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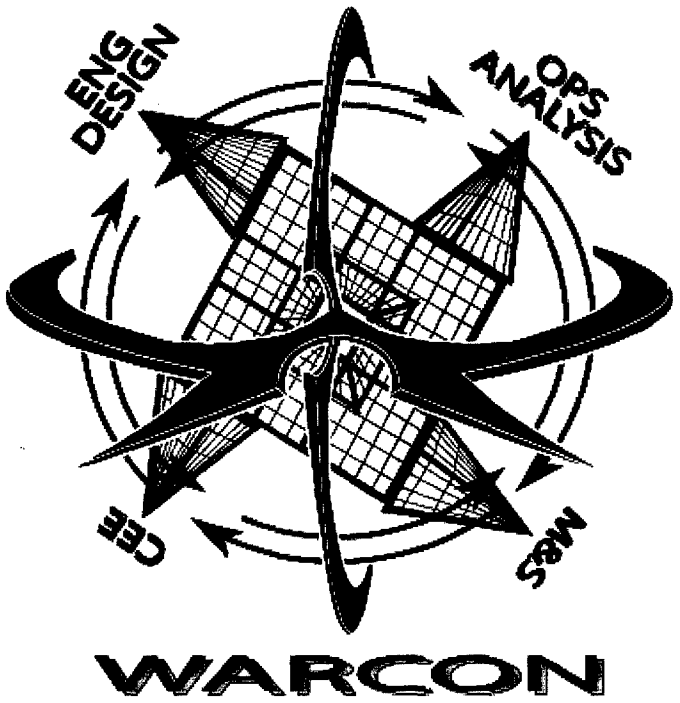
Warfighting Concepts To Future Weapon System Designs (WARCON)



RECOMMENDED PRACTICES GUIDE

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Warfighting Concepts to Future Weapon System Designs (WARCON) Recommended Practices Guide

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WARCON Phase III
Final Report

September 2003

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Executive Summary

Using Simulation and Modeling in Procurement

The end of the Cold War brought decreased military budgets at a time when existing platforms and weapons were reaching the end of their service life. The emergence of new military missions and technologies lead to a need for revolution in acquisition strategy. The Department of Defense (DoD) searched for new ways to improve the systems acquisition process to meet the emerging need. Research confirmed the nation's military needed the means to field new or improved systems quickly and efficiently with reduced acquisition costs.

This philosophy, simplistic in its approach, is rather complex in execution. In its zeal to research, develop, test, and field systems, a program office must establish a balance among system capabilities, speed of acquisition and procurement costs. This balance is often measured in the degree of risk that exists in meeting the objectives that a proposed system is designed to achieve. These objectives include performance, schedule, and cost. DoD research conducted in the early 1990's concluded that practices and processes using simulation and modeling practices in procurement could increase the likelihood of acquiring and producing systems that have better performance, a faster schedule for delivery and fielding, and a significant cost savings compared to acquisition procedures and practices used during the Cold War.

The use of modeling and simulation tools enables a design team to perform "what if" analyses on hundreds of options and provides rapid feedback to the design engineers in charge of system development. In addition, Modeling and Simulation (M&S) techniques remain applicable to the entire product life cycle. As result of Joint Vision 2010, DoD directed that acquisition program managers use an M&S process in future systems procurement programs. The Defense Modeling and Simulation Office (DMSO) was tasked with assisting in developing models and simulations that support the acquisition process.

In 2000, the Office of Naval Research (ONR) sponsored development of a process that used M&S tools and for the first time, linked both the warfighter and operations analysis to the acquisition process. Warfighting Concepts to Future Weapon System Designs (WARCON) is one of the first Navy efforts in developing an effective simulation and modeling procurement process.

What is WARCON?

Conceptually, the WARCON process links requirements and capabilities desired by the warfighter with establishment of Measures of Performance and Measures of Effectiveness (MOPs/ MOEs) for a future system. Development of models and simulations based on current capabilities support the measurement of performance factors and comparison of cost data to obtain the rapid feedback required by simulation and modeling procurement approaches.

Why WARCON? A number of other methods exist to support procurement investigations and activities. Many have as their foundation the required M&S tools with which to make acquisition decisions, field new systems, and involve the warfighter in the process.

WARCON uniquely provides a proven and demonstrated method for linking operations analysis to the warfighter and to the M&S toolset, while managing the project in a virtual environment. In addition, the WARCON process allows the decision-maker to provide a rapid response to acquisition issues and a way to link systems and design engineers who may be from different and even competing firms. For example, during development of the WARCON process, a linkage between Northrop-Grumman Newport News Shipbuilding, Lockheed-Martin Corp. and ONR facilitated a trade study on practices and products to improve throughput of the Carrier Weapons Handling System (CWHS) on Nimitz-class aircraft carriers for the next generation of platform, the CVN-21.

Depending upon the issue under study, the WARCON process can employ a synthetic battlespace with a range of models across a distributed, federated, simulation network, enabling the warfighter to apply technological concepts to anticipated threats.

A Collaborative Engineering Enterprise (CEE) permits the engineer to apply design processes that are cognizant of total life cycle costs while satisfying the warfighter's requirements.

Using the WARCON process will increase long-term effectiveness, decrease acquisition cycle time, and reduce Total Ownership Cost (TOC) of new weapon systems. WARCON achieves this through co-development of operational concepts and weapon system designs in an end-to-end, strategy-to-task collaboration of warfighters, weapon system designers, and operations analysts.

The WARCON process focuses on establishing Integrated Process Teams (IPTs) and Virtual Project Management techniques that allow for the rapid tracking and completion of the WARCON process for participants in diverse organizations and locations. At a minimum, the IPT structure includes an Operations Analysis IPT, an Engineering Concept Development IPT, and a Modeling & Simulation IPT. These Integrated Process Teams report to a Management IPT, comprised of the Program Manager, senior managers, and representatives from each of the functional IPTs described above. Each IPT can establish working groups as needed for specific tasks.

The WARCON Process

Six major steps have been developed and tested for the WARCON process (see Figure 1). WARCON uses the Integration Definition for Function Modeling (IDEF0) format to depict and document the generic management process. WARCON personnel tailor these processes for each specific application depicted in Program-specific IDEF0 diagrams. These diagrams document the process steps required in WARCON, and serve as a roadmap for the IPTs.

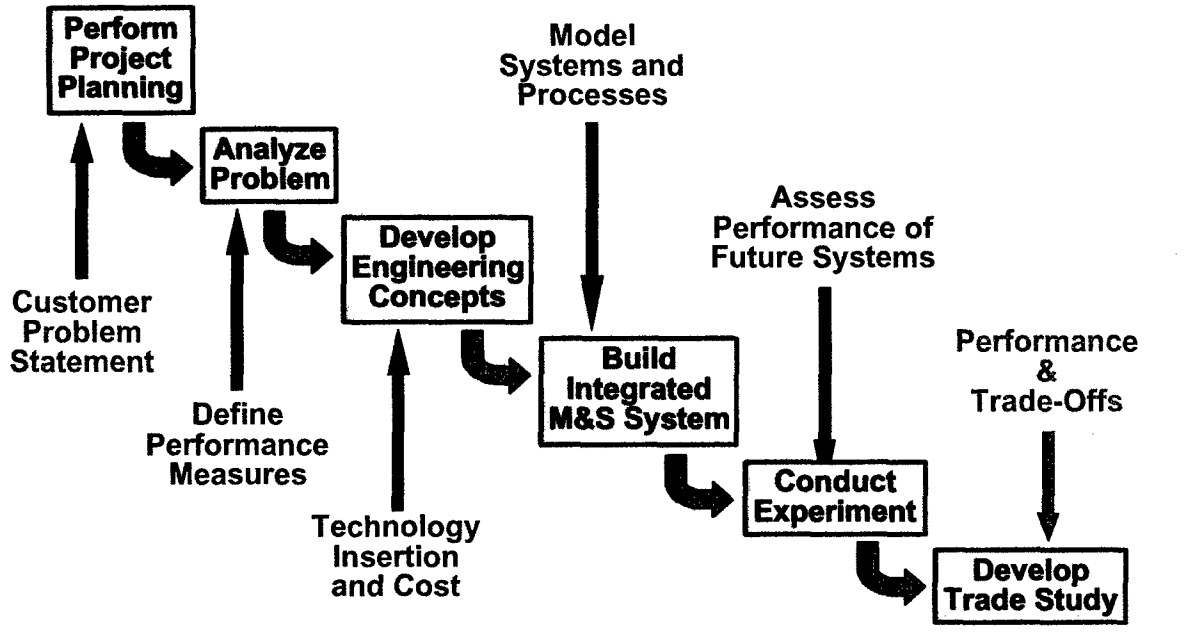


Figure 1. The WARCON Process

- The WARCON process begins with the Project Planning Phase, shown as Node A1 in Integration Definition for Function Modeling (IDEF0) Format in Appendix B.

- During this time, the issue or problem is defined, the WARCON process is tailored for this problem, functional IPTs are identified, and a Project Management Plan is developed. In addition, the management and analysis plans reflect requirements and policies outlined in appropriate DoD documents.

Operations Analysis

The next step in the process is an analysis of the customer problem (Appendix B; IDEF0 Node A2). Through the systematic use of operations analysis, the user can refine the requirements, including those from the warfighter, in the context of the current operational environment. This permits rapid inclusion of these changes into the process thereby reducing development and testing costs.

This phase of the project produces two critical sets of metrics. The first set encompasses Measures of Effectiveness (MOEs). These are measures of success based upon the operational objective established by the acquisition PM. Examples of MOEs may include number of bombs on target or strike response time. The second metric is a set of Measures of Performance (MOPs), which as a subset of MOEs represent a level of performance of a particular subsystem or process step. Examples of MOPs may include speed, payload, range, time on station, or other quantifiable performance features.

Other products of this step include documentation of the legacy system being analyzed for the acquisition decision, a description of one or more scenarios upon which to base models and experimentation, and a survey of the available technologies and capabilities under consideration as candidates for the new system that will be acquired. In addition, because the WARCON process can link competing technologies, it can identify the most cost-effective system that meets or exceeds established requirements.

The Problem Analysis phase of the process culminates in the development of an Experiment Plan. The Experiment Plan drives the development of alternative or "candidate" engineering concepts; a Modeling & Simulation environment that will test and measure the concepts, and generate metrics that can be analyzed and used to make Trade Study Plan. The Trade Study Plan defines methods and tools for producing a cost-performance trade-off study of system alternatives to be simulated in the models. Operations Analysis assesses these results and the metrics generated in the model and develops a Trade Study Report.

Develop Engineering Concepts

The concept development engineers use the Experiment Plan to determine the gap between the current capabilities of the legacy system and the objective system. Next, they identify potential process improvements and candidate technologies that may satisfy the requirements of the "new" system, Methodologies are developed to evaluate and measure the various engineering concept alternatives under consideration. Then they develop alternative engineering concepts for improving the current weapon system or developing a new system (Appendix B; IDEF0 Node A3).

Early identification of key sources of critical information supports flexibility, accuracy, and maturity in all parts of the WARCON process. Identifying the key sources of critical information early on reduces the risk of choosing unproven technologies, and proprietary systems. The engineers often build models to assist in designing the system so that it will allow quick, low cost changes to the system to accommodate different concepts or changes to the system design. After the engineers are satisfied with their options for alternative designs, they provide design data and cost estimates to the Analysis IPT for inclusion in the Experiment and Trade Study Plans.

Build Integrated M&S Environment

The M&S IPT uses the associated technical data to incorporate these alternative designs into the simulated operational environment (Appendix B; IDEF0 Node A4). It is in this environment that analysts and acquisition decision makers consider the operational performance of the alternative designs for the chosen operational scenarios. M&S professionals choose operational models and simulations to optimize reuse of existing models if possible, and to integrate models developed by other organizations. Incomplete knowledge of model capabilities and limitations can significantly affect other aspects of the WARCON process. This is especially important when concept development and M&S activities share the same models.

The M&S IPT tailors the synthetic components for each WARCON problem or alternative technology under consideration. They may include component models and simulations for entities at levels from joint theater-level warfare operations to individual ships and aircraft, or ground combat units down to the individual Marine or soldier.

Key outputs for this part of the process are operational performance measures for each scenario and combinations of platforms, weapons, and systems defined in the Experiment Plan. In addition, an output of this part of the process is a Verification and Validation (V&V) Report that verifies that the models developed during this phase of the process accurately represent system performance and warfare operations for the selected operational environments.

Conduct Experiment

After development of the models and simulations, the WARCON process proceeds to the Experimentation Phase (Appendix B; IDEF0 Node A5). In this phase, the M&S IPT uses outputs of the preceding phases (e.g.; the Experiment Plan, Hypotheses, MOEs/MOPs, and M&S systems) to conduct experiments and excursions for the system under study. The warfighter can play a significant role during this part of the process by "using" the virtual system under study. This portion of the process outputs detailed performance data for use with baseline or comparison systems and each experiment excursion.

Develop Trade Study

The WARCON process culminates in developing and publishing a Trade Study Report (Appendix B; IDEF0 Node A6). This report summarizes project data and presents results of the cost/performance trade-off analysis for each alternative design. The Trade Study gives the acquisition decision-maker an assessment of the TOC of the system and each alternative engineering design. Where appropriate, the Trade Study can recommend to the decision maker the best system from among a group of candidate systems.

In some circumstances, the Trade Study may even recommend that the production or procurement of a candidate system would not be in the best interests of the government based upon a cost-benefit analysis. In other words, the WARCON process allows the decision-maker to decide not to procure a system, or any alternative, based on the data.

WARCON in the Simulation and Modeling in Procurement Process

WARCON exceeds the basics of the simulation and modeling procurement process by enabling the decision-maker to render an informed, metrics-based decision in a short amount of time. The WARCON infrastructure includes IPTs, M&S tools, operations analysis and design methods and models, which the Program Manager can adapt and tailor for each individual acquisition program. Management of the program, and its milestones, are under the direct cognizance of the PM and the Management IPT that the PM establishes.

The key advantage of the WARCON process is the ability to incorporate the warfighter's needs and operations analysis results in decisions regarding the system being procured. The results are defensible because they have integrated the three key

process components: operations analysis, engineering concept design, and M&S. In this way, the new system will be able to meet projected requirements at the lowest cost instead of being obsolete and cost-prohibitive by the time it is introduced to operational forces.

Putting It All Together

An example of how the WARCON process works can be seen in a study performed concerning aircraft carrier weapons handling systems. The current design is based on the Nimitz-class aircraft carrier developed in the late 1960's. The system was designed for standard ballistic ordnance, an air wing consisting of 65 combat aircraft, and an operational requirement to provide continuous flight operations (i.e.; 24-hours per day).

After introduction to the fleet, combat aircraft aboard the Nimitz-class carrier increased to more than 80. This necessitated parking aircraft on areas of the flight deck that covered the weapons elevators, thus rendering the weapons elevators useless for transporting built weapons to the flight deck. Now, most of the ordnance being transferred from the hangar deck to the flight deck must be moved using the aircraft elevators. This slows ordnance movement by requiring it to be coordinated with other aircraft elevator movements.

The current vision for 2010 is an air wing of 50 aircraft armed with joint guided ("smart") weapons. Guided weapons are generally larger than their counterpart ballistic ("dumb") weapons. The current weapons elevators are inadequate to meet the high demand of cyclic flight operations using aircraft armed with physically larger, "smart" weapons.

Using the WARCON process, the analyst defines the problem in several ways. The first considers the newer joint ordnance (J-Weapons) size and adaptations of the weapons magazines. The second considers the number of aircraft available in the 2010 air wing. The next considers the Projected Operational Environment (POE) and how much ordnance needs to be placed on a target set in a given time period.

In this case, the IPT structure of Management, Operations Analysis, Engineering Concept Development, and Systems Engineering/M&S personnel is well suited to meet the requirements of the study. The concept development engineers have a number of technologies available for study. In addition, existing flight deck and hangar deck models can be adapted or new ones developed to represent ordnance-handling operations. The Analysis IPT defines operational scenarios, collects inputs from the warfighter, and defines weapons handling system MOPs and MOEs. Analysts also develop the Experiment and Trade Study Plans.

The concept development engineers survey the available technologies and provide possible alternative concepts. The first is to retain the weapons elevators as currently designed. The second is to make structural changes that place the weapons elevators in different parts of the hull to enable their use on the flight deck during flight operations. Data from the resulting concept designs are given to the M&S group for running within the simulated environment. M&S tools are then produced for performing experiments. During this phase, various aspects of the problem

are assessed and evaluated. Numerous excursions are run and the results are used as inputs to the Trade Study.

The Trade Study adds cost data to the alternative system performance data. In our example, it is determined that the baseline system (i.e.; the elevators remain as originally designed) appears the most cost-effective design for the problem. The cost of relocating the weapons elevators appears to be prohibitive for the existing ship class. However, results of the study will be important in the design and placement of weapons elevators aboard future classes of aircraft carrier.

Using the WARCON methodology, the entire end-to-end process for the weapons handling example takes 6 to 9 months to complete, far less than previous design and acquisition decision-making activities.

Holistic Overview of this Guide

The purpose of this summary is to introduce the Acquisition Manager to the WARCON process and to give the manager a fundamental understanding of how the process can be used to help in the decision-making element of the acquisition process.

Chapter 1 looks at Project Planning. One of the great advantages of the WARCON process over other simulation and modeling procurement processes is the flexibility to tailor the process specifically to meet the requirements of the acquisition program under study. The planning phase establishes the IPT structure; defines and refines the Customer Problem Statement; determines the operations analysis, engineering concept development and systems engineering approaches; and provides the initial Management Plan for the project as a whole. This phase is most critical in that it establishes the specifics of the problem or required decision, tailors the process and defines the resources and time required to produce the Trade Study for the decision-maker.

Chapter 2 provides specific guidance on analyzing the problem. The process includes reviews of existing technologies and models and provides an assessment of their suitability for use in the current project. Technologies and models already in existence often will be sufficient or can be modified to complete the project, thereby reducing the overall cost of the WARCON assessment. Scenarios and functional requirements for the engineering concept development and M&S environment are defined. Experiment and Trade Study Plans are developed and reviewed by the customer.

Chapter 3 is dedicated to assisting the WARCON user in tailoring the engineering concept development and design part of the process for the warfare system being studied for improvement or replacement. It discusses technology assessment and system concept development and assessment processes. Modeling tools to support this activity are also discussed.

Chapter 4 is dedicated to building the integrated M&S environment and production of the V&V Report. The models must be realistic enough to be relevant in the current operational environment and the simulations must be sufficiently rigorous to support the MOPs/MOEs, and yield practical results.

Conducting the experiment, with baseline systems and excursions, is described in Chapter 5. The experiment is conducted using inputs from the warfighter and the major participants (i.e.; design engineers, modelers, and analysts) are involved.

A complete analysis of the results is compiled and published for use in developing the Trade Study Report, which is discussed in Chapter 6. The Trade Study provides the cost-benefit analysis and may make recommendations to the Program Manager regarding what systems/equipments to buy or not buy. Explanations of TOC and design alternative costs are included in this section.

Chapter 7 discusses the Collaborative Engineering Environment (CEE), a powerful management tool. The CEE provides the methodology for virtual project management. Any number of participants may participate in the WARCON process. The CEE allows the Program Manager to manage the program regardless of anyone's physical location. Tools, texts, and data can reside within the CEE; this makes program management simpler and more cost effective. The CEE can reduce the requirements for face-to-face meetings, thus reducing travel funds expenditure, and can render up-to-date information on tasking and project status to members of the WARCON team.

Summary

The WARCON process is a powerful decision-support tool, which provides for project management, rigorous determination of cost and performance, and rapid response to the inevitable "what if" questions inherent in the procurement environment. In the era of having to buy more systems for less money, managers are being required to justify every decision they make.

WARCON is a tool that enables the Program Manager to answer the barrage of questions that come from those who control the money while simultaneously providing the warfighter the most sophisticated systems for use on the battlefield.

Given the current threat environment, rapid fielding of improved systems helps the United States maintain technical superiority over her adversaries.

Chapter 1 — Project Planning

"... [P]lanning is the process of determining what needs to be accomplished, by whom, when, and under what resource constraints. It is arguably the most important of the program management functions."[1]

WARCON and IDEF0

Initially developed by the U.S. Air Force in the 1970s and 1980s, Integration Definition for Function Modeling (IDEF0) techniques are widely used in government and commercial sectors to support modeling efforts.

"IDEF0 models provide a 'blueprint' of functions and their interfaces that must be captured and understood in order to make systems engineering decisions that are logical, affordable, integratable and achievable."[2]

The WARCON process uses IDEF0 techniques to provide flexibility for analysis support to acquisition decision makers. WARCON allows the customer, through operations analysis and a collection of models and simulations, to examine multiple technological options before committing resources to unproven design concepts.

Coordinating activities among organizations and tailoring the WARCON process to support simulation and modeling based analysis of a specific Customer Problem Statement are the critical first steps in applying the WARCON process.

The distributive nature of the WARCON process requires capturing the functions and processes of the various IPTs in a single, coherent picture. The IDEF0 proved to one successful method. However, functional flow diagrams, assuming they depict similar tasks and guidelines, may also engender a satisfactory organization and execution.

Defining the Problem

WARCON IDEF0 diagrams provide a basic tool for tailoring and managing the WARCON process. DoD does not envision a "cookie cutter" approach to weapons procurement. Each customer problem presents unique decision requirements:

"There is no one best way to structure an acquisition program so that it accomplishes the objectives of the Defense Acquisition System. Decision-makers and program managers shall tailor acquisition strategies to fit the particular conditions of an individual program, consistent with common sense, sound business management practice, applicable laws and regulations, and the time-sensitive nature of the user's requirement."[3]

[1] William W. Bahnmaier, Ed., *DSMC -Scheduling Guide for Program Managers*, Defense Management College Press, Ft. Belvoir, VA, Oct 2001

[2] Announcing *the Standard for Integration Definition for Function Modeling [IDEF0]*, Draft Federal Information Processing Standards Publication 183, Department of Commerce, National Institutes of Standards and Technology, Gaithersburg, MD, 21 December 1993

[3] DODINST 5000.1; The Defense Acquisition System (Incorporating Change 1, January 4, 2001); 23 October 2000

The first step in developing a WARCON Project Management Plan (PMP) is to define and refine the warfighter requirements from the Customer Problem Statement (i.e., "What question does the customer really want answered?"). Questions become more clearly articulated problem statements, limiting the project scope. Second, develop and list planning assumptions, examine resource costs, and identify affected functional areas. Often there is only one problem or issue under consideration. However, there are times when a customer has a number of problems or issues related to the acquisition decision. In these cases, a review of the available resources (e.g., personnel, tools, funding) is necessary and those resources balanced against the problems.

For example, if a customer has 12 unrelated systems requiring upgrade or replacement and the funding level for the WARCON process is only $2 million for the fiscal year, the PM must determine how much of the process can be accomplished given these constraints. Since model development traditionally requires a significant fiscal outlay, the realistic answer may be to scale back the process to accomplish all process steps leading to model development.

New concepts can bring paradigm changes that depart from currently accepted practices. The process requires considering ideas in an unconstrained environment, which leads to defining working hypotheses. It is important all participants remain open-minded and resist accepting or rejecting initial ideas or hypotheses early in the process. Participants need to remember that just because something is being investigated, does not imply it is being advocated.

Defining the problem shapes the entire WARCON process. Providing the PMP to the WARCON team early in the process focuses the IPTs and various corporate and government entities on the warfighter's problem, and the measurements used to assess the possible solutions. The teams, with delineated lines of responsibility knowledge of milestones, remain free to coordinate their activities and, if necessary, forward potential conflicts to the Management IPT for early interventions and solutions.

Tailoring the WARCON Process

A clear understanding of the customer problem is required to tailor the WARCON process effectively. The Analysis IPT leads the tailoring effort, but all members of the Management IPT must participate. This guide is one resource for tailoring the process. Other resources include lessons learned and publications from previous WARCON projects, and professional papers and presentations made by WARCON practitioners. As other programs employ the WARCON process, a central repository for WARCON results would be beneficial.

What factors should direct the tailoring process? Clearly, the time and resources available for the project are limiting factors. Other factors may include:

- If the problem's focus is related to systems improvements, process improvements, or both

- The anticipated availability of existing technologies for system improvements that will assist in determining if concept development will focus on designing new systems or assessing existing Commercial off the Shelf (COTS) or Government off the Shelf (GOTS) technologies
- Availability of knowledge and data on the existing system or process for studying the baseline
- The anticipated availability of models that can be federated with reasonable changes, or whether extensive new model development will be required
- The anticipated availability of data to support determination of total ownership costs for alternative solutions
- Whether experiments are anticipated to include participation of warfighters or other users as part of the experiment design
- The anticipated degree to which the customer is expected to be an active participant in the process
- The anticipated relative amount of time and resources required for each major part of the WARCON process.

IPT Functions and Project Planning

The WARCON PM defines the organizational structure. Since the key WARCON functions are Operations Analysis, Engineering Concept Development, and Systems Engineering, it makes sense to identify IPTs and group leads for each function. Management IPT membership usually includes the PM and the Group Leads. The Management IPT tailors the process for each customer problem, develops the Project Management Plan (PMP), and generally directs and oversees the entire project. The Management IPT uses the PMP to address configuration management practices (including adjudication of issues) for all project documents.

The PM charges the Analysis IPT with formalizing the Customer Problem Statement and identifying an overall approach for applying the WARCON process. The Analysis IPT then makes recommendations for tailoring the WARCON process to integrate operations analysis, concept development, and M&S to assess performance and TOC of future systems or system improvements for use in the Trade Study. The Analysis IPT submits these recommendations and a draft Trade Study Plan, evaluating potential solutions to the customer's problem, to the Management IPT for approval.

The Engineering Concept Development IPT does a first look at new concepts and technologies for system improvement during the Project Planning phase of WARCON. They determine whether system solutions are available using off the shelf sources, or develop new systems and concepts to address potential solutions to the customer problem.

The Systems Engineering Group then uses this assessment to select or develop the M&S tools. Examples of decisions that this Group must resolve for WARCON participants include whether models will be self contained at a single location on a Local Area Network (LAN) or geographically

distributed at multiple locations over a Wide Area Network (WAN). Occasionally, M&S tools may include the end users' participation.

The Management IPT authorizes the federation architecture and overview of models and simulation to be used to support the analysis. Simulations must provide useable information to the customer and satisfy validation requirements. Not every purchase or new product requires a significant investment in M&S and analysis. Maximum reuse of existing models is a key part of the WARCON process.

It is often possible to modify an existing model for application to a new WARCON problem. As part of the M&S approach, existing M&S standards are used where practical. Properly applied, M&S standards reduce cost by providing approved solutions to common problems. Examples of such standards encompass authoritative algorithms and models; interoperability standards for simulations, command and control systems, and data interchange standards.[4]

For example, a decision to upgrade to a different desktop computer for routine administrative requirements should not require an extensive M&S program with a detailed action list and assigned responsibilities. However, deciding on a cockpit upgrade for an F/A-18 would lend itself to extensive experimentation and analysis. WARCON works best for complex acquisition projects that require significant technological investments.

Successfully applying the WARCON process requires integrated planning and coordination among government, engineers, M&S, and analysis organizations. Models and Simulations that support an acquisition decision must represent capabilities ranging from concept design and technology assessment to operational effectiveness.

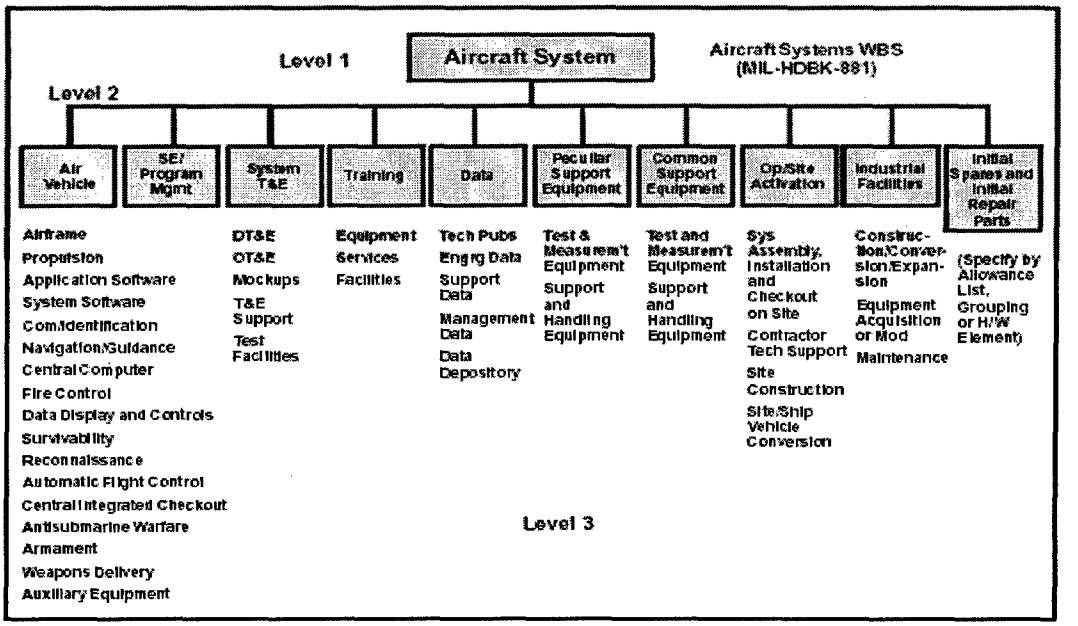
Armed with an understanding of operations analysis, concept engineering, and systems engineering components of the tailored WARCON process, the PM can develop a project Work Breakdown Structure (WBS). The WBS provides a coordinated and comprehensive view of tasks required to complete the process. It links products to financial and technical resources. It is oriented to a particular product and can be detailed to any level of interest.[5] Figure 2 is a sample WBS.

On any given WARCON project, it is likely that the major IPTs/Groups will be working simultaneously. Cooperation and coordination among teams and individuals exercising functional responsibility is paramount.

The Plan of Action and Milestones (POA&M) is a crucial management tool that ensures the integrated WARCON process is on track from cost, schedule, and performance viewpoints. It details the steps required to meet deliverables, on time and on budget and provides sufficient lead-time to account for coordinating inputs and submissions from the various groups.

[4] DoD 5000.2-R; Mandatory procedures for Major Defense Acquisition Programs (MDAPS) and Major Automated Information Systems (MAIS), 10 June 2001

[5] MIL-HDBK-881B of 02 January 1998



Source: *Systems Engineering Fundamentals*, Defense Systems Management College Press, Fort Belvoir, VA, December 1999, U.S. Government Printing Office, Washington, D.C.

Figure 2. Sample Work Breakdown Structure

Effective scheduling supports the following key management activities:[6]

- Provides the basis for communications within the government team and with contractors
- Identifies a baseline for program status monitoring, reporting, and program control
- Facilitates management
- Establishes a foundation for resource analysis, alternatives exploration, and trade-off studies

The Groups need to work in conjunction with each other, yet autonomously identify and resolve issues and make independent decisions within their areas of responsibility. Depending on the issue complexity, the Group's size, and the members' personalities, a team may require several months to reach optimal effectiveness.

The PM must create a structure to facilitate these interactions; not only among Groups, but also among matrix organizations supporting the WARCON process. The PM must build the flexibility to allow the various teams to meet POA&M plateaus but still account for program activity and funding.

Project Management Plan

Though additional coordination remains, the POA&M assigns responsibility and provides a scheduling framework. The PM, after resolving initial organizational issues, examines the resources available for the project. This input provides the Management Group the necessary information to formulate the Project Execution Plan, and then disseminate it to the WARCON partners.

[6] William W. Bahnmaier

This internal document contains the data needed for realistic cost and delivery estimates. After the customer accepts the cost, the Management IPT agrees upon the Project Management Plan (PMP). This provides overarching guidance to the remaining phases of the WARCON process.

Summary

The Project Management Plan provides the requisite guidance to the WARCON teams. In addition to a scheduling POA&M, this document, accepted by all participants and the customer, establishes organizational responsibility, realistic delivery and cost schedules, and the key analysis approach and M&S architecture. It also provides the flexibility to continue to fine-tune the tailored WARCON process.

Chapter 2 — Analyze Problem

Operations Analysis plays a critical role in the WARCON process. The WARCON process uses analysis linked to M&S to reduce the time, resources, and risks associated with systems acquisition while also increasing quality. Virtual prototypes in a synthetic environment allow assessment of future systems through various stages of the development process.

The Project Planning process includes development of the general problem statement and analysis approach in order to tailor the WARCON process, plan resources, and develop a Project Management Plan. Now the problem statement and approach must be defined in detail so that experimental hypotheses, performance measures, and Experiment and Trade Study Plans can be developed (Appendix B; IDEF0 Node A2).

Refine the Requirements in Detail

A successful acquisition program, whether designed to counter new threats or replace obsolete systems, must deliver supportable and capable systems to the warfighter.

Given this background, The Analysis IPT proceeds to the first step in the decision-support process – a functional analysis of existing systems and warfare processes as they relate to mission and other customer desires. The objective of such an analysis is to define the requirements a new or upgraded system must satisfy to address the Customer's Problem Statement. The WARCON analysis process links the National Military Strategy Document (NMSD), the current Defense Planning Guidance (DPG) and other formal requirements to the warfighter's operational needs.

Analytic definition of the customer problem occurs during Project Planning. For example, if the customer tasked WARCON to find out if an aircraft carrier air wing could service a given number of targets in 24 hours, analysts might redefine this problem as *"Determine the conditions under which a set number of targets could be serviced in 24 hours."* This represents an ideal issue for the WARCON process: it is complex and amenable to technological solutions and warfare process improvements.

The problem statement however needs significantly more detail before beginning a functional analysis. Analysts must first identify conditions that are important, such as air wing composition and weapons load, target type and distribution, scenario, environmental conditions and threats. In doing so, the analysts place the issue under study in an operational context.

Experimental hypotheses are derived from a combination of the detailed problem statement and the high-level solution set of concepts developed during Project Planning. A hypothesis describes a set of facts that can be tested by experimentation in an "if...then" formulation. They define combinations of conditions to be examined during experimentation.

Each experiment should test one or more hypotheses that relate directly to the Customer Problem Statement. In WARCON experiments, hypotheses are framed in terms of impacts on operational effectiveness.

Hypotheses may examine alternative design or warfare concepts using a variety of assumptions, constants, limitations, and conditions. In order to test the hypotheses, build an integrated M&S environment, and plan for information extraction, the Systems Engineering Group must know the data creation and collection needs. These requirements are discussed in the following section.

Define M&S System Functional Requirements

When presented an acquisition decision for a system that is open to a technical solution, analysts and systems engineers must first study the problem to determine whether an appropriate M&S environment already exists. If not, they need to decide if appropriate M&S tools could be designed. The WARCON Systems Engineer selects or builds models based on the M&S system functional requirements defined by the Analysis Group (Appendix B; IDEF0 Node A2.2).

The Customer Problem Statement and detailed problem definition are the basis for M&S functional requirements. They are unconstrained by M&S availability or design limitations of future systems. They include M&S capabilities needed to address various aspects of the customer problem. Functional requirements may include detailed warfare process models, technical characteristics of future aircraft or ships, system engineering data, or detailed scenario and virtual warfare concepts and operations simulations.

As functional requirements evolve, changes require rigorous management and clear documentation. They should be easily accessible to all participants and tracked in an electronic database. Numerous commercial tools exist to facilitate this process. Program management should investigate these tools and plan for them in the program budget.

Meeting all of these M&S functional requirements may not be possible within the available WARCON project resources. In addition, some M&S technical requirements may be unavailable or pose significant risk to project completion.

The Problem Definition, Scenario, and M&S Systems Requirements Document lay out the unconstrained requirements for assessment by systems engineers and concept development engineers for feasibility within project constraints. These constraints must be factored into the M&S system functional requirements before the Experiment and Trade Study Plans can be drafted. Soliciting inputs from Subject Matter Experts (SMEs) provides another method of determining weapon system functional requirements.

Management must convey the customer's objective for the project and the constraints contained in the problem statement to SMEs. The SME's role requires clear definition to ensure proper use of this asset and to schedule the SME's presence (if required) during the experiment phase. Experience proves early SME participation

and frequent SME consultation returns favorable results as the WARCON proceeds through its natural steps.

Experiment Assumptions and Limitations

A balanced analysis includes clearly defined assumptions and limitations. Without stipulating these details, analysis results lose valid references and contexts for the decision maker. In other words, assumptions and limitations provide a context for interpreting experimental results. For example, in determining if a new weapon system will meet targeting expectations, the analyst must consider assumptions made such as; expected adversary defenses, the distance the weapon must travel from the launch platform to the target, and external support (e.g., aircraft tanking or logistics).

A model's credibility for use depends upon the relevance of specific factors. Therefore, analysts' reports must explicitly identify operational and engineering assumptions. These assumptions provide the starting point for any analysis project. The WARCON process analysts must also address an experiment's limitations. For example, models may be limited in their ability to change weather or lighting conditions. Other limitations may include incomplete technical data regarding the studied system (e.g., fuel capacity). Some of these limitations may affect the value of the data derived from conducting the experiment.

Modeling software contains inherent limitations clearly identifiable by the developer/programmer. Other external factors may limit an experiment's fidelity (e.g., the need to keep the results unclassified). In other words, limitations exist in models and simulations. Effective decisions require full cognizance of these limitations. At a minimum, the experiment should realistically represent valid doctrine and specifically address each aspect of the Customer Problem Statement.

Experiment Plans

The Experiment Plan (Appendix B; IDEF0 Node A2.3.2) includes explicit procedures for conducting the WARCON experiment. An experiment's effectiveness is bounded by realism within previously identified constraints. The Analysis Group cannot design an experiment until it receives High Level Design (HLD) input from the Systems Engineering Group and preliminary descriptions of concepts or systems to be assessed. The HLD and Alternative Concept Descriptions present the information analysts need to make workable Experiment and Trade Study Plans from the unconstrained requirements of the Problem Definition, Scenario, and M&S Systems Requirements Document.

Analysis requires a thorough review of cause-and-effect relationships among a series of variables. An experiment plan allows the Analysis Group to trace changing variables to differing results. Controlling variables offers the additional flexibility of post-scenario analysis to determine resource limitations that may require adjustments from current practices. When the customer proposes a solution possibly open to an industrial/technical solution, the Analysis Group needs to determine the state of current and projected technologies.

An assembly of analysts and design engineers collaborate to form the Knowledge Acquisition/Engineering (KA/E) Group. This group will complete a Technology Survey to define the baseline conditions used in the experiment, provide baseline and comparison data, and assist the analysts in determining whether current procedures and systems fulfill the needs identified by the warfighter.

The KA/E group also determines if the necessary technology will be available in time for insertion into the acquisition decision-support process. If not, the KA/E develops a logic tree that demonstrates the necessary excursions, technology trials, and outcomes sought when developing the new technology. The Analysis Group clearly identifies data extraction and collection requirements in the Experiment Plan. Planned excursions to an experiment provide a means for correlating results to engineering design changes. The Experiment Plan also lists the models and capabilities likely required for an experiment's simulations.

In addition to data extraction and collection requirements, an experiment's critical outputs include MOPs and MOEs. The MOPs can be derived from or roll up to MOEs. For example, an MOE for a fuel-efficient vehicle may be an ability to drive, fully loaded, from Washington, DC to Tampa, FL on one tank of fuel. One MOP may be that the vehicle range must be at least 1,000 miles.

Initial experiment excursions must be defined for each set of experiment runs designed to investigate a single variable or question. The Draft Experiment Plan defines the objectives, hypotheses, scenarios, MOPs/MOEs, analysis methods, data extraction and collection requirements and methods, and procedures for conducting the WARCON project experiment.

Running a baseline experiment, based upon current configurations, will yield anticipated (i.e., "real-world") output data. When dissimilar results appear, possible causes include incorrect calibration or inaccurate assumptions. The baseline also provides a starting point for MOPs and MOEs. MOPs and MOEs provide the quantitative measures that characterize operational performance and effectiveness for the modeled excursions and scenario. The MOPs and MOEs are defined in the Draft Experiment Plan, prior to conducting the experiment, to identify data extraction points. These measures also determine if feedback from any individual excursion will change follow-on tests.

Engineering-level models indicate performance capabilities, or MOPs. MOPs characterize physical or functional attributes relating to execution of the mission or function. In other words, an MOP provides an indicator of achievement, such as radar acquisition range, or time to move aircraft from the hangar deck to the flight deck. These parameters may be used in system design specifications.

Each MOP should focus on meeting the customer's needs. They quantify a technical or performance requirement directly derived from the MOE. Therefore, the compilation of MOPs determines the MOE. An MOE is an output from mission and/or battle level models and simulations, and is an indicator of how well the system performed the customer's mission.

The WARCON process is most effective when measuring outcomes using a variety of repeatable scenarios. These "excursions" use the same scenario (save for the variables being examined in the excursion) to provide comparable data. These may include Order of Battle, warfare operations, and periods. Modeling scenarios may run at various speeds (e.g., faster-than-real-time) as long as the model's run speed does not adversely affect the human element's ability to react to the state of the system and adequately assess the information.

If supported by the M&S environment, the results obtained from running the baseline model of the legacy system in the simulation model early in the process, can provide useful information for the concept development process. These baseline model runs can also support validation of newly developed modeling environments. It is the Management IPT's responsibility to determine early in the process whether there are sufficient resources available to perform baseline runs of the legacy system in the same M&S environment that will be used to conduct the experiment.

The WARCON Analysis Group determines what data are required and when that data are to be collected during the experiment. This could be in the form of questionnaires, after-action reports, or running data-extraction tapes through another simulation. Detailed data extraction protocols ensure common responses and minimize variations between subjects and reviewers. Information obtained during the experiment should support MOP and MOE evaluations as well as serve the baseline/comparison and excursion cases.

In many M&S systems, the After Action Review System (AARS) can archive predetermined computations for later analysis. This system can identify the situations and excursions in order to determine an MOP. Human, equipment, tactical, geographic, and equipment variables may be recorded and compared for later analysis.

Once the Analysis Group identifies data extraction requirements for the Integrated M&S System, the excursions used throughout the experiment should cause an adjustment to the variables to prove (or disprove) the hypothesis and to determine MOPs based upon changing inputs.

Now, the Analysis Group should choose comparison methods, develop and quantify the criteria for comparison, and determine appropriate weighting factors. The appropriate models and methods dictate the objectivity and repeatability of the experiment.

Trade Study Plans

Trade studies identify desirable and practical alternatives among requirements.[7] Technical objectives, design, program schedule, functional and performance requirements, and life cycle costs are identified and conducted. Chapter 7 discusses the final WARCON Trade Study in detail.

The Trade Study supports comparison of alternative design options through a visual depiction of relevant operational performance and cost metrics in a top-level format

[7] *Systems Engineering Fundamentals*, Defense Systems Management College Press, Fort Belvoir, VA, December 1999, U.S. Government Printing Office, Washington, D.C.

that can be decomposed to show underlying detail. The visual depictions represent the "trade space region" (shown in Figure 3) with the objective and baseline requirement values for the various MOPs and MOEs.

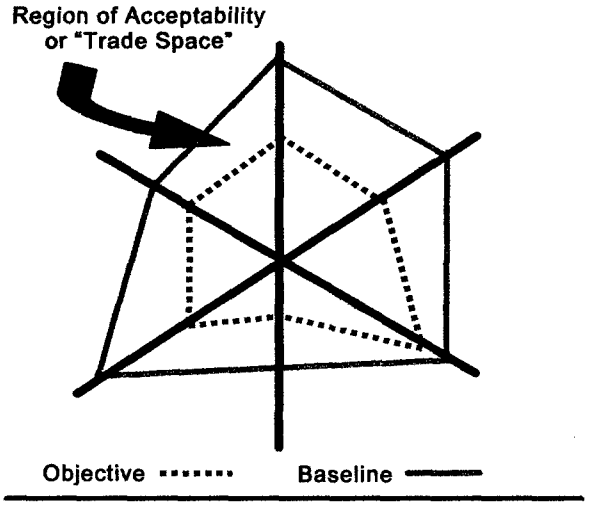


Figure 3. Example of Trade Space Region

The WARCON process needs to manage the documents, people, organizations, products, and data to provide a logical transition of information from the M&S domain to the production facility. Trade Study plans provide information on how to present experiment results to a decision maker. They include discussions of the selection criteria and methods for calculating TOC.

Analysts require tools to perform detailed trade-off analysis of alternate system designs and solutions. Opting for alternative solutions requires postulations of all potential ways of solving the customer problem and selecting those that appear viable. Trade-off relationships should be relevant and rational. Evaluating the alternatives forms the heart of the analysis portion of the Trade Study.

The analysts may review and/or revise the methodology if minor modifications in input data affect the solution. The analyst does not make recommendations. Rather the tools and the Trade Study provide a range of options upon which the warfighter makes a decision. Relevant and validated databases support evaluation decisions.

Customer Review

Before proceeding, the Analysis Group provides the Draft Experiment Plan and Draft Trade Study Plan to the customer for review. This ensures that the plans correctly reflect the customer problem statement. Problem statement complexity, coupled with the M&S assumptions and analysis definitions, may change from initial task to experiment execution. Changes must be accounted for before moving to the experimentation phase (Appendix B; IDEF0 Node A5).

Conclusion

After the customer completes the review of the drafts, the Analysis IPT can promulgate the final Experiment Plan and Trade Study Plan. The former is forwarded to the Engineering Concept Development and M&S teams to build the models and incorporate appropriate data extraction points. The focus of the Experiment Plan is on measuring performance of future system alternatives. In addition, the Experiment Plan identifies resources, objectives, analysis methods and input data requirements.

The Trade Study Plan summarizes project data requirements, with a focus on TOC data, and presents methods for producing the performance-cost trade-off analyses for each option assessed using the model.

