are validated and verified, they provide a baseline for comparison analysis. What-if scenarios can be executed to provide metrics on performance, cost, throughput, resource utilization, and cycle time. *Conceptual Validation* validates that the functional flows are depicted correctly, relationships are understood, and data feeding the simulation model is accurate. *Results Validation* checks the resulting statistics from the simulation model against historic data to ensure the simulation model is truly approximating the behavior and results of the modeled operation. Once this validation is complete, the baseline simulation model is ready to be used for the *Redesign* phase in which what-if analysis is performed and analyzed for return on investment. [Aust, et al, 2000]

The web-enabled resource center was built with this common methodology in mind. The BMSRC contains an on-line tutorial that walks the modeler through a structured methodology complete with data templates and tools. The first data collection template is the Project Summary. This template assists the modeler in firmly defining the requirements analysis to prepare for the knowledge acquisition phase of the project. The modeler must complete this portion before any detailed model data can be entered into the repository. Required information includes project background and scope, the Navy domain in which this effort belongs, the sponsoring organization, who is responsible for maintaining and updating information in the BMSRC, who is responsible for model validation, specific metrics the model will compute to determine return on investment, and other relevant summary information. As the BMSRC becomes populated, users will have the option to apply existing data, i.e. point of contact information, to their models as well, reducing data entry.

As stated before, simulation tools are becoming much more user-friendly and we are beginning to see a trend of new users who may not be well versed in rigorous analysis methods. Incorporating a structured approach through this type of tool will help compensate for some of the knowledge gap and better ensure a successful simulation project. For example, if model metrics are not clearly defined before data collection begins, too much or too little data, or even worse the wrong data, may be collected. This can be a very expensive oversight that could have been avoided through a structured approach.

Better Processes And Tools For Collecting Accurate Data

In order to solve the labor-intensive problem of collecting accurate data, we had to look to new technology. Although some of the data required to build a simulation model may already be contained in the legacy systems, it was difficult and confusing to try to locate the right data because it might be contained in multiple systems, and writing new queries to parse and transform the data was often labor-intensive and slow. The CNET staff required a solution that could quickly and accurately bring together the right data for simulation-based decision support. A web-enabled data mart seemed the best solution to this problem.

"A data mart is a decision-support application system that focuses on solving the specific business problems of a given department or area within a company" [Moeller, 2001]. Unlike the traditional data warehouse, data marts can be built fairly quickly and cost effectively with scalable technology. With a good enterprise data model, multiple data marts can later be fashioned into a distributed data warehouse or data mall. Data marts are characterized by their rapid response to ad hoc queries, and are much easier and cheaper to maintain than a traditional data warehouse. Since CNET's analysts chose a web-enabled data mart tool, remote accessibility was also possible. [Moeller, 2001].

Many Navy training simulation models will require the same types of data, i.e. information on Sailors processing through training classes. These common types of data required to build Navy training simulation models were identified and defined for data mart development.

Structured Tools And Techniques For Performing Conceptual Validation

Since it is impractical to standardize on one particular simulation tool, and interoperable computer simulation tools are not the standard yet, we had to find an innovative approach to standardize conceptual validation for the user community. To do this, we focused on the model data and business rules that controlled the simulation models. If we could find commonality in the data elements, then we could produce a standard conceptual validation report regardless of what software application or modeling techniques were used.

All computer simulation-modeling efforts have common elements. Something moves through the model to be processed, usually called an entity, discrete events are defined for processing, specific resources may be required to process the entity (like people or machines), and miscellaneous parameters are defined to make the model behave properly. Once these common elements were identified, we then had to create the conceptual validation report with generic naming conventions that were not specific to any one software application. We first looked to the Department of Defense (DoD) modeling and simulation community to determine generic naming conventions for the validation report.