Chapter 3 — Develop Engineering Concepts

Analysis performed in IDEF0 Nodes A1 and A2 (Appendix B) refined the Customer Problem Statement and analysis approach. This chapter discusses IDEF0 Node A3 (Appendix B), the development of engineering concepts and associated costs.

In this step of the WARCON process, engineers must identify and develop alternative systems and/or concepts to meet warfighter requirements, and propose engineering solutions to the Customer Problem Statement.

Engineering concepts determine the physical characteristics and associated TOC for each of the proposed concept systems. Detailed design data support modeling of potential solutions in the Integrated M&S Environment. The Trade study uses TOC data derived for each system alternative.

Using the Project Management Plan and the resources available to the design activity, Engineers develop a body of coherent and complimentary system requirements. These engineering-level functional requirements are then transitioned into physical requirements for designs that can be used to produce material entities that can be priced. Engineering-level models often are used to provide estimates for both material and non-material costs.

TOC includes acquisition costs, Operation and Support (O&S) costs for the life of the system and disposal costs at the end of the system's lifetime. O&S costs include operations, maintenance, labor, and other direct system support costs.

Determining the Capabilities Gap

The problem operationally defined by the Analysis Group is analyzed in engineering terms. This redefinition involves establishing engineering capabilities of the baseline system; positing an ideal or objective system that serves as a goal to achieve; quantifying the difference between the baseline capabilities and objective (called the capability gap); and finally, deriving a set of quantified engineering level requirements to meet ideal or objective system capabilities.

Determining the capability gap (Appendix B; IDEF0 Node A3.1) for the future system begins with the Problem Definition, Scenario and Functional Requirements provided by the Analysis Group. SMEs determine the general operation for IPTs to examine in engineering terms. SMEs, with first-hand experience and knowledge of the subject system and its operation, identify the individual activities involved. Depending on the problem, key attributes of each activity (e.g., time to execute, workload required, equipment used, facilities required, etc.) are established. If SMEs are not readily available, conduct data acquisition by observation of operations as they take place in the field.

Not all SMEs derive the same conclusions to solve a given customer problem. The PMP should establish a formal process to ensure resolution of conflicts among SME inputs and consistency of SME inputs among IPTs.

SMEs provide a significant input to the developing an Engineering Process Map. This map is an engineering level flowchart, detailing the activities and events involved with the operation under study. The map presents a functional baseline that determines the limits of the existing system (e.g., how fast, how much, with what workload, etc.).

Concurrently, Substance-Field Diagrams are developed. These diagrams provide an object-oriented view of the system under study. These diagrams are useful in finding and selecting technology options that may improve the system. Process Maps and Subject Field Diagrams define present baseline limitations in capabilities. Stating these limitations in terms of conflicting system characteristics defines System "Bottlenecks."

SMEs, engineers, and analysts expound upon a series of "what if" investigations to move the query beyond the current system and its limitations. "If I could remove a limit that is keeping me from achieving greater capability, what greater capability should I achieve before I come upon the next limitation"? All involved should remember that investigation of a concept is not an endorsement of that concept. Conflicts among SMEs and concept development personnel generally result from reluctance to accept concepts that lead to paradigm shifts.

The Desired Functional Capabilities delineates the functional capabilities that the engineers must address. Differences between baseline capabilities and the desired functional characteristics of the objective system can now be determined using quantitative metrics. Desired values of the metrics are compared to baseline quantities (using ratios) to establish quantitative criteria for concept acceptability. A Gap Measures Report provides the documentation for this effort.

Identifying Potential Innovation Concepts

Conflicts between current and objective capabilities are resolved by making associations with alternative solutions (Appendix B; IDEF0 Node A3.2). Before this can take place, technology information is mined from industry and DoD sources, and deposited into a Research and Development (R&D) roadmap for the project. Tools and techniques are available to bring the technology search out of the simple "brainstorming" mode and into a more disciplined realm. Technologies in the R&D database are grouped and organized into a classification system analogous to the functional requirements. Similar categorizations for requirements and technologies facilitate associations between the two sets of data.

Technological solutions in the R&D Database are rated for their completeness, feasibility, and relevance. Their prospect for becoming part of a real system is estimated. This effort supports the eventual estimate of risk of a Concept System in the final decision analysis.

Technology mining and requirements development proceed independently of one another. One may precede the other, or both may be conducted concurrently. Thus, it is desirable to devise a categorization scheme before either activity starts to assure compatibility.

Selecting Alternative Engineering Concepts

Technologies in the R&D Database are sources of potential solutions for meeting engineering requirements for the future improved system (Appendix B; IDEF0 Node A3.3). Technologies are coupled to requirements in a Technologies-to-Requirements Matrix colloquially known as the "Concept Box" (shown in Table 1). Candidate technologies that fulfill a requirement are so marked in the matrix.

Table 1. Example Technologies-to-Requirements Matrix

Concept Box	New Elevator technologies	Use of Unobtainium alloys	New accounting practices	Human Amplification
Elevator Speed shall be 3x faster.	✓			
Assembly costs shall be less.		✓	✓	
Reliability shall be much greater.	✓	✓		
Ship fitters lift more than Arnold S.				✓
The weight shall be reduced		✓		

The linked requirements and technologies form a body of valid specifications and associated relevant technologies. The technologies that best satisfy the requirements can now be selected.

The selected technologies form constituents of a concept system. The Concept System architecture develops as the constituents integrate into one cohesive idea. The engineer uses experience and prudent engineering practice to bring the disparate individual technologies together. An Initial Concept Schematic represents the fundamental architecture of the Concept System.

It is desirable to conceive of at least three Concept System alternatives to support later decision-making. Defining these alternatives presents options involving greater and lesser variants about the focal concept. A Parameter Design phase is entered after determining a Concept System's architecture in which system variables are balanced with one another to achieve a "best" solution. Parameter design quantifies what the Concept System architecture qualifies.

Complex engineering projects demand specialized knowledge from a variety of disciplines. Specialists come together to exchange information and negotiate agreements. This "Engineering Environment" includes a system of individual rights, protocols, and institutional relationships for disciplined business conduct.

A "Concept Investigation Environment (CIE)" facilitates communications between disparate parties. Initially in a CIE, engineers working for distinct organizations act in coordination by bringing their collective expertise to bear on the evolving Concept System.

The Concept Engineers develop calculation routines (i.e., models) for calculating the significant characteristics of the Concept System for the component of which they are cognizant. Types of models that may be developed include:

- SME Input models
- Vendor Input models
- System Characteristics Calculations
- Acquisition Cost Estimators
- Reliability Estimators
- Performance Estimators
- Life Cycle Cost Estimators
- Staffing Estimators

The models are subsequently linked together in a manner determined by the Engineering Concept Development IPT, but firmly managed by a project leader. A Concept Investigation Environment application is the software that brings together the respective applications upon which the models reside.

Details of the links are elaborated through the CIE. Interfaces are precisely documented. This is constructed to protect any proprietary knowledge that exists between models.

Engineering and cost models may be developed at different geographic locations. It is highly desirable to be able to integrate the models remotely. Integrating models over a WAN dictates some requirements. Strict requirements exist for transmitting information that is sensitive but unclassified. With data flowing over public networks such as phone lines or the internet, a Federal Information Processing Standard (FIPS140-1) certified encryption device is required to handle sensitive but unclassified data. A Virtual Private Network (VPN) may be needed to satisfy the requisite security requirements.

Handling classified data poses still more requirements. Government supplied encryption devices will be necessary. Government entities must also ensure that networked sites meet minimum requirements, and the networks must be regularly inspected. Mechanisms such as Secret Defense Research and Engineering Network (SDREN) and Secret Internet Protocol Router Network (SIPRNET) are available to transmit government-classified data.

Once brought together, the CIE is exercised as individual design parameters are varied and a balance between them is found to arrive at a "best solution." After the final Concept System solution is determined, the CIE provides some persistent data that allows the work to be reviewed, or expanded upon by others in the future.

The primary output of this CIE effort should be the significant physical characteristics necessary for developing dynamic models and simulations, as well as rough order-of-magnitude material scopes for cost and staffing estimates.

The intent here is not actually to design a working system, but only develop a system concept to the extent necessary so that the requisite data may be obtained.

Developing Engineering Alternative Concepts

Concept System data developed by the engineering effort is brought into a cohesive package for promulgation to M&S and Trade Study functions in the WARCON process (Appendix B; IDEF0 Node A3.4). A Concept Engineering Package is devel-

oped for each Concept System alternative developed by the engineering effort. This package presents the Engineering Data for Alternative Designs.

The package consists of:

- A Concept Schematic
- Software design documents
- A Material List
- Final Engineering Process Maps
- A System Description
- A Concept System Specification
- Concept prospects for realization

Cost Data for each alternative system is presented in a separate document. Truth in negotiation requirements often restrict release of cost information. Common practice is for cost data that could be used in price negotiation to be produced and held only by the entity authorized to negotiate costs. This is seldom the engineer. Engineers usually deal with only relative costs to conduct comparative studies.

Handling of such cost information by unauthorized sources can cause complicity in establishing sound costs, possibly giving rise to litigation.

Cost information that may support, or may be construed to support, negotiations is usually provided only when specifically required by contract. These issues are addressed by the PM and customer during Project Planning.

Engineering Data for Alternative System Designs, and the Cost Data for Alternative Systems, are provided to the Analysis Group for use in the next process phases of M&S, Experimentation, and finally Trade Study analysis.

Chapter 4 — Build Integrated M&S Environment

Using an Integrated M&S Environment for assessing performance of alternate system designs is an essential element of the WARCON process. Building an M&S Environment includes planning, designing, implementing, and testing the federation of models and simulations to meet requirements established in the Experiment Plan.

Planning the Modeling and Simulation Environment

The Experiment Plan places a number of functional requirements on the M&S environment:

- Experiment objectives to be satisfied
- Data extraction and collection requirements
- Scenarios to be developed and examined
- Explicit guidelines defining how the experiment will be run
- The Integrated M&S Environment must incorporate models of alternative designs.

It is likely that available models can satisfy many of these requirements. Still more may be attainable by modification of existing codes. Maximizing reuse of existing models is a significant factor in reducing the cost of applying the WARCON process when using models and simulations to facilitate a procurement decision. The System Requirements Document (SRD) codifies requirements for the integrated system. This document may include engineering design, software development, warfare operations, and cost models and simulations required for in designing and building the M&S Environment.

Engineering models can become quite complex. In a distributed engineering environment having multiple entities wishing to maintain propriety over their procedures and data, a centralized hub administered by one entity may not be acceptable. Phoenix Model Center works through a centralized hub, and does not facilitate peer-to-peer security.

Alternatives such as those offered by Technosoft® may overcome this issue; they are currently being explored by the WARCON Management IPT.

Technosoft® links KA/E and development of business rules into a software package. These efforts may overcome proprietary concerns, offer peer-to-peer security, and exponentially increase the speed at which these occur.

Generating a qualitative definition of the concept may require significant time. The issues involved may be arrangement specific and involve the basic architecture of the concept.

Designing the Modeling and Simulation Environment

A System Subsystem Specification (SSS) database identifies the hardware and software specifications and requirements to design the system as derived from the SRD.

Analysis of the design information (concept, description, and cost) for each alternative subject system determines its acceptability. To obtain accreditation for their intended purpose the model, simulation, or federation of models must meet a set of established standards.

When mapping System Requirements Specification, the overriding constraints are; (1) the design derives from "real world" capabilities, (2) the model meets all requirements, and (3) it provides for traceability during system design, implementation, and testing. A key to creating accurate models is identifying model constraints early in the development phase. It is important to establish a standard, formal method of capturing and communicating engineering/SME data among IPTs. This process is fundamentally iterative in nature.

Continuing the process leads to creation of a High Level Design (HLD) which describes the major components and how they fit together in the M&S environment. A design can afford certain capabilities while curtailing others, so it is important to understand the system's rough design in order to gain better understanding of what is feasible for the system to simulate. The M&S IPT provides preliminary HLD information to the Analysis IPT during development of the Experiment Plan to ensure model can generate data within resource and technological constraints during the project timeline.

Further decomposition of the HLD produces the Detailed Design Document. This document details what codes need to be written or modified, and how for the software developers working on the M&S environment.

The System Test Document details how to test the created or modified codes to ensure that they adhere to the detailed design, and it details testing criteria for the environment as a whole. This part of the testing procedure ensures that the system meets the requirements in the SRD.

Implementing and Testing the Modeling and Simulation Environment

Guided by the Detailed Design document, software engineers produce the vision of the design effort. As with design, there are many styles of implementation, and here the only constant is that the implementation satisfies the test plan.

Two types of testing take place in this phase: unit testing and system testing. Unit testing consists of ensuring that the design has been properly implemented. Every component that has been created or modified is tested to be sure it does exactly what it is supposed to do. If a code performs computations, the computations are verified. If a code is supposed to produce output in a certain manner, the output is scrutinized for format errors.

System testing ensures the system as a whole is functioning as expected. Systems of codes often have many subtle interactions. Unforeseen side effects may appear when systems are modified. This suite of tests is designed to illuminate any of these unforeseen effects before the experiments begin.

A design perfectly implemented does not always achieve what the design intended. The system test will test the M&S environment against the System Requirements Document, to ensure that the M&S environment performs as required.

After this activity is completed, several key elements are in place:

- A tested M&S environment that meets WARCON experimentation needs
- An M&S Inventory of codes that can be used in future modeling and simulation endeavors
- Clear instructions on how to use the environment in the proposed experiment
- Validation and Verification Report, which lends credence to the M&S environment and any experiments performed within it.

Chapter 5 — Conduct Experiment

After development of the models and simulations, the WARCON process begins the Experimentation phase. During this part of the process, the products of preceding efforts coalesce and provide the framework for conducting experiments to examine performance for the base line and excursions on the system under study.

What is Involved in Conducting an Experiment?

An experiment is an operation or process employed to resolve an uncertainty. A successful experiment provides the necessary rigor to satisfy the requirements set forth in the Project Management and Experiment Plans. It details performance and cost data for each excursion event.

The Experiment Phase can be broken down into a three-step process. First, identify requirements and resources necessary to conduct the experiment (Appendix B; IDEF0 Node A5.1). Then run the model using current practices and processes to develop a baseline for comparison with experiment data. The Engineering Concept Development IPT uses the baseline data to identify bottlenecks in the process. Accordingly, it is necessary to run a baseline as early as feasible in the project and make the baseline data available to the Engineering Concept Development IPT.

After establishing a baseline, the IPTs conduct the experiment using previously explored alternatives. The teams review the data to ensure there is sufficient information for a Trade Study analysis.

Additional Planning

The early WARCON process formulates three documents: Project Management Plan, Experiment Plan, and Trade Study Plan. Together these documents provide the basis on which the experiment is built. The experiment is the critical element in the WARCON process because it provides performance data for subject system alternatives for use in the Trade Study. A successful experiment requires detailed scheduling and an execution plan for use within an acceptable M&S Environment.

A successful experiment depends upon the orchestration of resources. Resource elements should include event times, people, funds, facilities, hardware, software and connectivity requirements, as well as mission level simulations used for experimentation and analysis. Early identification of good Reliability & Maintainability sources databases is critical to good Reliability and Life Cycle Cost numbers. Investigate and identify tools to manipulate Reliability, Maintenance, and Availability (RMA) data early in the process and make recommendations to the Management IPT on the feasibility of purchasing tools. A compilation of this information contributes to the development of an experiment Concept of Operations (CONOPS) document.

The CONOPS document provides events sequencing to support the Experiment Plan. An experiment execution schedule is

drafted to guide the CONOPS. This schedule lays out the timeline for the resources required in performing the experiment, including availability of system engineers, analysts, SMEs, and modeling and simulation runs for the experiment.

Experiment Execution

Before running an experiment, the experiment team (analysts and systems engineers and M&S engineers) conducts a review of the Experiment Plan and the CONOPS (Appendix B; IDEF0 Node A5.2). This is done to ensure that any last-minute scheduling changes or resource limitations have been taken into consideration. Additionally, this review identifies constraints and undesirable variables that could unfavorably affect the execution or the excursion run data.

Based on this review, the Experiment Execution Plan is refined if necessary. Care must be exercised to ensure that solutions to remedy any exposed difficulties are not at the expense of the Experiment Plan's guidance.

Case Runs

Establishment of an initial reference point is essential in any experiment. "Before you know where you are going, you must first know where you are." A baseline experiment run, usually based on current system or process capabilities, is done for each set of variables to provide the foundation on which subsequent excursions are compared. It is established by using the Integrated M&S tool.

The baseline/comparison case runs take into consideration all the variables that are defined in the Experiment Plan. The analysts perform a quick-look data analysis on the baseline/comparison run output data to determine the need for any fine-tuning of input variables or additional excursions. If additional testing is necessary, which is not in conflict with the Experiment Plan, the refined data becomes input data in the next baseline data production run for case comparison.

Collecting and reviewing the data, and subsequent testing, continue until experiment data requirements have been met for establishing a baseline/ comparison case. Excursion case runs of the variables are designed to test the parameters set forth in the Experiment Plan and CONOPS.

Quick-look Analysis

Analysts and M&S personnel review the results of excursion case runs to determine if the experiment data requirements have been satisfactorily met, or if additional runs are necessary. A quick-look examination of the results of each model run helps to refine input data for the next run. Analysts also check the output data to ensure that the results "make sense" for each run as it occurs and in the context of other M&S results.

Even though the quick-look examination can indicate when data gathered is sufficient for review, the Experiment Plan remains the controlling document. Therefore, the Experiment Plan should allow for minor on-site experiment parameter adjustments if called for by the quick-look analysis.

Conclusion

The analysts evaluate the experiment case data as it relates to the Experiment Plan's MOE and MOP requirements (Appendix B; IDEF0 Node A5.3). Using validated analysis methods, the Analysis Group compiles performance and cost information for each alternative solution tested. These data are analyzed in detail to support development of the Trade Study Report.

Chapter 6 — Develop Trade Study

WARCON Process and Trade Studies

A Trade Study is required to support acquisition decisions presented by the WARCON process. The Trade Study Report, summarizing project analysis and cost-performance trade-offs for each improved system alternative, is the final product of a project using the WARCON system to reach an acquisition decision.

Trade Studies have been used in a number of manufacturing and acquisition environments. One type of trade study is used for requirements analysis. During this analysis, requirements are balanced against each other or against specified constraints, including cost. Requirements analysis trade studies examine and analyze alternative functional and performance requirements to present system options to satisfy customer needs. During this type of analysis, functions are balanced with interface and established equipment requirements, configuration considerations, functional partitioning, and requirements "flow down."

Trade studies are conducted during design production to support decisions for new product and process developments versus non-developmental products and processes. They are used to evaluate alternative solutions to optimize cost, schedule, performance, and risk.

Trade study methods are used during WARCON engineering concept development to weigh engineering level trade-offs in system design and associated costs. These methods are used again during the final step of the WARCON process to assess cost-performance trade-offs among alternative system concepts and any process improvements that were part of the experiment conducted in the simulation model.

Making Defensible Choices

Trade Studies are a formal decision making methodology used by integrated teams to make choices, provide alternatives, and resolve conflicts during the systems engineering process. Good trade study analyses demand participation, collaboration, and continuous communications between and among the integrated teams. Without this collaboration, unwarranted assumptions may form the basis for a solution and could result in omission of important data. Trade studies identify desirable and practical alternatives among technical objectives, competing designs, program schedules, and functional and performance requirements. Trade Studies also identify Total Ownership Costs and enable analysts and acquisition professionals to choose among the alternatives using pre-defined criteria.

Trade studies are defined, conducted, and documented in enough detail to support decision-making and lead to a balanced system solution. The level of detail of any trade study needs to be commensurate with cost, schedule, performance, and risk impacts.

Both formal and informal trade studies are conducted in any systems engineering activity. Formal trade studies tend to be those that will be used in formal decision forums, (e.g., milestone decisions). These typically will be well documented and become a part of the decision database. Conversely, engineering choices are less formal, involve trade-offs and decisions that parallel the trade study process, and are documented in summary detail only. These summaries are important in that they define the design as it evolves.

Trade Study Basics

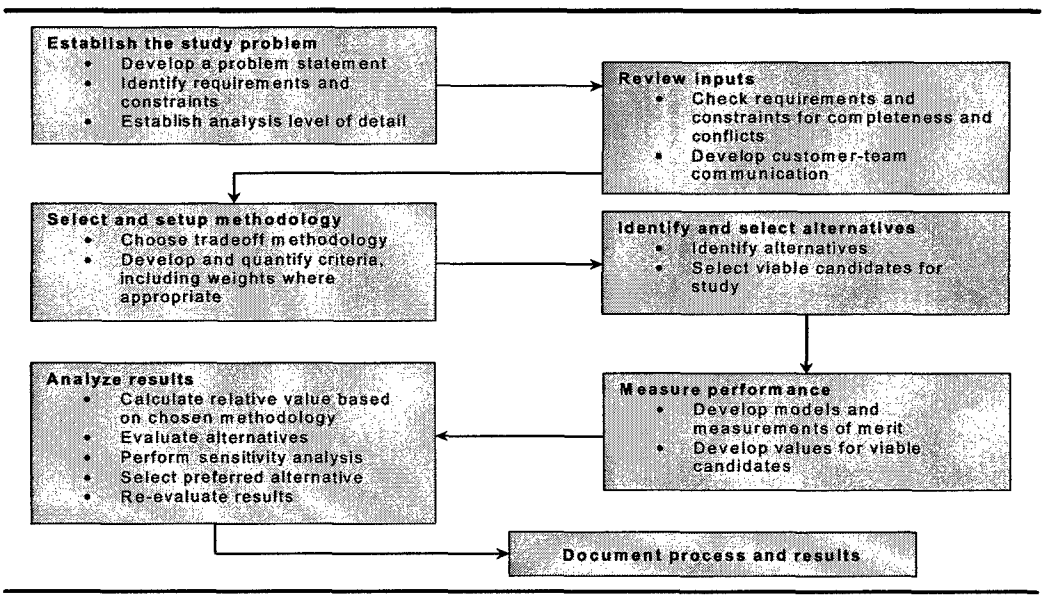
Trade Studies or Trade-Off Analyses are processes that examine viable alternatives to determine the preferred option. It is important that there be criteria established that are acceptable to all members of the integrated team as a basis for a decision. In addition, there must be an agreed upon approach to measuring alternatives against the criteria. If these principles are followed, the trade study should produce decisions that are rational, objective, supportable, and repeatable.

Trade study results must be easily communicated to customers and decision makers. If results of a trade study are too complex to communicate with ease, it is unlikely that the process will result in timely decisions.

Trade Study Process

As shown in Figure 4, the process of tradeoff analysis consists of defining the problem, establishing a trade-off methodology (to include the establishment of decision criteria), selecting alternative solutions, determining key characteristics of each alternative, evaluating the alternatives, and choosing a solution.

The first steps of this process are performed during the "Analyze Problem" part of the WARCON process (Appendix B; IDEF0 Node A1) where the Trade Study Plan was developed.



Source: *Systems Engineering Fundamentals*, Defense Systems Management College Press, Fort Belvoir, VA, 1999

Figure 4. Trade Study Process

Total Ownership Cost Analyses

The initial stage in Develop Trade Study is to analyze the combined cost data (Appendix B; IDEF0 Node A6.1). The inputs necessary include the System Description, Alternative Design Concepts and their associated costs, and cost data derived from the design engineers and modeled by the systems engineers. The analysts integrate the cost data with the system designs and develop a matrix listing systems and costs.

Acquisition decisions for future systems must consider more than just the cost for developing and buying the system. Although acquisition cost often drives a high-level decision about whether to upgrade or acquire a system, decisions regarding which system or system alternatives to buy must include TOC over the lifetime of the system.

TOC has three major components: Acquisition, Operating and Support (O&S), and Disposal. Disposal may not be a factor in acquisition of small electronics systems, such as for a few computers, but it is a major factor for systems containing hazardous materials or when removing a system from a ship would require major structural changes.

Operating and Support are the recurring costs that are required for maintaining and using the system, and are usually budgeted annually. Although DoD procurement often focuses on acquisition, organizations must budget for the legacy O&S costs throughout the system's life cycle. Using TOC rather than acquisition cost for procurement through modeling and simulation and Trade Study analysis allows the decision maker to weigh trade-offs between systems that may cost more initially, but be cheaper to operate in the end.

Three major categories of O&S costs are staffing, maintenance, and sustaining support. While maintenance and sustaining support costs are best addressed as analysis problems, staffing levels can be incorporated into M&S systems, and directly analyzed in the WARCON process. Warfare process models can be designed and built to a level of detail that allows workload to be tracked and reported out as an MOP.

Some Trade Studies may also describe these categories as "Reliability, Maintainability, and Availability" (RMA) when referring to life cycle or total ownership cost. Regardless of the term of art chosen, these costs are an important part of any trade-off analysis.

For example, the current Weapons Handling Process for an aircraft carrier is manual and therefore labor intensive. System improvements that include automation of key process steps may have a significant acquisition cost, but may show even greater savings in labor throughout the life cycle of the system.

The Engineering Concept Development phase of the WARCON process (Appendix B; IDEF0 Node A3) may use a Trade Study approach at the engineering level for assessing system trade-offs for each alternate design. However, the cost models available for this phase may not be available to address all aspects of TOC. The first step in performing a WARCON

Trade Study is therefore combining cost data from the alternative design data set with any other information required for TOC. This data may include, for example, labor cost data from the Navy for individual billets or ranks. This data can be used to estimate the labor cost savings achieved by introducing new technology into system improvements.

Performance Data

The product of the Conduct Experiment phase of the WARCON process (Appendix B; IDEF0 Node A5) is a set of experiment data for the baseline/ comparison case and each excursion case.

This information includes:

- A summary of input data, including scenario data and performance data for the engineering concept alternative being tested
- Output performance data as values of MOPs and MOEs

Outputs of the experiment, from the Integrated M&S environment, and TOC data combine to form the basis of Trade Study Analyses.

Trade Study Analysis

The final step in the WARCON process is to perform a cost-performance trade-off analysis for the different design alternatives (Appendix B; IDEF0 Node A6.2). This part of the process is shown in Figure 5. The analysts combine the TOC data matrix with results of the experiment conducted earlier (performance data in the form of MOPs and MOEs) for the alternative designs.

Each experiment excursion's results are tabulated and costs compared. The experiment results are listed in terms of satisfaction of the MOP/MOE requirements and to what degree the results meet the predetermined requirements. For each excursion, warfighter requirements are reviewed once more to ensure that operational requirements match up with each design alternative under study.

In addition, analysts review "Areas of Interest" (AOIs) that were communicated by the customer during the development of the Experiment Plan. These Customer AOIs are an important element of the final acquisition recommendation and decision, since the customer might choose Cost as the primary consideration for one of the subsystems, and choose Performance as the major factor in selecting yet another component of the system.

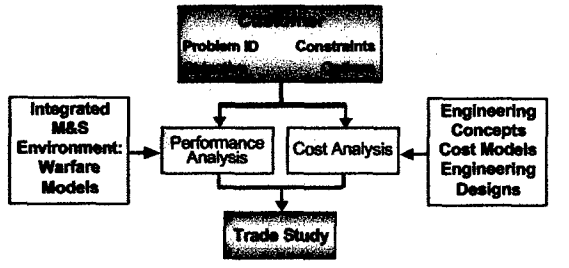


Figure 5. Trade Study Analysis

Spider Diagram Tool Set

An important consideration in developing the Trade Study is identifying a visual means of displaying trade-off results. To support this effort, a Spider Graph Visualization capability has been developed. Spider Diagrams (also sometimes called radar or polar plots) are useful for comparing multiple sets of data that contain multi-

ple variables. Spider Diagrams provide a simple means to visualize and highlight the differences between comparative sets of data. This format is ideal for displaying cost-performance trade-offs for alternate system designs.

A very basic Spider Diagram capability is included in Microsoft® Excel as a function titled Radar Chart. A much more capable Spider Diagram Tool Set was developed over the last two years as part the WARCON effort. The Spider Diagram Tool Set enables the user to organize data hierarchically, specify data sources and relationships, and then interactively explore the resultant information displays. Analysts can start at a top-level diagram and drill down into the underlying data, to build a better understanding of the information presented.

An example of a spider diagram showing notional WARCON performance results used to compare alternative systems designs for improvements to a Carrier Weapons Handling System is shown in Figure 6. The performance measures used for the analysis were Response Time, TOC, and Workload. Therefore, the variables shown on the spider diagram are Cost, Response Time, and Workload.

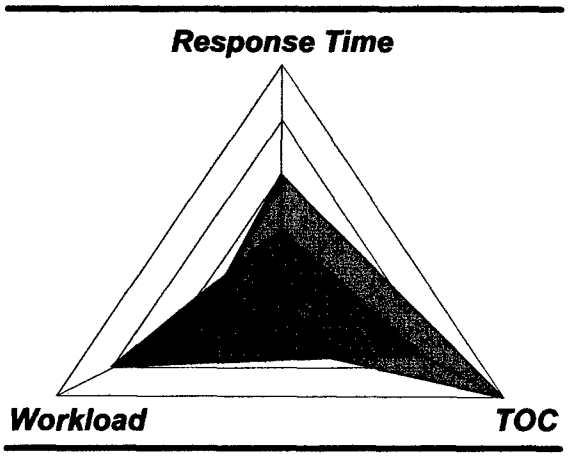


Figure 6. Example of WARCON Spider Diagram Results

For this notional comparison of two alternative system options, the one that has the highest TOC provides dramatic changes in both response time and workload. Supporting documentation would show details of these numbers over the lifetime of the system. The Spider Diagram tool provides a visual depiction of the results to support analysis.

Summary

The purpose of a Trade Study is to make better and more informed decisions in selecting the best from alternative solutions. Initial trade studies focus on alternative system concepts and requirements. Later studies assist in selecting component part designs. Cost effectiveness analyses provide assessments of alternative solution performance relative to cost.

The cost effectiveness, performance trade-offs and proposed recommendations are then formulated into the Draft Trade Study (Appendix B; IDEF0 Node A6.3). This data is then compared to the Customer's Problem Statement to determine if the analysis provides a solution to the customer's problem.

The important factor to consider in development of the Trade Study once the TOC data are analyzed is the relationship to the problem the process was invoked to consider. The customer feedback loop (Appendix B; IDEF0 Node A6.4) is central to completion of the Trade Study and the eventual completion of the WARCON process.

Finally, a Trade Study Report is prepared (Appendix B; IDEF0 Node A6.5). The Trade Study can make recommendations on what system or upgrades to acquire. It can also make a recommendation not to acquire anything, but rather maintain what is already in place. An analysis of alternative designs may reveal that current technologies are insufficient to meet the requirements specified by the customer. In other words, it is perfectly acceptable to make a negative recommendation in the Trade Study.

Chapter 7 — Collaborative Engineering Enterprise

The WARCON process is designed to bring together representatives from government and industry to study a system procurement or change issue. Members of a WARCON team often are geographically dispersed and the efforts of the individual Groups (i.e., Analysis, Engineering Concept Design and Systems Engineers), although dedicated to a common goal, are wide-ranging. Accordingly, a tool is needed by which the Program Manager can manage details of the project in a virtual environment, and allow for collaboration among the different groups. The WARCON process uses a Collaborative Engineering Enterprise (CEE) to accomplish this task.

The strategy for CEE development is to establish a collaboration framework in step with existing and emerging domain-specific resources to support scientific and engineering collaboration between distributed government and industry teams. When two or more enterprises form a team to design and build a complex system, one of the first tasks that must be performed is the exchange of information required for design, specification generation, document review, and system performance evaluation.

Complex projects are usually executed by multi-skilled teams, whose members are often made up of personnel from both inside and outside of the organization. Coordinating a complex project across the country or even around the globe is common. The CEE is a system that electronically links government and industry partners who are members of a multi-tiered enterprise. Going far beyond a simple integrated email and web system, a CEE can be used to distribute and manage documentation and data associated with a large scale enterprise, serve as an on-line meeting place for team collaboration and tasking support as well as providing common tools and management support capabilities.

CEE Architecture and Development Approach

The CEE employs a client-server paradigm. Users can access the CEE through the Internet or a classified network. The CEE architecture includes the layers shown in Figure 7. The system is intended to run on a range of hardware from desktop computers to hand held wireless personal digital assistants (PDAs). The repository is implemented with distributed databases so the system will scale to serve a large number of users simultaneously.

Defense applications require unique common tools. In addition, some tools required by a particular program must be included. The architecture is designed to fit the purpose.

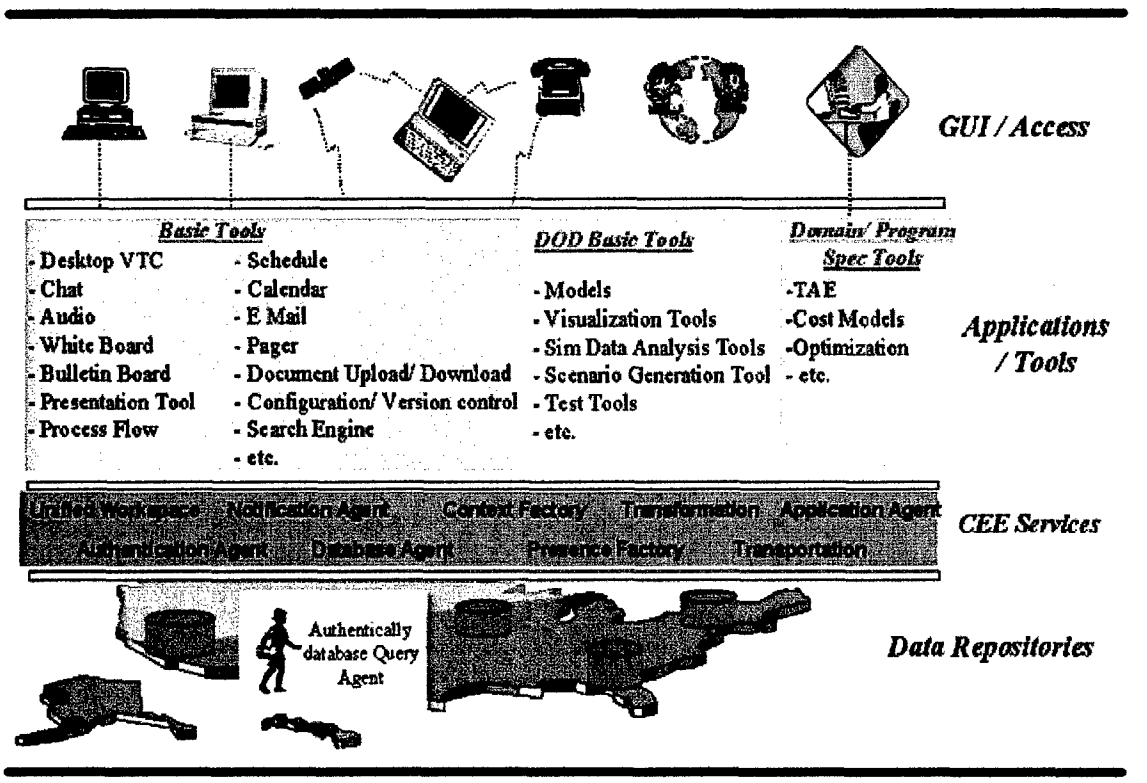


Figure 7. CEE Reference Architecture

To support the operation of these programs, some of the desired CEE functions include the following:

- **Application integration and management** – Embed internal and external user applications (e.g. simulations, analysis tools, etc.) capable of automatically launching and setting the collaboration if needed
- **Authentication** – Confirms the identity of system users or agents
- **Context factory** – Maintains context-specific information, e.g. shared calendars and files, thereby allowing consistent and separable data to be accessed by the user
- **Database and query engine** – Transports enterprise information into the database for the collaborative enterprise. In addition, the engine can acquire appropriate information from external databases.
- **Meeting session management** – Establish meeting sessions and broker messages directed to the meetings
- **Notification** – Accept and route messages between participants, determine the status of the user (on or off line) and direct appropriate notification
- **Presence factory** – Generate and deliver a personalized interface to remote users, and store configuration information such as shortcuts and preferences for later use
- **Transformation** – Translate documents, data and multi-media files from one format to another, such as Rich Text Format (RTF) to simple text

- **Transportation** – Distribute documents, data and multi-media files through the entire domain of the collaborative enterprise, regardless of where it is stored
- **Unified workspace** – Incorporate a seamless management of shared data resources throughout. Components and agents can interact, communicate, and collaborate.
- **Summations and Action Items** – Produce a summary with action items for teleconferences and meetings. These notes should be available for review and comment on Groove™, a commercial collaborative software "workspace" being used by WARCON IPTs, or other appropriate collaborative enterprise software that may be available in the future.

Graphic User Interface Considerations

It is important to understand that the CEE user interface must support the different needs required by each of its users. Three different views are needed to accomplish this:

- General information display and navigation
- Self-oriented view
- Team/task-oriented view.

The general information display should facilitate the data and document navigation and retrieval. The characteristics for the self-oriented view are self-project and self-activities management. The team/task-oriented view characteristics are information sharing among or across the team members to collaborate both concurrently and non-concurrently.

It is helpful to think of a collaborative working environment as a series of buildings, each with floors and rooms. The building represents the project whereas the floors and rooms might represent shared responsibilities and tasks within the group. This paradigm represents virtual space within which applications, documents, and people are directly accessible.

Commercial Off-The-Shelf tools and applications, designed for team operation can be embedded in the CEE. With certain programs, members initializing these tools, will automatically set up a meeting session and link the users together without the need for a lengthy manual procedure. As a new tool is developed for the enterprise, it can be embedded here for the teams to use.

The CEE provides the basis for document sharing and distributed operations for conducting analysis and study. Users can place documents of different types into the CEE, allowing anyone else with access to read the document. Persistence is supported because the document exists even though no one is logged onto the CEE. Consequently, the document remains in the CEE for future visitors to see until it is moved or deleted by an authorized user.

The CEE must provide the ability to restrict access, based on an access control list. Specific individuals may be added or removed from the access control list as necessary. This is especially important for protecting the proprietary information from different companies participating in a joint venture. This will reduce the reluctance for

making sensitive information available within a shared, but access-controlled environment.

Process Flow

Major challenges to overcome in the WARCON process are communicating and working together through the distributed nature of the program. For this reason, the CEE should incorporate a Process Flow capability to aid team operations. This will enable IPTs to collaborate, define, and develop the process for a given task associated with the WARCON process. More importantly, it fosters communication within the team to minimize misunderstandings regarding responsibilities and roles for each team member. The Process Flow is used as a vehicle for team members to submit their completed works. The work completed by one member will be automatically uploaded and saved in the CEE servers after their submission into the system and a copy is automatically routed to the next responsible member(s). The major advantage of the Process Flow is its ability to function as the "glue" for different IPT teams.

Analysis and Visualization Tool

A primary goal of using the WARCON process goal is to provide readily understood information that reflects the tradeoffs and impact of various system designs. The means to understanding the tradeoffs involved in this process can be provided by analysis and visualization tools incorporated in the CEE. Spider Graph (see Figure 7) visualization is one example of a tool developed to do this task. The Spider Graph application is integrated into the CEE so it can be used as shared resource for the team.

Summary

Hardware, software, telecommunication, and network technology advances enable creation of the virtual enterprise; however, technology by itself does not ensure the success of the virtual enterprise. Rather, it is an enabler. The CEE will provide capabilities to enhance the IPT team operations.

Appendix A — ACRONYMS

AARS ..... After Action Review System
CEE ..... Collaborative Engineering Environment
CIE ..... Concept Investigation Environment
CONOPS ..... Concept of Operations
COTS ..... Commercial off the Shelf
CWHS ..... Carrier Weapons Handling System
DMSO ..... Defense Modeling and Simulation Office
DoD ..... Department of Defense
DPG ..... Defense Planning Guidance
GOTS ..... Government off the Shelf
HLD ..... High Level Design
IDEF0 ..... Integration Definition for Function Modeling
IPT ..... Integrated Process Team
KA/E ..... Knowledge Acquisition/Engineering
LAN ..... Local Area Network
M&S ..... Modeling and Simulation
MOE ..... Measure of Effectiveness
MOP ..... Measure of Performance
NMSD ..... National Military Strategy Document
O&S ..... Operations and Support
ONR ..... Office of Naval Research
PDA ..... Personal Digital Assistant
PM ..... Project Manager
PMP ..... Project Management Plan
POA&M ..... Plan of Action and Milestones
POE ..... Projected Operational Environment
R&D ..... Research and Development
RMA ..... Reliability, Maintenance, and Availability
RTF ..... Rich Text Format
SDREN ..... Secret Defense Research and Engineering Network
SIPRNET ..... Secret Internet Protocol Router Network
SME ..... Subject Matter Expert
SRD ..... Systems Requirement Document
SSS ..... System Subsystem Specification
TOC ..... Total Ownership Cost
V&V ..... Verification and Validation
VPN ..... Virtual Private Network
WAN ..... Wide Area Network
WARCON ..... Warfighting Concepts to Future Weapon System Designs
WBS ..... Work Breakdown Structure

Appendix B — Integration Definition for Function Modeling (IDEFØ) format

Diagrams and Definitions

A0 - WARCON Integration Definition for Function Modeling (IDEF0)

A process using Warfighter Concepts, coupled with operations analysis linked to modeling and simulation, to increase long-term effectiveness, improve acquisition cycle time, and reduce total ownership costs of new weapons systems (Figure A-A-0).

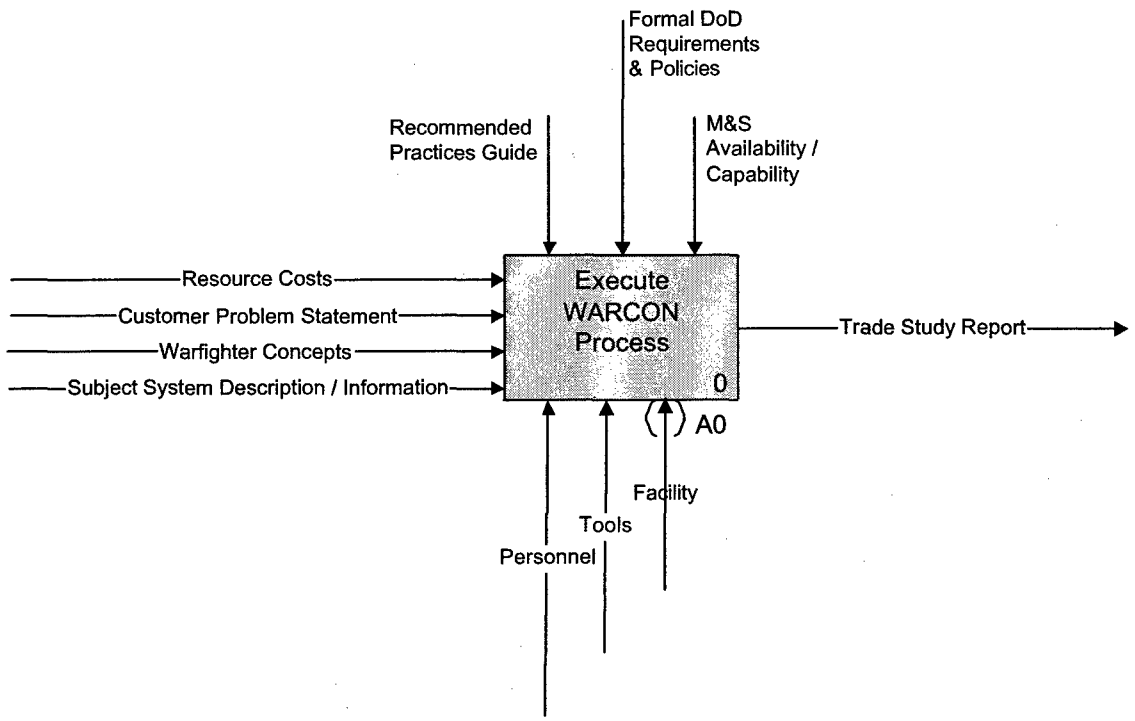


Figure A-A-0 WARCON IDEF0

Inputs

Customer Problem Statement – Tasking from the customer that defines the acquisition decision that application of the WARCON process will support.

Warfighter Concepts – Requirements for future weapon system designs that may include ORDs, MNS, ROCs, OAG inputs, etc.

Subject System Description/Information – Information and data available from external sources about the current and future warfare system being analyzed that is required to plan and perform the experiment and analysis.

Resource Costs – External financial resource data required to support the WARCON process regarding equipping, sustaining, and operating military forces sufficient to meet national goals.

Controls

Formal DoD Requirements and Policies – Formal requirements documents and policy instructions related to the acquisition process and future weapons systems requirements.

Technology Availability/Capability – The technologies currently available to improve the weapon system or process being studied and an initial appraisal of the available technologies.

Recommended Practices Guide – A WARCON Publication provided to users for use in tailoring and implementing the WARCON process for a specific customer problem.

Modeling and Simulation (M&S) Availability/Capability – Identification and assessment of the models and simulations available to support the analysis, and their capabilities, for potential inclusion into the integrated system/federation.

Subject System Data Availability – Access to data concerning Operational Capabilities, Availability, Maintainability and Reliability of the weapon system (and associated systems) to be studied.

Outputs

Trade Study Report – The primary product resulting from the WARCON process to support acquisition decision makers. This formal report summarizes cost-performance trade-offs among the different options for future weapon system designs.

Mechanisms:

Personnel – Government, contract employees, subject matter experts, systems engineers and analysts available to support using the WARCON process.

Tools – Previously validated methods, models and simulations that support the modeling and analysis environments.

Facility - Buildings and equipment necessary to support personnel and tools in the conduct of the activities.

A1 Perform Project Planning

Identifying all functions and resources required to support implementation of the WARCON process based on the customer problem statement (Figure A-A0(a)).

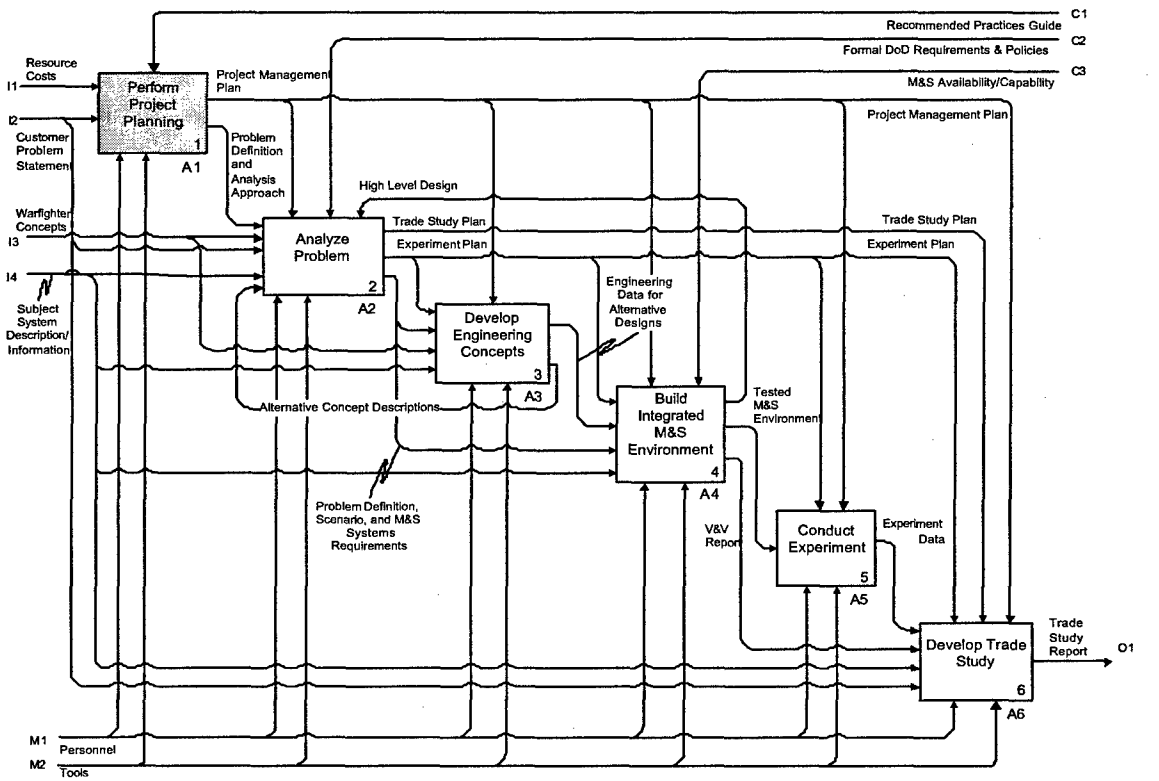


Figure A-A0(a) Execute WARCON Process

Inputs:

Customer Problem Statement – Tasking from the customer that defines the acquisition decision that application of the WARCON process will support.

Controls:

Recommended Practices Guide – A WARCON Publication provided to users for use in tailoring and implementing the WARCON process for a specific customer problem.

Outputs:

Project Management Plan – The overall direction for all phases of the WARCON process to include tasks, organization, program resources and costs, software development, products, schedules and milestones. The Software Development Plan is included within this Plan.

Problem Definition and Analysis Approach – An expansion of the customer problem statement providing sufficient detail to support program planning, process tailoring, and determining the procedures the experiment and analysis will use to study the customer's issues.

Mechanisms:

Personnel – Government, contract employees, subject matter experts, systems engineers and analysts available to support using the WARCON process.

Tools – Previously validated methods, models and simulations that support the modeling and analysis environments.

A1.1 Tailor WARCON Process

Customizing the generic WARCON process for analyzing the subject systems identified in customer problem statement using the Recommended Practices Guide (RPG) and problem definition (Figure A-A1(a)).

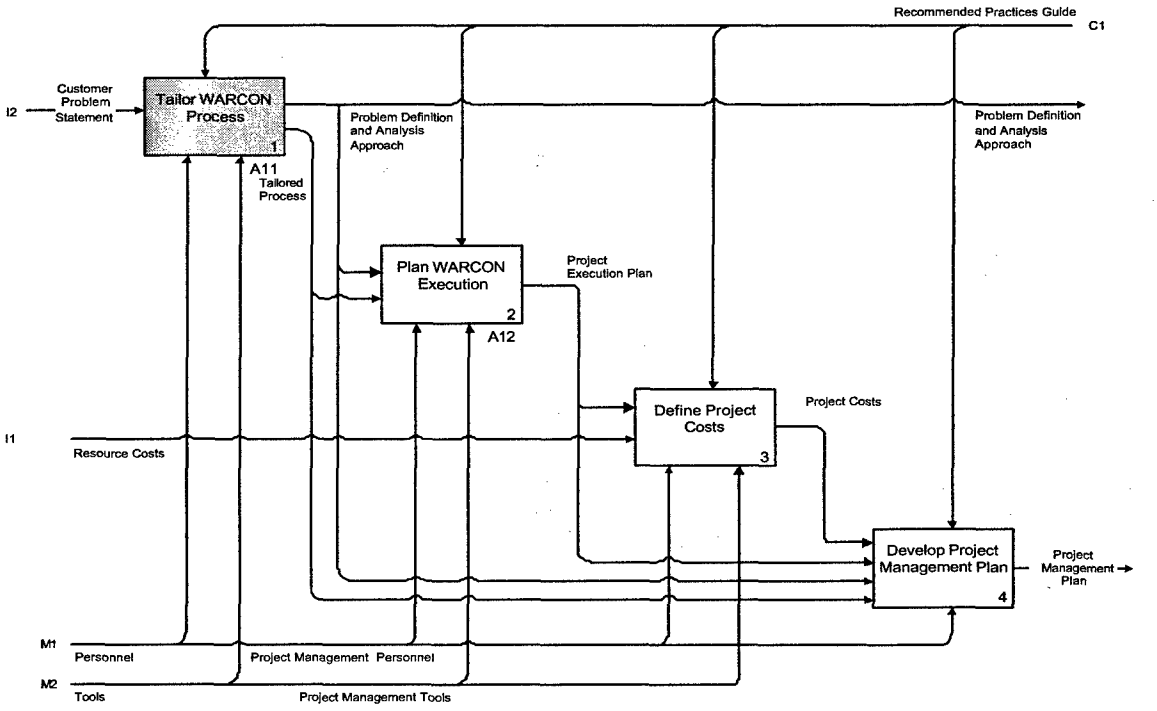


Figure A-A1(a) Perform Project Planning

Inputs:

Customer Problem Statement – Tasking from the customer that defines the acquisition decision that application of the WARCON process will support.

Controls:

Recommended Practices Guide – A WARCON Publication provided to users for use in tailoring and implementing the WARCON process for a specific customer problem.

Outputs:

Problem Definition and Analysis Approach – An expansion of the customer problem statement providing sufficient detail to support program planning, process tailoring, and determining the procedures the experiment and analysis will use to study the customer's issues.

Tailored Process – Customized IDEF0 diagrams and definitions developed for each specific customer problem statement for applying the WARCON process.

Mechanisms:

Personnel – Government, contract employees, subject matter experts, systems engineers and analysts available to support using the WARCON process.

Tools – Previously validated methods, models and simulations that support the modeling and analysis environments.

A1.1.1 Define Problem

Analyzing the Customer's Problem Statement and determining the problem domain, the context in which the problem occurs, the scope of the system that will be studied and identify necessary planning assumptions (Figure A-A1.1(a)).

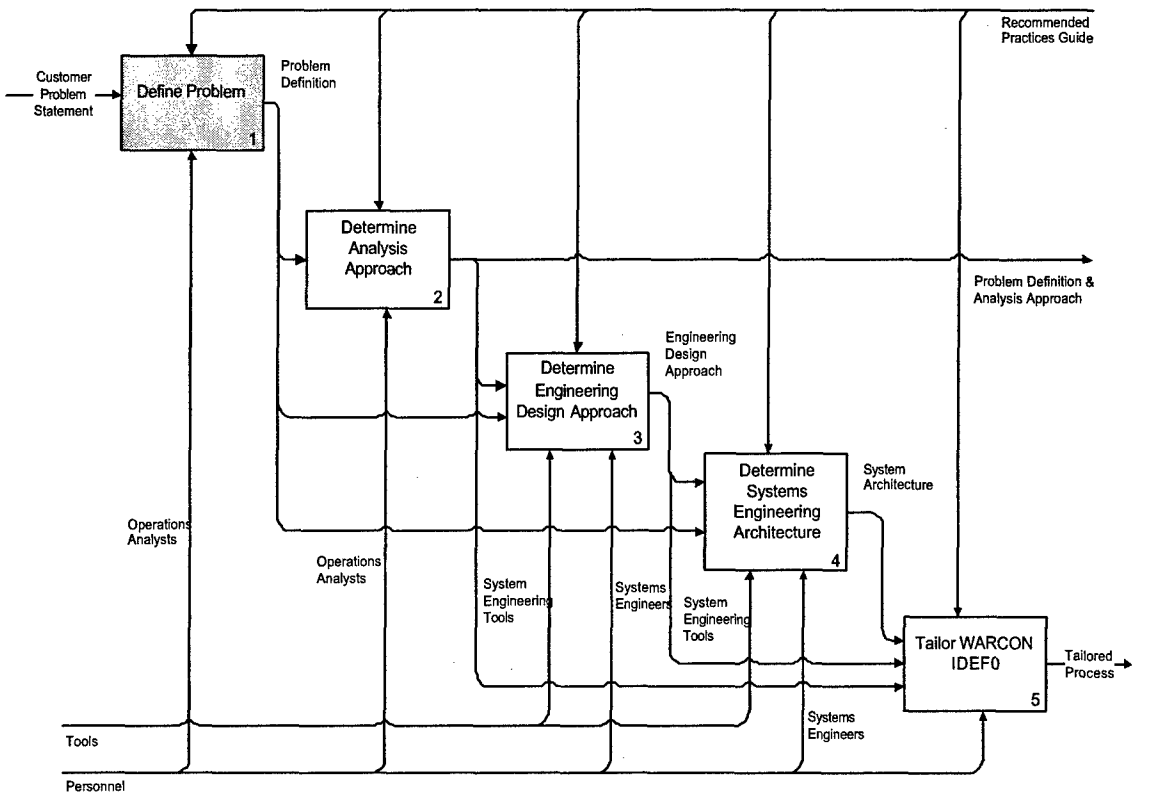


Figure A-A1.1(a) Tailor WARCON Process

Inputs:

Customer Problem Statement – Tasking from the customer that defines the acquisition decision that application of the WARCON process will support.

Controls:

Recommended Practices Guide – A WARCON Publication provided to users for use in tailoring and implementing the WARCON process for a specific customer problem.

Outputs:

Problem Definition – The customer problem statement providing sufficient detail to support program planning, process tailoring, and determining the procedures the experiment will use to study the customer's issues.

Mechanisms:

Personnel – Government, contract employees, subject matter experts, systems engineers and analysts available to support using the WARCON process.

Tools – Previously validated methods, models and simulations that support the modeling and analysis environments.

A1.1.2 Determine Analysis Approach

Determining the analytic framework and methods to be used to evaluate and compare alternate solutions to support the customer's acquisition decision (Figure A1.1(b))

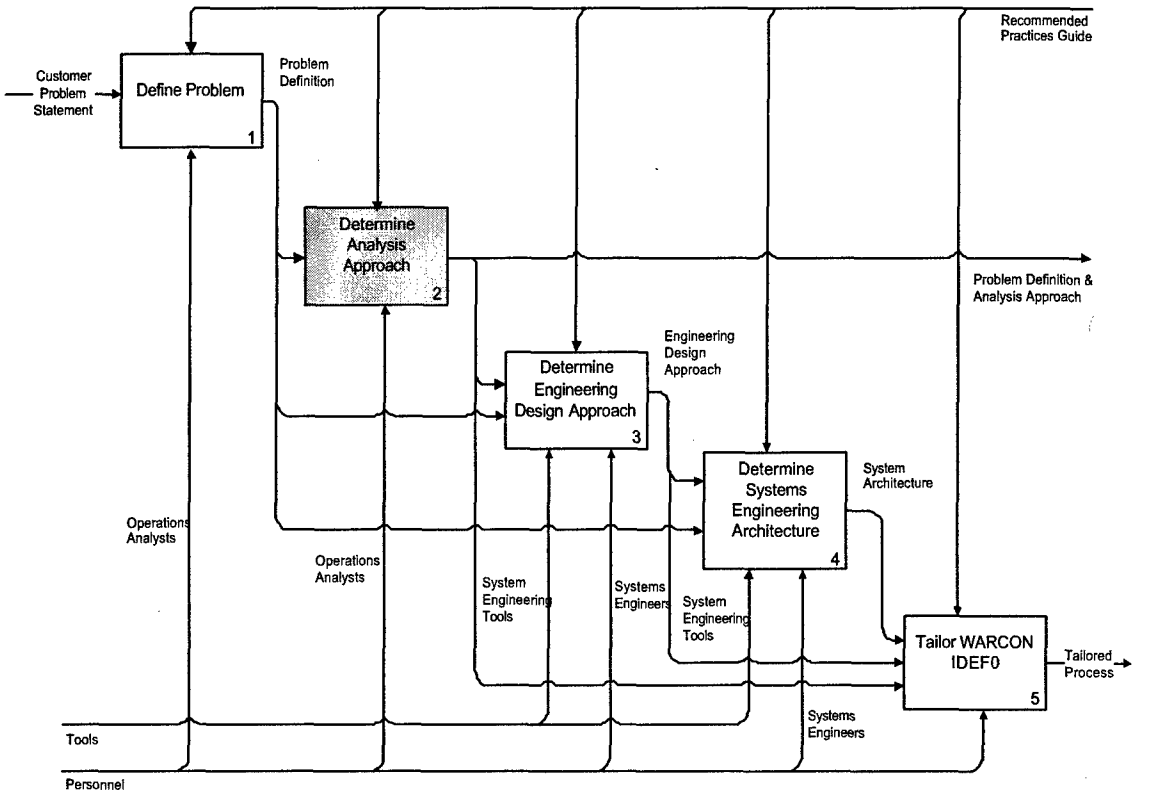


Figure A-A1.1(b) Tailor WARCON Process

Inputs:

Problem Definition – The customer problem statement providing sufficient detail to support program planning, process tailoring, and determining the procedures the experiment will use to study the customer's issues.

Controls:

Recommended Practices Guide – A WARCON Publication provided to users for use in tailoring and implementing the WARCON process for a specific customer problem.

Outputs:

Problem Definition and Analysis Approach – An expansion of the customer problem statement providing sufficient detail to support program planning, process tailoring, and determining the procedures the experiment and analysis will use to study the customer's issues.

Mechanisms:

Personnel – Government, contract employees, subject matter experts, systems engineers and analysts available to support using the WARCON process.

A1.1.3 Determine Engineering Design Approach

Identify the general approach to be used in developing the engineering concepts for subject system improvement alternatives (Figure A1.1(c)).

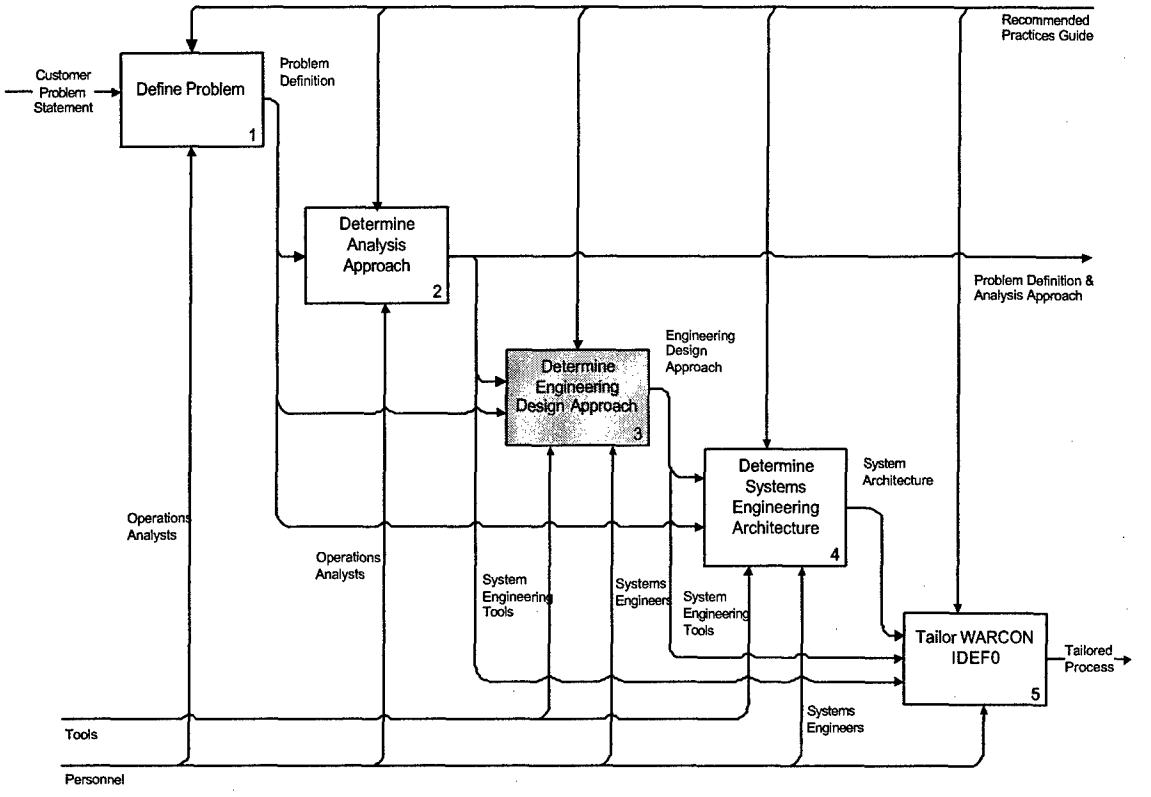


Figure A-A1.1(c) Tailor WARCON Process

Inputs:

Problem Definition – The customer problem statement providing sufficient detail to support program planning, process tailoring, and determining the procedures the experiment will use to study the customer's issues.

Problem Definition and Analysis Approach – An expansion of the customer problem statement providing sufficient detail to support program planning, process tailoring, and determining the procedures the experiment and analysis will use to study the customer's issues.

Controls:

Recommended Practices Guide – A WARCON Publication provided to users for use in tailoring and implementing the WARCON process for a specific customer problem.

Outputs:

Engineering Design Approach – Description of the design for the federation architecture and models needed for simulation and evaluation.

Mechanisms:

Personnel – Government, contract employees, subject matter experts, systems engineers and analysts available to support using the WARCON process.

Tools – Previously validated methods, models and simulations that support the modeling and analysis environments.

A1.1.4 Determine Systems Engineering Architecture

Define the Integrated modeling and simulation environment required to support execution of the experiment (Figure A-A1.1(d)).

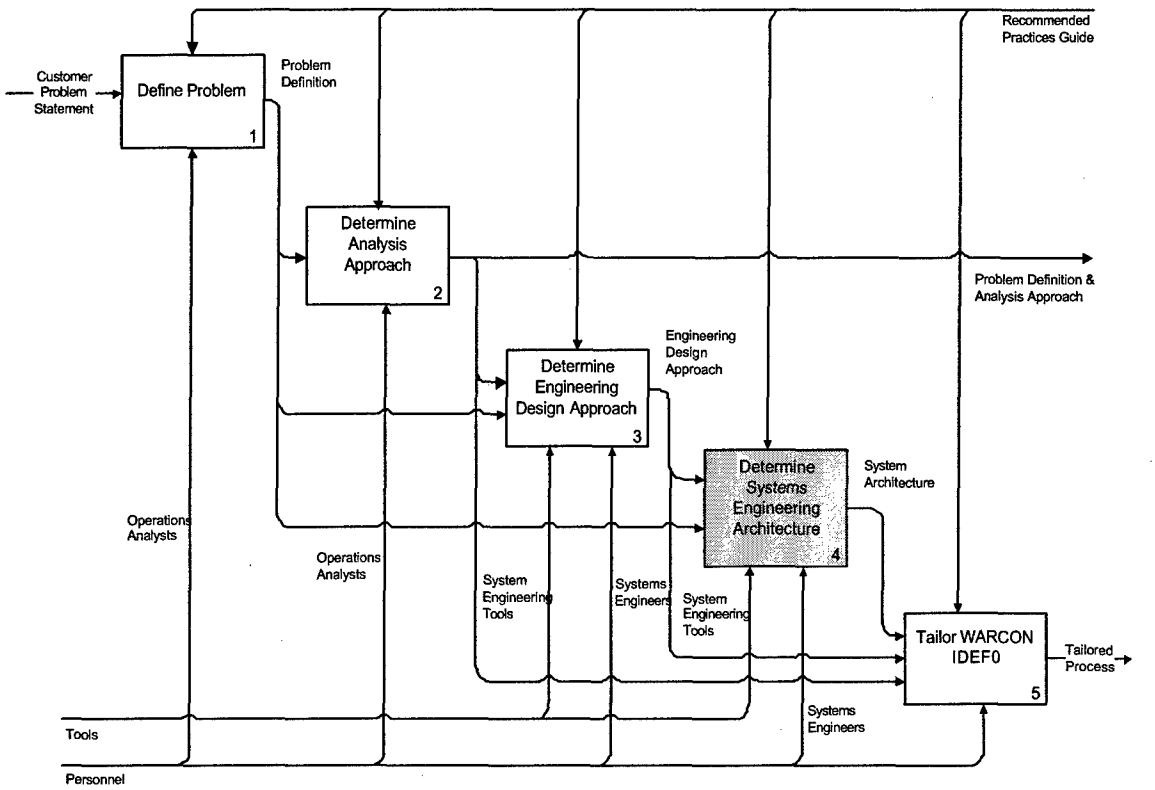


Figure A-A1.1(d) Tailor WARCON Process

Inputs:

Problem Definition – The customer problem statement providing sufficient detail to support program planning, process tailoring, and determining the procedures the experiment will use to study the customer's issues.

Engineering Design Approach – Description of the design for the federation architecture and models needed for simulation and evaluation.

Controls:

Recommended Practices Guide – A WARCON Publication provided to users for use in tailoring and implementing the WARCON process for a specific customer problem.

Outputs:

System Architecture – The integrated modeling and simulation environment required to support execution of the experiment.

Mechanisms:

Personnel – Government, contract employees, subject matter experts, systems engineers and analysts available to support using the WARCON process.

Tools – Previously validated methods, models and simulations that support the modeling and analysis environments.

A1.1.5 Tailor WARCON IDEF0

Refine and customize the generic WARCON process to best fit the Analysis Approach and System Engineering Architecture for the specific customer problem being addressed using the WARCON Recommended Practices Guide (Figure A-A1(e)).

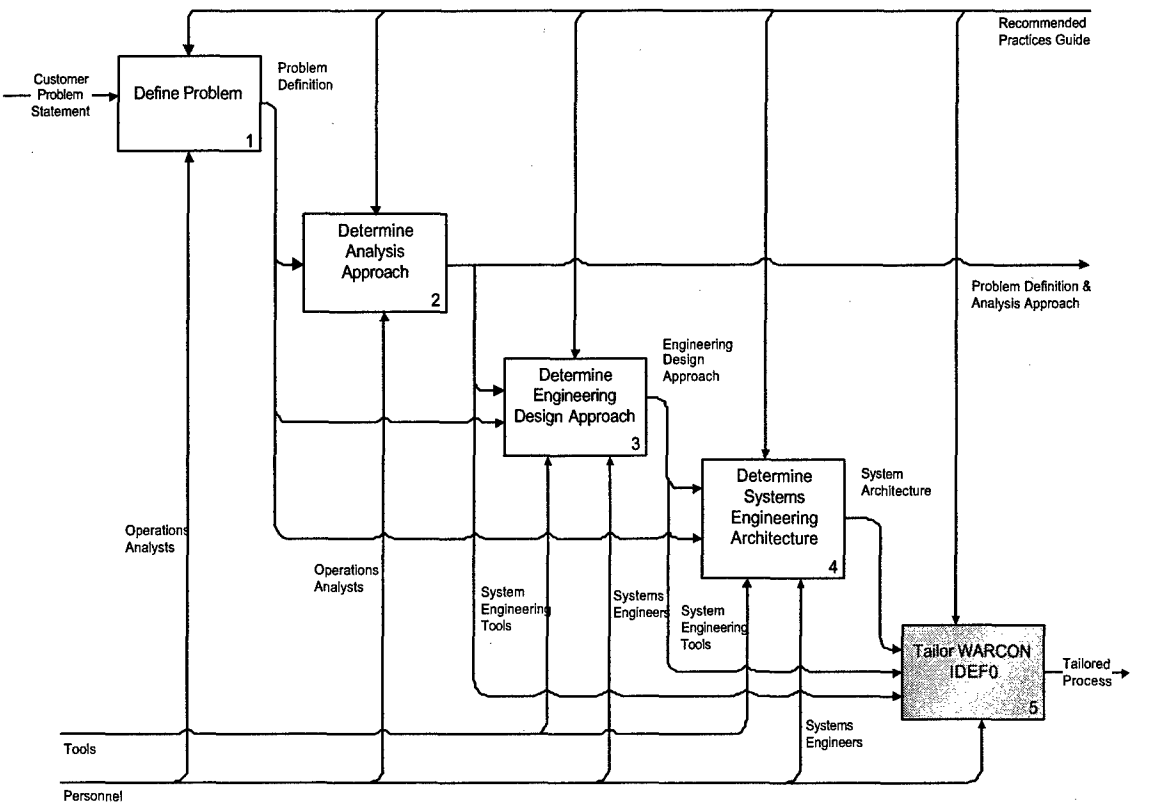


Figure A-A1.1(e) Tailor WARCON Process

Inputs:

System Architecture – The integrated modeling and simulation environment required to support execution of the experiment.

Engineering Design Approach – Description of the design for the federation architecture and models needed for simulation and evaluation.

Problem Definition and Analysis Approach – An expansion of the customer problem statement providing sufficient detail to support program planning, process tailoring, and determining the procedures the experiment and analysis will use to study the customer's issues.

Controls:

Recommended Practices Guide – A WARCON Publication provided to users for use in tailoring and implementing the WARCON process for a specific customer problem.

Outputs:

Tailored Process – Customized IDEF0 diagrams and definitions developed for each specific customer problem statement for applying the WARCON process.

Mechanisms:

Personnel – Government, contract employees, subject matter experts, systems engineers and analysts available to support using the WARCON process.

Tools – Previously validated methods, models and simulations that support the modeling and analysis environments.

A1.2 Plan WARCON Execution

Defining and developing the tasks, products, organization, schedules and resources necessary to successfully implement the WARCON process for a specific program (Figure A-A1(b)).

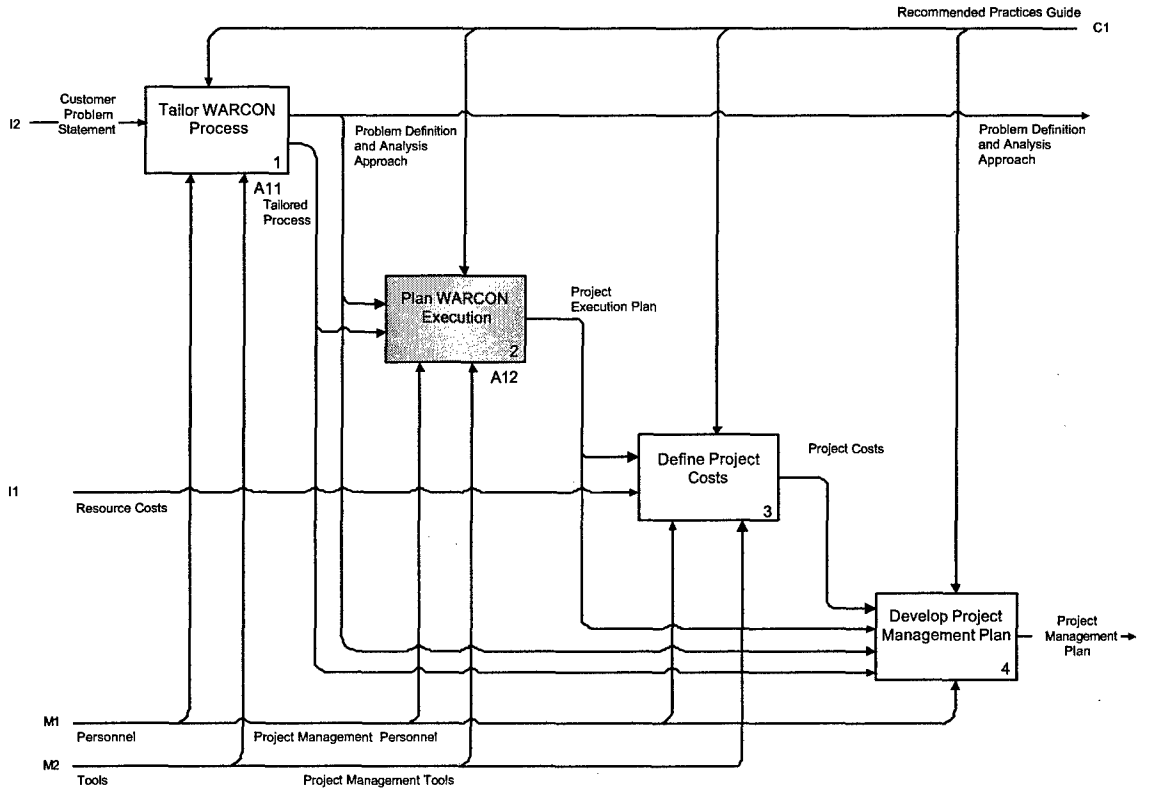


Figure A-A1(b) Perform Project Planning

Inputs:

Problem Definition and Analysis Approach – An expansion of the customer problem statement providing sufficient detail to support program planning, process tailoring, and determining the procedures the experiment and analysis will use to study the customer's issues.

Tailored Process – Customized IDEF0 diagrams and definitions developed for each specific customer problem statement for applying the WARCON process.

Controls:

Recommended Practices Guide – A WARCON Publication provided to users for use in tailoring and implementing the WARCON process for a specific customer problem.

Outputs:

Project Execution Plan – The detailed plan for products, tasks, schedules, organization, and resources necessary to complete the experiment and analysis that investigates the customer's problem statement.

Mechanisms:

Personnel - Government, contract employees, subject matter experts, systems engineers and analysts available to support using the WARCON process.

Tools – Previously validated methods, models and simulations that support the modeling and analysis environments.

A1.2.1 Develop List of Products

Defining a list of products needed to support and document the tailored WARCON process for a specific customer problem using the RPG (Figure A-A1.2(a)).

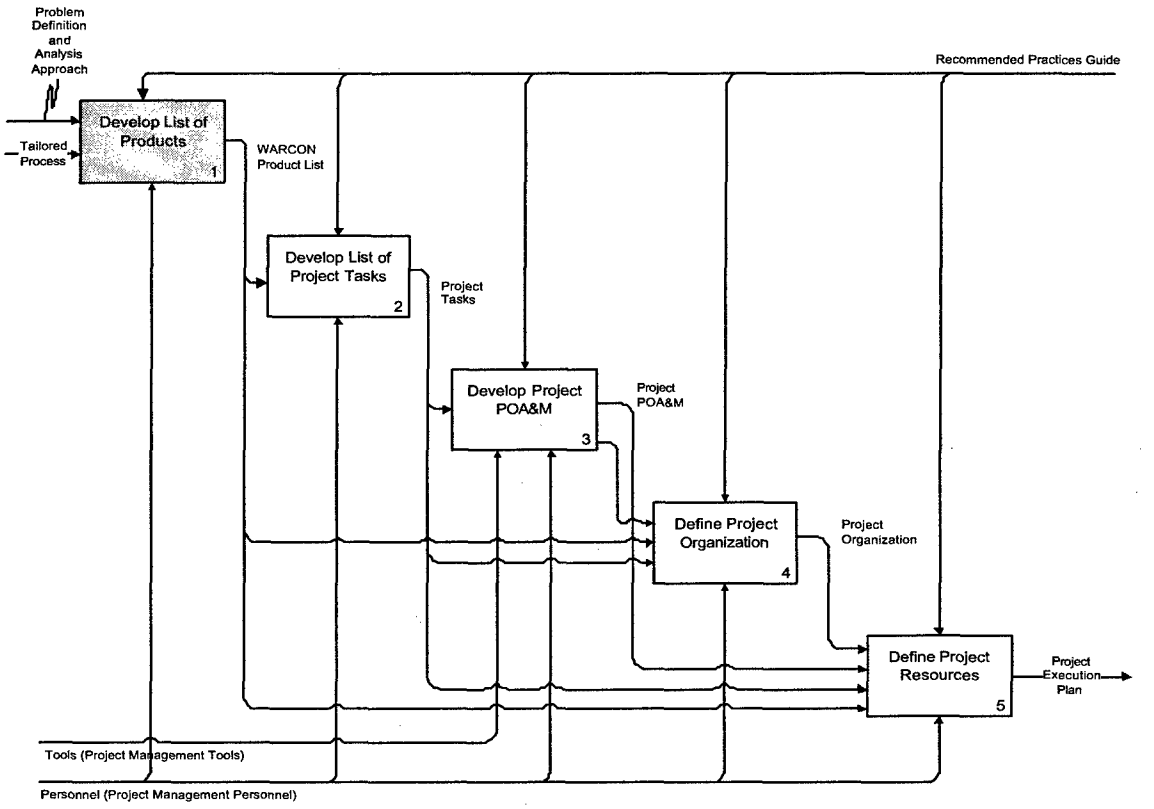


Figure A-A1.2(a) Plan WARCON Execution

Inputs:

Problem Definition and Analysis Approach – An expansion of the customer problem statement providing sufficient detail to support program planning, process tailoring, and determining the procedures the experiment and analysis will use to study the customer's issues.

Tailored Process – Customized IDEF0 diagrams and definitions developed for each specific customer problem statement for applying the WARCON process.

Controls:

Recommended Practices Guide – A WARCON Publication provided to users for use in tailoring and implementing the WARCON process for a specific customer problem.

Outputs:

WARCON Product List – List of products required to support and document the tailored WARCON process for a specific customer problem.

Mechanisms:

Personnel - Government, contract employees, subject matter experts, systems engineers and analysts available to support using the WARCON process.

A1.2.2 Develop List of Project Tasks

Performing a work breakdown structure (WBS) and determining the tasks required to complete the WARCON process for a specific customer problem statement using the list of products and tailored WARCON process (Figure A-A1.2(b)).

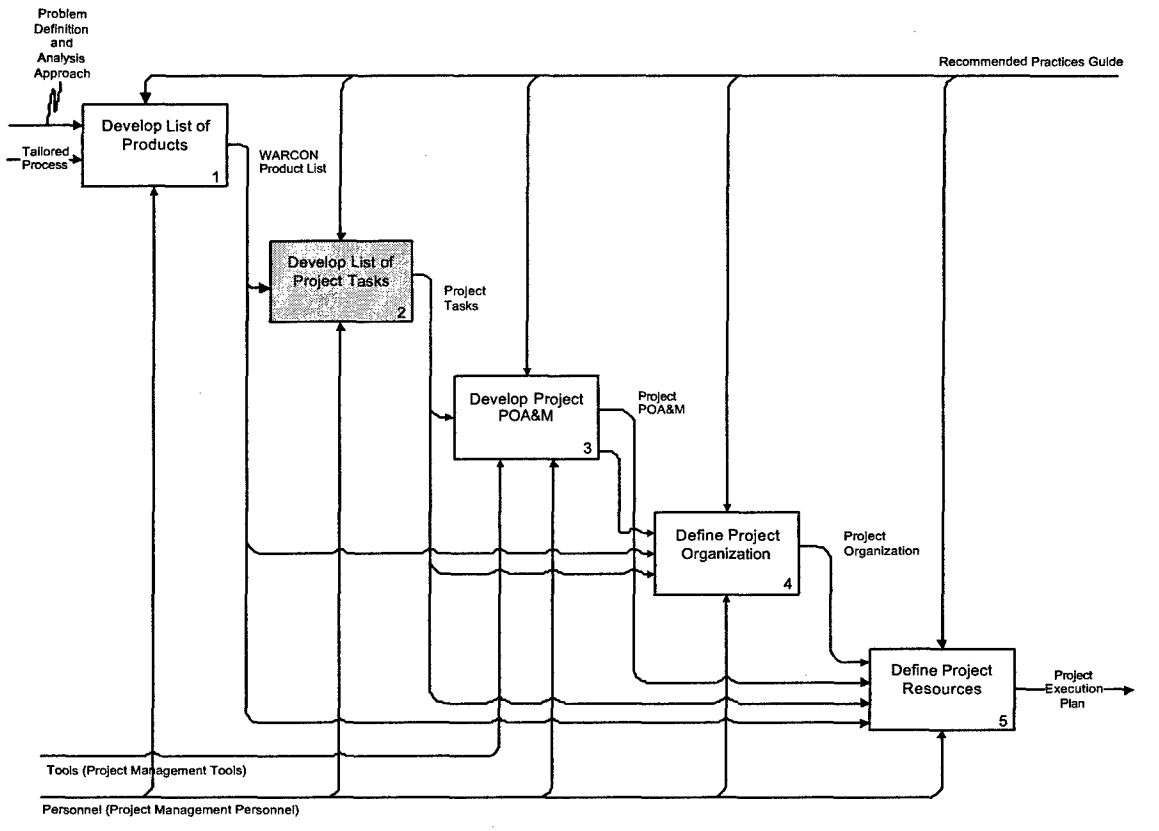


Figure A-A1.2(b) Plan WARCON Execution

Inputs:

WARCON Product List – List of products required to support and document the tailored WARCON process for a specific customer problem.

Controls:

Recommended Practices Guide – A WARCON Publication provided to users for use in tailoring and implementing the WARCON process for a specific customer problem.

Outputs:

Project Tasks – A single element of the WBS required for employing the WARCON process.

Mechanisms:

Personnel – Government, contract employees, subject matter experts, systems engineers and analysts available to support using the WARCON process.

A1.2.3 Develop Project POA&M

Producing a schedule and milestones for task execution using the WBS (Figure A-A1.2(c)).

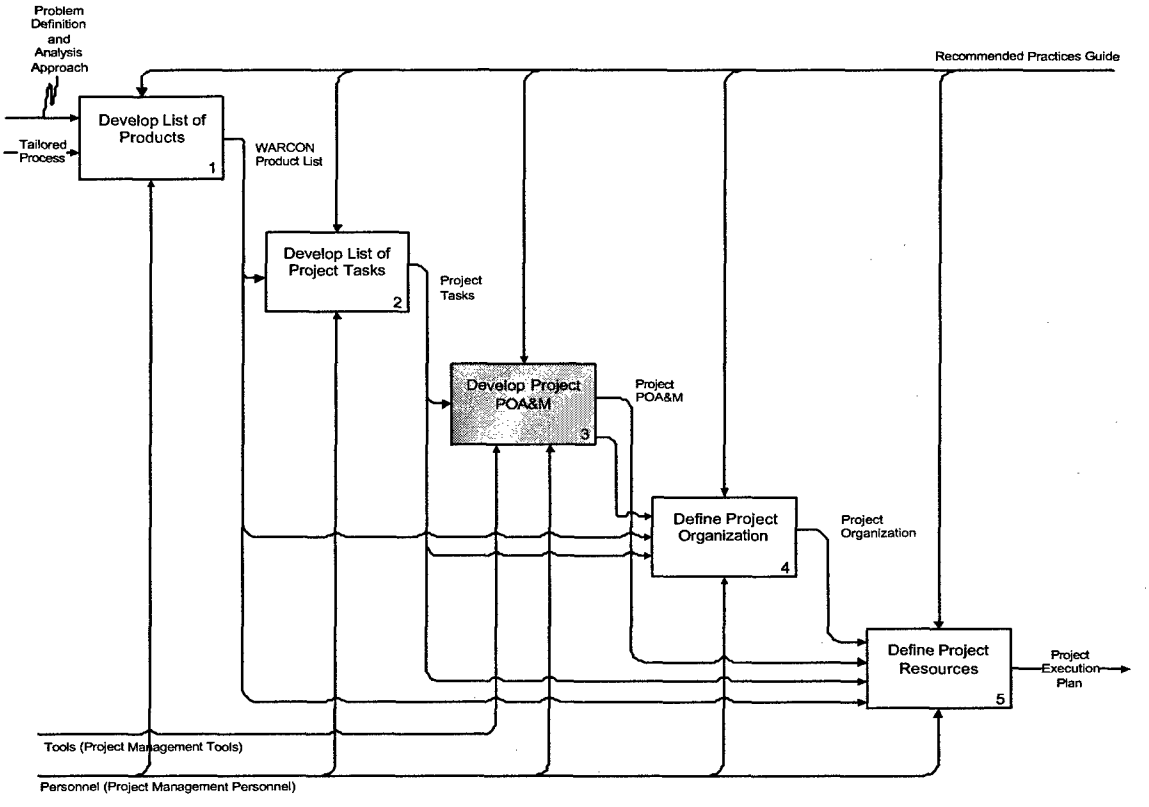


Figure A-A1.2(c) Plan WARCON Execution

Inputs:

Project Tasks – A single element of the WBS required for employing the WARCON process.

Controls:

Recommended Practices Guide – A WARCON Publication provided to users for use in tailoring and implementing the WARCON process for a specific customer problem.

Outputs:

Project POA&M – Plan of Action and Milestones for executing the WARCON process for a specific customer problem.

Mechanisms:

Personnel – Government, contract employees, subject matter experts, systems engineers and analysts available to support using the WARCON process.

Tools – Previously validated methods, models and simulations that support the modeling and analysis environments.

A1.2.4 Define Project Organization

Determining the program organizational structure that will best support completing tasks, supporting product development, and achieving program goals for a specific customer problem (Figure A-A1.2(d)).

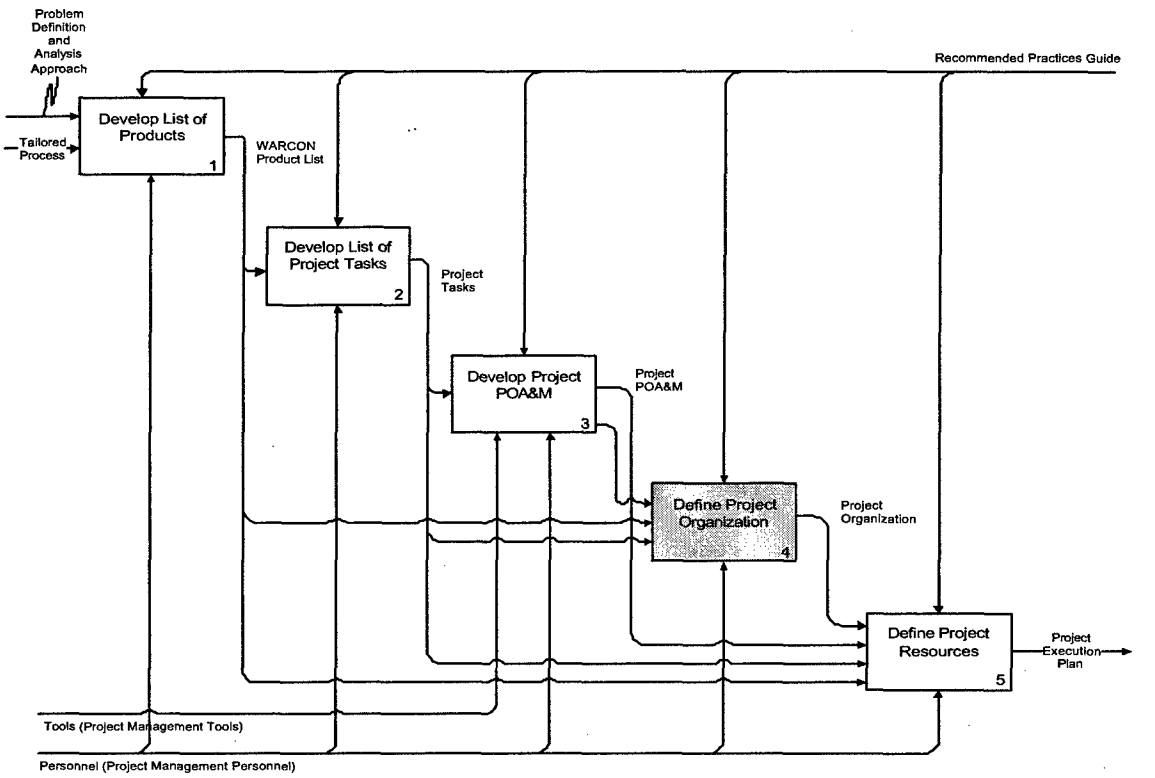


Figure A-A1.2(d) Plan WARCON Execution

Inputs:

Project POA&M – Plan of Action and Milestones for executing the WARCON process for a specific customer problem.

Controls:

Recommended Practices Guide – A WARCON Publication provided to users for use in tailoring and implementing the WARCON process for a specific customer problem.

Outputs:

Project Organization – Organizational structure designed to meet requirements for executing the WARCON process for a specific customer problem.

Mechanisms:

Personnel – Government, contract employees, subject matter experts, systems engineers and analysts available to support using the WARCON process.

A1.2.5 Define Project Resources

Identifying resources required to execute the WARCON process for a specific customer problem (Figure A-A1.2(e)).