Although we are not creating truly interoperable simulation models, we knew we could gain substantial benefit from High-Level Architecture (HLA) concepts and structured modeling approaches used throughout organizations like the Navy Modeling and Simulation Management Office. We used the HLA Object Model Template (OMT) as our foundation for defining many of the terms in the conceptual validation report and also for defining some of our data tables in the BMSRC. Even though we are not working with "objects", we still required a table similar to the Object Model Identification Table, which became much of our Summary Report discussed previously. Computer models also have data elements similar to parameters, attributes, routings, and specific ways to define relationships throughout the model. Using the foundation of model element commonality in conjunction with the structure from the OMT, a standard conceptual validation report was created. This conceptual validation report with common terms is required for all simulation-modeling efforts at CNET, regardless of the tool chosen or the modeler's individual simulation techniques.

The conceptual validation report is composed of five major sections, many of which relate to data elements in other sections of the report. The first section describes all entities and their associated attributes to include name, availability, travel speed, cost, arrival amount and frequency, and source information. The second section defines all resources and their associated attributes to include name, quantity, availability, cost, and source information. The third section defines all model parameters, i.e. any user or software defined variable or attribute used to manipulate model behavior. The fourth section describes any operating rules defined within the model, to include name, brief description, operating rule syntax, and required parameters. The fifth section defines all model Units of Behavior (UOB). These are all discrete-events defined for the model, which may include activities, locations, routings, waiting lines, etc. Associated attributes include name, availability, capacity, processing time, cost, entities processed, required resources, operating rules, and source information.

Model Reusability

The standard conceptual validation report provided a common framework for the modeler and the user to better communicate and made the task of conceptual validation mush easier for the user. However, it does require additional work for the modeler. The modeler not only has to create the simulation model and perform his own validation, but now also has to enter the data into a separate report for user conceptual validation. In order to make this task more worthwhile for the modeler, we needed to look beyond model validation to the bigger picture of data reuse.

Many of the data elements and business rules used to create one simulation model for the Navy are also applicable to other simulation models. For example, a common metric tracked in Navy training is Awaiting Instruction (AI) time. This is the time a Sailor must wait for a class to begin after he/she has in processed to the training location. A common algorithm to track this time would be to capture the simulation clock time when the Sailor in processed, let's say it is day 215, and subtract it from the simulation clock time when the Sailor started the course, which is now day 218. AI equates to 218 – 215, or 3 days AI.

Entering these types of model data elements into the BMSRC provides reusable data for future models. Although the first time the data is entered into the BMSRC will cause additional work for the modeler, it will save the modeler considerable time in the creation of future models.

Sharing Knowledge

A primary function of the web-enabled resource center is to share knowledge and support a community of practice. Since modelers use the BMSRC to enter data about their models, they have exposure to all the work performed by their peers. They have the benefit of lessons learned, other modeling techniques, successful algorithms, and reusable model data.

The BMSRC also provides collaboration capability. If several modelers are developing separate pieces of the same model, or need to collaborate often as a model is developed, they can easily perform the collaborative tasks even though personnel are not centrally located. This, of course also provides an avenue to conduct interim reviews with users as the models are built to ask questions, clarify issues, or validate an approach.

The user community finds the information contained in the BMSRC valuable long after the analysis effort is complete. Managers use the process pictures and associated data to train new personnel. Tacit knowledge is not lost. The analysis is used to justify resource requirements to senior leadership. The IT department uses the data to analyze the impact of projected new technology.

A CASE STUDY FOR NAVY HOME PORT TRAINING

A simulation modeling study for the CNET Home Port Training (HPT) Program was used to validate the BMSRC functionality. We specifically focused our analysis on the course acquisition package process that currently contained many manual tasks. An automated workflow application was proposed to reduce cycle time and decrease package errors. The simulation would provide ROI numbers on implementing the automation.

In the Summary Report we clearly defined roles and responsibilities, project purpose and background, validation personnel, validation criteria, and other relevant high-level data. Specific model goals were to document ROI in automating the HPT course acquisition package process, reduce risk of packages getting stopped in process, and eliminate disconnects between the Local Training Authority requirement, the package, and the vendor. These goals translated into the following model metrics: processing cost per package, package cycle time, and package error rate.