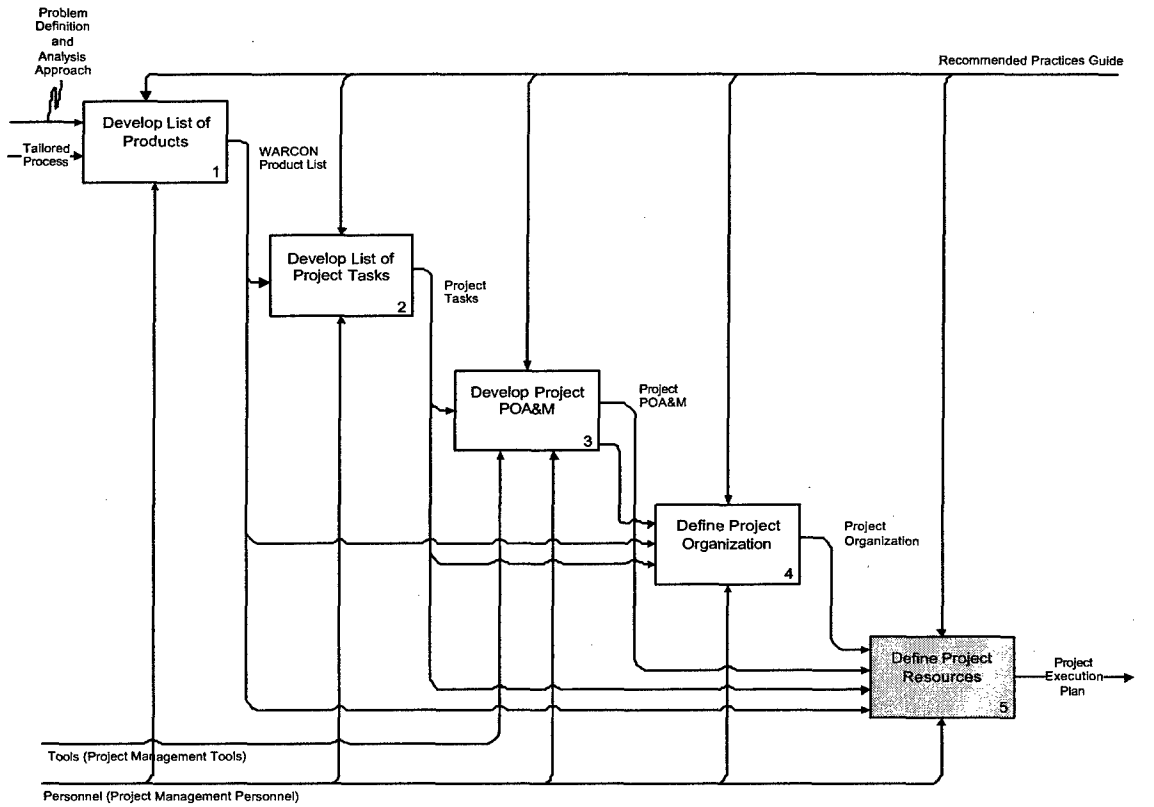


Figure A-A1.2(e) Plan WARCON Execution

Inputs:

Project Organization – Organizational structure designed to meet requirements for executing the WARCON process for a specific customer problem.

Project POA&M – Plan of Action and Milestones for executing the WARCON process for a specific customer problem.

Project Tasks – A single element of the WBS required for employing the WARCON process.

WARCON Product List – List of products required to support and document the tailored WARCON process for a specific customer problem.

Controls:

Recommended Practices Guide – A WARCON Publication provided to users for use in tailoring and implementing the WARCON process for a specific customer problem.

Outputs:

Project Execution Plan – The detailed plan for products, tasks, schedules, organization, and resources necessary to complete the experiment and analysis that investigates the customer's problem statement.

Mechanisms:

Personnel – Government, contract employees, subject matter experts, systems engineers and analysts available to support using the WARCON process.

A1.3 Define Project Costs

Determining the modeling and simulation, hardware, software, personnel, analysis tools, and other costs required to complete the WARCON process for a specific customer problem using the Project Execution Plan (Figure A-A1(c)).

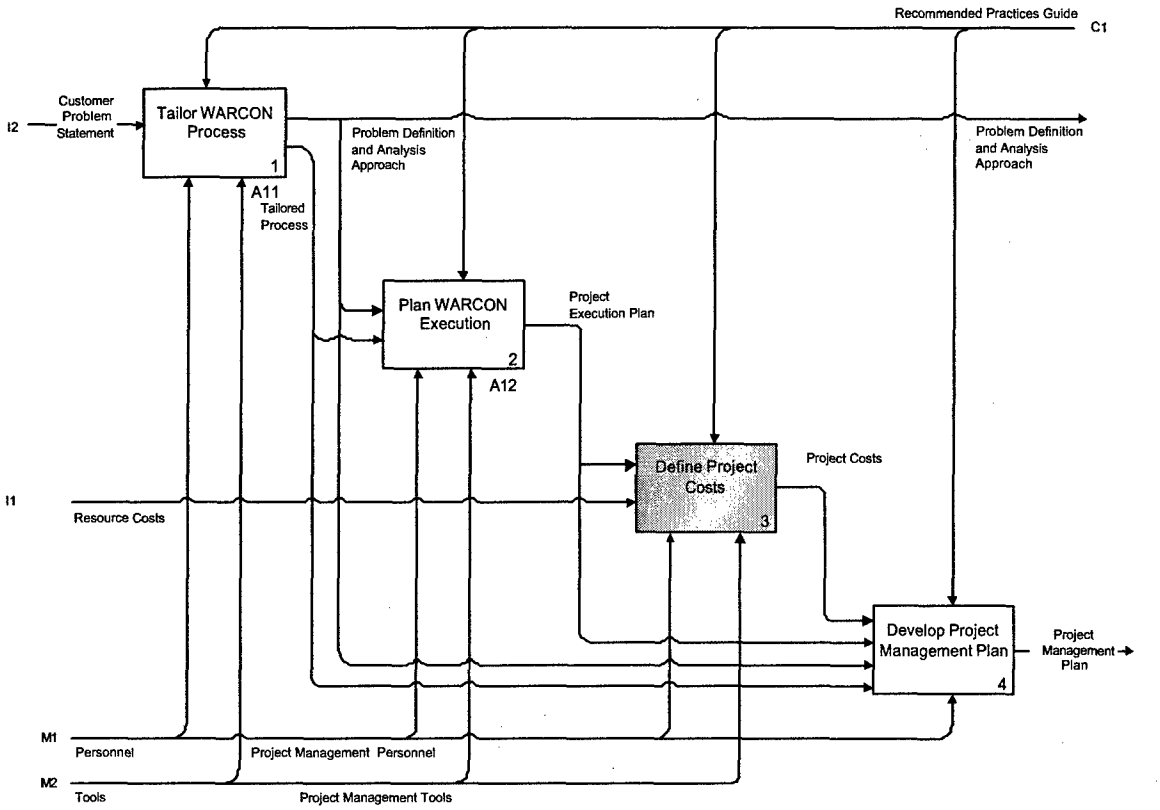


Figure A-A1.2(c) Plan WARCON Execution

Inputs:

Project Execution Plan – The detailed plan for products, tasks, schedules, organization, and resources necessary to complete the experiment and analysis that investigates the customer's problem statement.

Resource Costs – External financial resource data required to support the WARCON process regarding equipping, sustaining, and operating military forces sufficient to meet national goals.

Controls:

Recommended Practices Guide – A WARCON Publication provided to users for use in tailoring and implementing the WARCON process for a specific customer problem.

Outputs:

Project Costs – The final dollar figure submitted to the customer to complete the investigation.

Mechanisms:

Personnel – Government, contract employees, subject matter experts, systems engineers and analysts available to support using the WARCON process.

Tools – Previously validated methods, models and simulations that support the modeling and analysis environments.

A1.4 Develop Project Management Plan

Combining the contract costs and the Execution Plan to provide guidance for executing all phases of the WARCON process (Figure A-A1(d)).

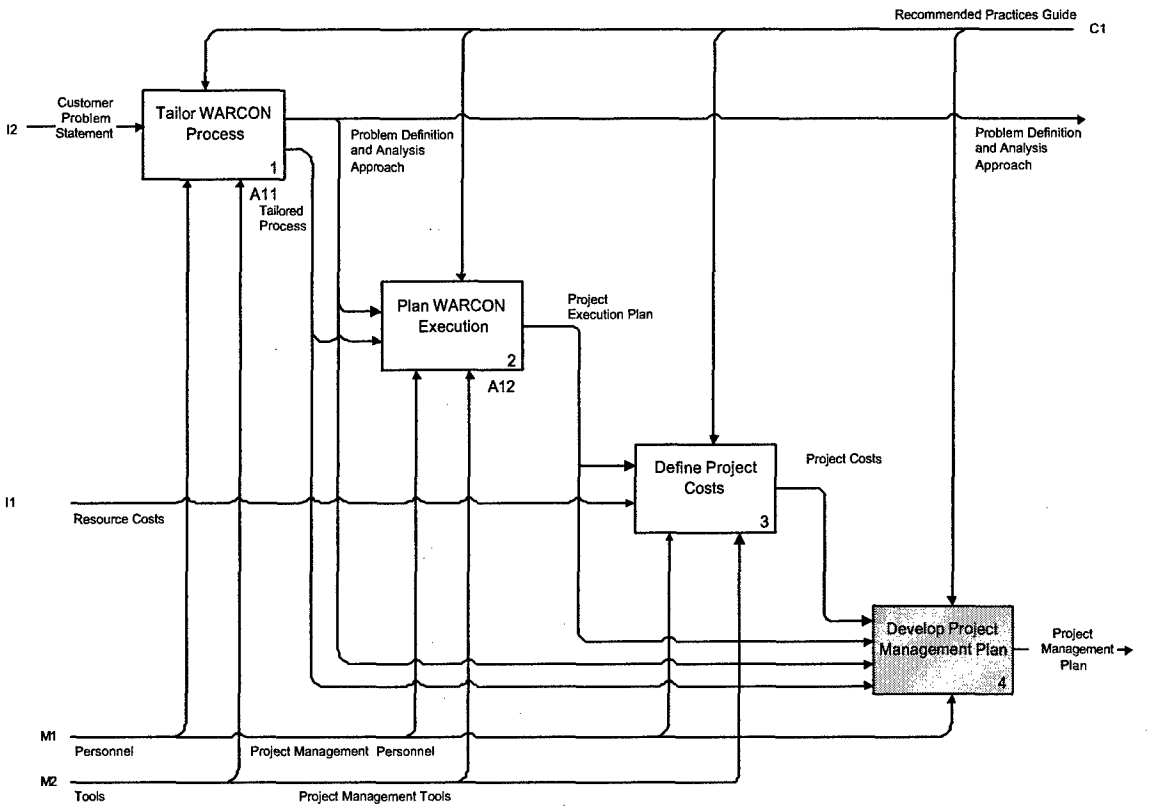


Figure A-A1.2(d) Plan WARCON Execution

Inputs:

Project Costs – The final dollar figure submitted to the customer to complete the investigation.

Project Execution Plan – The detailed plan for products, tasks, schedules, organization, and resources necessary to complete the experiment and analysis that investigates the customer's problem statement.

Problem Definition and Analysis Approach – An expansion of the customer problem statement providing sufficient detail to support program planning, process tailoring, and determining the procedures the experiment and analysis will use to study the customer's issues.

Tailored Process – Customized IDEF0 diagrams and definitions developed for each specific customer problem statement for applying the WARCON process.

Controls:

Recommended Practices Guide – A WARCON Publication provided to users for use in tailoring and implementing the WARCON process for a specific customer problem.

Outputs:

Project Management Plan – The overall direction for all phases of the WARCON process to include tasks, organization, program resources and costs, software development, products, schedules and milestones. The Software Development Plan is included within this Plan.

Mechanisms:

Personnel – Government, contract employees, subject matter experts, systems engineers and analysts available to support using the WARCON process.

A2 Analyze Problem

Detailing examination of the customer requirements using current capabilities and future resources (Figure A-A0(b)).

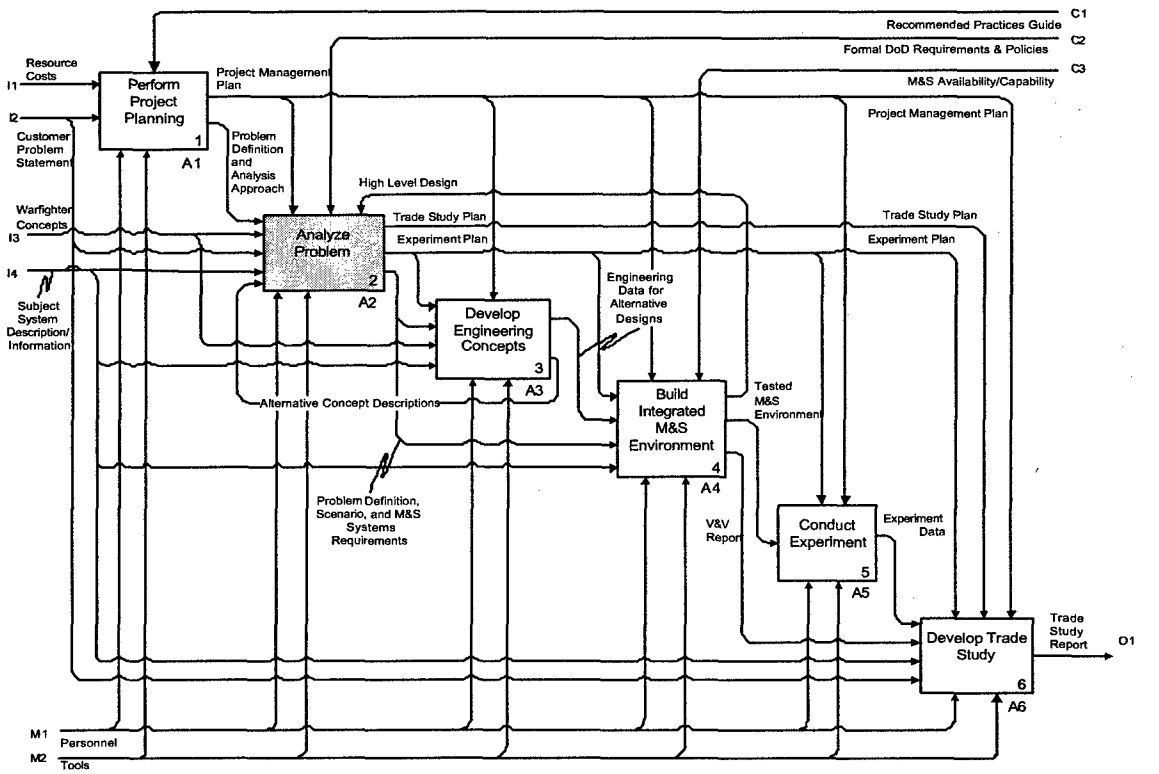


Figure A-A0(b) Execute WARCON Process

Inputs:

Problem Definition and Analysis Approach – An expansion of the customer problem statement providing sufficient detail to support program planning, process tailoring, and determining the procedures the experiment and analysis will use to study the customer's issues.

Customer Problem Statement – Tasking from the customer that defines the acquisition decision that application of the WARCON process will support.

Warfighter Concepts – Requirements for future weapon system designs that may include ORDs, MNS, ROCs, OAG inputs, etc.

Subject System Description/Information – Information and data available from external sources about the current and future warfare system being analyzed that is required to plan and perform the experiment and analysis.

Alternative Concept Designs – Potential design innovations that may resolve or reduce the capabilities gap.

Controls:

Formal DoD Requirements and Policies – Formal requirements documents and policy instructions related to the acquisition process and future weapons systems requirements.

Project Management Plan – The overall direction for all phases of the WARCON process to include tasks, organization, program resources and costs, software development, products, schedules and milestones. The Software Development Plan is included within this Plan.

High Level Design (HLD) – Plan for building the Integrated System; requires program review approval.

Outputs:

Trade Study Plan – Document that defines the approach, methods, and performance measures to be used to assess trade-offs among alternate weapon system designs and total ownership costs.

Experiment Plan – Document that defines the experiment approach, objectives, hypotheses, measures of performance and effectiveness (MOPs/MOEs), analysis methods, data extraction and collection requirements, scenarios, and explicit procedures for conducting the experiment.

Problem Definition, Scenario, and M&S System Requirements – Description of the unconstrained functional requirements for the M&S System needed to address all aspects of the customer problem statement, including representations of the subject system, technologies, and operational scenarios.

Mechanisms:

Personnel – Government, contract employees, subject matter experts, systems engineers and analysts available to support using the WARCON process.

Tools – Previously validated methods, models and simulations that support the modeling and analysis environments.

A2.1 Define Problem in Detail

Performing a detailed analysis of the Problem Definition in an operational context to restate the problem in terms amenable to defining scope, assumptions and limitations, and detailed analysis approach (Figure A-A2(a)).

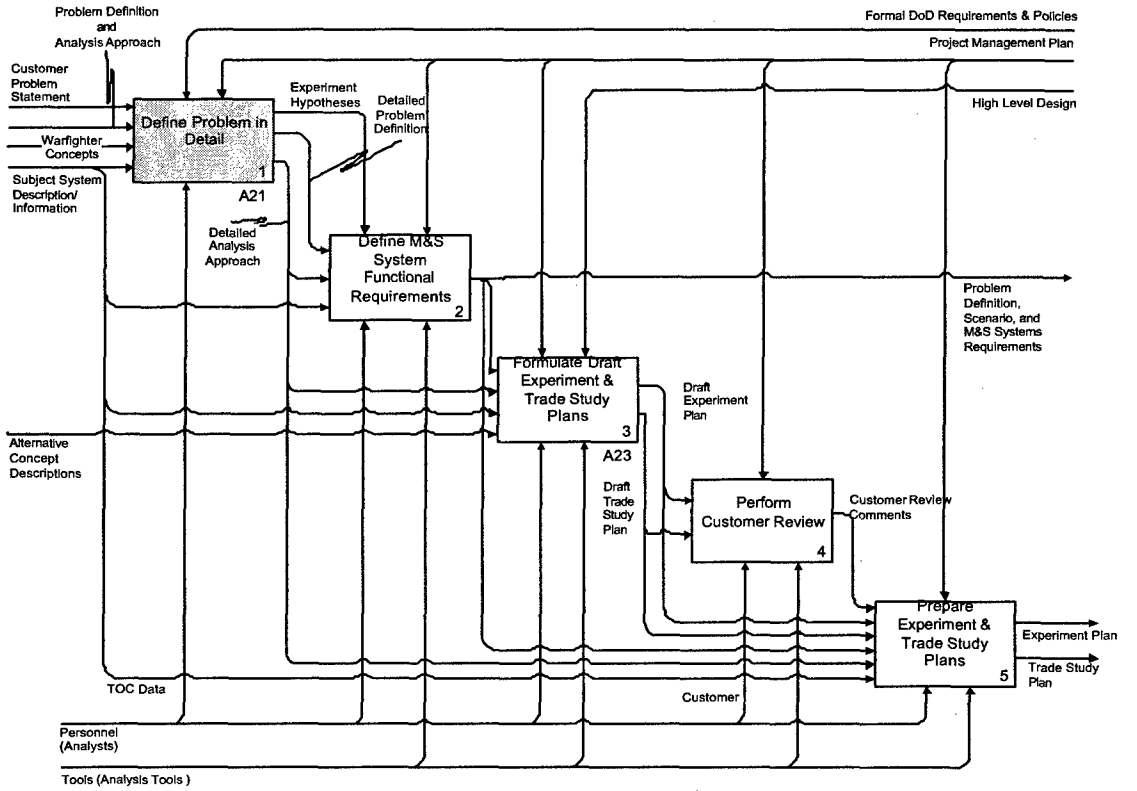


Figure A-A2(a) Analyze Problem

Inputs:

Customer Problem Statement – Tasking from the customer that defines the acquisition decision that application of the WARCON process will support.

Warfighter Concepts – Requirements for future weapon system designs that may include ORDs, MNS, ROCs, OAG inputs, etc.

Subject System Description/Information – Information and data available from external sources about the current and future warfare system being analyzed that is required to plan and perform the experiment and analysis.

Problem Definition and Analysis Approach – An expansion of the customer problem statement providing sufficient detail to support program planning, process tailoring, and determining the procedures the experiment and analysis will use to study the customer's issues.

Controls:

Formal DoD Requirements and Policies – Formal requirements documents and policy instructions related to the acquisition process and future weapons systems requirements.

Project Management Plan – The overall direction for all phases of the WARCON process to include tasks, organization, program resources and costs, software development, products, schedules and milestones. The Software Development Plan is included within this Plan.

Outputs:

Detailed Problem Definition – A detailed description of the customer problem in analytic terms including the scope of the problem, assumptions and limitations, and analysis approach.

Mechanisms:

Personnel – Government, contract employees, subject matter experts, systems engineers and analysts available to support using the WARCON process.

A2.1.1 Define Problem in Analytic Terms

Analyzing the customer problem statement with sufficient thoroughness to devise modeling, simulation, analysis and trade study requirements (Figure A-A2.1(a)).

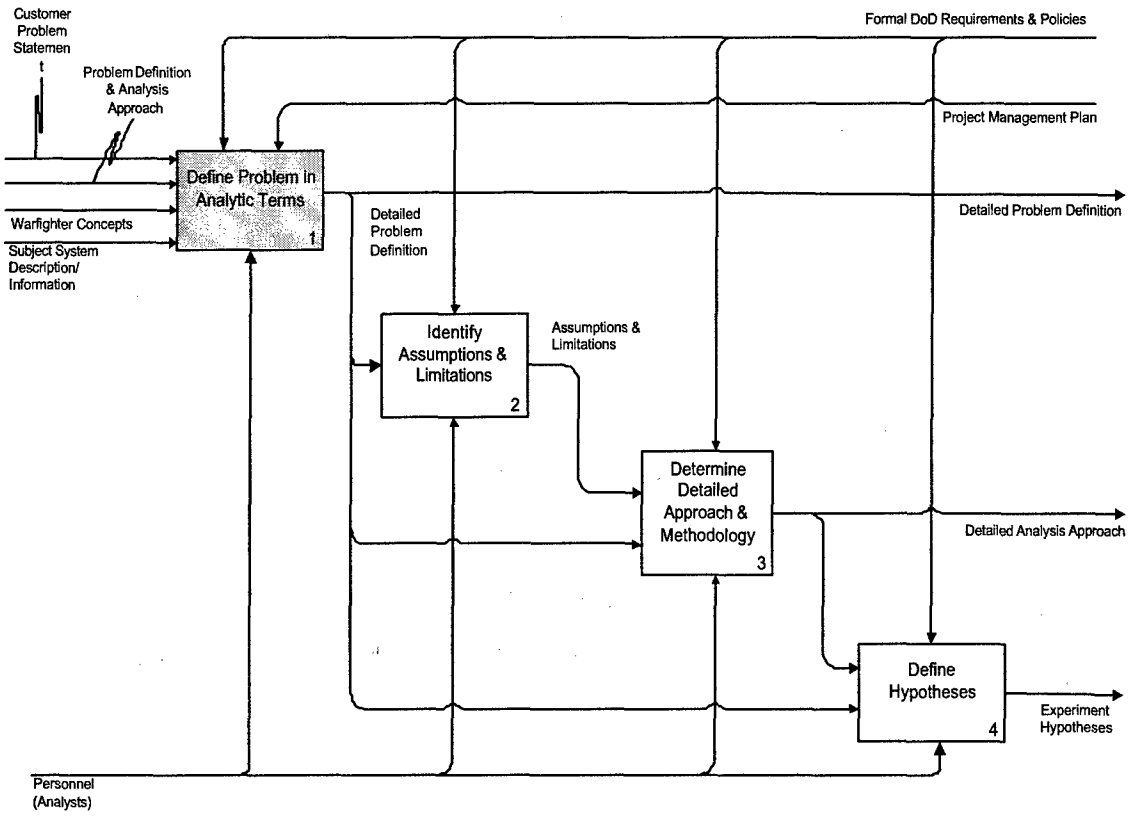


Figure A-A2.1(a) Define Problem in Detail

Inputs:

Customer Problem Statement – Tasking from the customer that defines the acquisition decision that application of the WARCON process will support.

Problem Definition and Analysis Approach – An expansion of the customer problem statement providing sufficient detail to support program planning, process tailoring, and determining the procedures the experiment and analysis will use to study the customer's issues.

Warfighter Concepts – Requirements for future weapon system designs that may include ORDs, MNS, ROCs, OAG inputs, etc.

Subject System Description/Information – Information and data available from external sources about the current and future warfare system being analyzed that is required to plan and perform the experiment and analysis.

Controls:

Formal DoD Requirements and Policies – Formal requirements documents and policy instructions related to the acquisition process and future weapons systems requirements.

Project Management Plan – The overall direction for all phases of the WARCON process to include tasks, organization, program resources and costs, software development, products, schedules and milestones. The Software Development Plan is included within this Plan.

Outputs:

Detailed Problem Definition – A detailed description of the customer problem in analytic terms including the scope of the problem, assumptions and limitations, and analysis approach.

Experiment Hypotheses – Description of the hypotheses that will be tested during the experiment.

Detailed Analysis Approach – Description, in detail, of the analysis approach that will support definition of functional requirements and Experiment/Trade Study design.

Mechanisms:

Personnel – Government, contract employees, subject matter experts, systems engineers and analysts available to support using the WARCON process.

A2.1.2 Identify Assumptions and Limitation

Identifying operational, analytical and system engineering assumptions and limitations that will constrain how the analysis is performed and provide a context for interpreting experiment results (Figure A-A2.1(b)).

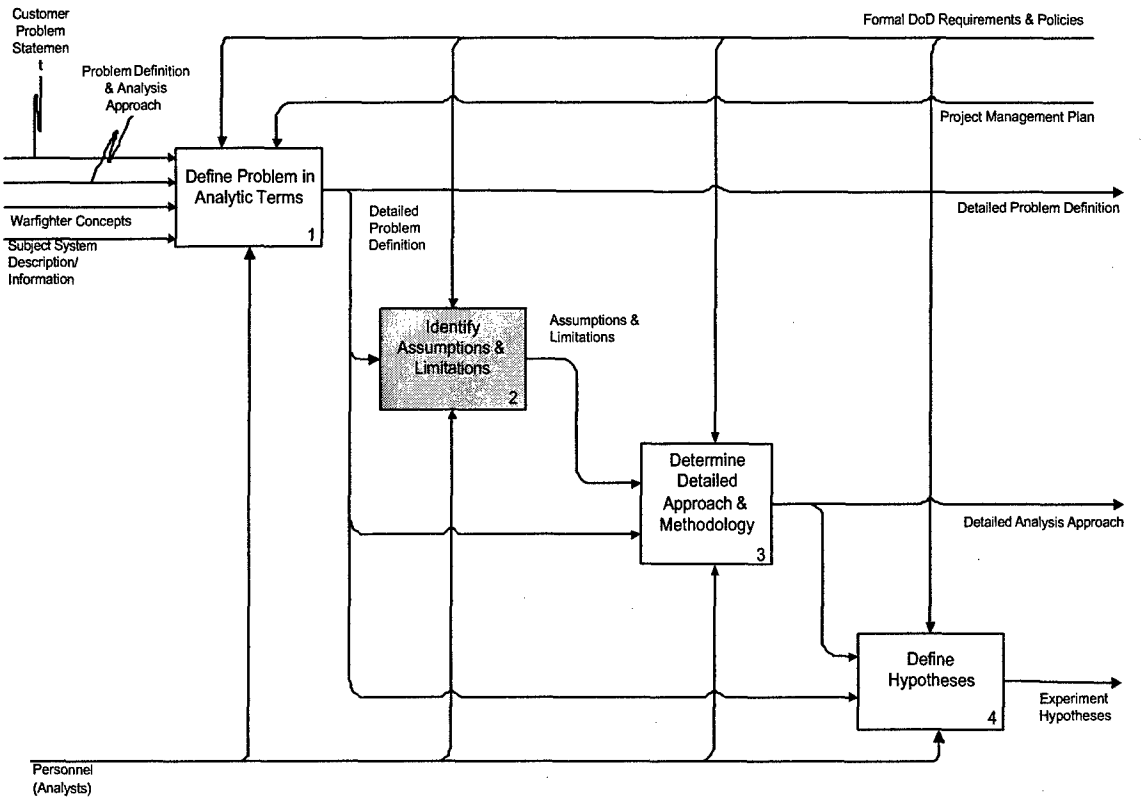


Figure A-A2.1(b) Define Problem in Detail

Inputs:

Detailed Problem Definition – A detailed description of the customer problem in analytic terms including the scope of the problem, assumptions and limitations, and analysis approach.

Controls:

Formal DoD Requirements and Policies – Formal requirements documents and policy instructions related to the acquisition process and future weapons systems requirements.

Outputs:

Assumptions and Limitations – Description of the assumptions and limitations for the analysis and experiment.

Mechanisms:

Personnel – Government, contract employees, subject matter experts, systems engineers and analysts available to support using the WARCON process.

A2.1.3 Determine Detailed Approach and Methodology

Defining the Analysis Approach in sufficient detail to allow the detailed functional requirements for the Integrated M&S System to be defined to address all aspects of the customer problem (Figure A-A2.1(c)).

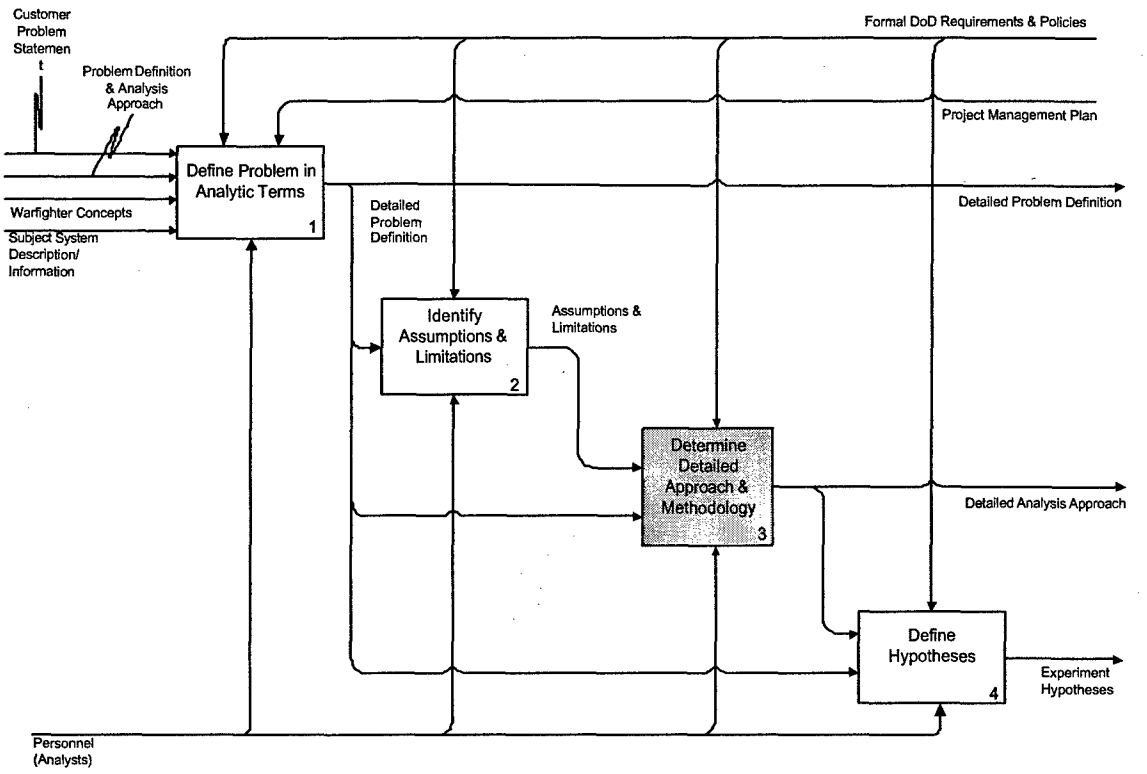


Figure A-A2.1(c) Define Problem in Detail

Inputs:

Assumptions and Limitations – Description of the assumptions and limitations for the analysis and experiment.

Detailed Problem Definition – A detailed description of the customer problem in analytic terms including the scope of the problem, assumptions and limitations, and analysis approach.

Controls:

Formal DoD Requirements and Policies – Formal requirements documents and policy instructions related to the acquisition process and future weapons systems requirements.

Outputs:

Detailed Analysis Approach – Description, in detail, of the analysis approach that will support definition of functional requirements and Experiment/Trade Study design.

Mechanisms:

Personnel – Government, contract employees, subject matter experts, systems engineers and analysts available to support using the WARCON process.

A2.1.4 Define Hypotheses

Defining the specific experimental hypotheses to be tested during the experiment using the Integrated M&S System (Figure A-A2.1(d)).

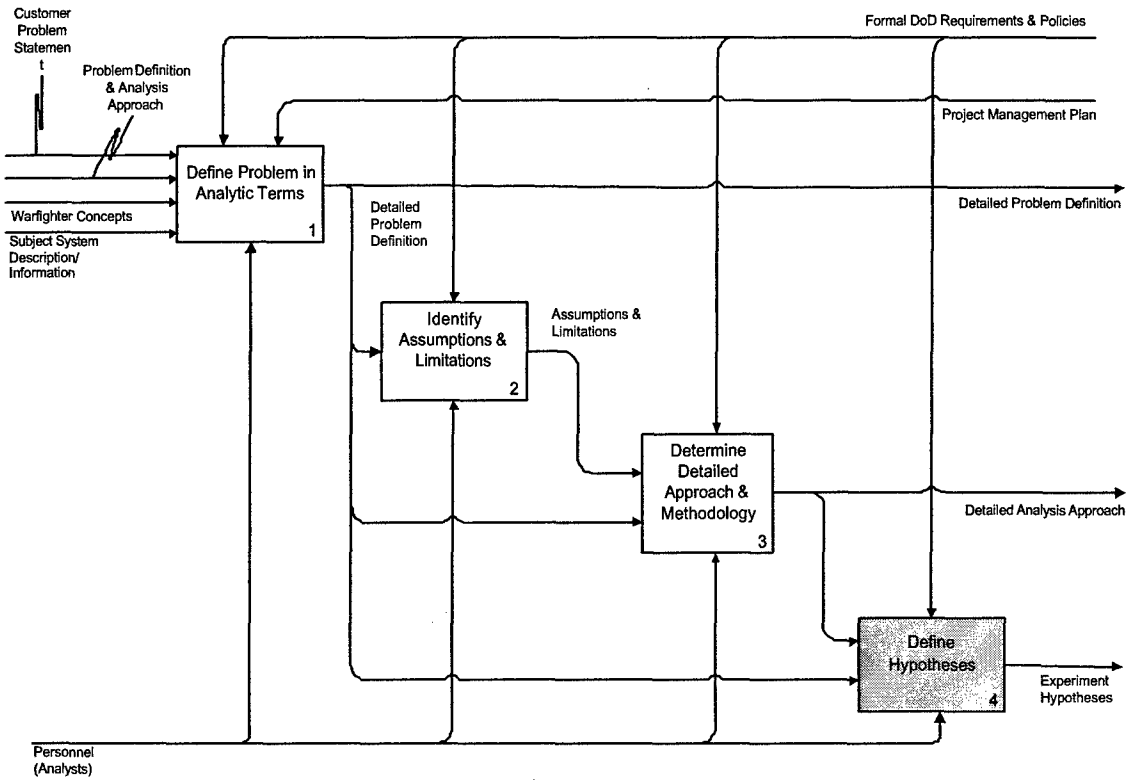


Figure A-A2.1(d) Define Problem in Detail

Inputs:

Detailed Analysis Approach – Description, in detail, of the analysis approach that will support definition of functional requirements and Experiment/Trade Study design.

Assumptions and Limitations – Description of the assumptions and limitations for the analysis and experiment.

Detailed Problem Definition – A detailed description of the customer problem in analytic terms including the scope of the problem, assumptions and limitations, and analysis approach.

Controls:

Formal DoD Requirements and Policies – Formal requirements documents and policy instructions related to the acquisition process and future weapons systems requirements.

Outputs:

Experiment Hypotheses – Description of the hypotheses that will be tested during the experiment.

Mechanisms:

Personnel – Government, contract employees, subject matter experts, systems engineers and analysts available to support using the WARCON process.

A2.2 Define M&S System Functional Requirements

Determining the unconstrained modeling and simulation requirements for completely assessing all aspects of the customer problem statement (Figure A-A2.2(b)).

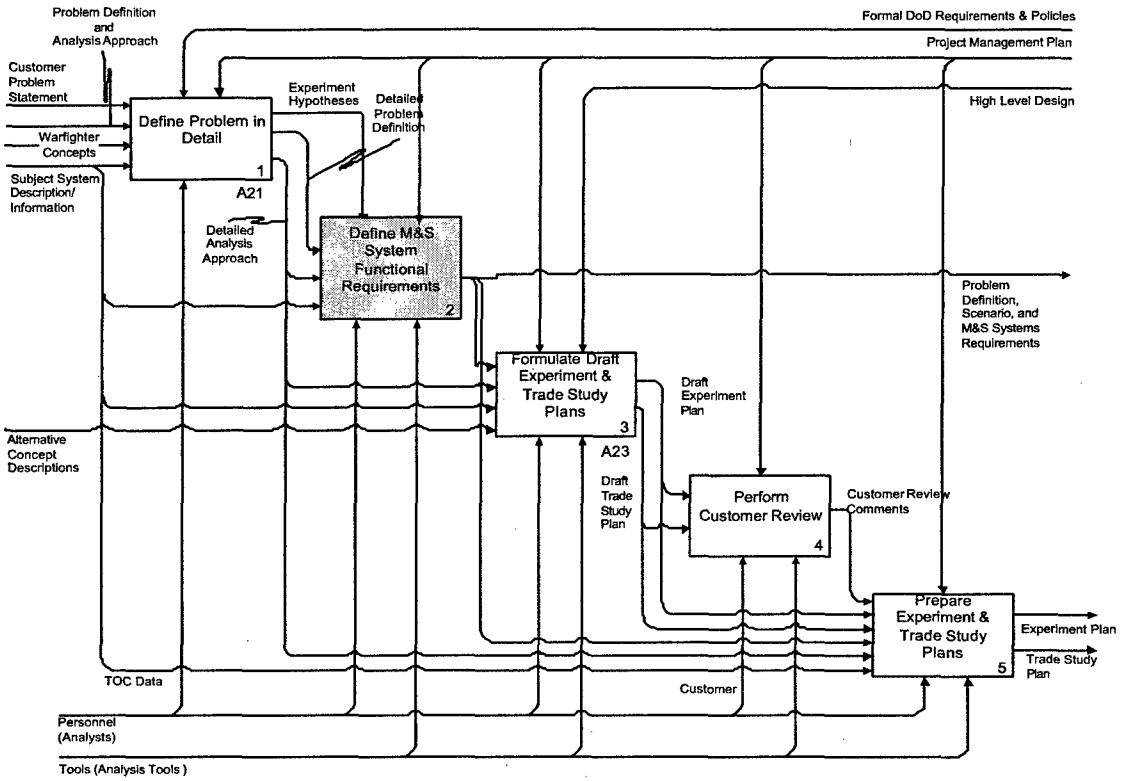


Figure A-A2(b) Analyze Problem

Inputs:

Detailed Problem Definition – A detailed description of the customer problem in analytic terms including the scope of the problem, assumptions and limitations, and analysis approach.

Detailed Analysis Approach – Description, in detail, of the analysis approach that will support definition of functional requirements and Experiment/Trade Study design.

Subject System Description/Information – Information and data available from external sources about the current and future warfare system being analyzed that is required to plan and perform the experiment and analysis.

Controls:

Experiment Hypotheses – Description of the hypotheses that will be tested during the experiment.

Project Management Plan – The overall direction for all phases of the WARCON process to include tasks, organization, program resources and costs, software development, products, schedules and milestones. The Software Development Plan is included within this Plan.

Outputs:

Problem Definition, Scenario, and M&S System Requirements – Description of the unconstrained functional requirements for the M&S System needed to address all aspects of the customer problem statement, including representations of the subject system, technologies, and operational scenarios.

Mechanisms:

Personnel – Government, contract employees, subject matter experts, systems engineers and analysts available to support using the WARCON process.

Tools – Previously validated methods, models and simulations that support the modeling and analysis environments.

A2.3 Formulate Draft Experiment and Trade Study Plans

Comparing the unconstrained functional requirements to the available M&S capabilities to determine the parts of the customer problem can be addressed, using analysis and available M&S, within program resource constraints (Figure A-A2(c)).

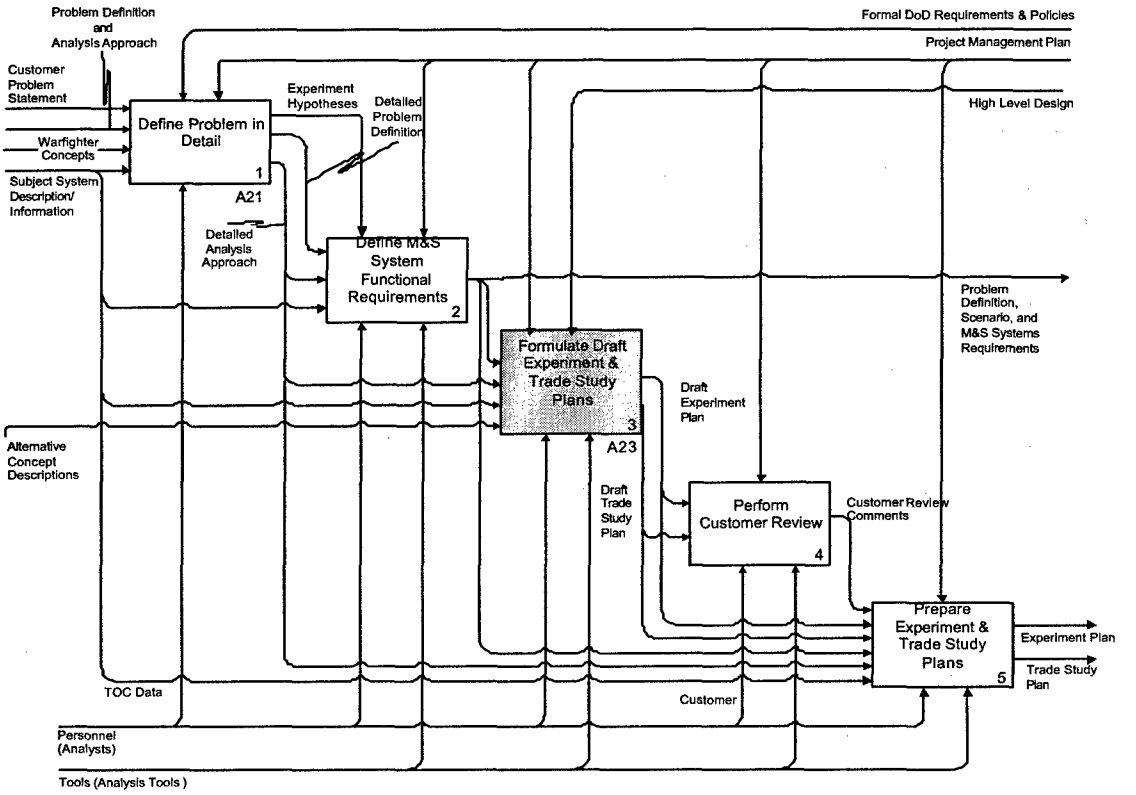


Figure A-A2(c) Analyze Problem

Inputs:

Problem Definition, Scenario, and M&S System Requirements – Description of the unconstrained functional requirements for the M&S System needed to address all aspects of the customer problem statement, including representations of the subject system, technologies, and operational scenarios.

Detailed Analysis Approach – Description, in detail, of the analysis approach that will support definition of functional requirements and Experiment/Trade Study design.

Subject System Description/Information – Information and data available from external sources about the current and future warfare system being analyzed that is required to plan and perform the experiment and analysis.

Alternative Concept Descriptions – Potential innovations that may resolve or decrease the capability gap.

Controls:

Project Management Plan – The overall direction for all phases of the WARCON process to include tasks, organization, program resources and costs, software development, products, schedules and milestones. The Software Development Plan is included within this Plan.

High Level Design (HLD) – Plan for building the Integrated System; requires program review approval.

Outputs:

Draft Experiment Plan – Draft document that defines the experiment approach, objectives, hypotheses, measures of performance and effectiveness (MOPs/MOEs), analysis methods, data extraction and collection requirements, scenarios, and explicit procedures for conducting the experiment.

Draft Trade Study Plan – Draft document that defines the approach, methods, and performance measures to be used to assess trade-offs among alternate weapon system designs and total ownership costs.

Mechanisms:

Personnel – Government, contract employees, subject matter experts, systems engineers and analysts available to support using the WARCON process.

Tools – Previously validated methods, models and simulations that support the modeling and analysis environments.

A2.3.1 Review Constraints on Functional Requirements

Taking the unconstrained functional requirements for the M&S System and imposing constraints based on the High Level Design and Project Management Plan (Figure A-A2.3(a)).

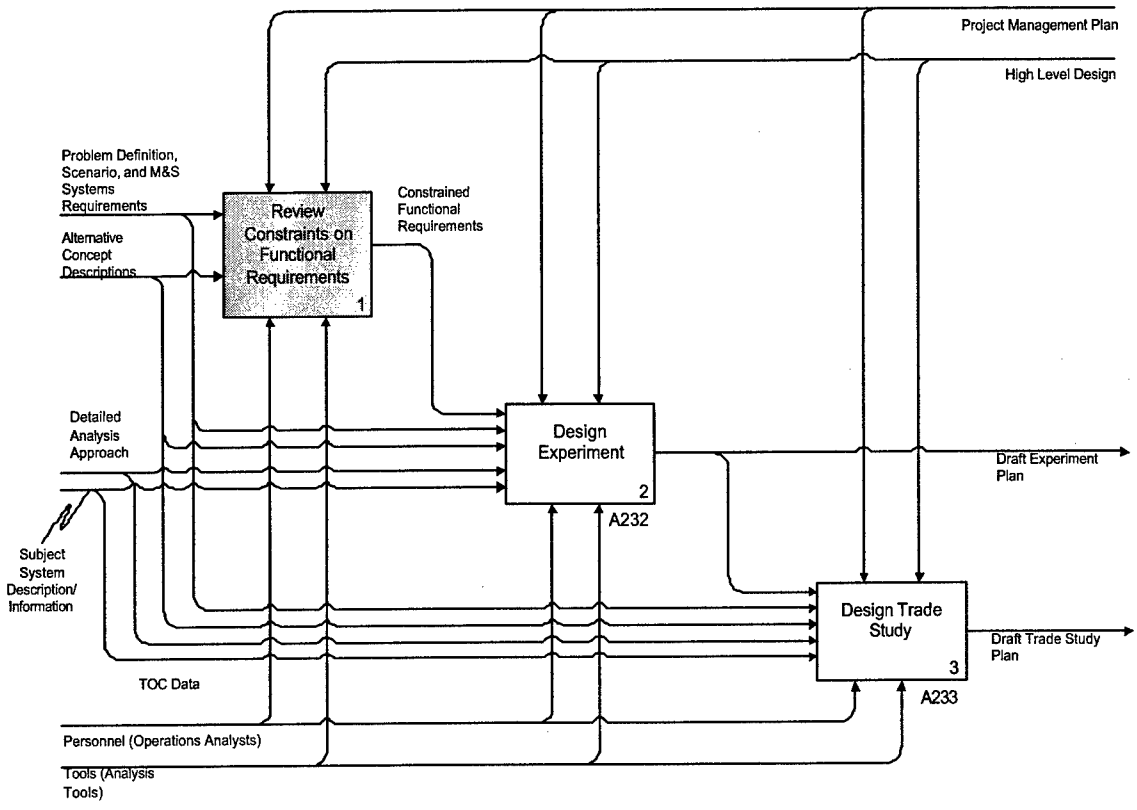


Figure A-A2.3(a) Formulate Draft Experiment and Trade Study Plans

Inputs:

Problem Definition, Scenario, and M&S System Requirements – Description of the unconstrained functional requirements for the M&S System needed to address all aspects of the customer problem statement, including representations of the subject system, technologies, and operational scenarios.

Alternative Concept Descriptions – Potential innovations that may resolve or decrease the capability gap.

Controls:

High Level Design – Plan for building the Integrated System; requires program review approval.

Project Management Plan – The overall direction for all phases of the WARCON process to include tasks, organization, program resources and costs, software development, products, schedules and milestones. The Software Development Plan is included within this Plan.

Outputs:

Constrained Functional Requirements – List of constrained M&S system functional requirements.

Mechanisms:

Personnel – Government, contract employees, subject matter experts, systems engineers and analysts available to support using the WARCON process.

Tools – Previously validated methods, models and simulations that support the modeling and analysis environments.

A2.3.2 Design Experiment

Designing an experiment that can be realistically performed within the resource constraints of the project using the selected M&S capabilities and the detailed analysis approach (Figure A-A2.3(b)).

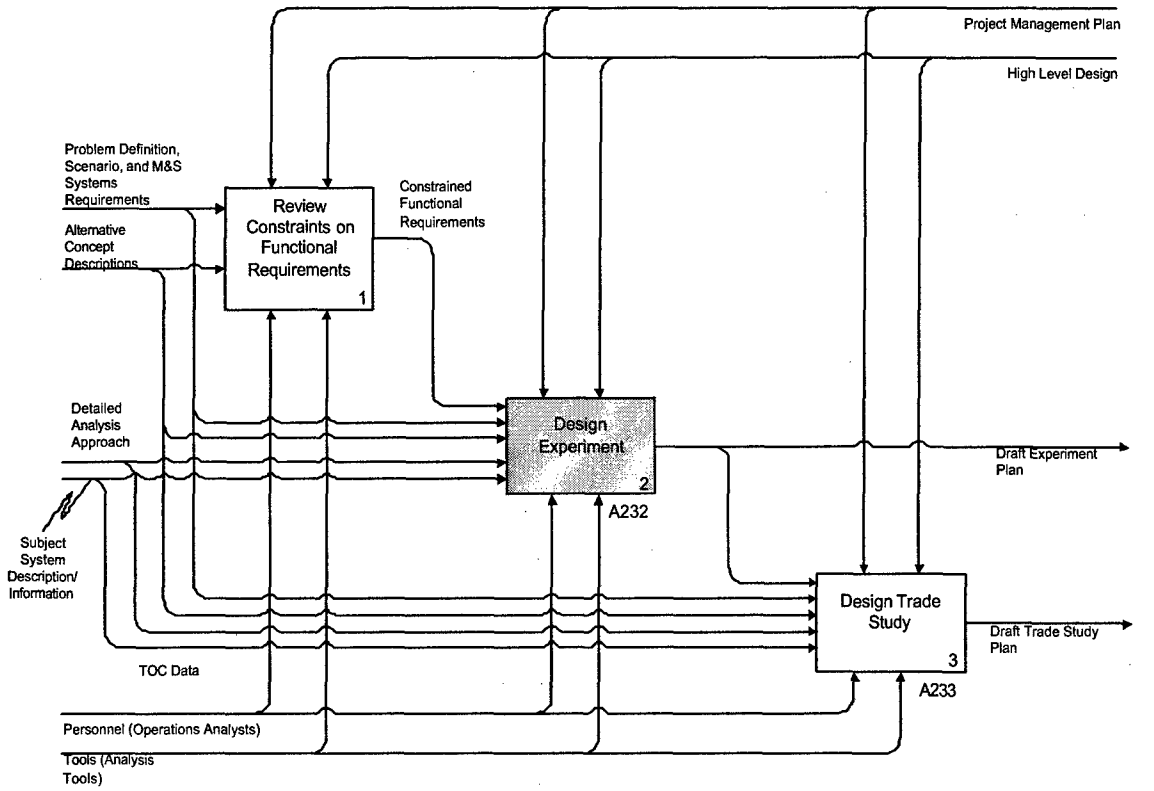


Figure A-A2.3(b) Formulate Draft Experiment and Trade Study Plans

Inputs:

Constrained Functional Requirements – List of constrained M&S system functional requirements.

Problem Definition, Scenario, and M&S System Requirements – Description of the unconstrained functional requirements for the M&S System needed to address all aspects of the customer problem statement, including representations of the subject system, technologies, and operational scenarios.

Detailed Analysis Approach – Description, in detail, of the analysis approach that will support definition of functional requirements and Experiment/Trade Study design.

Subject System Description/Information – Information and data available from external sources about the current and future warfare system being analyzed that is required to plan and perform the experiment and analysis.

Alternative Concept Descriptions – Potential innovations that may resolve or decrease the capability gap.

Controls:

High Level Design – Plan for building the Integrated System; requires program review approval.

Project Management Plan – The overall direction for all phases of the WARCON process to include tasks, organization, program resources and costs, software development, products, schedules and milestones. The Software Development Plan is included within this Plan.

Outputs:

Draft Experiment Plan – Draft document that defines the experiment approach, objectives, hypotheses, measures of performance and effectiveness (MOPs/MOEs), analysis methods, data extraction and collection requirements, scenarios, and explicit procedures for conducting the experiment.

Mechanisms:

Personnel – Government, contract employees, subject matter experts, systems engineers and analysts available to support using the WARCON process.

Tools – Previously validated methods, models and simulations that support the modeling and analysis environments.

A2.3.2.1 Identify Baseline/Comparison Case

Identifying the experiment case that will use as a baseline for comparing results of each excursion. The baseline/comparison case may be based on a current warfare system or operational concept that the customer problem statement seeks to improve or on a previously defined system solution (Figure A-A2.3.2(a)).

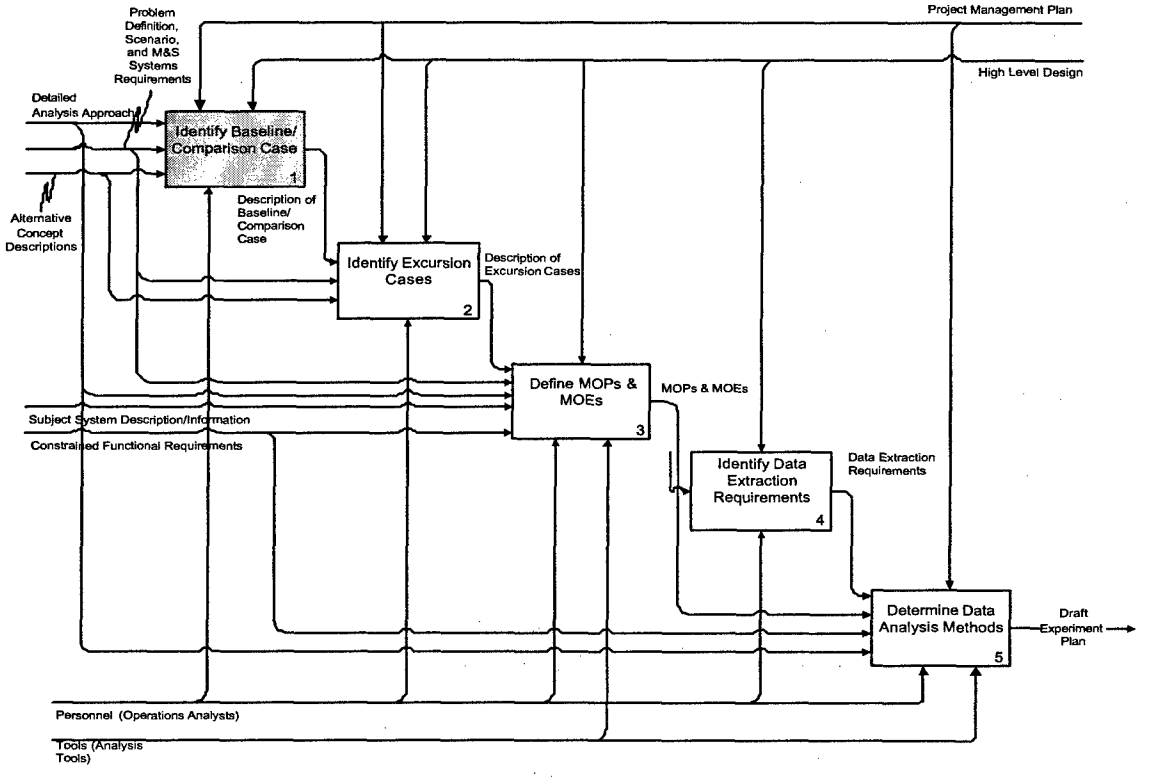


Figure A-A2.3.2(a) Design Experiment

Inputs:

Detailed Analysis Approach – Description, in detail, of the analysis approach that will support definition of functional requirements and Experiment/Trade Study design.

Problem Definition, Scenario, and M&S System Requirements – Description of the unconstrained functional requirements for the M&S System needed to address all aspects of the customer problem statement, including representations of the subject system, technologies, and operational scenarios.

Alternative Concept Descriptions – Potential innovations that may resolve or decrease the capability gap.

Controls:

High Level Design – Plan for building the Integrated System; requires program review approval.

Project Management Plan – The overall direction for all phases of the WARCON process to include tasks, organization, program resources and costs, software development, products, schedules and milestones. The Software Development Plan is included within this Plan.

Outputs:

Description of Baseline/Comparison Case – Description of the baseline or comparison experiment case used to compare excursion results, based on minimum subject system requirements.

Mechanisms:

Personnel – Government, contract employees, subject matter experts, systems engineers and analysts available to support using the WARCON process.

A2.3.2.2 Identify Excursion Cases

Developing variations to the Baseline/Comparison Case, based on potential improvements to the minimum subject system requirements, to be modeled and analyzed using experiment data (Figure A-A2.3.2(b)).

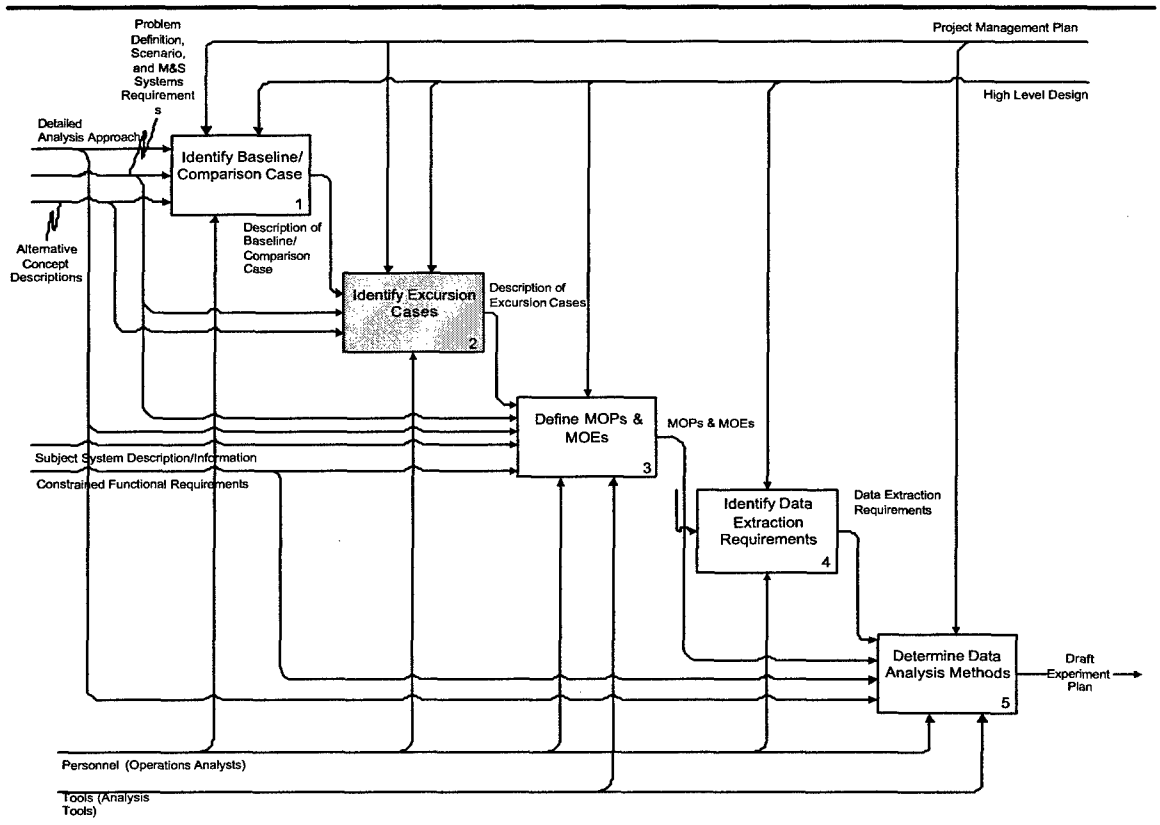


Figure A-A2.3.2(b) Design Experiment

Inputs:

Description of Baseline/Comparison Case – Description of the baseline or comparison experiment case used to compare excursion results, based on minimum subject system requirements.

Problem Definition, Scenario, and M&S System Requirements – Description of the unconstrained functional requirements for the M&S System needed to address all aspects of the customer problem statement, including representations of the subject system, technologies, and operational scenarios.

Alternative Concept Descriptions – Potential innovations that may resolve or decrease the capability gap.

Controls:

High Level Design – Plan for building the Integrated System; requires program review approval.

Project Management Plan – The overall direction for all phases of the WARCON process to include tasks, organization, program resources and costs, software development, products, schedules and milestones. The Software Development Plan is included within this Plan.

Outputs:

Description of Excursion Cases – Description of Excursion Cases to be used during the experiment execution in sufficient detail to allow quantitative performance measures to be defined.

Mechanisms:

Personnel – Government, contract employees, subject matter experts, systems engineers and analysts available to support using the WARCON process.

A2.3.2.3 Define MOPs and MOEs

Identifying and defining quantitative measures that can be used to characterize operational performance and effectiveness for the subject system excursions being modeled (Figure A-A2.3.2(c)).

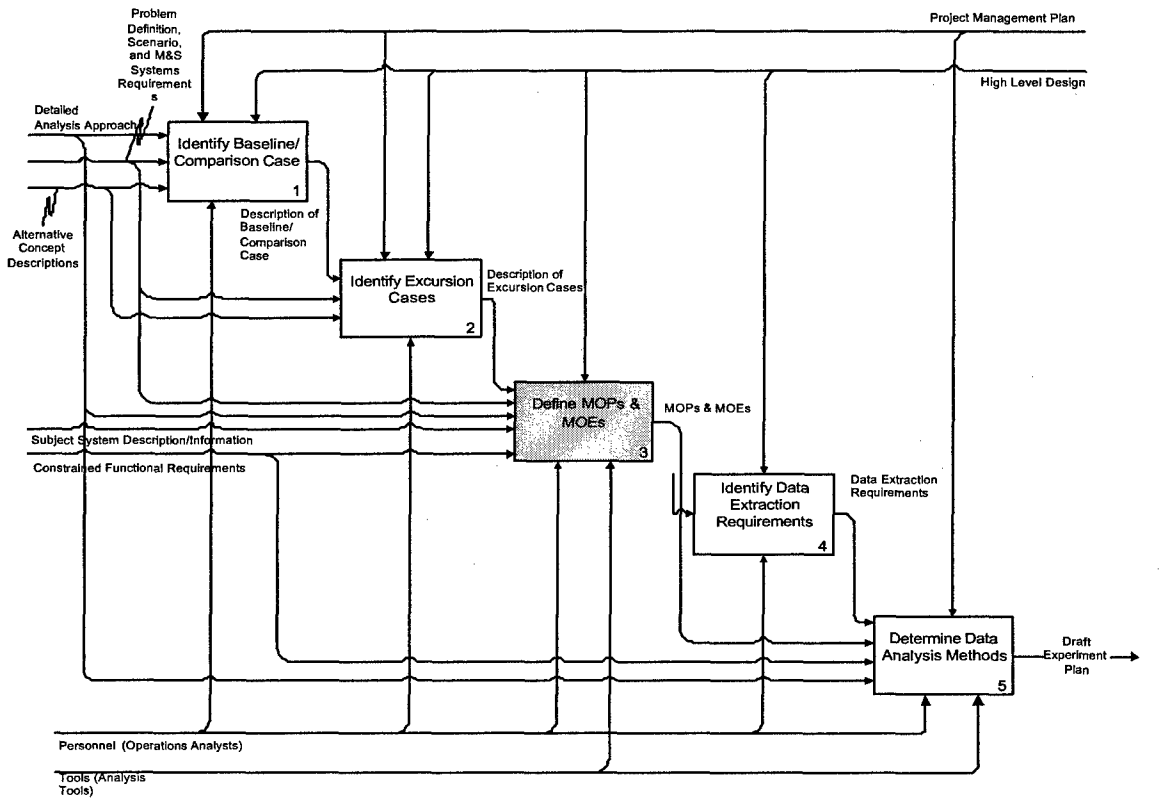


Figure A-A2.3.2(c) Design Experiment

Inputs:

Description of Excursion Cases – Description of Excursion Cases to be used during the experiment execution in sufficient detail to allow quantitative performance measures to be defined.

Problem Definition, Scenario, and M&S System Requirements – Description of the unconstrained functional requirements for the M&S System needed to address all aspects of the customer problem statement, including representations of the subject system, technologies, and operational scenarios.

Detailed Analysis Approach – Description, in detail, of the analysis approach that will support definition of functional requirements and Experiment/Trade Study design.

Subject System Description/Information – Information and data available from external sources about the current and future warfare system being analyzed that is required to plan and perform the experiment and analysis.

Constrained Functional Requirements – List of constrained M&S system functional requirements.

Controls:

High Level Design – Plan for building the Integrated System; requires program review approval.

Outputs:

MOPs and MOEs – Description of quantitative Measures of Performance and Measures of Effectiveness to be used for the experiment and Trade Study.

Mechanisms:

Personnel – Government, contract employees, subject matter experts, systems engineers and analysts available to support using the WARCON process.

Tools – Previously validated methods, models and simulations that support the modeling and analysis environments.

A2.3.2.4 Identify Data Extraction Requirements

Determining the data required from the Integrated M&S System during experiment execution to support MOP and MOE evaluation for the Baseline/Comparison and Excursion Cases (Figure A-A2.3.2(d)).

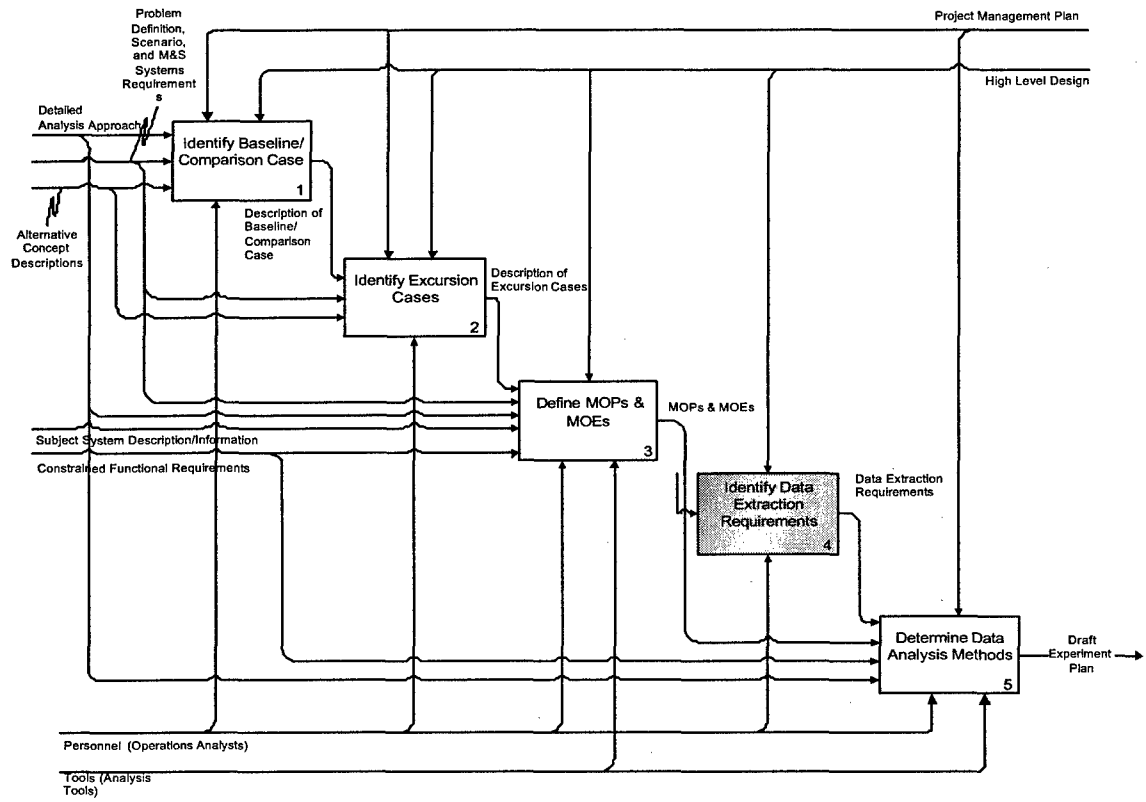


Figure A-A2.3.2(d) Design Experiment

Inputs:

MOPs and MOEs – Description of quantitative Measures of Performance and Measures of Effectiveness to be used for the experiment and Trade Study.

Controls:

High Level Design – Plan for building the Integrated System; requires program review approval.

Outputs:

Data Extraction Requirements – List of data extraction requirements for the Integrated M&S System during experiment execution.

Mechanisms:

Personnel – Government, contract employees, subject matter experts, systems engineers and analysts available to support using the WARCON process.

A2.3.2.5 Determine Data Analysis Methods

Identifying the analysis methods and tools to be used in analyzing experiment data (Figure A-A2.3.2(e)).

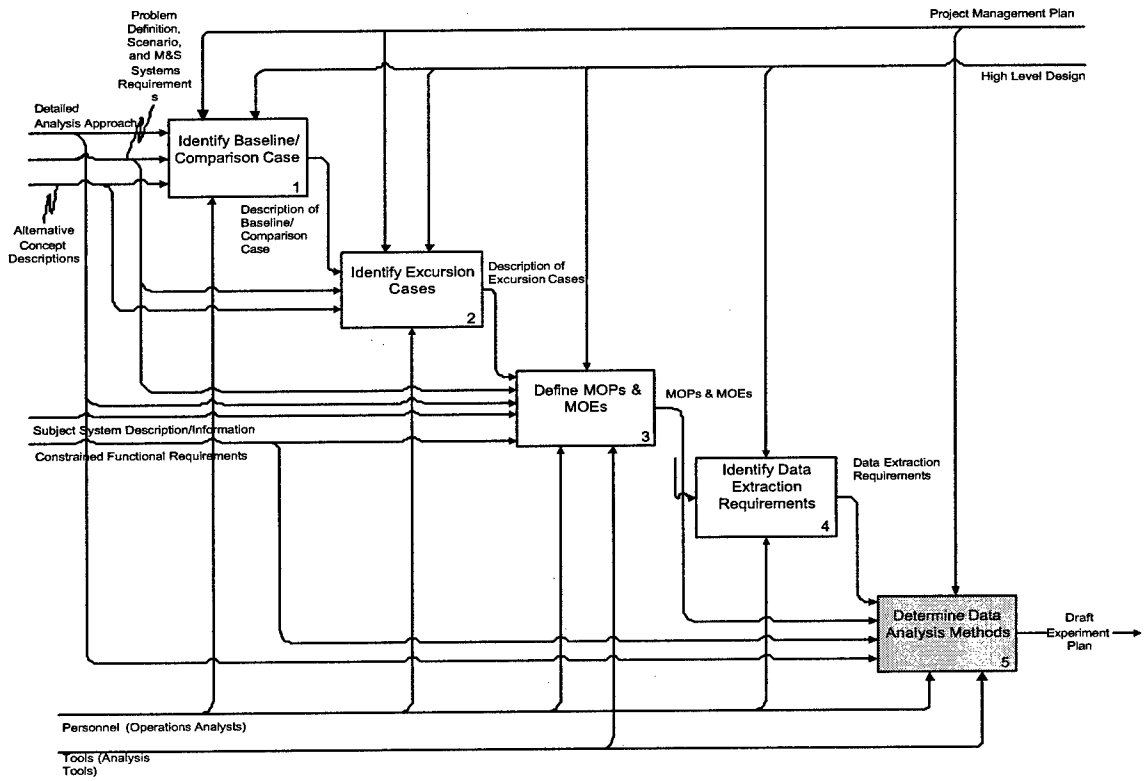


Figure A-A2.3.2(e) Design Experiment

Inputs:

Data Extraction Requirements – List of data extraction requirements for the Integrated M&S System during experiment execution.

MOPs and MOEs – Description of quantitative Measures of Performance and Measures of Effectiveness to be used for the experiment and Trade Study.

Detailed Analysis Approach – Description, in detail, of the analysis approach that will support definition of functional requirements and Experiment/Trade Study design.

Constrained Functional Requirements – List of constrained M&S system functional requirements.

Controls:

Project Management Plan – The overall direction for all phases of the WARCON process to include tasks, organization, program resources and costs, software development, products, schedules and milestones. The Software Development Plan is included within this Plan.

Outputs:

Draft Experiment Plan – Draft document that defines the experiment approach, objectives, hypotheses, measures of performance and effectiveness (MOPs/MOEs), analysis methods, data extraction and collection requirements, scenarios, and explicit procedures for conducting the experiment.

Mechanisms:

Personnel – Government, contract employees, subject matter experts, systems engineers and analysts available to support using the WARCON process.

Tools – Previously validated methods, models and simulations that support the modeling and analysis environments.

A2.3.3 Design Trade Study

Determining the approach, methods, and performance measures to be used to assess trade-offs among alternate weapon system designs and total ownership costs, based on experiment data for operational performance and cost, and integrating any required external cost-performance data (Figure A-A2.3(c)).

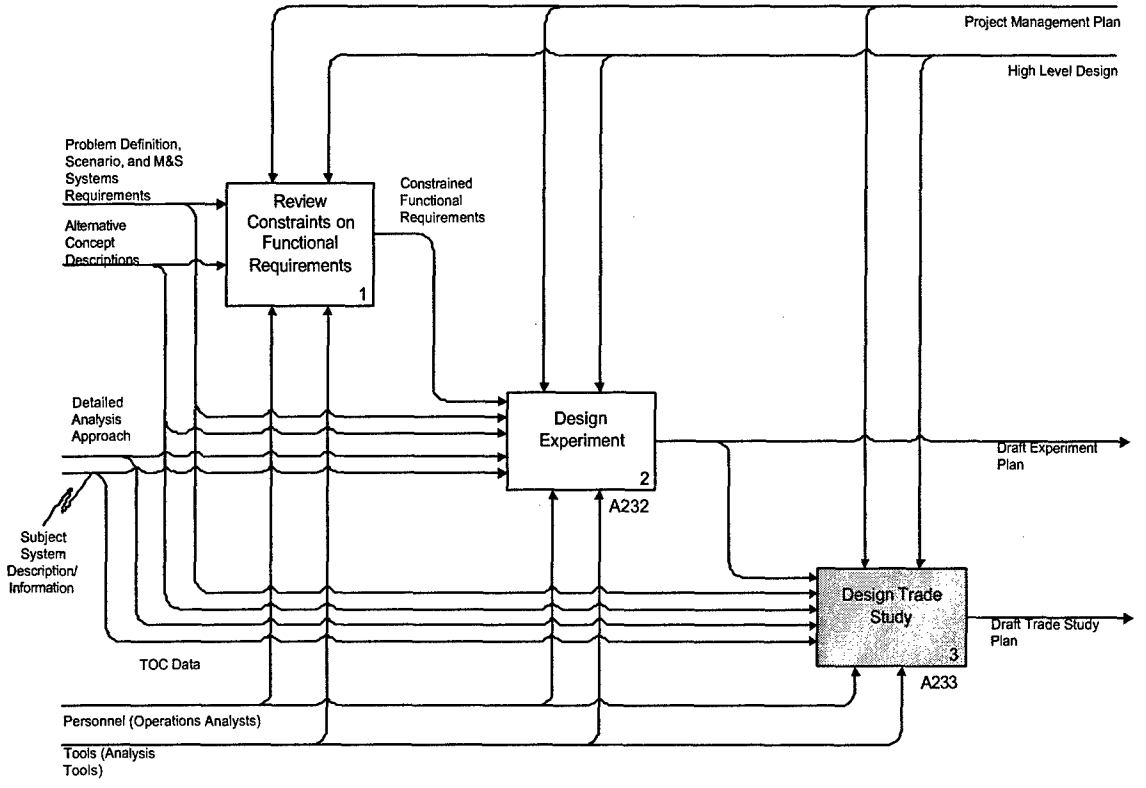


Figure A-A2.3(c) Formulate Draft Experiment and Trade Study Plans

Inputs:

Draft Experiment Plan – Draft document that defines the experiment approach, objectives, hypotheses, measures of performance and effectiveness (MOPs/MOEs), analysis methods, data extraction and collection requirements, scenarios, and explicit procedures for conducting the experiment.

Detailed Analysis Approach – Description, in detail, of the analysis approach that will support definition of functional requirements and Experiment/Trade Study design.

Problem Definition, Scenario, and M&S System Requirements – Description of the unconstrained functional requirements for the M&S System needed to address all aspects of the customer problem statement, including representations of the subject system, technologies, and operational scenarios.

TOC Data – External financial resource data required to support the WARCON process regarding equipping, sustaining, and operating military forces sufficient to meet national goals.

Alternative Concept Descriptions – Potential innovations that may resolve or decrease the capability gap.

Controls:

High Level Design – Plan for building the Integrated System; requires program review approval.

Project Management Plan – The overall direction for all phases of the WARCON process to include tasks, organization, program resources and costs, software development, products, schedules and milestones. The Software Development Plan is included within this Plan.

Outputs:

Draft Trade Study Plan – Draft document that defines the approach, methods, and performance measures to be used to assess trade-offs among alternate weapon system designs and total ownership costs.

Mechanisms:

Personnel – Government, contract employees, subject matter experts, systems engineers and analysts available to support using the WARCON process.

Tools – Previously validated methods, models and simulations that support the modeling and analysis environments.

A2.3.3.1 Define Trade Study Analysis Framework

Determining the detailed approach to be used to evaluate trade-offs between operational performance and total ownership cost for improved subject system alternatives based on experiment data (Figure A-2.3.3(a)).

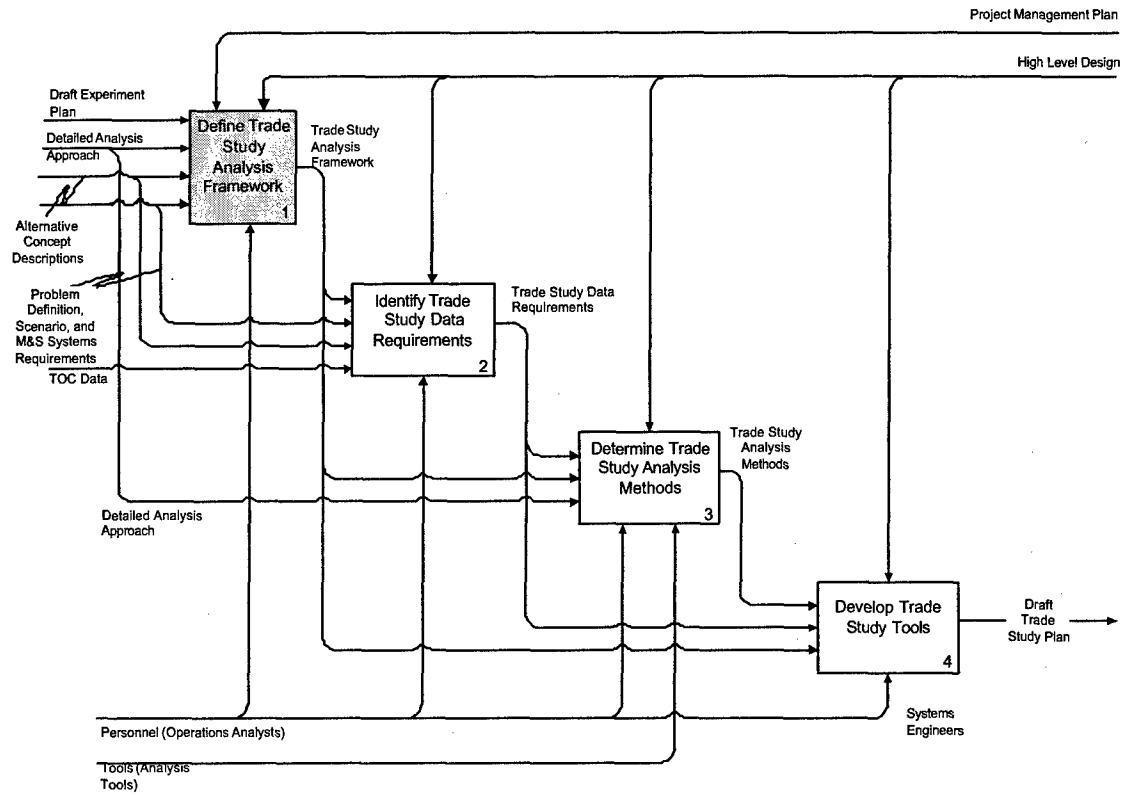


Figure A-A2.3.3(a) Design Trade Study

Inputs:

Draft Experiment Plan – Draft document that defines the experiment approach, objectives, hypotheses, measures of performance and effectiveness (MOPs/MOEs), analysis methods, data extraction and collection requirements, scenarios, and explicit procedures for conducting the experiment.

Detailed Analysis Approach – Description, in detail, of the analysis approach that will support definition of functional requirements and Experiment/Trade Study design.

Alternative Concept Descriptions – Potential innovations that may resolve or decrease the capability gap.

Problem Definition, Scenario, and M&S System Requirements – Description of the unconstrained functional requirements for the M&S System needed to address all aspects of the customer problem statement, including representations of the subject system, technologies, and operational scenarios.

Controls:

High Level Design – Plan for building the Integrated System; requires program review approval.

Project Management Plan – The overall direction for all phases of the WARCON process to include tasks, organization, program resources and costs, software development, products, schedules and milestones. The Software Development Plan is included within this Plan.

Outputs:

Trade Study Analysis Framework – Description of the detailed approach to be used to evaluate trade-offs between operational performance and total ownership cost for improved subject system alternatives based on experiment data.

Mechanisms:

Personnel – Government, contract employees, subject matter experts, systems engineers and analysts available to support using the WARCON process.

A2.3.3.2 Identify Trade Study Data Requirements

Determining the types and sources of data required to perform the Trade Study, based on experiment data, and including any required external data (Figure A-A2.3.3(b)).

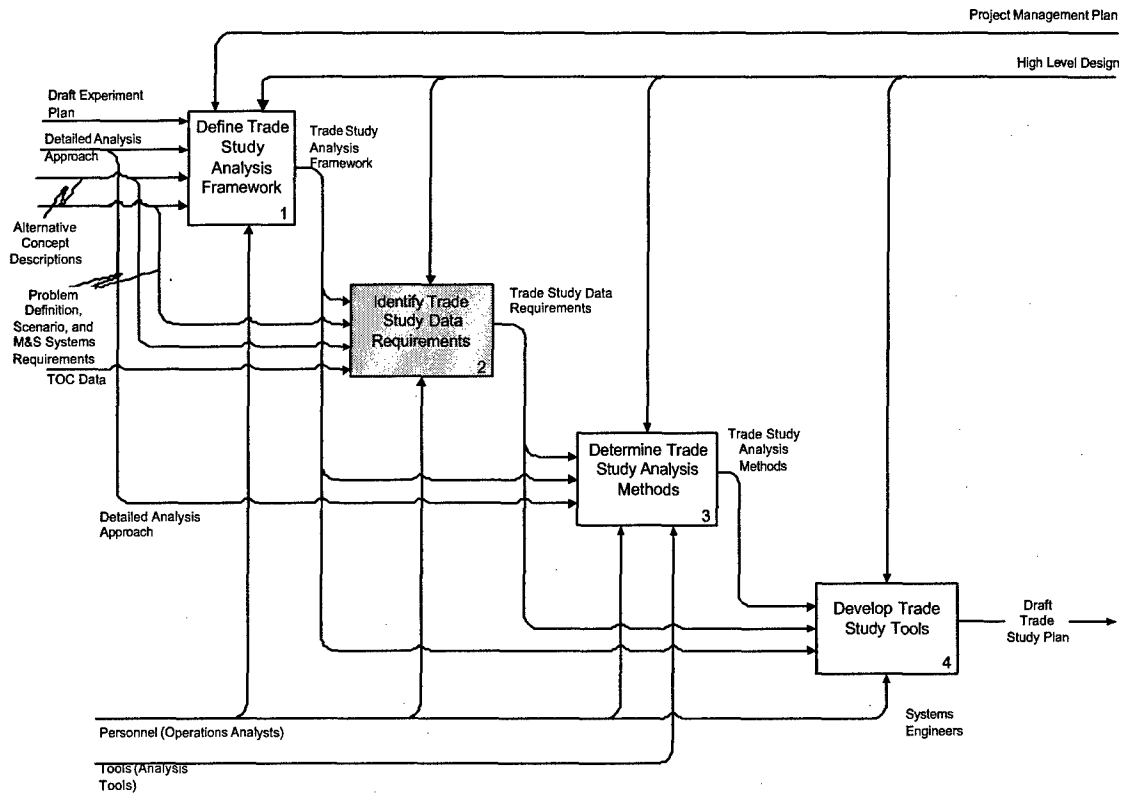


Figure A-A2.3.3(b) Design Trade Study

Inputs:

Trade Study Analysis Framework – Description of the detailed approach to be used to evaluate trade-offs between operational performance and total ownership cost for improved subject system alternatives based on experiment data.

Alternative Concept Descriptions – Potential innovations that may resolve or decrease the capability gap.

Problem Definition, Scenario, and M&S System Requirements – Description of the unconstrained functional requirements for the M&S System needed to address all aspects of the customer problem statement, including representations of the subject system, technologies, and operational scenarios.

TOC Data – External financial resource data required to support the WARCON process regarding equipping, sustaining, and operating military forces sufficient to meet national goals.

Controls:

High Level Design – Plan for building the Integrated System; requires program review approval.

Outputs:

Trade Study Data Requirements – Description of all data required to perform the Trade Study.

Mechanisms:

Personnel – Government, contract employees, subject matter experts, systems engineers and analysts available to support using the WARCON process.

A2.3.3.3 Determine Trade Study Analysis Methods

Determining the detailed analysis methods and tools required to perform the detailed trade-off analysis of alternate subject system designs and solutions (Figure A-A2.3.3(c)).

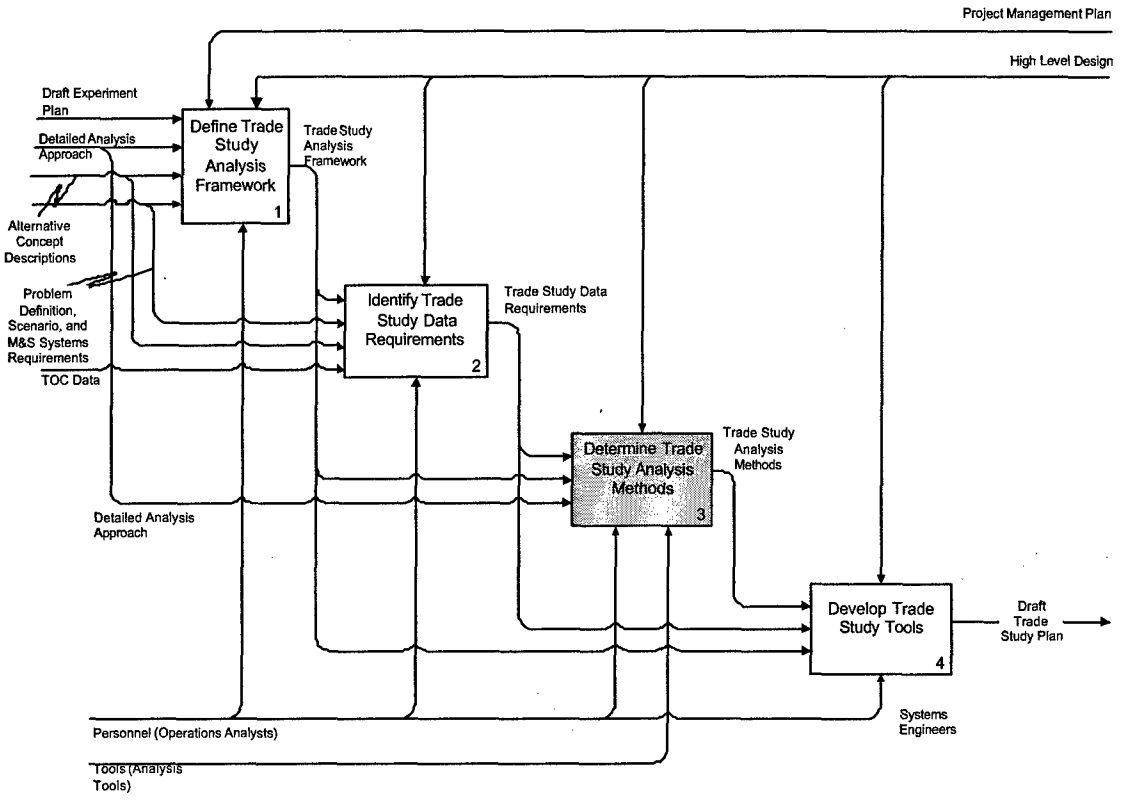


Figure A-A2.3.3(c) Design trade Study

Inputs:

Trade Study Data Requirements – Description of all data required to perform the Trade Study.

Trade Study Analysis Framework – Description of the detailed approach to be used to evaluate trade-offs between operational performance and total ownership cost for improved subject system alternatives based on experiment data.

Detailed Analysis Approach – Description, in detail, of the analysis approach that will support definition of functional requirements and Experiment/Trade Study design.

Controls:

High Level Design – Plan for building the Integrated System; requires program review approval.

Outputs:

Trade Study Analysis Methods – Description of the analysis methods and tools required to perform the detailed trade-off analysis of alternate subject system designs and solutions.

Mechanisms:

Personnel – Government, contract employees, subject matter experts, systems engineers and analysts available to support using the WARCON process.

Tools – Previously validated methods, models and simulations that support the modeling and analysis environments.

A2.3.3.4 Develop Trade Study Tools

Assessing available methods and tools for performing Trade Study analysis, adapting and tailoring the available tools as required, and developing any new tools not already available (Figure A-A2.3.3(d)).