Building The Simulation Model

The course acquisition package process spanned multiple Navy organizations at different geographical locations. To build the model, we formed a cross functional team of experts in the process and proceeded with knowledge acquisition. Figure 6 depicts the As-Is course acquisition package process.

Once we had the model flow built, we collected all necessary data to develop the model and produce metrics on cost, cycle time, and errors. This began the knowledge engineering phase of the project; building the computer simulation model. Simultaneously, all model data elements on entities, resources, parameters, operating rules, and units of behavior were entered into the BMSRC.

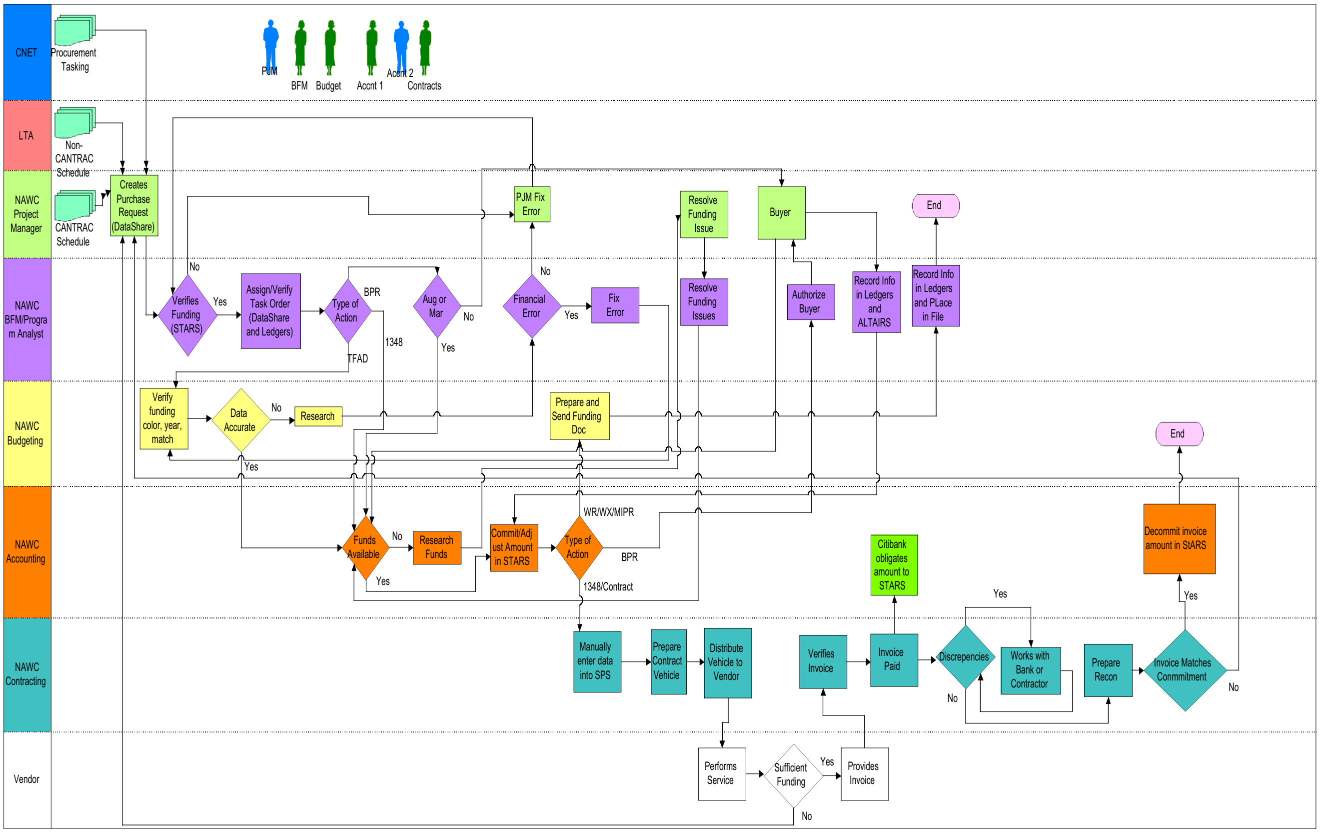

Figure 6: As-Is Home Port Training Course Acquisition Package Process

Validating The Model

Once all required data was entered into the model and the model was working properly, the modeler initiated the validation process in the BMSRC. Electronic notices were sent in turn to the respective personnel previously defined in the summary report to perform conceptual validation. The validators reviewed a standardized conceptual validation report listing all model data elements, along with a picture of the model for reference purposes. Required modifications were documented and the modeler was notified to initiate model changes. This process would continue until all validators completed conceptual validation phase. Once all modifications were completed in the model, the modeler initiated the results validation phase. Again, electronic notices were sent in turn to the respective personnel previously defined in the summary report to perform results validation and they each reviewed and approved or submitted discrepancies with provided model output metric data. When this phase was complete, the baseline model was approved in the BMSRC for it's stated purpose.

Model Analysis

The valid baseline model was manipulated to perform what-if analysis. The first scenario analyzed the model metrics when the manual tasks are automated. This elimination of manual tasks decreased the average cycle time of processing a package by approximately .6 days, and decreased the average error rate by 2.5%. Since personnel performing these tasks are paid to be available a set number of hours to perform this work, regardless of production, we did not see a change in cost per package because the same number of packages were processed. Activity-based costing techniques were used to compute cost figures.