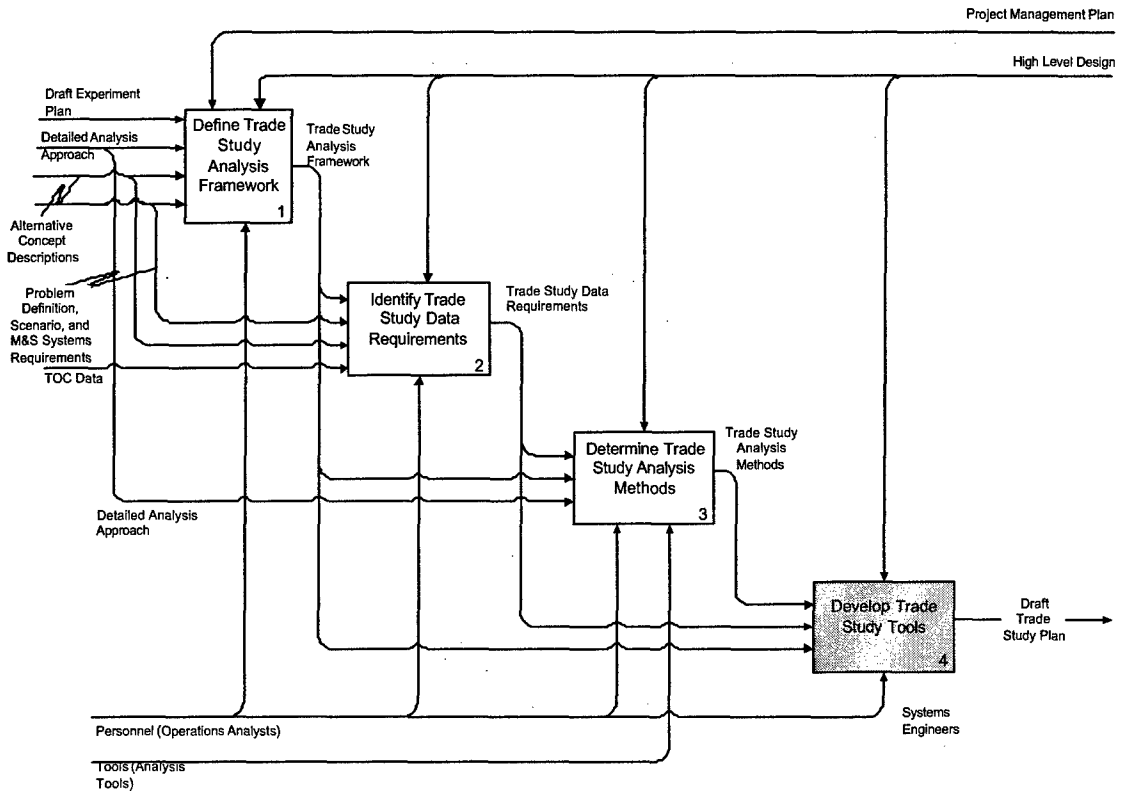


Figure A-A2.3.3(d) Design Trade Study

Inputs:

Trade Study Analysis Methods – Description of the analysis methods and tools required to perform the detailed trade-off analysis of alternate subject system designs and solutions.

Trade Study Data Requirements – Description of all data required to perform the Trade Study.

Trade Study Analysis Framework – Description of the detailed approach to be used to evaluate trade-offs between operational performance and total ownership cost for improved subject system alternatives based on experiment data.

Controls:

High Level Design – Plan for building the Integrated System; requires program review approval.

Outputs:

Draft Trade Study Plan – Draft document that defines the approach, methods, and performance measures to be used to assess trade-offs among alternate weapon system designs and total ownership costs.

Mechanisms:

Personnel – Government, contract employees, subject matter experts, systems engineers and analysts available to support using the WARCON process.

A2.4 Perform Customer Review

Providing the customer with draft Experiment and Trade Study Plans for review and meeting to discuss customer comments and recommendations (Figure A-A2(d)).

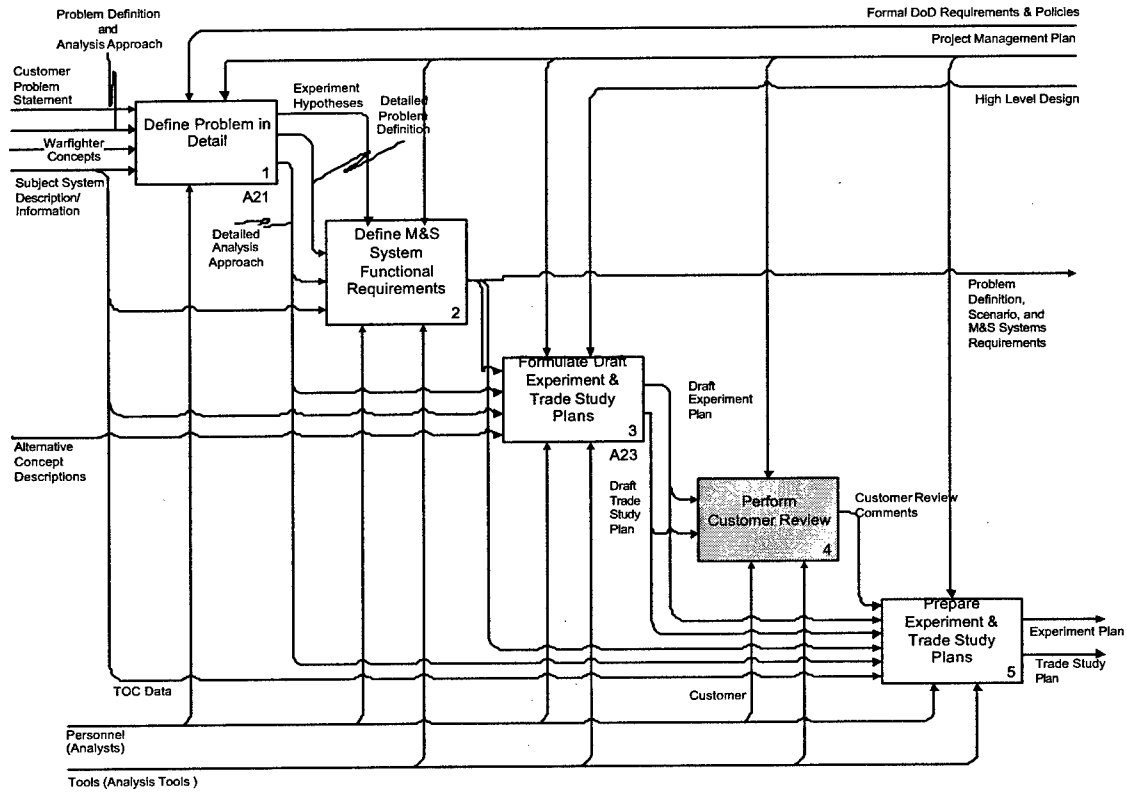


Figure A-A2(d) Analyze Problem

Inputs:

Draft Experiment Plan – Draft document that defines the experiment approach, objectives, hypotheses, measures of performance and effectiveness (MOPs/MOEs), analysis methods, data extraction and collection requirements, scenarios, and explicit procedures for conducting the experiment.

Draft Trade Study Plan – Draft document that defines the approach, methods, and performance measures to be used to assess trade-offs among alternate weapon system designs and total ownership costs.

Controls:

Project Management Plan – The overall direction for all phases of the WARCON process to include tasks, organization, program resources and costs, software development, products, schedules and milestones. The Software Development Plan is included within this Plan.

Outputs:

Customer Review Comments – Comments received from the customer during the review process.

Mechanisms:

Personnel – Government, contract employees, subject matter experts, systems engineers and analysts available to support using the WARCON process.

Tools – Previously validated methods, models and simulations that support the modeling and analysis environments.

A2.5 Prepare Experiment and Trade Study Plans

Incorporating customer comments into the draft plans (Figure A-A2(e)).

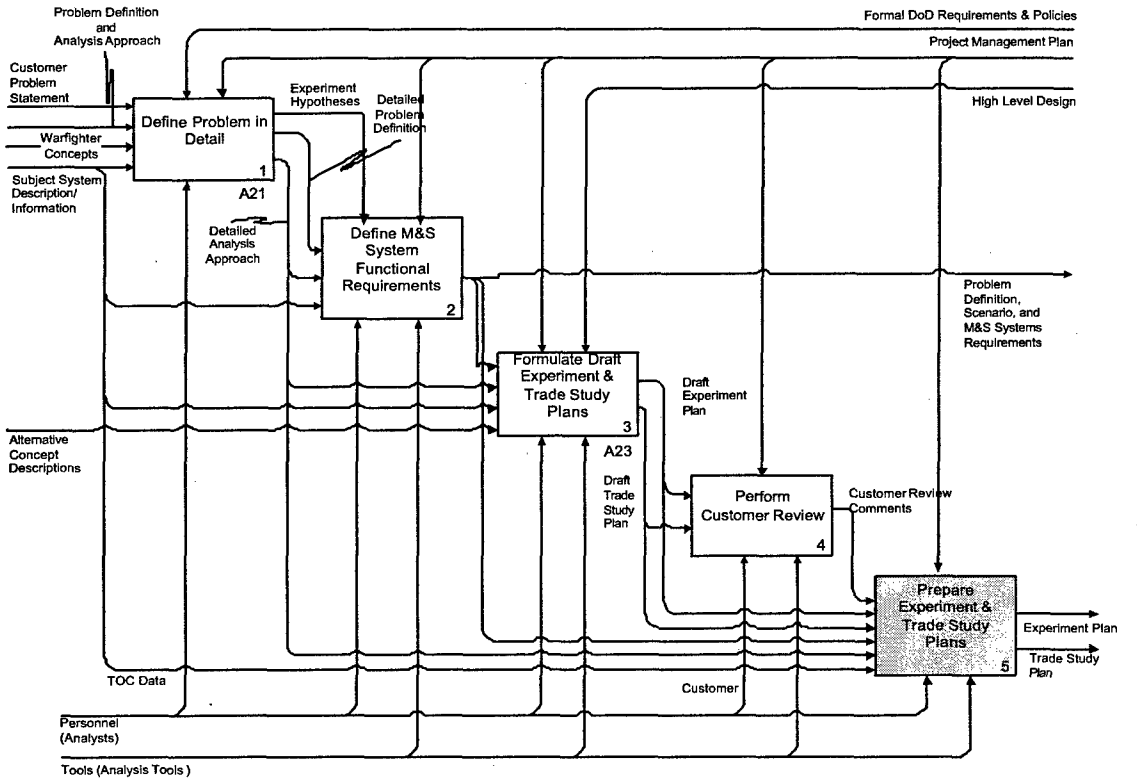


Figure A-A2(e) Analyze Problem

Inputs:

Customer Review Comments – Comments received from the customer during the review process.

Draft Experiment Plan – Draft document that defines the experiment approach, objectives, hypotheses, measures of performance and effectiveness (MOPs/MOEs), analysis methods, data extraction and collection requirements, scenarios, and explicit procedures for conducting the experiment.

Draft Trade Study Plan – Draft document that defines the approach, methods, and performance measures to be used to assess trade-offs among alternate weapon system designs and total ownership costs.

Problem Definition, Scenario, and M&S System Requirements – Description of the unconstrained functional requirements for the M&S System needed to address all aspects of the customer problem statement, including representations of the subject system, technologies, and operational scenarios.

TOC Data – External financial resource data required to support the WARCON process regarding equipping, sustaining, and operating military forces sufficient to meet national goals.

Detailed Analysis Approach – Description, in detail, of the analysis approach that will support definition of functional requirements and Experiment/Trade Study design.

Controls:

Project Management Plan – The overall direction for all phases of the WARCON process to include tasks, organization, program resources and costs, software development, products, schedules and milestones. The Software Development Plan is included within this Plan.

Outputs:

Experiment Plan – Document that defines the experiment approach, objectives, hypotheses, measures of performance and effectiveness (MOPs/MOEs), analysis methods, data extraction and collection requirements, scenarios, and explicit procedures for conducting the experiment.

Trade Study Plan – Document that defines the approach, methods, and performance measures to be used to assess trade-offs among alternate weapon system designs and total ownership costs.

Mechanisms:

Personnel – Government, contract employees, subject matter experts, systems engineers and analysts available to support using the WARCON process.

Tools – Previously validated methods, models and simulations that support the modeling and analysis environments.

A3 Develop Engineering Concepts

Develops concepts in physical terms, and provides cost estimates for them, that may be modeled, and simulated. The physical characteristics of the alternative Concept System(s) are determined. The concepts developed are the potential physical solutions to the operational problem set forth by prior analysis (Figure A-A0(c)).

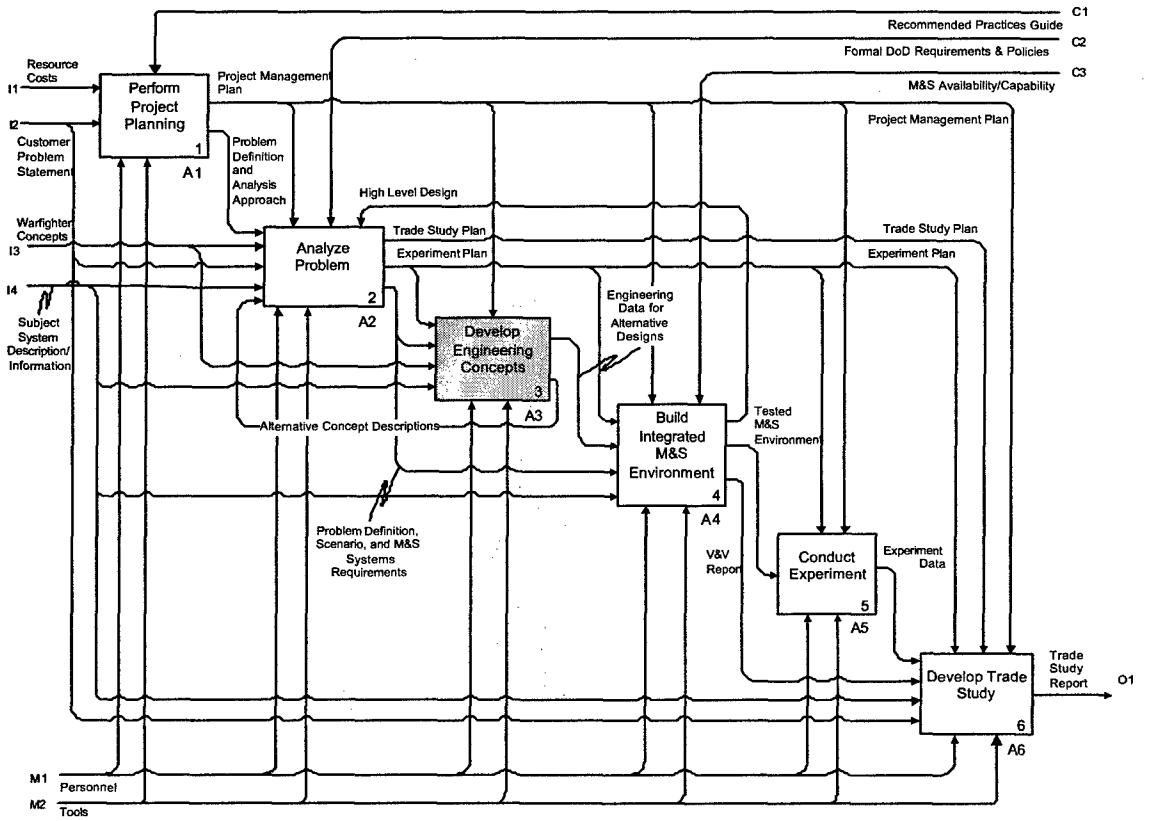


Figure A-A0(c) Execute WARCON Process

Input:

Experiment Plan – Document that defines the experiment approach, objectives, hypotheses, Measures of Performance and Effectiveness (MOPs/MOEs), analysis methods, data extraction and collection requirements, scenarios, and explicit procedures for conducting the experiment.

Subject System Description/Information – Information and data available from external sources about the current and future warfare system being analyzed that is required to plan and perform the experiment and analysis.

Problem Definition, Scenario, and M&S System Requirements – Description of the unconstrained functional requirements for the M&S System needed to address all aspects of the customer problem statement, including representations of the subject system, and operational scenarios.

Warfighter Concepts – Requirements for future weapon system designs that may include ORDs, MNS, ROCs, OAG inputs, etc.

Industry DoD Technical Data – Relevant information for design gathered from industry and DoD sources about new and otherwise applicable technologies that may be used to determine a concept system.

Controls:

Project Management Plan – The overall direction for all phases of the WARCON process to include tasks, organization, program resources and costs, software development, products, schedules and milestones. The Software Development Plan is included within this Plan.

Outputs:

Alternate Concepts Descriptions – Tabulates the conglomeration of technologies selected to be part of the concept system with a general vision of their eventual arrangement with one another.

Engineering Data for Alternative Designs – Concept System data collated in the form of a Concept Engineering Package providing a Concept Schematic, any Software Design Documents that may be applicable, Material Lists, a Short System Description, a Concept System Specification, and a likelihood estimate for the Concept System's prospects of actually being developed.

Cost Data for Alternative Designs – Rough order of magnitude estimates of acquisition costs in relative terms, as well as estimates of total ownership costs of the subject Concept Systems under study.

Mechanisms:

Personnel – Engineers, Analysts, Subject Matter Experts, and other government and contracted employees having cognizance in the activity.

Tools – Accepted methods and engineering resources that support the activity.

Facility – Building and equipment necessary to support the personnel and tools involved in the activity.

A3.1 Determine Capabilities Gap

Identifies the difference between existing and desired operational states, and reduces these differences into engineering terms for design (Figure A-A3(a)).

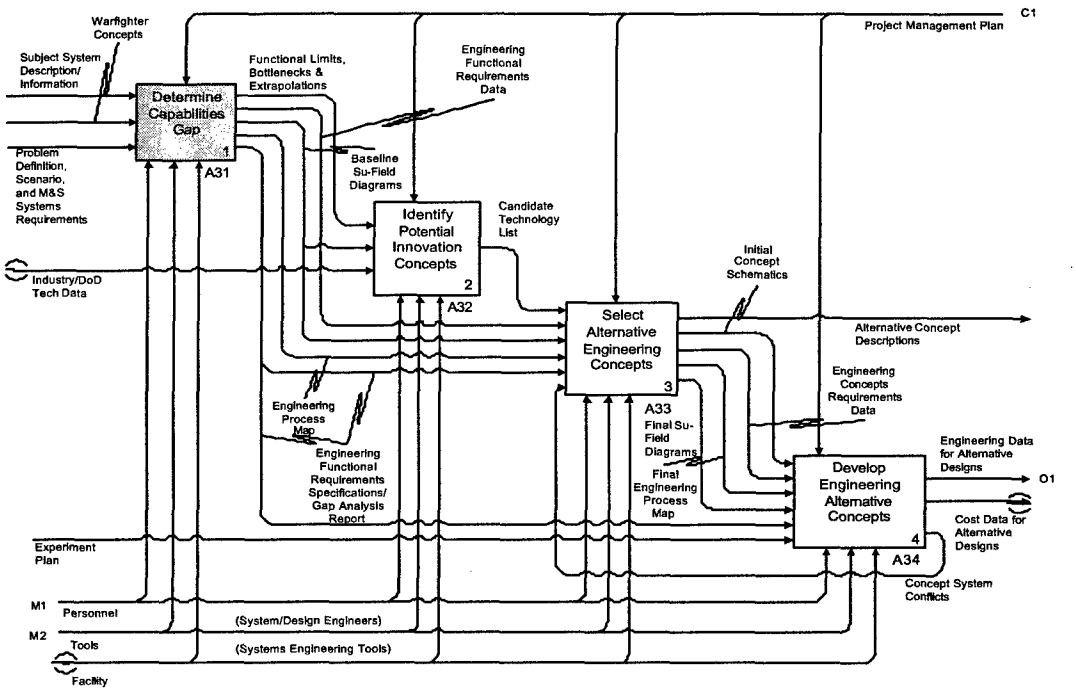


Figure A-A3(a) Develop Engineering Concepts

Input:

Subject System Description/Information – Information and data available from external sources about the current and future warfare system being analyzed that is required to plan and perform the experiment and analysis.

Warfighter Operations Data – The representation of facts, information, or instructions, formalized to be suitable for communication, of warfighter operations as experienced in the field.

Warfighter Concepts – Requirements for future weapon system designs that may include ORDs, MNS, ROCs, OAG inputs, etc.

Problem Definition, Scenario, and M&S System Requirements – Description of the unconstrained functional requirements for the M&S System needed to address all aspects of the customer problem statement, including representations of the subject system, and operational scenarios.

Controls:

Project Management Plan – The overall direction for all phases of the WARCON process to include tasks, organization, program resources and costs, software development, products, schedules and milestones. The Software Development Plan is included within this Plan.

Outputs:

Baseline Substance Field (Su-Field) Diagrams – Schematics depicting Subject – Action – Object relationships between component objects in the baseline system under study.

Functional Limits, Bottlenecks, and Extrapolations – A report describing the functional capability limitations to the existing baseline system. These limits are presented as system conflicts, i.e. bottlenecks that prohibit the system from achieving greater capability. Extrapolations beyond these limits that show what greater capability can be achieved if the limits were to be overcome are also included in the report.

Engineering Process Map – A flowchart detailing on an engineering level the activities and events involved with the operation under study. The map is developed by Subject Matter Experts having intimate experience with and immediate knowledge of, the operation being studied.

Engineering Functional Requirements Specifications – Delineates on the engineering level the functional capabilities for engineering to address in subsequent development of the Concept Systems.

Gap Analysis Report – A description of the gap measures determined. The report may include descriptions of the system conflicts causing a gap, and the functional system requirements aimed at closing a gap.

Engineering Functional Requirements Data – Requirements extracted from the Engineering Functional Requirements Specification and put onto a Requirements Management Application database for subsequent tracking and analysis.

Mechanisms:

Personnel – Engineers, Analysts, Subject Matter Experts, and other government and contracted employees having cognizance in the activity.

Tools – Accepted methods and engineering resources that support the activity.

Faculty – Building and equipment necessary to support the personnel and tools involved in the activity.

A3.1.1 Establish Baseline Functional Limits and Excursions

Determines limitations to the existing baseline system. Limits are presented as system conflicts, i.e. bottlenecks that prohibit the system from achieving greater capability. Excursions are extrapolated beyond these limits to see what greater capability can be achieved if the limits were to be overcome (Figure A-A3.1(a)).

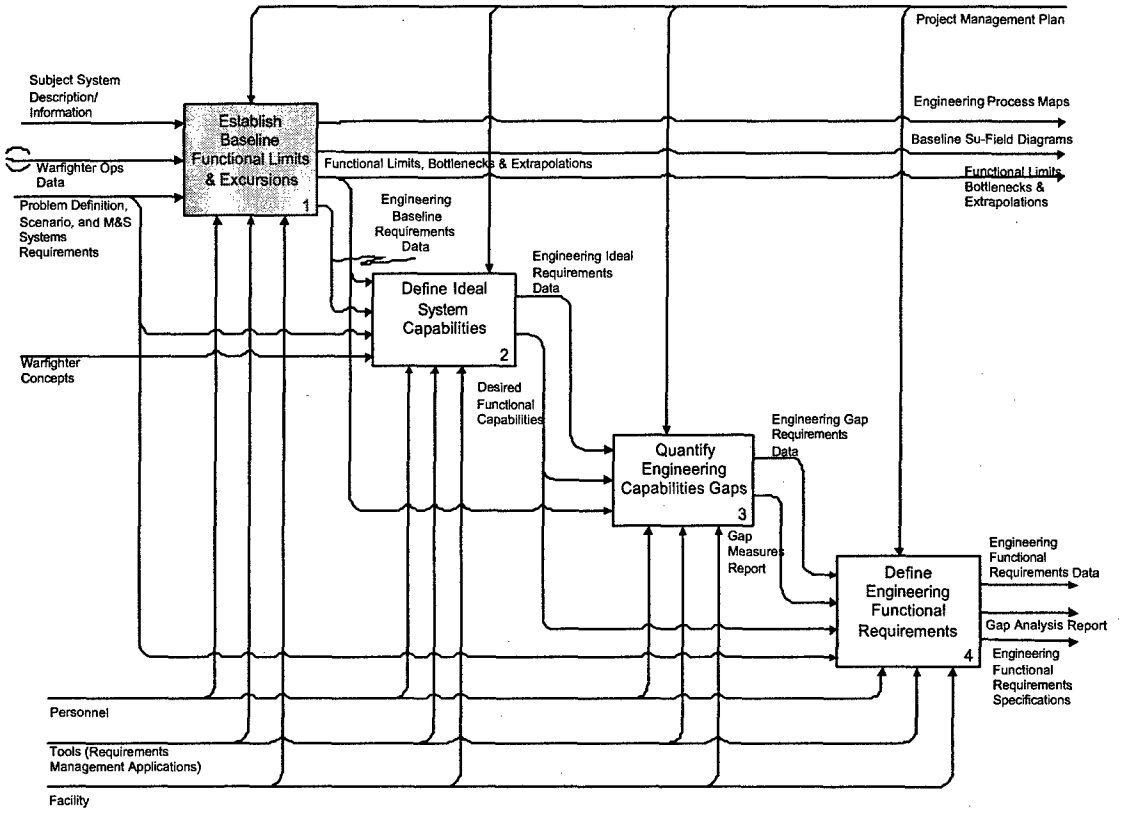


Figure A-A3.1(a) Determine Capabilities Gap

Inputs:

Subject System Description/Information – Information and data available from external sources about the current and future warfare system being analyzed that is required to plan and perform the experiment and analysis.

Problem Definition, Scenario, and M&S System Requirements – Description of the unconstrained functional requirements for the M&S System needed to address all aspects of the customer problem statement, including representations of the subject system, and operational scenarios.

Warfighter Operations Data – The representation of facts, information, or instructions, formalized to be suitable for communication, of warfighter operations as experienced in the field.

Controls:

Project Management Plan – The overall direction for all phases of the WARCON process to include tasks, organization, program resources and costs, software development, products, schedules and milestones. The Software Development Plan is included within this Plan.

Outputs:

Baseline Su-Field Diagrams – Schematics depicting Subject – Action – Object relationships between component objects in the baseline system under study.

Functional Limits, Bottlenecks, and Extrapolations – A report describing the functional capability limitations to the existing baseline system. These limits are presented as system conflicts, i.e. bottlenecks that prohibit the system from achieving greater capability. Extrapolations beyond these limits that show what greater capability can be achieved if the limits were to be overcome are also included in the report.

Engineering Process Map – A flowchart detailing on an engineering level the activities and events involved with the operation under study. The map is developed by Subject Matter Experts having intimate experience with and immediate knowledge of the operation being studied.

Engineering Baseline Requirements Data – Requirements extracted from the Engineering Process Maps, and Su-Field Diagrams and put onto a Requirements Management Application database with the requirements data from prior engineering activities for subsequent tracking and analysis.

Mechanisms:

Personnel – Subject Matter Experts, Analysts, Engineers and other government and contracted employees having cognizance in the activity.

Tools – Accepted methods, and engineering resources that support the activity.

Requirements Management Application – Software designed handle requirements extracted from output documents. The software is to track requirements from their inception to application in support of requirements and design analysis throughout the engineering activities.

Facility– Buildings and equipment necessary to support personnel and tools in the conduct of the activities.

A3.1.2 Define Ideal System Capabilities

Determines the actual functional capabilities desired for engineering to address from considerations of the problem posed, the limits and bottlenecks (Figure A-A3.1(b)).

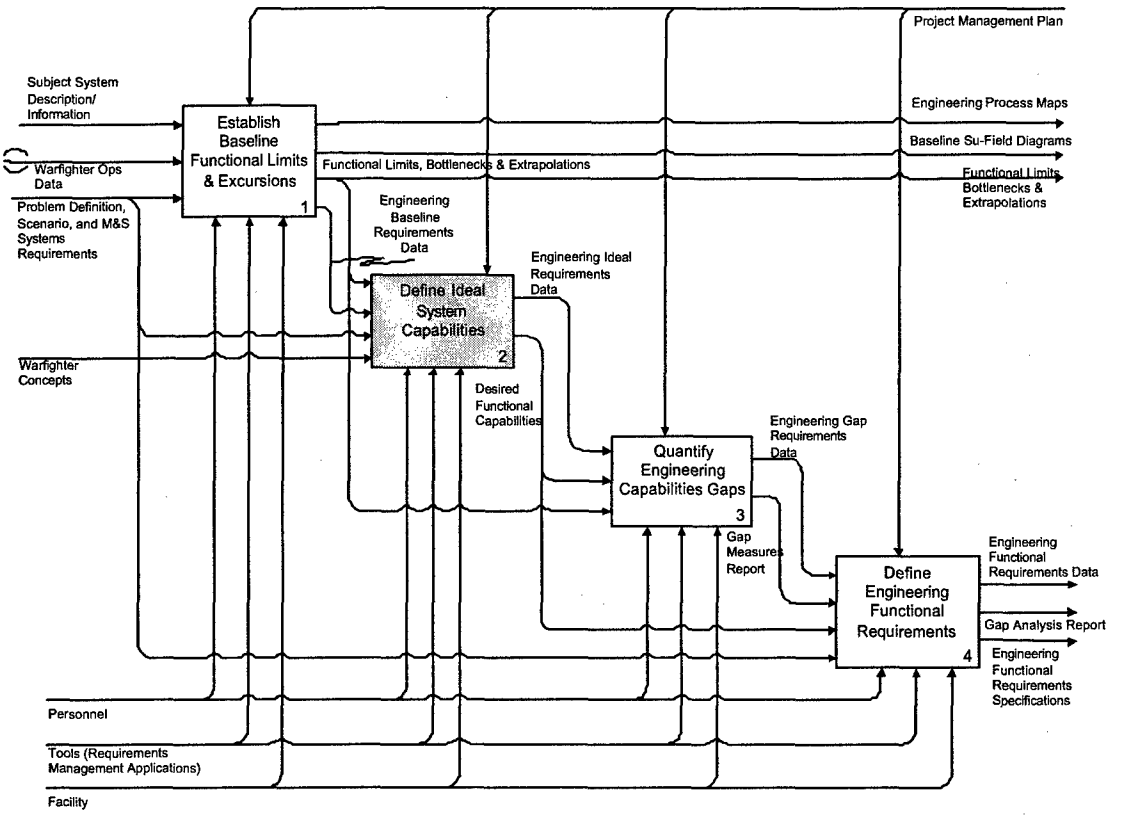


Figure A-A3.1(b) Determine Capabilities Gap

Inputs:

Functional Limits, Bottlenecks, and Extrapolations – A report describing the functional capability limitations to the existing baseline system. These limits are presented as system conflicts, i.e. bottlenecks that prohibit the system from achieving greater capability. Extrapolations beyond these limits that show what greater capability can be achieved if the limits were to be overcome are also included in the report.

Engineering Baseline Requirements Data – Requirements extracted from the Engineering Process Maps, and Su-Field Diagrams and put onto a Requirements Management Application database with the requirements data from prior engineering activities for subsequent tracking and analysis.

Problem Definition, Scenario, and M&S System Requirements – Description of the unconstrained functional requirements for the M&S System needed to address all aspects of the customer problem statement, including representations of the subject system, and operational scenarios.

Warfighter Concepts – Requirements for future weapon system designs that may include ORDs, MNS, ROCs, OAG inputs, etc.

Controls:

Project Management Plan – The overall direction for all phases of the WARCON process to include tasks, organization, program resources and costs, software development, products, schedules and milestones. The Software Development Plan is included within this Plan.

Outputs:

Desired Functional Capabilities – A report delineating the functional capabilities desired for engineering to address.

Engineering Ideal Requirements Data – Requirements extracted from the Desired Functional Capabilities, and put onto a Requirements Management Application database with other requirements data for subsequent tracking and analysis.

Mechanisms:

Personnel – Analysts, Subject Matter Experts, Engineers and other government and contracted employees having cognizance in the activity.

Tools – Accepted methods that support the activity.

Requirements Management Application – Software designed handle requirements extracted from output documents. The software is to track requirements from their inception to application in support of requirements and design analysis throughout the engineering activities.

Facility– Buildings and Equipment that are necessary to support personnel and tools in the conduct of the activities.

A3.1.3 Quantify Engineering Capabilities Gaps

Expresses capabilities of the existing baseline system, and the capabilities desired in terms of measures (Figure A-A3.1(c))

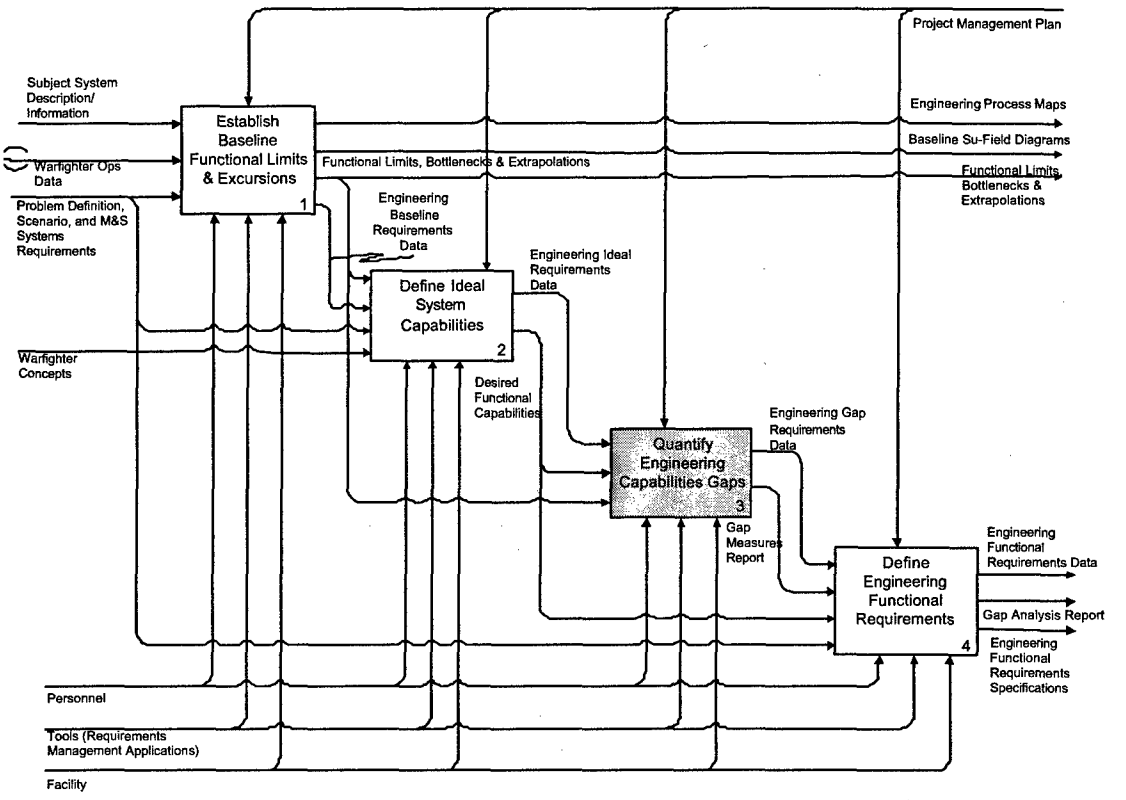


Figure A-A3.1(c) Determine Capabilities Gap

Inputs:

Desired Functional Capabilities – A report delineating the actual functional capabilities desired for engineering to address.

Functional Limits, Bottlenecks, and Extrapolations – A report describing the functional capability limitations to the existing baseline system. These limits are presented as system conflicts, i.e. bottlenecks that prohibit the system from achieving greater capability. Extrapolated beyond these limits that show what greater capability can be achieved if the limits were to be overcome are also included in the report.

Engineering Ideal Requirements Data – Requirements extracted from the Desired Functional Capabilities, and put onto a Requirements Management Application database with other requirements data for subsequent tracking and analysis.

Controls:

Project Management Plan – The overall direction for all phases of the WARCON process to include tasks, organization, program resources and costs, software development, products, schedules and milestones. The Software Development Plan is included within this Plan.

Outputs:

Gap Measures – A listing of measures that express the differences between the capabilities of the existing baseline system, and the capabilities desired.

Engineering Gap Requirements Data – Requirements extracted from the Gap Measures, and put onto a Requirements Management Application database with other requirements data for subsequent tracking and analysis.

Mechanisms:

Personnel – Analysts, Subject Matter Experts, Engineers and other government and contracted employees having cognizance in the activity.

Tools – Accepted methods that support the activity.

Requirements Management Application – Software designed handle requirements extracted from output documents. The software is to track requirements from their inception to application in support of requirements and design analysis throughout the engineering activities.

Facility – Buildings and Equipment that are necessary to support personnel and tools in the conduct of the activities.

A3.1.4 Define Engineering Functional Requirements

Reduces the gap measures to essential functional requirements for engineering. Those functional requirements that are in conformance with the problem definition, scenario, and greater operational functional requirements are to be considered essential. Requirements are transitioned from the language of the warfighter to the language understood by engineers (Figure A-A3.1(d)).

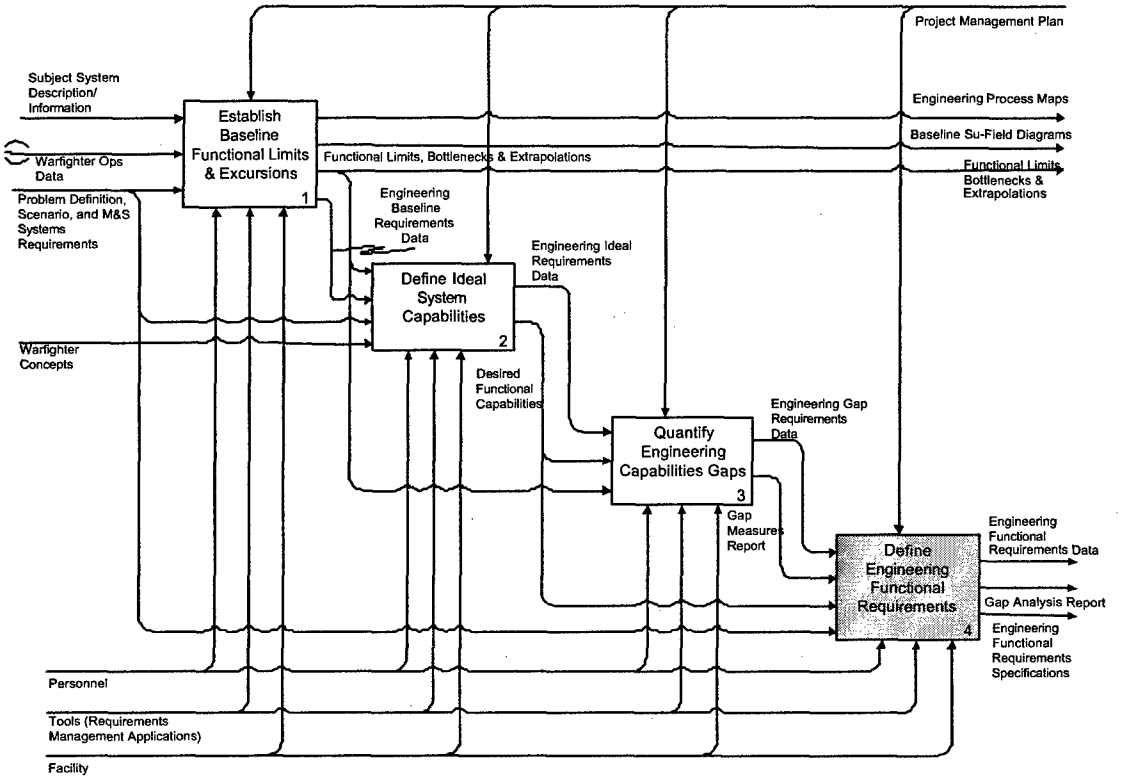


Figure A-A3.1(d) Determine Capabilities Gap

Inputs:

Gap Measures – A list of measures that express the differences between the capabilities of the existing baseline system, and the capabilities desired.

Engineering Gap Requirements Data – Requirements extracted from the Gap Measures, and put onto a Requirements Management Application database with other requirements data for subsequent tracking and analysis.

Problem Definition, Scenario, and M&S System Requirements – Description of the unconstrained functional requirements for the M&S System needed to address all aspects of the customer problem statement, including representations of the subject system, and operational scenarios.

Desired Functional Capabilities – A report developed delineating the actual functional capabilities desired for engineering to address.

Controls:

Project Management Plan – The overall direction for all phases of the WARCON process to include tasks, organization, program resources and costs, software development, products, schedules and milestones. The Software Development Plan is included within this Plan.

Outputs:

Engineering Functional Requirements Specifications – Delineates on the engineering level the functional capabilities for engineering to address in subsequent development of the Concept Systems.

Engineering Functional Requirements Data – Requirements extracted from the Engineering Functional Requirements Specifications, and put onto a Requirements Management Application database with other requirements data for subsequent tracking and analysis.

Gap Analysis Report – A description of the gap measures determined. The report may include descriptions of the system conflicts causing a gap, and the functional system requirements aimed at closing a gap.

Mechanisms:

Personnel – Analysts, Subject Matter Experts, Engineers and other government and contracted employees having cognizance in the activity.

Tools – Accepted methods that support the activity.

Requirements Management Application – Software designed handle requirements extracted from output documents. The software is to track requirements from their inception to application in support of requirements and design analysis throughout the engineering activities.

Facility – Buildings and Equipment that are necessary to support personnel and tools in the conduct of the activities.

A3.2 Identify Potential Innovation Concepts

Finds technology solutions to reduce or eliminate the identified capability gaps (Figure A-A3(b)).

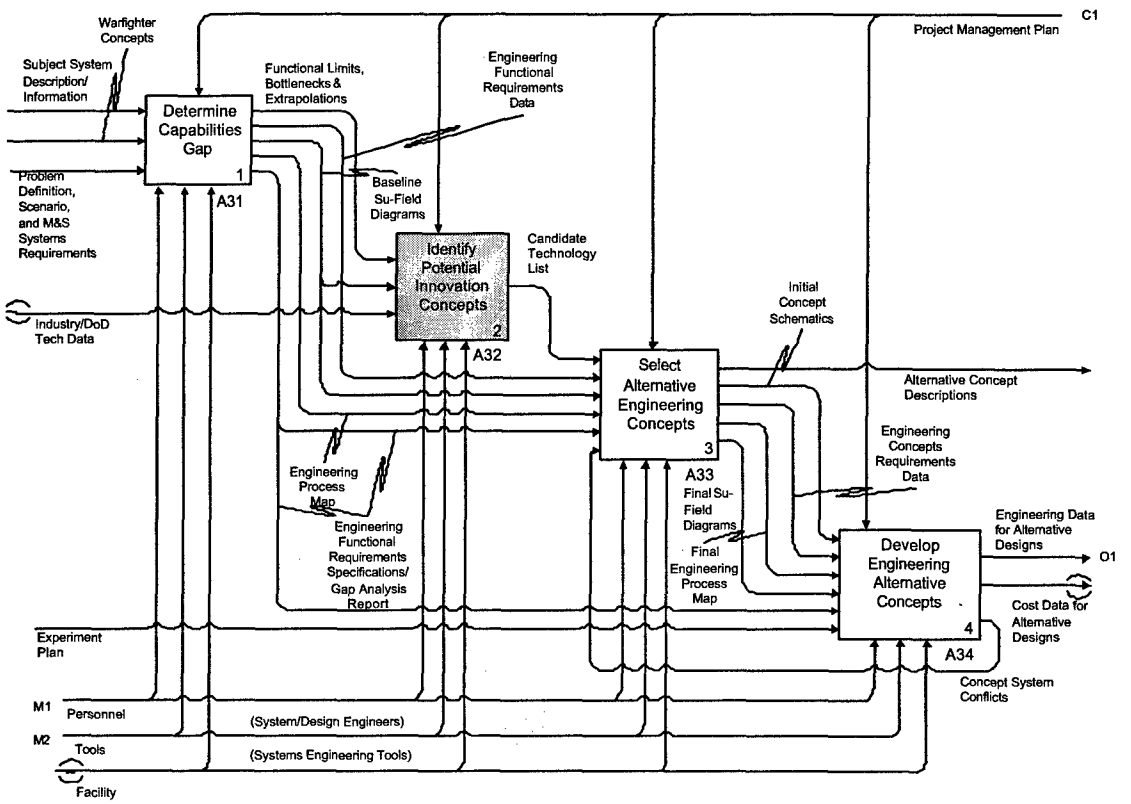


Figure A-A3(b) Develop Engineering Concepts

Input:

Functional Limits, Bottlenecks, and Extrapolations – A report describing the functional capability limitations to the existing baseline system. These limits are presented as system conflicts, i.e. bottlenecks that prohibit the system from achieving greater capability. Extrapolated beyond these limits that show what greater capability can be achieved if the limits were to be overcome are also included in the report.

Baseline Su-Field Diagrams – Schematics depicting Subject – Action – Object relationships between component objects in the baseline system under study.

Industry DoD Technical Data – Relevant information for design gathered from industry and DoD sources about new and otherwise applicable technologies that may be used to determine a concept system.

Controls:

Project Management Plan – The overall direction for all phases of the WARCON process to include tasks, organization, program resources and costs, software development, products, schedules and milestones. The Software Development Plan is included within this Plan.

Outputs:

Candidate Technology List – Tabulation of technologies that appear candidate for inclusion into a physical system design. The tabulation would include key characteristics for consideration of each technology listed.

Mechanisms:

Personnel – Subject Matter Experts, Engineers, and other government and contracted employees having cognizance in the activity.

Tools – Accepted methods that support the activity.

Facility – Buildings and equipment necessary to support personnel and tools in the conduct of the activities.

A3.2.1 Search Industry and DoD Technology Databases

Finds technologies that pose to resolve the performance gaps between the existing baseline and with what is desired (Figure A-A3.2(a)).