The second scenario analyzed the impact of making substantial process changes in conjunction with all automation improvements from first scenario. This scenario reduced cycle time by an additional 1.2 days, and decreased errors by an additional 40%. Again, cost per package remained constant since the same numbers of packages were processed.

Although implementing new technology certainly helped reduce cycle time and package errors, the substantial savings came from making process changes in conjunction with this new technology.

Home Port Training is a growing program in the Navy. Some estimate the number of courses and corresponding acquisition task packages (currently at approximately 400) will double over the next two years. This last scenario analyzes the capacity and cost to process twice the number of packages using the current year resource baseline. When we ran the baseline As-Is model with twice the input, the average cycle time increased by 15 days, which greatly exceeded acceptable processing time from the customer (see figure 7). In order to get the average package cycle time within acceptable limits, additional resources had to be added.

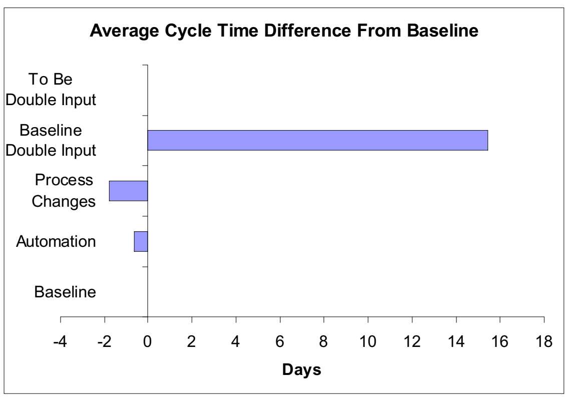

Figure 7: Average Cycle Time

However, when we ran the new scenario with the process changes, new technology implemented, and twice the number of packages, the average cycle time is still within the 4-day threshold, we do not have to add any additional staff hours, and our cost per package has decreased by 275 dollars (see figure 8).

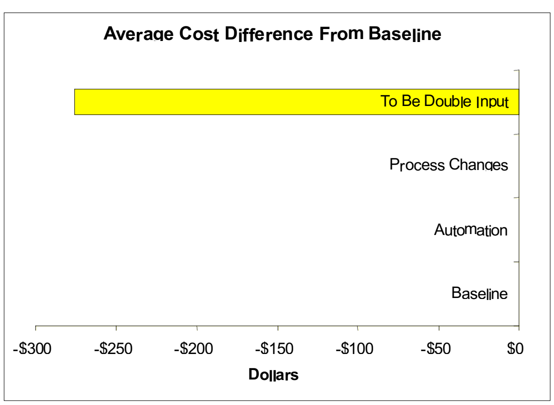

Figure 8: Average Cost Difference

Reusable Data Elements

In the course of the HPT workflow analysis and simulation, a significant amount of redundant data entry was identified which induced processing errors into the system. This discovery led to developing an integrated HPT management data model that would eliminate numerous spreadsheets and databases, and concentrate collection of source data at the first point of entry to maintain data quality. This required the development of an HPT data mart, and the application of a COTS data migration tool to capture data from spreadsheets, databases, and legacy systems. The resulting applications permits users to collect the source data in a familiar format, and the migration tool conducts queries against the source data files to construct the data mart used for program management and analysis.