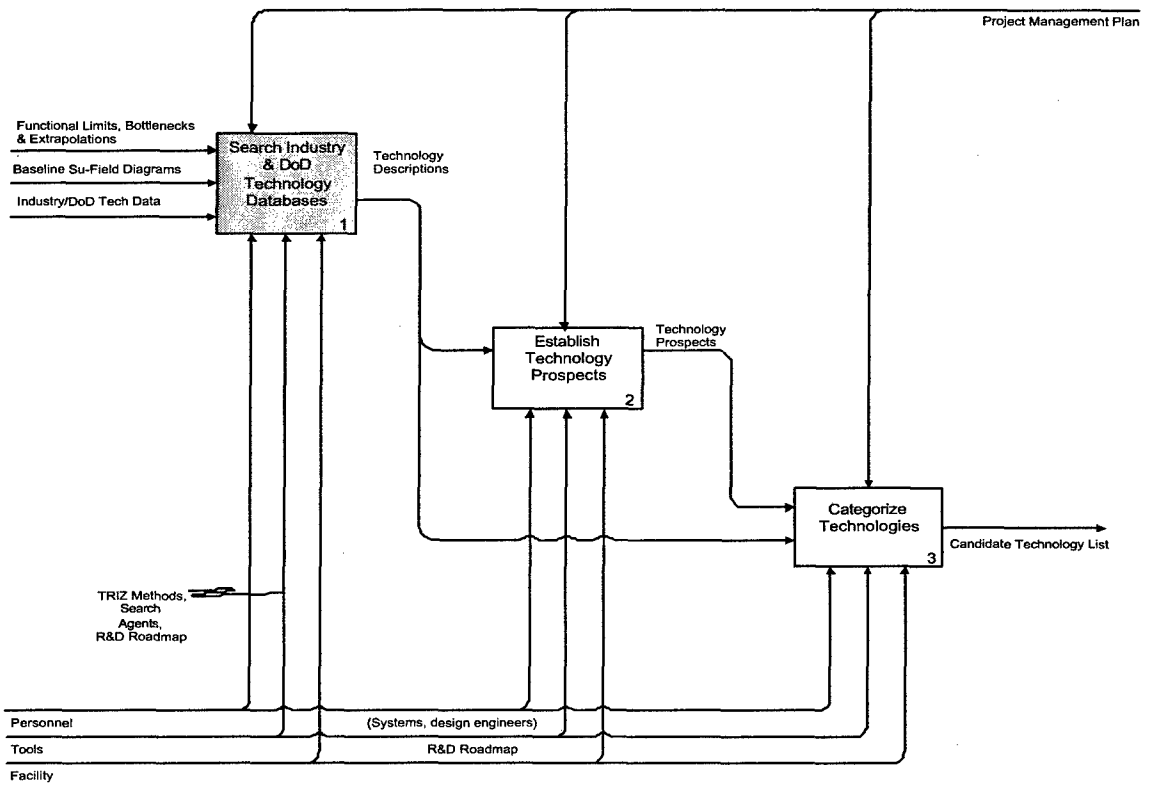


Figure A-A3.2(a) Identify Potential Innovation Concepts

Inputs:

Baseline Su-Field Diagrams – Schematics depicting Subject – Action – Object relationships between component objects in the baseline system under study.

Functional Limits, Bottlenecks, and Extrapolations – A report describing the functional capability limitations to the existing baseline system. These limits are presented as system conflicts, i.e. bottlenecks that prohibit the system from achieving

greater capability. Extrapolated beyond these limits that show what greater capability can be achieved if the limits were to be overcome are also included in the report.

Industry DoD Technical Data – Relevant information for design gathered from industry and DoD sources about new and otherwise applicable technologies that may be used to determine a concept system.

Controls:

Project Management Plan – The overall direction for all phases of the WARCON process to include tasks, organization, program resources and costs, software development, products, schedules and milestones. The Software Development Plan is included within this Plan.

Outputs:

Technology Descriptions – Short Synopsis of subject technologies found from searches of Industry and DoD sources.

Mechanisms:

Personnel – Subject Matter Experts, Engineers and other government and contracted employees having cognizance in the activity.

Tools – Accepted methods that support the activity.

Search Agents – Autonomous software modules decoupled from regular software applications with a level of intelligence able to accomplish the goal of finding new technology solutions from existing Industry and DoD databases.

TRIZ Methods – Regular means developed or otherwise descendent from the Theory of Inventive Problem Solving as originally described by Dr. Altshuller.

R&D Roadmap – Databases inherent to the particular project that warehouse data on new emerging or otherwise applicable technologies for future considerations.

Facility – That necessary to support personnel and tools in the conduct of the activities.

A3.2.2 Establish Technology Maturity, Feasibility, and Relevance

Applies ratings of maturity, feasibility, and relevance to subject technologies for the purpose of eventually establishing a likelihood probability of the technologies actual future existence ultimately for an estimate of a future concept's risk (Figure A-A3.2(b)).

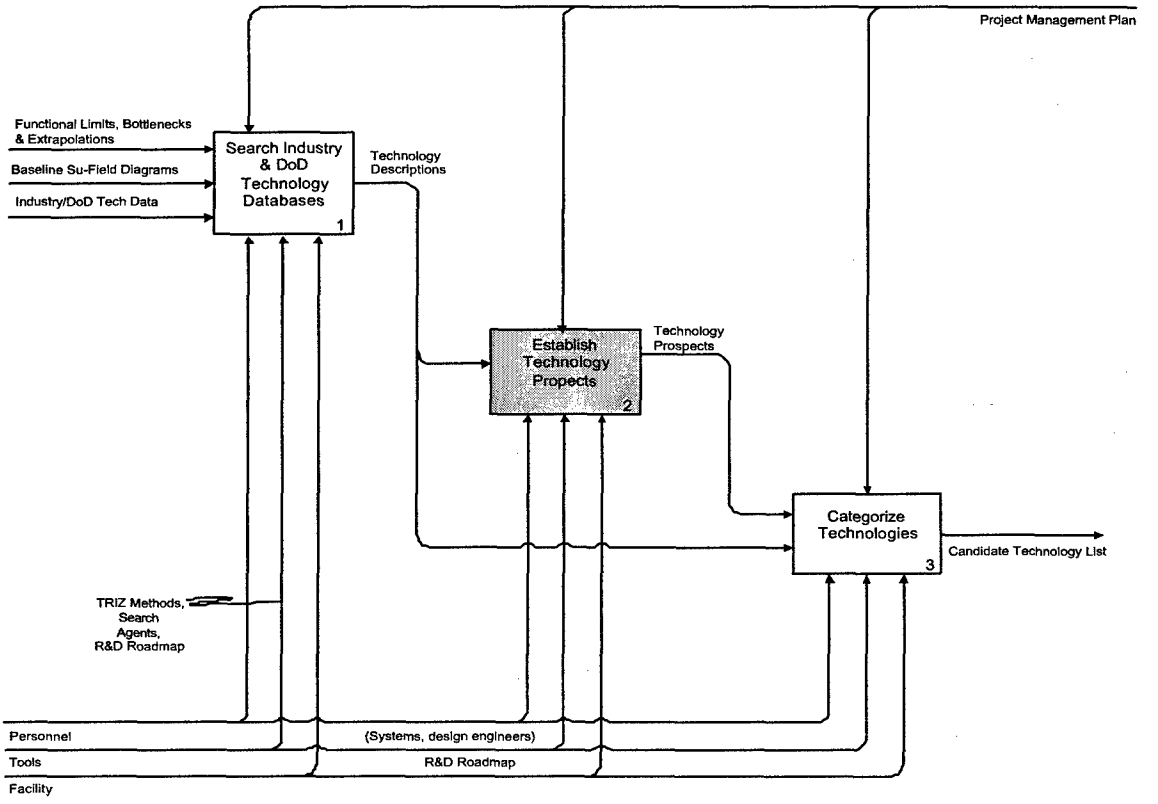


Figure A-A3.2(b) Identify Potential Innovation Concepts

Inputs:

Technology Descriptions – Short Synopsis of subject technologies found from searches of Industry and DoD sources.

Controls:

Project Management Plan – The overall direction for all phases of the WARCON process to include tasks, organization, program resources and costs, software development, products, schedules and milestones. The Software Development Plan is included within this Plan.

Outputs:

Technology Prospects – Probability of the technology's actual future existence determined from estimates of technology maturity, feasibility, and relevance.

Mechanisms:

Personnel – Engineers and other government and contracted employees having cognizance in the activity.

Tools – Accepted methods that support the activity.

R&D Roadmap – Databases inherent to the particular project that warehouse data on new emerging or otherwise applicable technologies for future considerations.

Facility – That necessary to support personnel and tools in the conduct of the activities.

A3.2.3 Categorize Technologies

Brings technologies found in searches of industry and DoD sources into the classification systems pertinent to the particular project (Figure A-A3.2(c)).

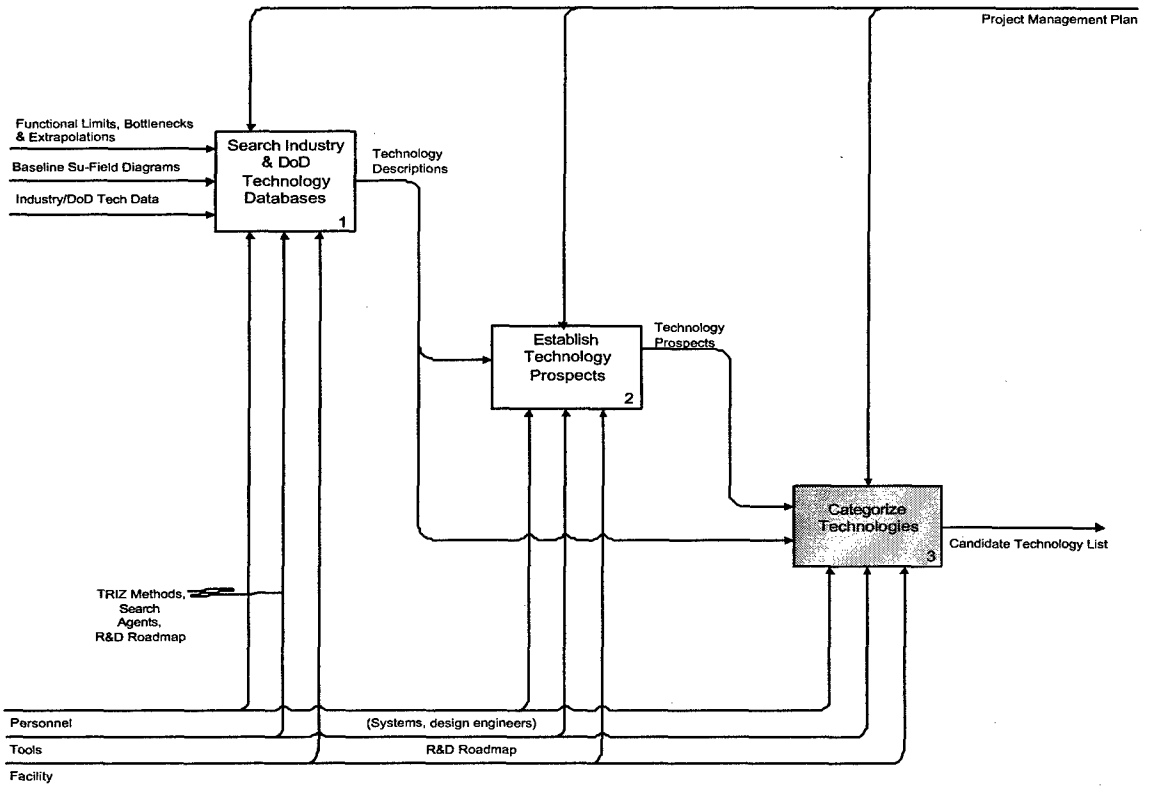


Figure A-A3.2(c) Identify Potential Innovation Concepts

Inputs:

Technology Descriptions – Short Synopsis of subject technologies found from searches of Industry and DoD sources.

Technology Prospects – Probability of the technology's actual future existence determined from estimates of technology maturity, feasibility, and relevance.

Controls:

Project Management Plan – The overall direction for all phases of the WARCON process to include tasks, organization, program resources and costs, software development, products, schedules and milestones. The Software Development Plan is included within this Plan.

Outputs:

Candidate Technology List – Tabulation of technologies that appear candidate for inclusion into a physical system design. The tabulation would include key characteristics for consideration of each technology listed.

Mechanisms:

Personnel – Engineers and other government and contracted employees having cognizance in the activity.

Tools – Accepted methods that support the activity.

R&D Roadmap – Databases inherent to the particular project that warehouse data on new emerging or otherwise applicable technologies for future considerations.

Facility – That necessary to support personnel and tools in the conduct of the activities.

A3.3 Select Alternative Engineering Concepts

Correlates engineering requirements stating the problem to technology solutions that pose as solutions to the problem, and then architects cohesive engineering concepts embodying those technologies actually selected (Figure A-A3(c)).

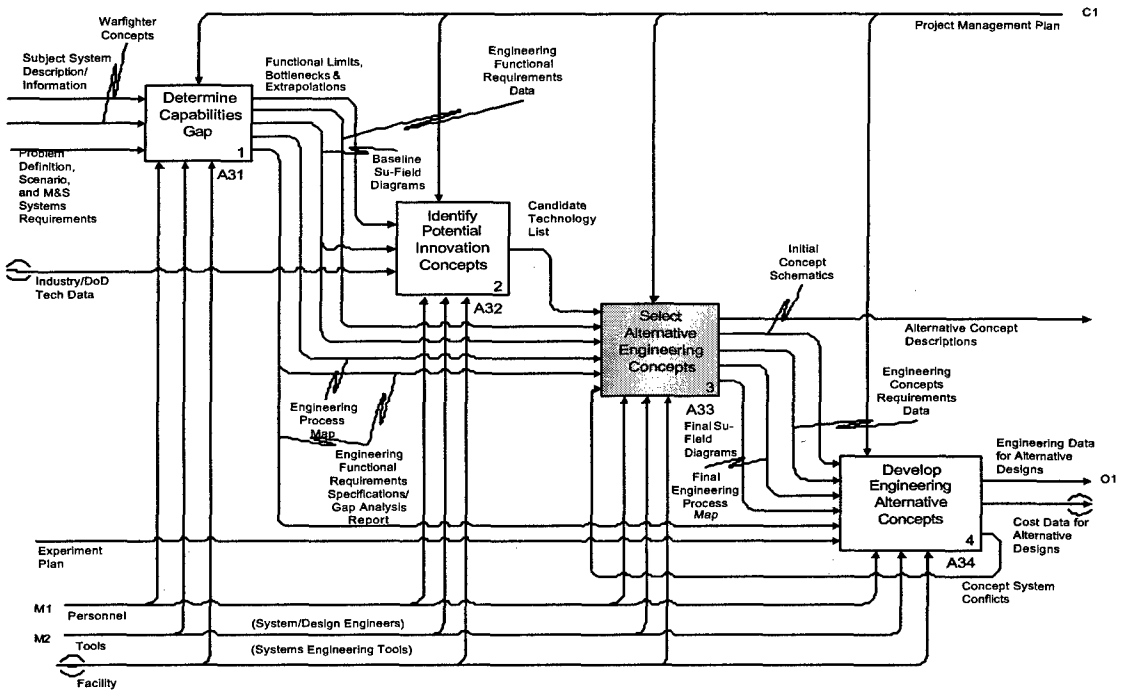


Figure A-A3(c) Develop Engineering Concepts

Input:

Engineering Functional Requirements Specifications – Delineates on the engineering level the functional capabilities for engineering to address in subsequent development of the Concept Systems.

Gap Analysis Report – A description of the gap measures determined. The report may include descriptions of the system conflicts causing a gap, and the functional system requirements aimed at closing a gap.

Candidate Technology List – Tabulation of technologies that appear candidate for inclusion into a physical system design. The tabulation would include key characteristics for consideration of each technology listed.

Engineering Functional Requirements Data – Requirements extracted from the Engineering Functional Requirements Specifications, and put onto a Requirements

Management Application database with other requirements data for subsequent tracking and analysis.

Engineering Process Map – A flowchart detailing on an engineering level the activities and events involved with the operation under study. The map is developed by SMEs having intimate experience with and immediate knowledge of the operation being studied.

Concept System Conflicts – System characteristics working against one another causing limitations in the concept system that prohibits the system from realizing the full functionality desired. This provides iterative feedback to designated prior activities.

Controls:

Project Management Plan – The overall direction for all phases of the WARCON process to include tasks, organization, program resources and costs, software development, products, schedules and milestones. The Software Development Plan is included within this Plan.

Outputs:

Alternative Concept Descriptions – Tabulates the conglomeration of technologies selected to be part of the concept system with a general vision of their eventual arrangement with one another.

Initial Concept Schematics – Initial generalized diagrams depicting the Concept Systems to be further developed.

Engineering Concepts Requirements Data – Requirements extracted from the Initial Concept Diagrams, the Descriptions, The final Su-field Diagrams, and Engineering Process Maps; and put onto a Requirements Management Application database with other requirements data for subsequent tracking and analysis.

Final Engineering Process Map – The baseline Process Map modified to reflect the new functionality allowed by the alternative Concept Systems identified.

Final Su-Field Diagrams – The baseline Su-field Diagrams modified to reflect the new functionality allowed by the selected technologies for the concept system to be developed.

Mechanisms:

Personnel –Subject Matter Experts, Engineers, and other government and contracted employees having cognizance in the activity.

Tools – Accepted methods that support the activity.

Facility – That necessary to support personnel and tools in the conduct of the activities.

A3.3.1 Correlate Technologies to Requirements

Technologies are matched to the functional requirements they may satisfy (Figure A-A3.3(a)).

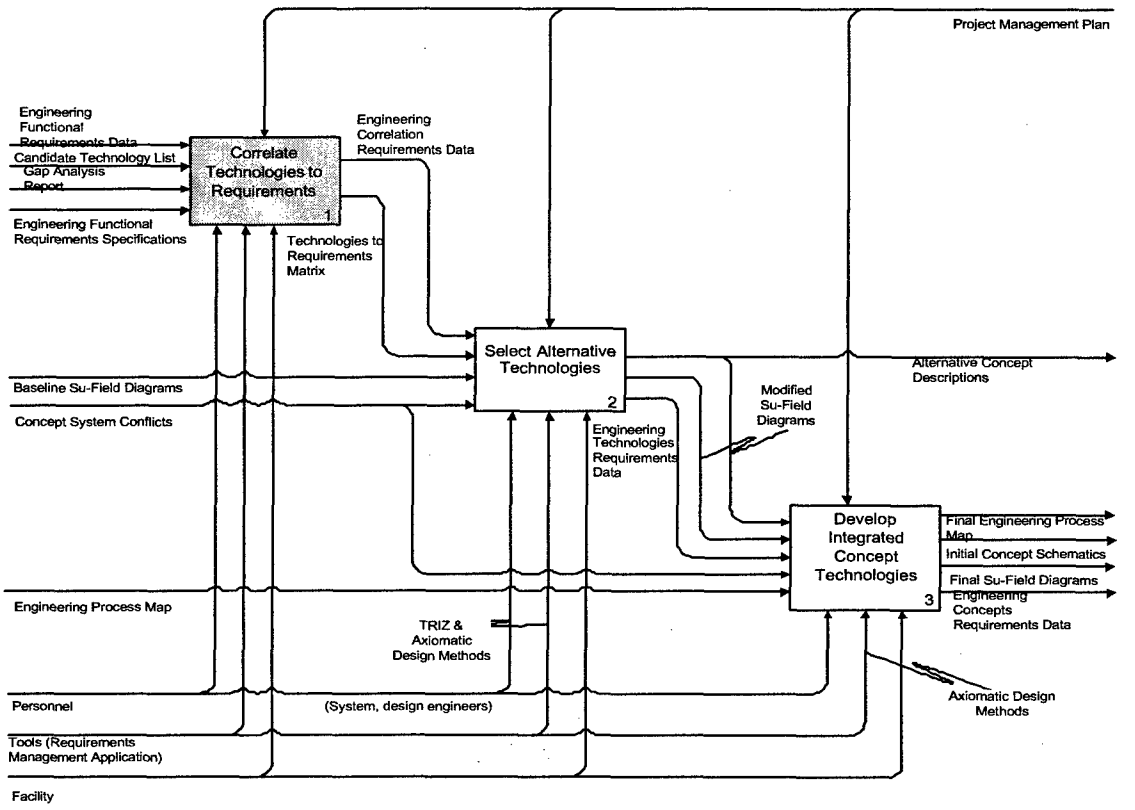


Figure A-A3.3(a) Select Alternative Engineering Concepts

Inputs:

Engineering Functional Requirements Data – Requirements extracted from the Engineering Functional Requirements Specifications, and put onto a Requirements Management Application database with other requirements data for subsequent tracking and analysis.

Candidate Technology List – Tabulation of technologies that appear candidate for inclusion into a physical system design. The tabulation would include key characteristics for consideration of each technology listed.

Engineering Functional Requirements Specifications – Delineates on the engineering level the functional capabilities for engineering to address in subsequent development of the Concept Systems.

Gap Analysis Report – A description of the gap measures determined. The report may include descriptions of the system conflicts causing a gap, and the functional system requirements aimed at closing a gap.

Controls:

Project Management Plan – The overall direction for all phases of the WARCON process to include tasks, organization, program resources and costs, software development, products, schedules and milestones. The Software Development Plan is included within this Plan.

Outputs:

Technologies to Requirements Matrix (Concept Box) – A matrix relating technologies to respective functional requirements that are satisfied by the technology. This document is colloquially known as the "Concept Box".

Engineering Correlation Requirements Data – Requirements extracted from the Concept Box, and put onto a Requirements Management Application database with other requirements data for subsequent tracking and analysis.

Mechanisms:

Personnel – Engineers and other government and contracted employees having cognizance in the activity.

Tools – Accepted methods that support the activity.

Requirements Management Application – Software designed handle requirements extracted from output documents. The software is to track requirements from their inception to application in support of requirements and design analysis throughout the engineering activities.

Facility – Buildings and equipment necessary to support personnel and tools in the conduct of the activities.

A3.3.2 Select Alternative Technologies

Down selects technologies in the Technologies to Requirements Matrix that best satisfy the functional requirements set forth (Figure A-A3.3(b)).

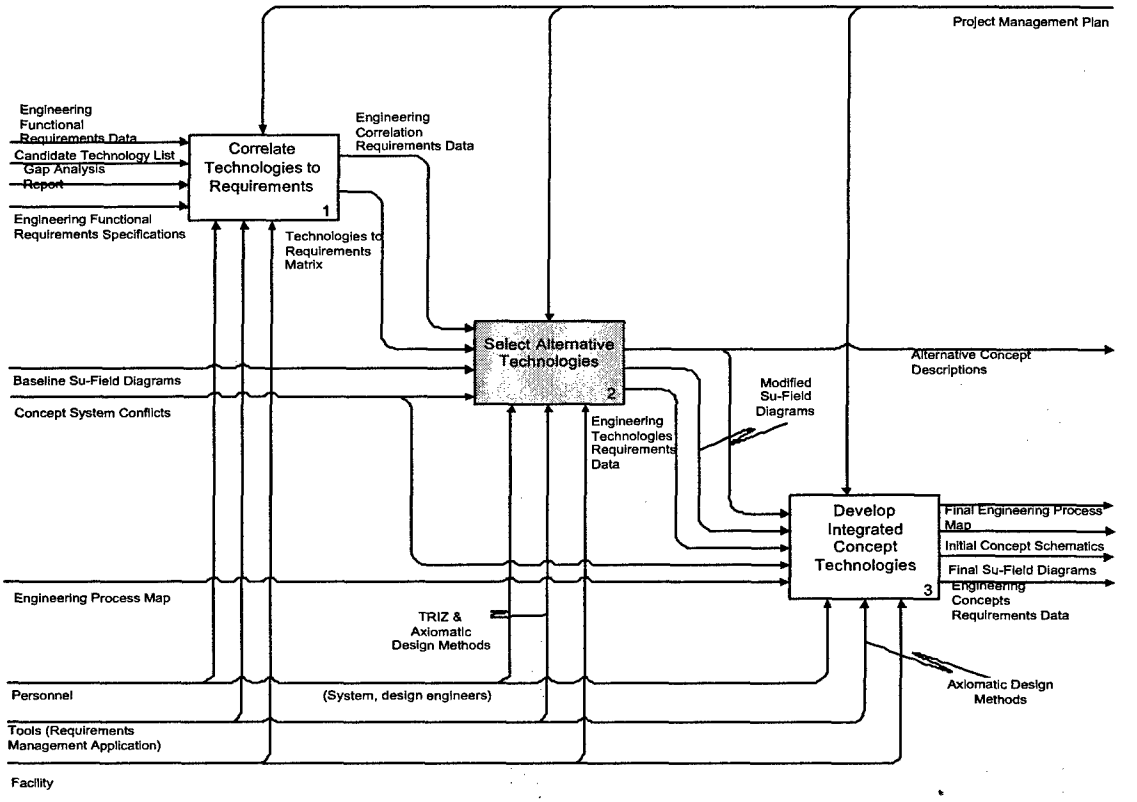


Figure A-A3.3(b) Select Alternative Engineering Concepts

Inputs:

Technologies to Requirements Matrix – The matrix relating technologies to functional requirements that are satisfied by a respective technology.

Engineering Correlation Requirements Data – Requirements extracted from the Concept Box, and put onto a Requirements Management Application database with other requirements data for subsequent tracking and analysis.

Baseline Su-Field Diagrams – Schematics depicting Subject – Action – Object relationships between component objects in the baseline system under study.

Concept System Conflicts – System characteristics working against one another causing limitations in the concept system that prohibits the system from realizing the full functionality desired. This provides iterative feedback to designated prior activities.

Controls:

Project Management Plan – The overall direction for all phases of the WARCON process to include tasks, organization, program resources and costs, software development, products, schedules and milestones. The Software Development Plan is included within this Plan.

Outputs:

Alternative Concept Description – Tabulates the conglomeration of technologies selected to be part of the concept system with a general vision of their eventual arrangement with one another.

Modified Su-Field Diagrams – The baseline Su-field Diagrams modified to reflect the new functionality allowed by the selected technologies for the concept system to be developed.

Engineering Technologies Requirements Data – Requirements extracted from the Alternative Concept Descriptions, Modified Su-field Diagrams, and put onto a Requirements Management Application database with other prior requirements data for subsequent tracking and analysis.

Mechanisms:

Personnel – Engineers, Subject Matter Experts, and other government and contracted employees having cognizance in the activity.

Tools – Accepted methods that support the activity.

TRIZ Methods – Regular means developed or otherwise descendent from the Theory of Inventive Problem Solving as originally described by Dr. Altshuller.

Axiomatic Design Methods – Regular means based on a systematic set of rules for the synthesis of concept designs.

Requirements Management Application – Software designed handle requirements extracted from output documents. The software is to track requirements from their inception to application in support of requirements and design analysis throughout the engineering activities.

Facility – Buildings and equipment necessary to support personnel and tools in the conduct of the activities.

A3.3.3 Develop Integrated Concept Technologies

Takes the conglomeration of selected technologies and integrates then into a cohesive idea; establishes the Concept System (Figure A-A3.3(c)).

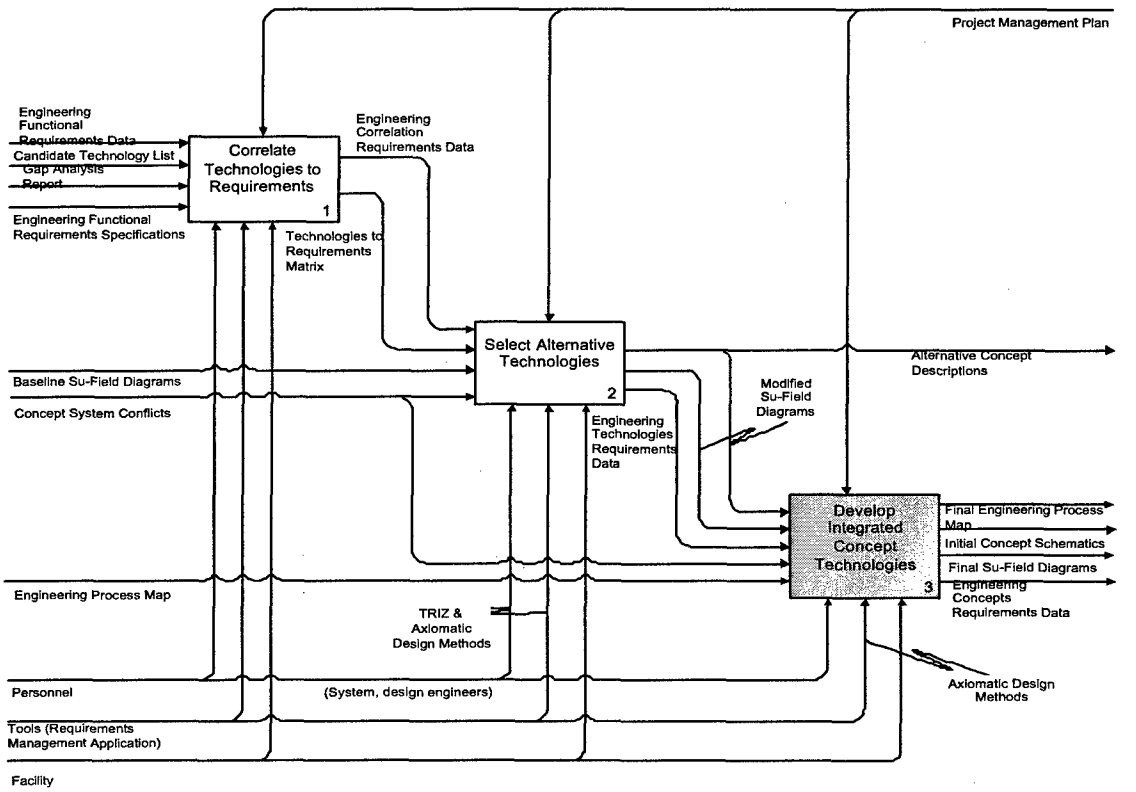


Figure A-A3.3(c) Select Alternative Engineering Concepts

Inputs:

Alternative Concept Descriptions – Tabulates the conglomeration of technologies selected to be part of the concept system with a general vision of their eventual arrangement with one another.

Modified Su-Field Diagrams – The Su-field Diagrams modified to reflect the new functionality allowed by selected technologies for the concept system to be developed.

Engineering Technologies Requirements Data – Requirements extracted from the Alternative Concept Descriptions, Modified Su-field diagrams, and put onto a Requirements Management Application database with other requirements data for subsequent tracking and analysis.

Concept System Conflicts – System characteristics working against one another causing limitations in the concept system that prohibits the system from realizing the full functionality desired. This provides iterative feedback to designated prior activities.

Engineering Process Map – A flowchart detailing on an engineering level the activities and events involved with the operation under study. The map is developed by Subject Matter Experts having intimate experience with and immediate knowledge of the operation being studied.

Controls:

Project Management Plan – The overall direction for all phases of the WARCON process to include tasks, organization, program resources and costs, software development, products, schedules and milestones. The Software Development Plan is included within this Plan.

Outputs:

Initial Concept Schematic – An initial generalized diagram depicting the Concept System.

Final Su-Field Diagrams – The Su-field Diagram further modified in this activity to be consistent with the concept system depicted by the Initial Concept Schematic.

Engineering Concepts Requirements Data – Requirements extracted from the Final Engineering Process Maps, the Final Su-Field Diagrams, and the Initial Concept Schematics; and put onto a Requirements Management Application database with other requirements data for subsequent tracking and analysis.

Final Engineering Process Map – The Engineering Process Map modified to be consistent with the concept system depicted by the Initial Concept Schematic.

Mechanisms:

Personnel – Engineers and other government and contracted employees having cognizance in the activity.

Tools – Accepted methods that support the activity.

Axiomatic Design Methods – Regular means based on a systematic set of rules for the synthesis of concept systems.

Requirements Management Application – Software designed handle requirements extracted from output documents. The software is to track requirements from their inception to application in support of requirements and design analysis throughout the engineering activities.

Facility – Buildings and equipment necessary to support personnel and tools in the conduct of the activities.

A3.4 Develop Engineering Alternative Concepts

Develops the engineering concepts into a truly integrated and balanced engineering solutions that include estimates of their likelihood to become a reality as well as their cost (Figure A-A3(d)).

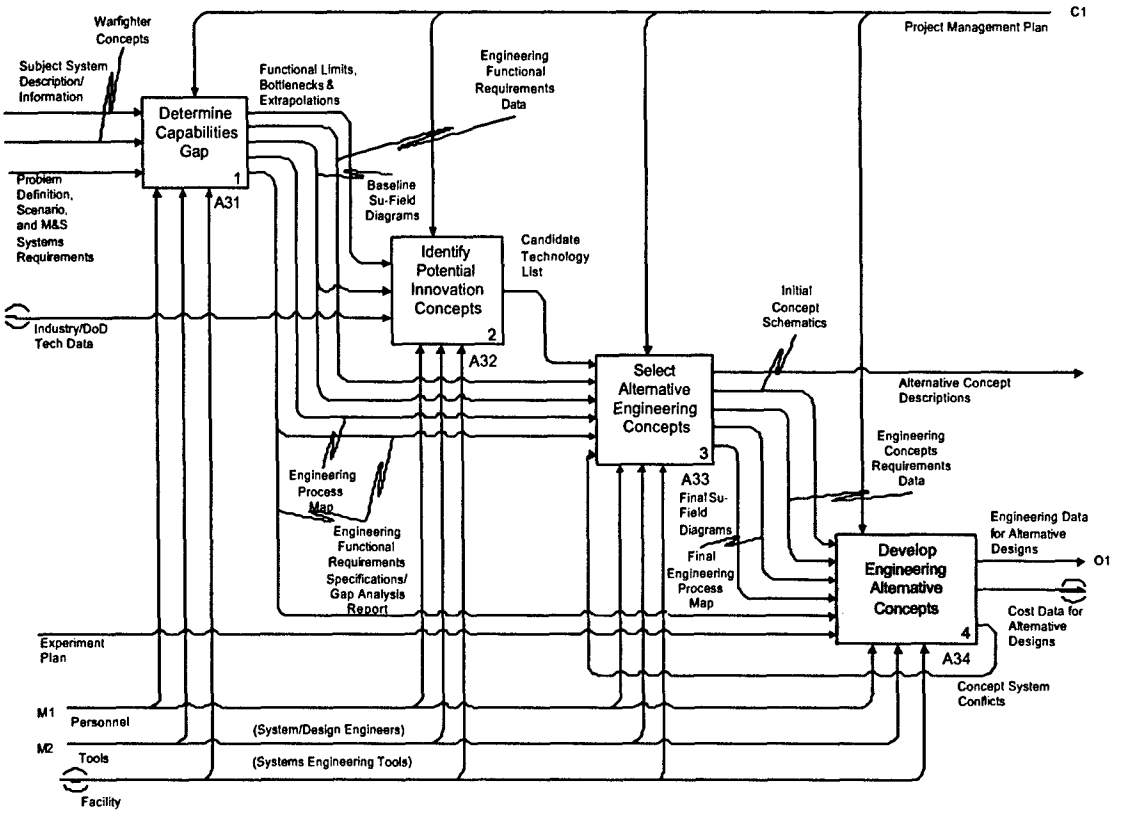


Figure A-A3(d) Develop Engineering Concepts

Inputs:

Initial Concept Schematics – The initial generalized diagrams depicting the Concept Systems.

Engineering Concepts Requirements Data – Requirements extracted from the Final Engineering Process Maps, the Final Su-Field Diagrams, and the Initial Concept

Schematics; and put onto a Requirements Management Application database with other requirements data for subsequent tracking and analysis

Final Engineering Process Map – The Engineering Process Map modified to be consistent with the concept system depicted by the Initial Concept Schematics.

Final Su-Field Diagrams – The final modified Su-field Diagram.

Engineering Functional Requirements Specifications – Delineates on the engineering level the functional capabilities for engineering to address in subsequent development of the Concept Systems.

Gap Analysis Report – A description of the gap measures determined. The report may include descriptions of the system conflicts causing a gap, and the functional system requirements aimed at closing a gap.

Experiment Plan – Document that defines the experiment approach, objectives, hypotheses, measures of performance and effectiveness (MOPs/MOEs), analysis methods, data extraction and collection requirements, scenarios, and explicit procedures for conducting the experiment.

Controls:

Project Management Plan – The overall direction for all phases of the WARCON process to include tasks, organization, program resources and costs, software development, products, schedules and milestones. The Software Development Plan is included within this Plan.

Outputs:

Engineering Data for Alternative Designs – Concept System data collated in the form of a Concept Engineering Package providing a Concept Schematic, any Software Design Documents that may be applicable, Material Lists, a Short System Description, a Concept System Specification, and a likelihood estimate for the Concept System's prospects of actually being developed.

Cost Data for Alternative Designs – Rough order of magnitude estimates of acquisition costs in relative terms, as well as estimates of total ownership costs of the subject concept systems under study.

Concept Systems Conflicts – Concept System characteristics working against one another causing limitations in the concept system that prohibits the system from realizing the full functionality desired. This provides iterative feedback to the predicate activity of Selecting Alternative Engineering Concepts.

Mechanisms:

Personnel – Engineers, cost estimators, manning estimators, Software Experts, and other government and contracted employees having cognizance in the activity.

Tools – Accepted methods that support the activity.

Acquisition Cost Application – software upon which acquisition cost models reside.

Manning Application – software upon which manning models reside.

Total Ownership Cost Application – software upon which models for computing total ownership costs reside.

Assorted Engineering Applications – the body of software upon which models for computing engineering characteristics reside.

Requirements Management Application – Software designed handle requirements extracted from output documents. The software is to track requirements from their inception to application in support of requirements and design analysis throughout the engineering activities.

Facility – Buildings and equipment necessary to support personnel and tools in the conduct of the subject activity.

A3.4.1 Acquire Engineering and Cost Component Models

Develops new or obtains existing engineering models as well as cost, and manning models that provide for the computation of engineering, cost and manning characteristics of the key components of the Concept System (Figure A-A3.4(a)).

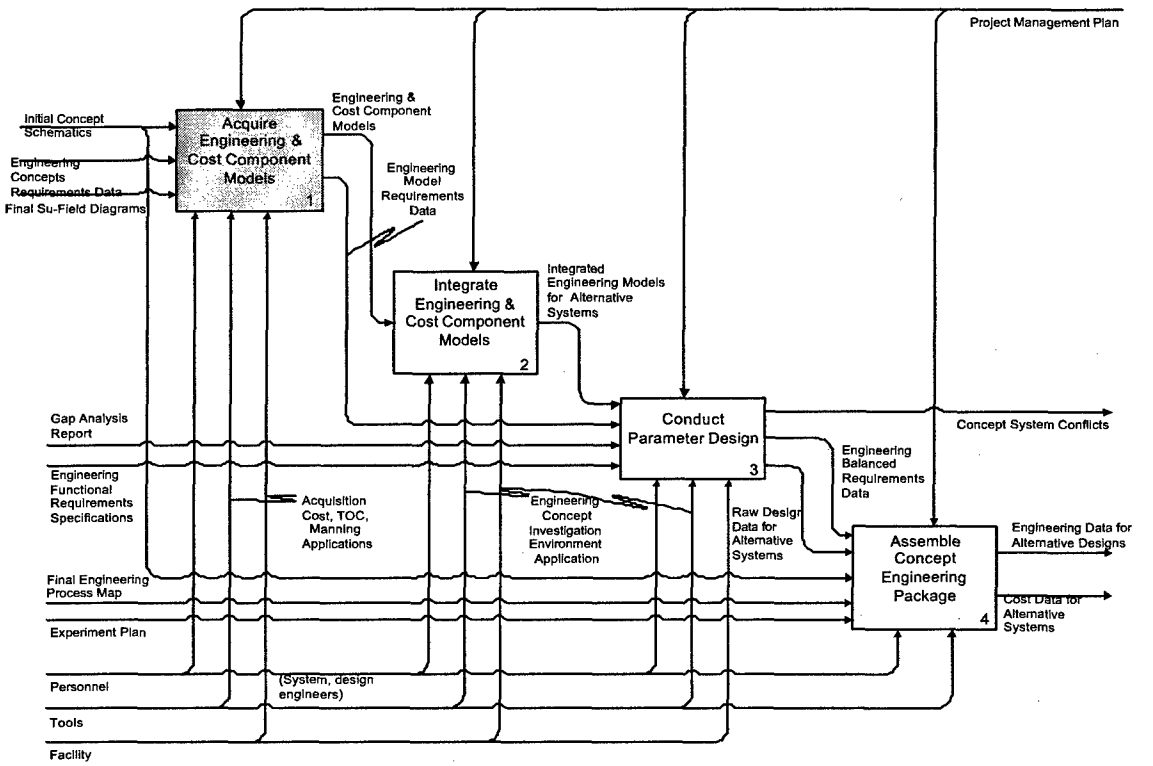


Figure A-A3.4(a) Develop Engineering Alternative Concepts

Inputs:

Engineering Concepts Requirements Data – Requirements extracted from the Final Engineering Process Maps, the Final Su-Field Diagrams, and the Initial Concept Schematics; and put onto a Requirements Management Application database with other requirements data for subsequent tracking and analysis.

Initial Concept Schematic – The initial generalized diagram depicting the Concept System.

Final Su-Field Diagram – The final modified Su-field Diagram.

Controls:

Project Management Plan – The overall direction for all phases of the WARCON process to include tasks, organization, program resources and costs, software development, products, schedules and milestones. The Software Development Plan is included within this Plan.

Outputs:

Engineering and Cost Component Models – Calculation routines for computing the engineering, cost, and manning characteristics of the Concept System(s) components.

Engineering Model Requirements Data – Requirements extracted from the engineering models; and put onto a Requirements Management Application database with other requirements data for subsequent tracking and analysis.

Mechanisms:

Personnel – Engineers, cost estimators, manning estimators, and other government and contracted employees having cognizance in the activity.

Tools – Accepted methods that support the activity.

Acquisition Cost Application – software upon which acquisition cost models reside.

Manning Application – software upon which manning models reside.

Total Ownership Cost Application – software upon which models for computing total ownership costs reside.

Assorted Engineering Applications – the body of software upon which models for computing engineering characteristics reside.

Requirements Management Application – Software designed handle requirements extracted from output documents. The software is to track requirements from their inception to application in support of requirements and design analysis throughout the engineering activities.

Facility – Buildings and equipment necessary to support personnel and tools in the conduct of the subject activity.

A3.4.2 Integrate Engineering and Cost Component Models

Synthesizes the conglomeration of models residing on their respective applications into one cohesive interacting whole (Figure A-A3.4(b)).

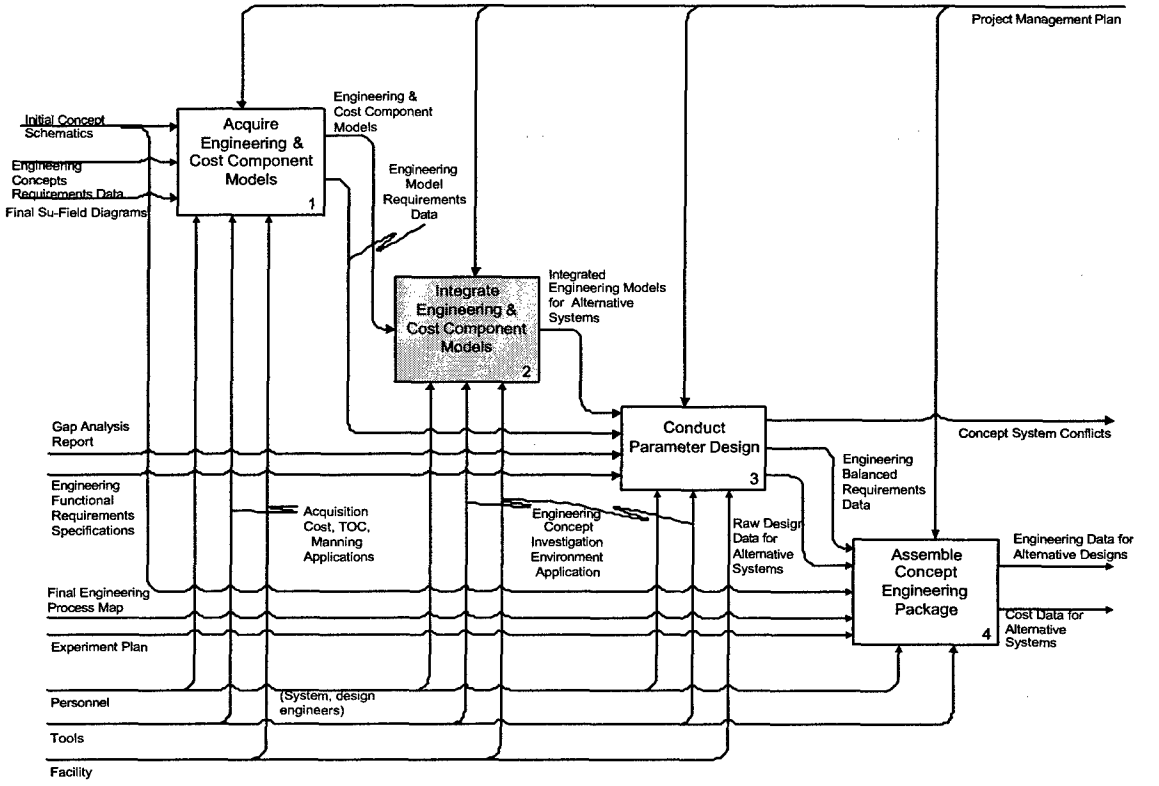


Figure A-A3.4(b) Develop Engineering Alternative Concepts

Inputs:

Engineering and Cost Component Models – Calculation routines for computing the characteristics of Concept System components.

Controls:

Project Management Plan – The overall direction for all phases of the WARCON process to include tasks, organization, program resources and costs, software

development, products, schedules and milestones. The Software Development Plan is included within this Plan.

Outputs:

Integrated Engineering Models for Alternative Systems – The medium in which the connected engineering, cost, and manning algorithms reside.

Mechanisms:

Personnel – Engineers, Software experts, and other government and contracted employees having cognizance in the activity.

Tools – Accepted methods that support the activity.

Concept Investigation Environment Application – The software that brings together the respective applications upon which the individual engineering, cost, and manning models reside.

Facility – Buildings and equipment necessary to support personnel and tools in the conduct of the activities. Facility for this particular activity includes a Virtual Private Network (VPN) for secure distributed computing.