Sharing Knowledge

Sharing knowledge will certainly help with future similar efforts in reuse of data, algorithms, and modeling approach. In this case, sharing of knowledge opened the door to even greater improvements for Home Port Training than already realized. Some of the personnel involved in the course acquisition package process are also major players in a different process to support Home Port Training. Their involvement in this effort brought to light some needed analysis, improvements, and new technology that will benefit HPT long into the future.

EXPECTED IMPLEMENTATION RESULTS AND BENEFITS

Building the BMSRC provides a structured approach to what were once complex, and difficult to replicate analysis efforts, helped address five major obstacles in developing simulation-based support capability. The structured data templates and on-line tutorial aids in consistent and more accurate computer simulation model development for the CNET staff. Moving towards web-enabled data mart development provides many of the specific data elements required for computer simulation development more accurately and quickly. The standardized validation report helps bridge the communication gap between users and modelers to ensure more accurate computer simulation analysis and results. Defining the BMSRC with a common ontology (firmly founded from the DoD modeling and simulation community), and data element capture and reuse provides the required structure while simultaneously allowing each organization the flexibility to choose the best computer simulation application. By web-enabling this resource center, allowing access to all Navy Manpower Personnel and Training organizations, the knowledge sharing for future modeling efforts grows exponentially.

Modelers gain several benefits in updating the BMSRC as a model is built. The modeler has access to the work other modelers have accomplished and may find a better way to define an operating rule or reuse a previously defined parameter. The structure of entering data in the repository forces the modeler to fully define each piece of the model, thereby avoiding modeling errors and confusion later about the purpose of each element. Using a web-enabled resource center allows model building collaboration that may have been difficult otherwise, especially if a team of people are building different parts of the model from remote sites.

The users now have a common framework for performing conceptual and results validation without regard to software application used or modeling techniques chosen. The BMSRC provides a common repository where all analysis efforts are stored to promote reusability and reference material. Proposed technology upgrades will have more data, especially the tacit knowledge, to better assess technology impact.

The simulation-based methodology developed by the CNET staff is applied to complex systems and processes to thoroughly analyze system relationships and behavior. Implementation of business simulation can be frustrating and difficult to get started. The old adage of "garbage in – garbage out" applies to simulation studies just as it applies to a simple spreadsheet. The complicating factor is that the amount of data and information required to conduct simulation studies is substantially greater than most other analysis methods. Consequently, errors in simulation study design and development tend to come at a more significant cost. However, simulation studies do not have to take a long time and be excessively manpower intensive. The staff at CNET has accomplished complete, validated modeling initiatives in less than two weeks using proven development methodologies and structured tools and techniques.

Selection of a simulation software product can be very time consuming and expensive depending on how much capability is needed. Simulation software products range from a low cost of just over $1,000 to well over $30,000. The lower cost products tend to keep the user interface quite simple and apply familiar flowcharting tools to simplify the modeling process. The advantage to the lower cost products is a shorter lead time to get started. More advanced tools run more efficiently for larger studies and have much more robust features for handling data, animations, or visualization capabilities. Higher cost simulation software tends to require a greater learning curve up front, but can save cost and time later in the process.

The key to success in using business simulation is in following a structured approach like the one presented in this paper, and getting knowledgeable process owners who support the effort involved up front. The power of simulation as an analytical tool is extraordinary in the amount of explicit and tacit knowledge that is discovered and stored from the effort. Using the BMSRC, this knowledge is captured, shared, and reused throughout the enterprise.

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