A3.4.3 Conduct Parameter Design

Exercises the Concept Investigation Environment by varying and balancing key design parameters with one another to achieve a set of viable, or best concept system solutions. The concept design is improved here to a point where desired systems characteristics are maximized without detriment to other desired system characteristics (Figure A-A3.4(c)).

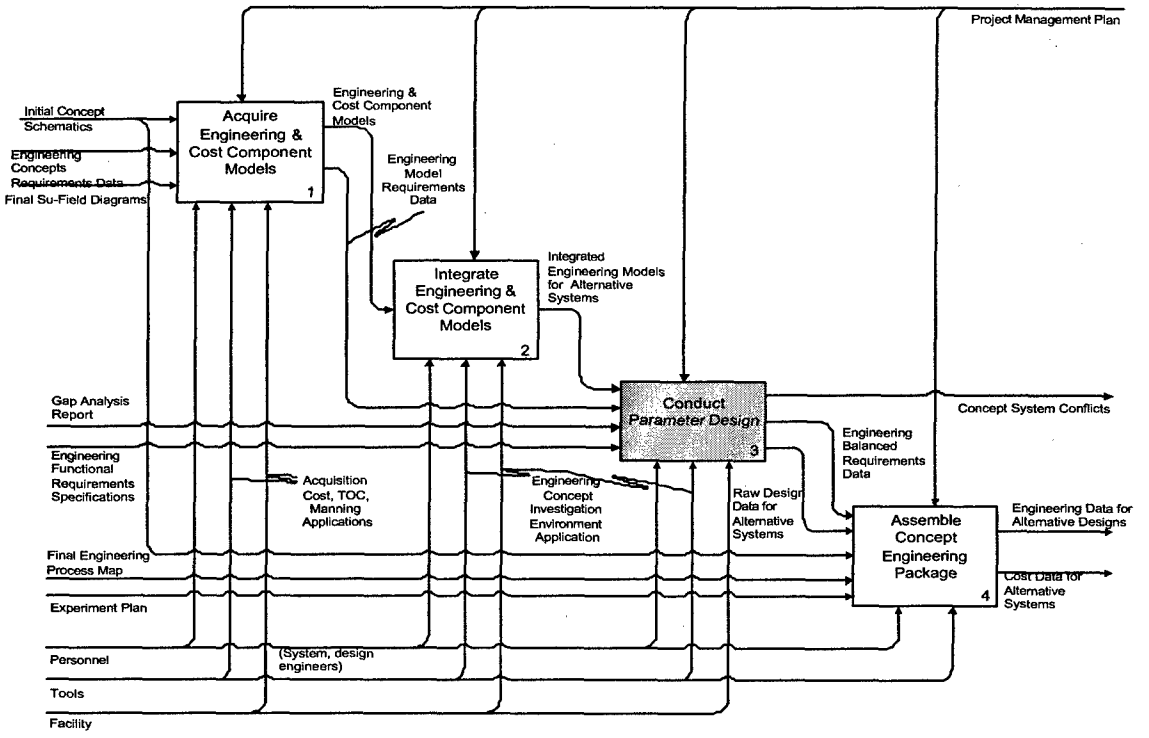


Figure A-A3.4(c) Develop Engineering Alternative Concepts

Inputs:

Integrated Engineering Models for Alternative Systems – The medium in which the connected engineering, cost, and manning algorithms reside.

Engineering Model Requirements Data – Requirements extracted from the engineering models; and put onto a Requirements Management Application database with other requirements data for subsequent tracking and analysis.

Engineering Functional Requirements Specifications – Delineates on the engineering level the functional capabilities for engineering to address in subsequent development of the Concept Systems.

Gap Analysis Report – A description of the gap measures determined. The report may include descriptions of the system conflicts causing a gap, and the functional system requirements aimed at closing a gap.

Controls:

Project Management Plan – The overall direction for all phases of the WARCON process to include tasks, organization, program resources and costs, software development, products, schedules and milestones. The Software Development Plan is included within this Plan.

Outputs:

Concept System Conflicts – System characteristics working against one another causing limitations in the concept system that prohibits the system from realizing the full functionality desired. This provides iterative feedback to designated prior activities.

Raw Data for Alternative Systems – Concept Investigation Output data depicting a balanced set of system characteristics in electronic spreadsheet format.

Engineering Balance Requirements Data – Requirements extracted from the Raw Data for Alternative Systems; and put onto a Requirements Management Application database with other requirements data for subsequent tracking and analysis.

Mechanisms:

Personnel – Engineers, and other government and contracted employees having cognizance in the activity.

Tools – Accepted methods that support the activity.

Engineering Concept Investigation Environment Application – The software that brings together the respective applications upon which the individual engineering, cost, and manning algorithms reside.

Requirements Management Application – Software designed handle requirements extracted from output documents. The software is to track requirements from their inception to application in support of requirements and design analysis throughout the engineering activities.

Facility – Buildings and equipment necessary to support personnel and tools in the conduct of the activities. Facility for this particular activity includes a Virtual Private Network (VPN) for secure distributed computing.

A3.4.4 Assemble Concept Engineering Package

Collates Concept System data into a cohesive package. Requirements documented on the Requirements Management Application Database are brought into a cohesive Concept System Specification. If numerous Concept System options are developed, this activity also ranks the concept as to their likelihood for development (Figure A-A3.4(d)).

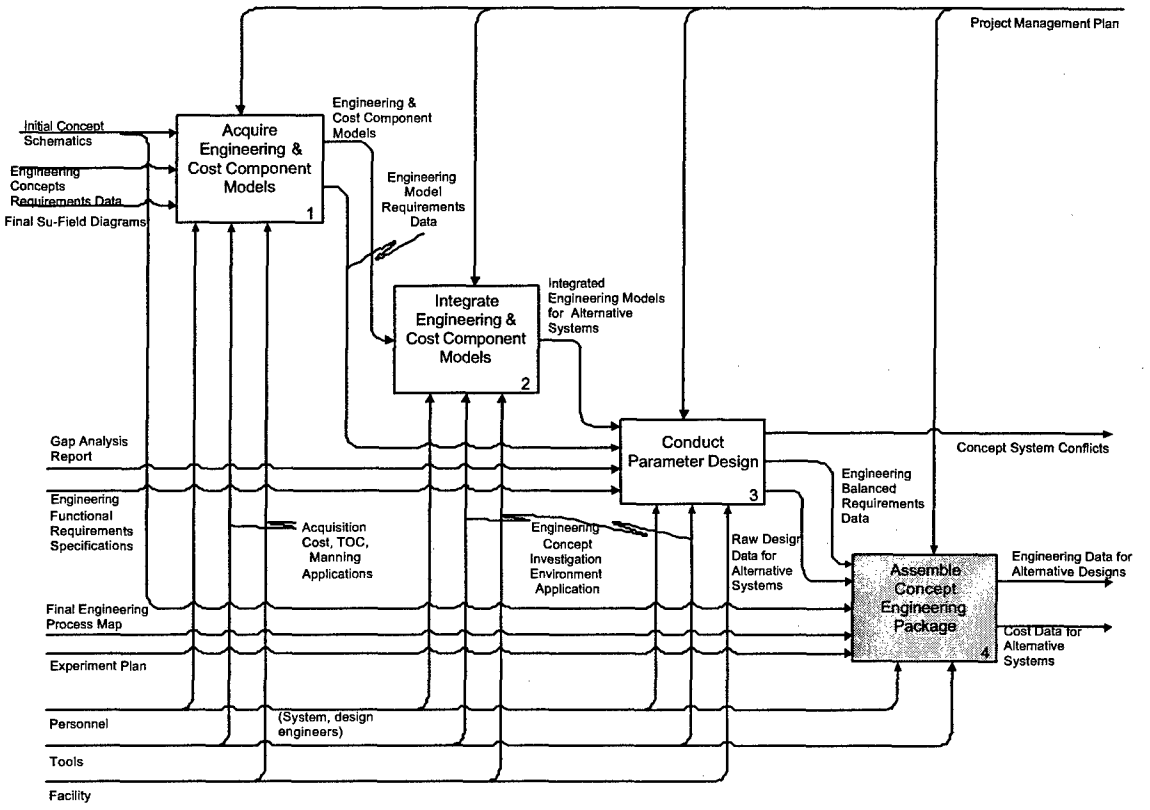


Figure A-A3.4(d) Develop Engineering Alternative Concepts

Inputs:

Raw Data for Alternative Systems – Concept Investigation Output data depicting a balanced set of system characteristics in electronic spreadsheet format.

Engineering Balance Requirements Data – Requirements extracted from the Raw Data for Alternative Systems; and put onto a Requirements Management Application database with other requirements data for subsequent tracking and analysis.

Experiment Plan – Document that defines the experiment approach, objectives, hypotheses, measures of performance and effectiveness (MOPs/MOEs), analysis methods, data extraction and collection requirements, scenarios, and explicit procedures for conducting the experiment.

Final Engineering Process Map – The Engineering Process Map modified to be consistent with the concept system depicted by the Initial Concept Schematics.

Controls:

Project Management Plan – The overall direction for all phases of the WARCON process to include tasks, organization, program resources and costs, software development, products, schedules and milestones. The Software Development Plan is included within this Plan.

Outputs:

Engineering Data for Alternative Designs – Concept System data collated in the form of a Concept Engineering Package providing a Concept Schematic, any Software Design Documents that may be applicable, Material Lists, a Short System Description, a Concept System Specification, and a likelihood estimate for the Concept System's prospects of actually being developed.

Cost Data for Alternative Designs – Rough order of magnitude estimates of acquisition costs in relative terms, as well as estimates of total ownership costs of the subject Concept Systems under study.

Mechanisms:

Personnel – Engineers, and other government and contracted employees having cognizance in the activity.

Tools – Accepted methods that support the activity.

Requirements Management Application – Software designed handle requirements extracted from output documents. The software is to track requirements from their inception to application in support of requirements and design analysis throughout the engineering activities.

Facility – Building and equipment necessary to support personnel and tools in the conduct of the activities.

A4 Build Integrated M&S Environment

Planning, Designing, Implementing and Testing the federation of models and simulations to meet the requirements established in the Experiment Plan (Figure A-A0(d)).

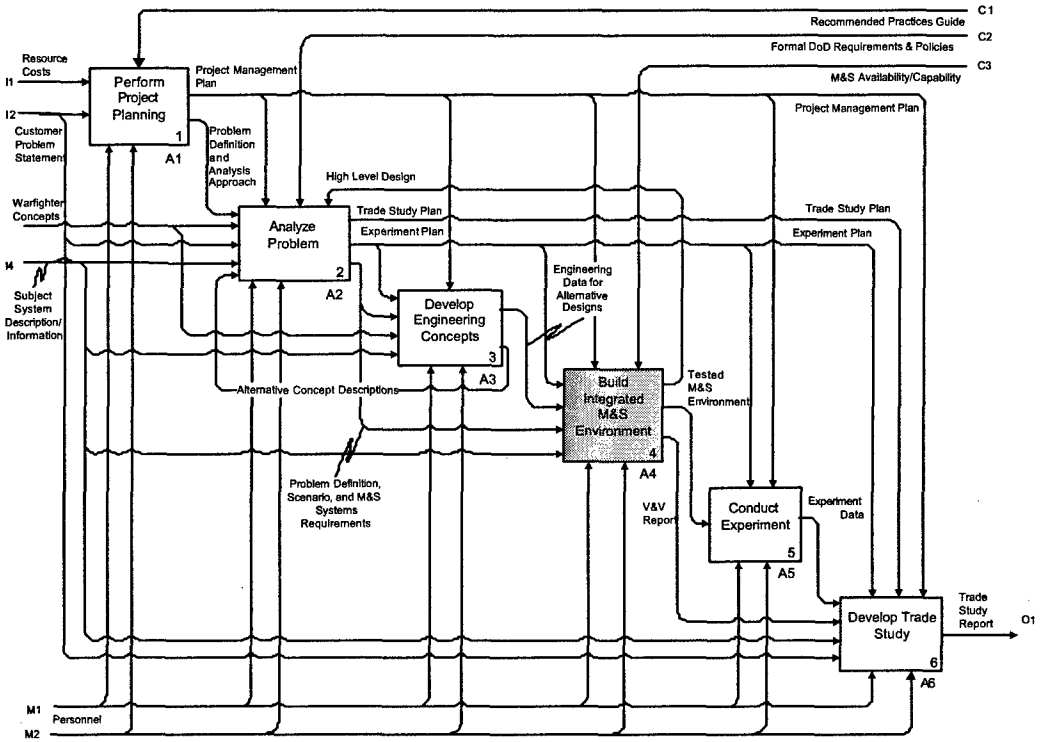


Figure A-A0(D) Execute WARCON Process

Inputs:

Experiment Plan – Document that defines the experiment approach, objectives, hypotheses, measures of performance and effectiveness (MOPs/MOEs), analysis methods, data extraction and collection requirements, scenarios, and explicit procedures for conducting the experiment.

Problem Definition, Scenario, and M&S System Requirements – Description of the unconstrained functional requirements for the M&S System needed to address all aspects of the customer problem statement, including representations of the subject system, technologies, and operational scenarios.

Subject System Description/Information – Information and data available from external sources about the current and future warfare system being analyzed that is required to plan and perform the experiment and analysis.

Alternative Design Data – Design information (design concept, description and associated cost) for alternate subject system designs to be analyzed.

Domain Data –

Hardware Components –

Software Components –

Existing Code –

Controls:

Project Management Plan – Provides the overall direction for all phases of the WARCON process to include tasks, organization, program resources and costs, software development, products, schedules and milestones. The Software Development Plan is included within this Plan.

Software Development Plan – Identifies software to be procured or written to conduct an experiment.

Modeling and Simulation (M&S) Availability/Capability – Identification and assessment of the models and simulations available to support the analysis, and their capabilities, for potential inclusion into the integrated system/federation.

Hardware (HW)/Software (SW) Availability/Capability –

Outputs:

System Sub-System Specifications (SSS) –

High Level Design – Plan for building the Integrated System; requires program review approval.

Tested M&S Environment – Integrated System after full testing.

M&S Inventory –

Operator Procedures –

Validation and Verification Report – Results and assessment based on the acceptability criteria that the built system is validated and verified given the intended use.

Mechanisms:

Personnel – Government, contract employees, subject matter experts, systems engineers and analysts available to support using the WARCON process.

Tools – Previously validated methods, models and simulations that support the modeling and analysis environments.

Facility -

A4.1 Plan M&S Environment

Reviewing the Experiment Plan and determining that all required information has been identified to design the system and develop the System Requirements Document (Figure A-A4(a)).

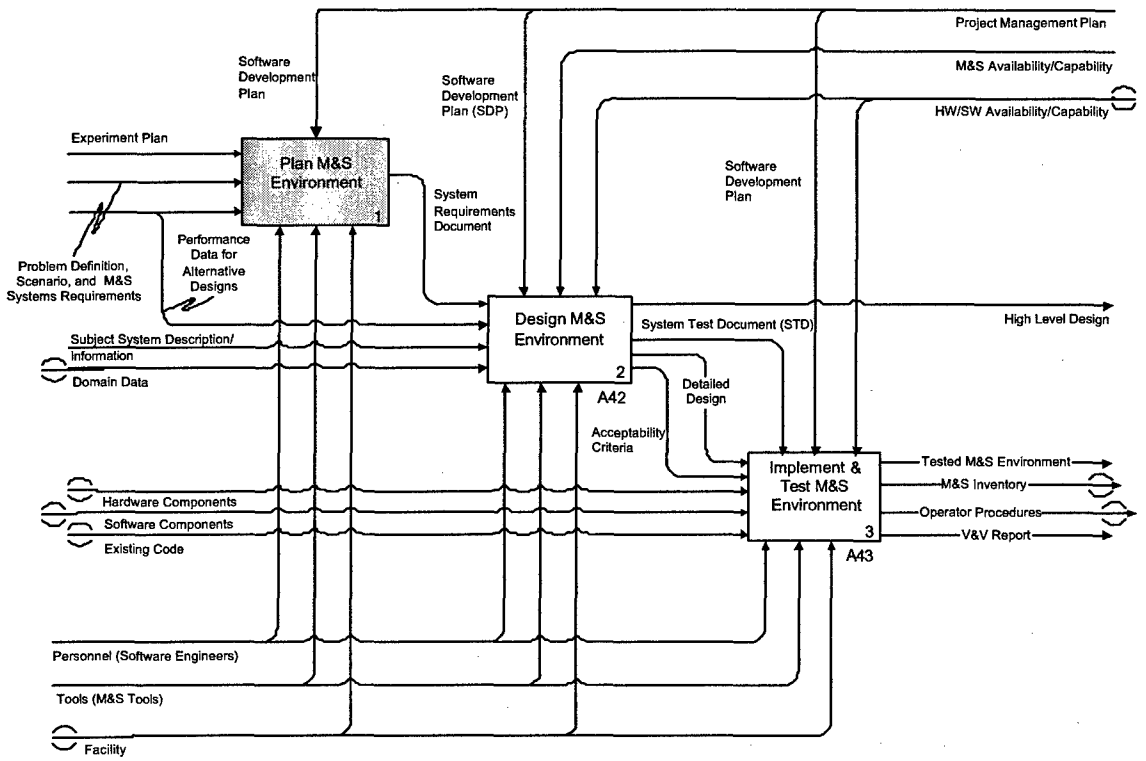


Figure A-A4(a) WARCON Build Integrated M&S Environment

Inputs:

Experiment Plan – Document that defines the experiment approach, objectives, hypotheses, measures of performance and effectiveness (MOPs/MOEs), analysis methods, data extraction and collection requirements, scenarios, and explicit procedures for conducting the experiment.

Problem Definition, Scenario, and M&S System Requirements – Description of the unconstrained functional requirements for the M&S System needed to address all

aspects of the customer problem statement, including representations of the subject system, technologies, and operational scenarios.

Alternative Design Data – Design information (design concept, description and associated cost) for alternate subject system designs to be analyzed

Controls:

Software Development Plan – Identifies software to be procured or written to conduct an experiment.

Outputs:

System Requirements Document (SRD) – Identifies functions and capabilities needed for the integrated system, and may include engineering design, software development, warfare operations, and cost models and simulations.

Mechanisms:

Personnel – Government, contract employees, subject matter experts, systems engineers and analysts available to support using the WARCON process.

Tools – Previously validated methods, models and simulations that support the modeling and analysis environments.

Facility -

A4.2 Design M&S Environment

Identifying the hardware and software required to build the integrated system (Figure A-A4(b)).

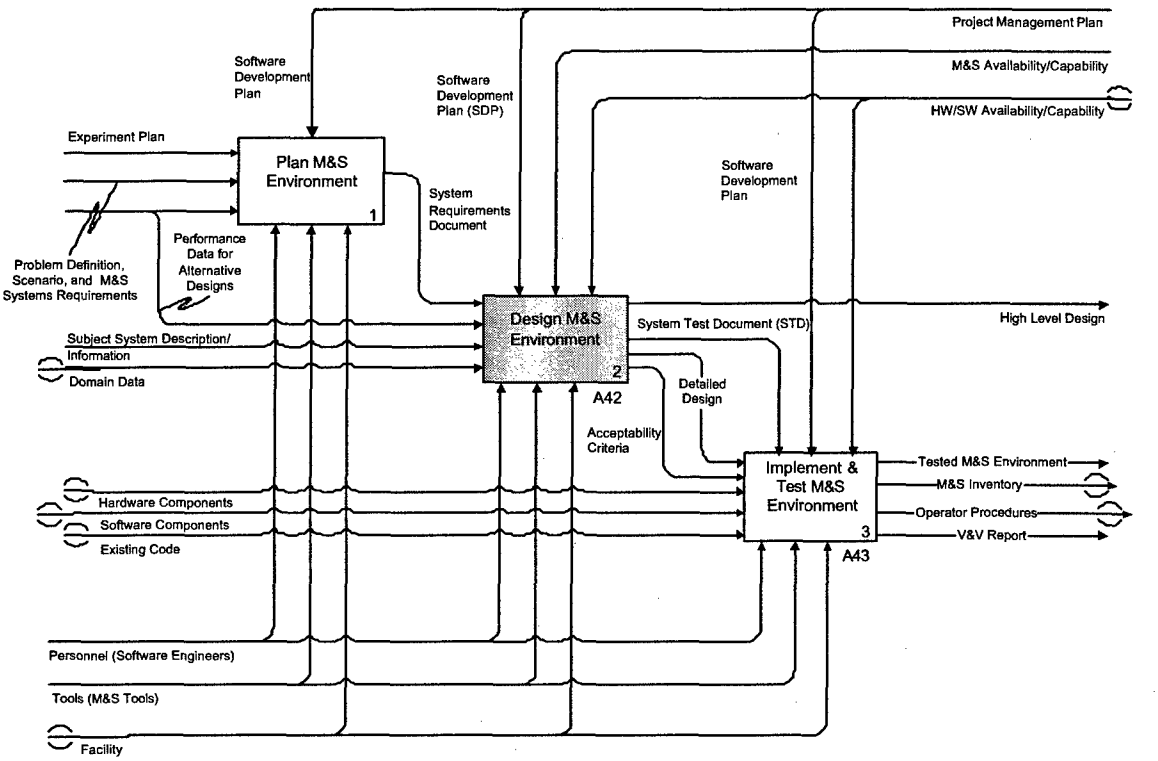


Figure A-A4(B) WARCON Build Integrated M&S Environment

Inputs:

System Requirements Document (SRD) – Identifies functions and capabilities needed for the integrated system, and may include engineering design, software development, warfare operations, and cost models and simulations.

Alternative Design Data – Design information (design concept, description and associated cost) for alternate subject system designs to be analyzed

Subject System Description/Information – Information and data available from external sources about the current and future warfare system being analyzed that is required to plan and perform the experiment and analysis.

Domain Data –

Controls:

Software Development Plan – Identifies software to be procured or written to conduct an experiment.

Modeling and Simulation (M&S) Availability/Capability – Identification and assessment of the models and simulations available to support the analysis, and their capabilities, for potential inclusion into the integrated system/federation.

Hardware/Software Availability/Capability –

Outputs:

SSS -

High Level Design – Plan for building the Integrated System; requires program review approval.

Detailed Design – Contains the specific hardware, software components/algorithms, data requirements for the integrated system..

System Test Document (STD) – Test criteria that are used to verify the built system against the detailed design and assist in validating the system against the acceptability criteria.

Acceptability Criteria (AC) – Testable requirements that are derived from "real world" capabilities based on intended use of the system being built.

Mechanisms:

Personnel – Government, contract employees, subject matter experts, systems engineers and analysts available to support using the WARCON process.

Tools – Previously validated methods, models and simulations that support the modeling and analysis environments.

Facility -

A4.2.1 Generate System Sub-System Specification

Building a database identifying the specification requirements to design the system (derived from the SRD) (Figure A-A4.2(a)).

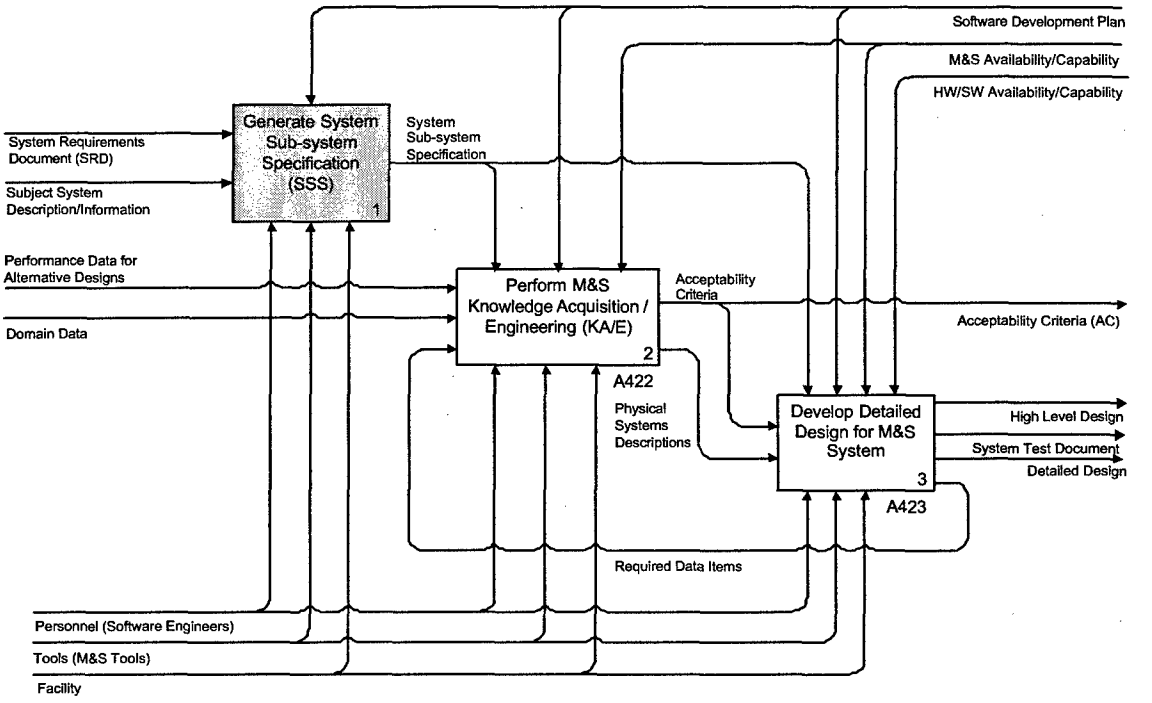


Figure A-A4.2(a) Design M&S Environment

Inputs:

System Requirements Document (SRD) – Identifies functions and capabilities needed for the integrated system, and may include engineering design, warfare operations, and cost models and simulations.

Subject System Description/Information – Information and data available from external sources about the current and future warfare system being analyzed that is required to plan and perform the experiment and analysis.

Controls:

Software Development Plan – Identifies software to be procured or written to conduct an experiment.

Outputs:

Subsystem Specification (SSS) –Database of requirements from the System Requirements Document that allows for requirements traceability during system design/implementation/test.

Mechanisms:

Personnel – Government, contract employees, subject matter experts, systems engineers and analysts available to support using the WARCON process.

Tools – Previously validated methods, models and simulations that support the modeling and analysis environments.

Facility -

A4.2.2 Perform M&S Knowledge Acquisition/Engineering (KA/E)

Performing a rigorous process of decomposing high-level requirements to acceptability criteria (AC) (Figure A-A4.2(b)).

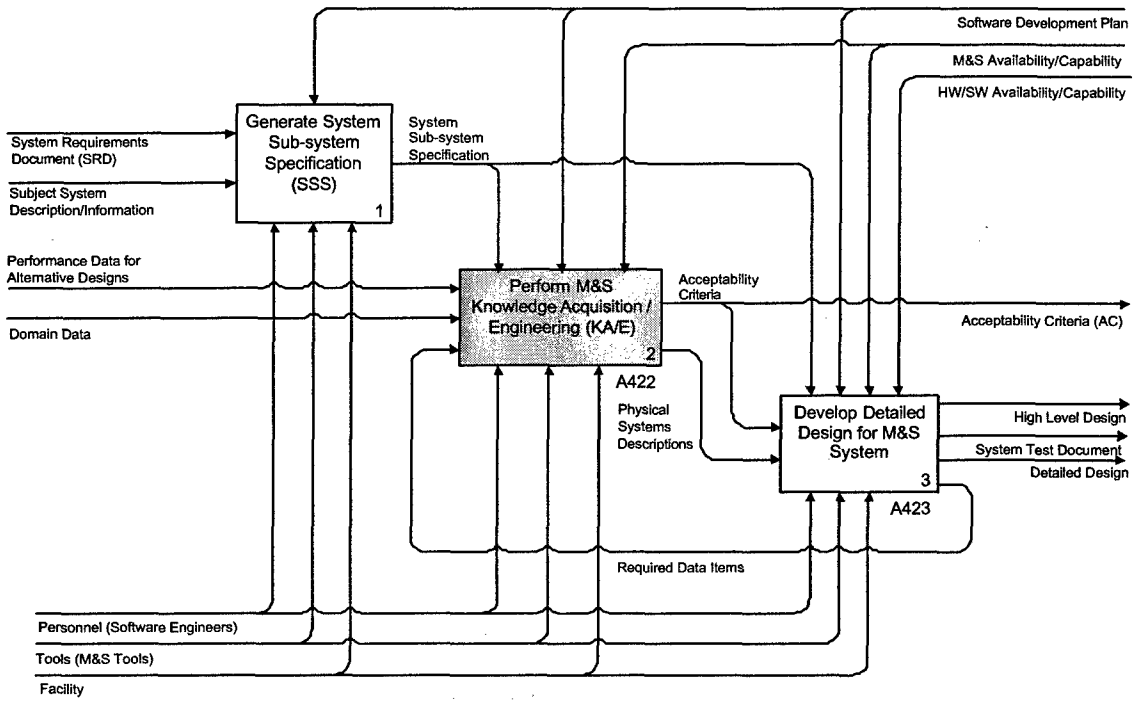


Figure A-A4.2(b) Design M&S Environment

Inputs:

Alternative Design Data – Design information (design concept, description and associated cost) for alternate subject system designs to be analyzed.

Domain Data –

Required Data Item –

Controls:

Subsystem Specification (SSS) –Database of requirements from the System Requirements Document that allows for requirements traceability during system design/implementation/test.

Software Development Plan – Identifies software to be procured or written to conduct an experiment.

Modeling and Simulation (M&S) Availability/Capability – Identification and assessment of the models and simulations available to support the analysis, and their capabilities, for potential inclusion into the integrated system/federation.

Outputs:

Acceptability Criteria – Testable requirements that are derived from "real world" capabilities based on intended use of the system being built.

Physical Systems Description –

Mechanisms:

Personnel – Government, contract employees, subject matter experts, systems engineers and analysts available to support using the WARCON process.

Tools – Previously validated methods, models and simulations that support the modeling and analysis environments.

Facility -

A4.2.2.1 Identify and Select Mission Tasks

(Figure A-A4.2.2(a)).

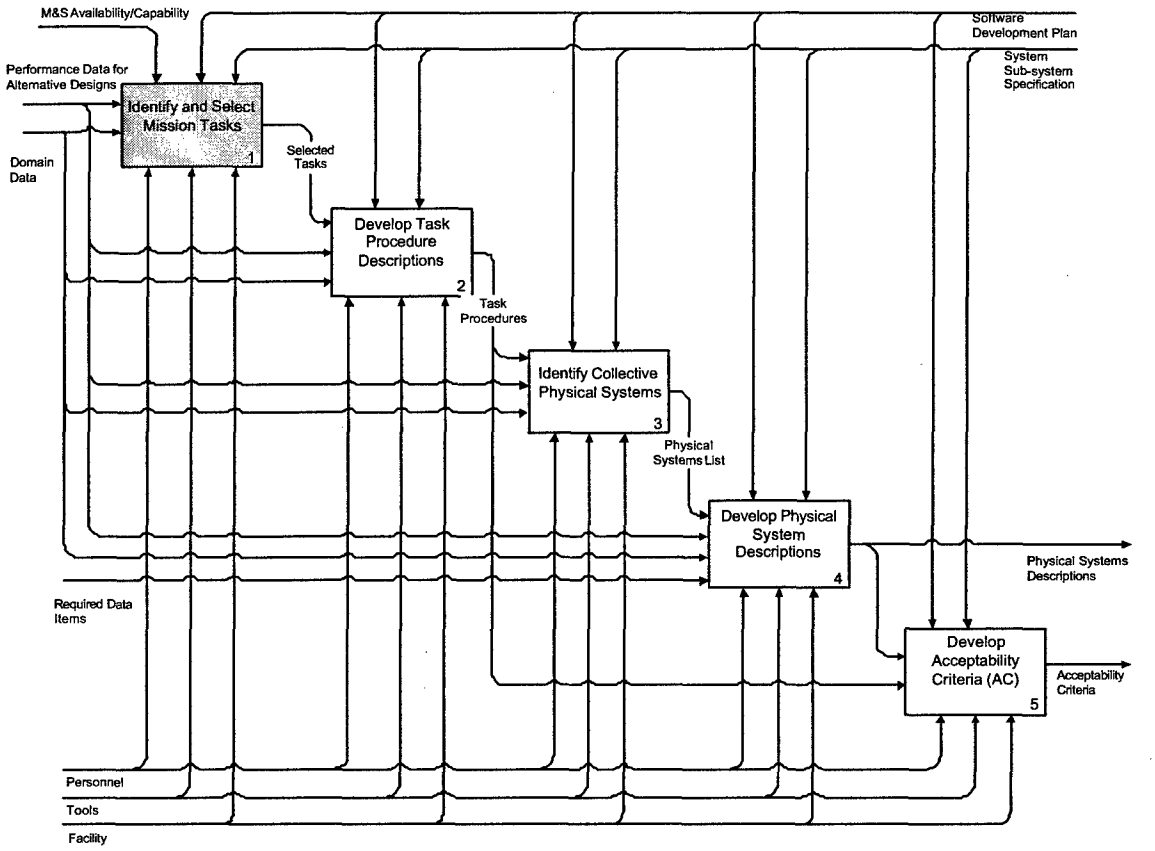


Figure A-A4.2.2(a) Perform M&S Knowledge Acquisition/Engineering

Inputs:

Alternative Design Data – Design information (design concept, description and associated cost) for alternate subject system designs to be analyzed.

Domain Data –

Controls:

Subsystem Specification (SSS) –Database of requirements from the System Requirements Document that allows for requirements traceability during system design/implementation/test.

Modeling and Simulation (M&S) Availability/Capability – Identification and assessment of the models and simulations available to support the analysis, and their capabilities, for potential inclusion into the integrated system/federation.

Software Development Plan – Identifies software to be procured or written to conduct an experiment.

Outputs:

Selected Tasks –

Mechanisms:

Personnel – Government, contract employees, subject matter experts, systems engineers and analysts available to support using the WARCON process.

Tools – Previously validated methods, models and simulations, and COTS that support the modeling and analysis environments.

Facility -

A4.2.2.2 Develop Task Procedure Descriptions

(Figure A-A4.2.2(b))

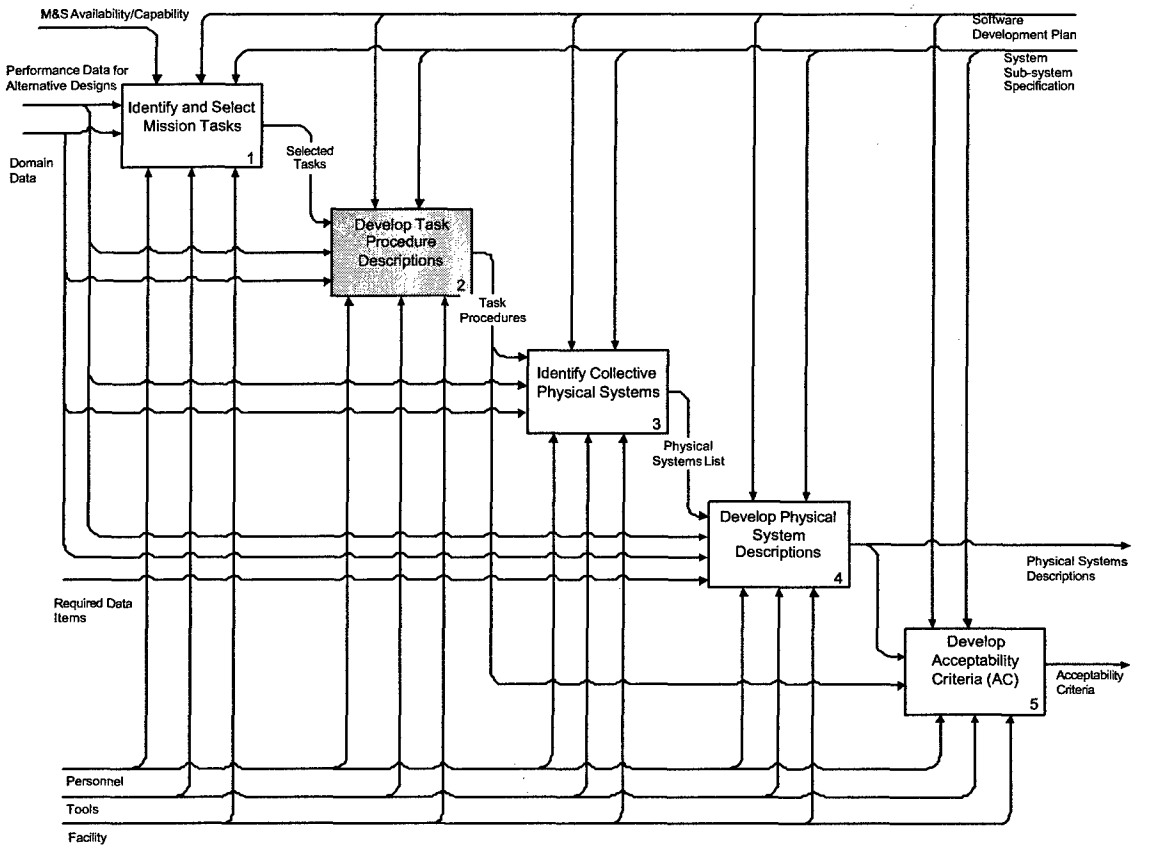


Figure A-A4.2.2(b) Perform M&S Knowledge Acquisition/Engineering

Inputs:

Selected Tasks –

Alternative Design Data – Design information (design concept, description and associated cost) for alternate subject system designs to be analyzed.

Domain Data –

Controls:

Subsystem Specification (SSS) –Database of requirements from the System Requirements Document that allows for requirements traceability during system design/implementation/test.

Software Development Plan – Identifies software to be procured or written to conduct an experiment.

Outputs:

Task Procedures –

Mechanisms:

Personnel – Government, contract employees, subject matter experts, systems engineers and analysts available to support using the WARCON process.

Tools – Previously validated methods, models and simulations, and COTS that support the modeling and analysis environments.

Facility -

A4.2.2.3 Identify Collective Physical Systems

(Figure A-A4.2.2(c))

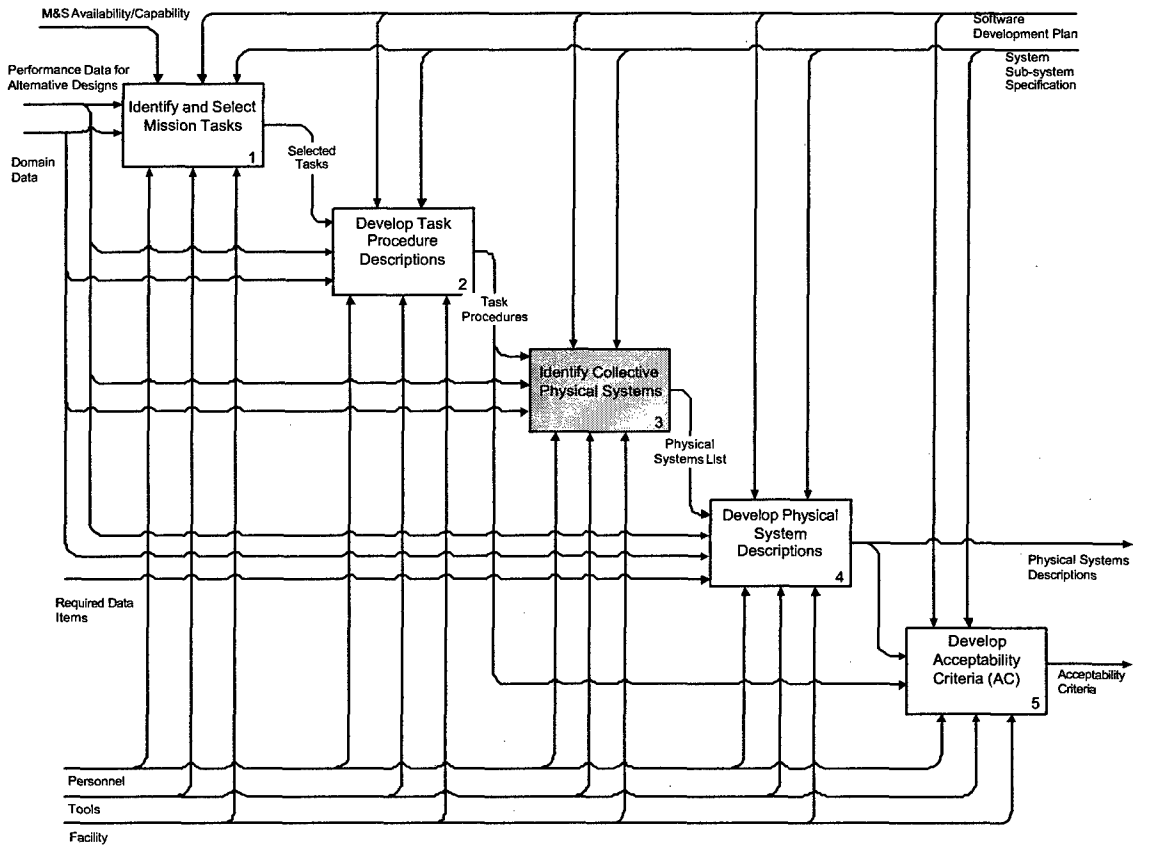


Figure A-A4.2.2(c) Perform M&S Knowledge Acquisition/Engineering

Inputs:

Task Procedures –

Alternative Design Data – Design information (design concept, description and associated cost) for alternate subject system designs to be analyzed.

Domain Data –

Controls:

Subsystem Specification (SSS) –Database of requirements from the System Requirements Document that allows for requirements traceability during system design/implementation/test.

Software Development Plan – Identifies software to be procured or written to conduct an experiment.

Outputs:

Physical Systems List -

Mechanisms:

Personnel – Government, contract employees, subject matter experts, systems engineers and analysts available to support using the WARCON process.

Tools – Previously validated methods, models and simulations, and COTS that support the modeling and analysis environments.

Facility -

A4.2.2.4 Develop Physical System Descriptions

(Figure A-A4.2.2(d))

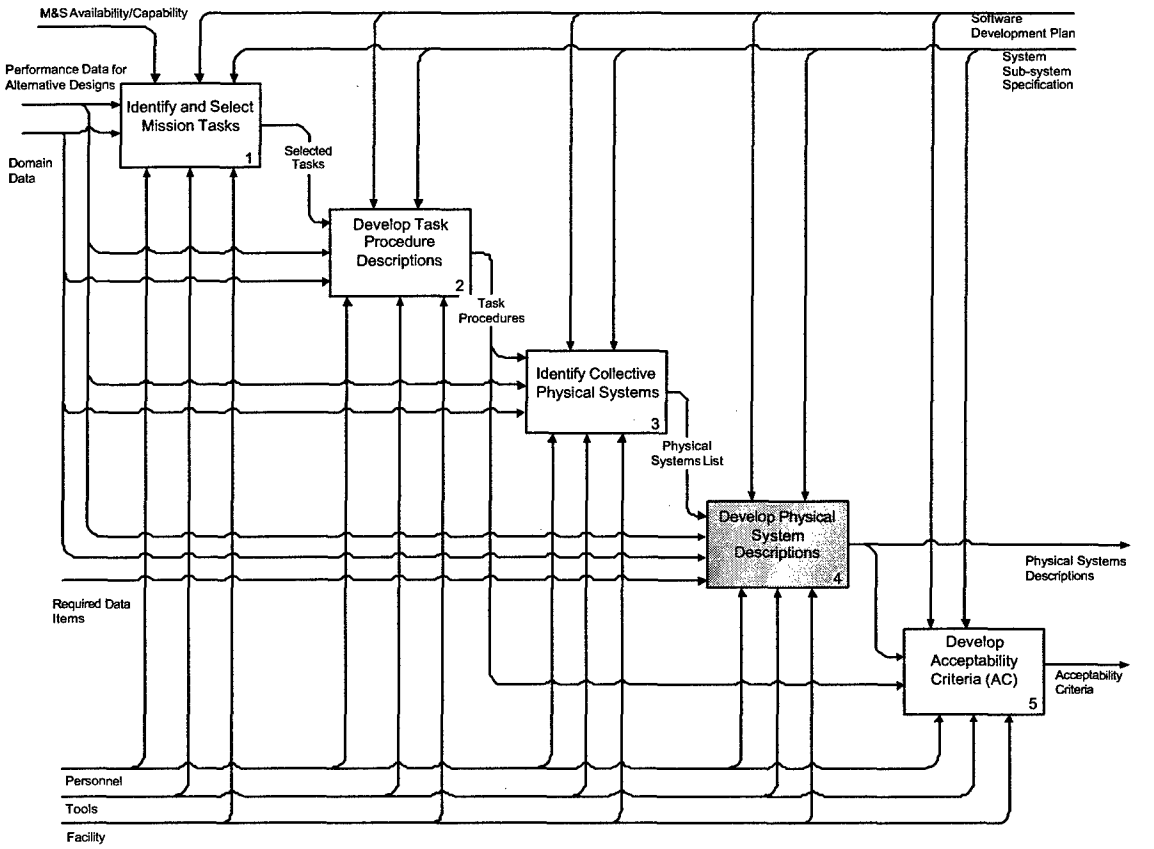


Figure A-A4.2.2(d) Perform M&S Knowledge Acquisition/Engineering

Inputs:

Physical Systems List -

Alternative Design Data – Design information (design concept, description and associated cost) for alternate subject system designs to be analyzed.

Domain Data –

Required Data Item-

Controls:

Subsystem Specification (SSS) –Database of requirements from the System Requirements Document that allows for requirements traceability during system design/implementation/test.

Software Development Plan – Identifies software to be procured or written to conduct an experiment.

Outputs:

Physical System Description -

Mechanisms:

Personnel – Government, contract employees, subject matter experts, systems engineers and analysts available to support using the WARCON process.

Tools – Previously validated methods, models and simulations, and COTS that support the modeling and analysis environments.

Facility -

A4.2.2.5 Develop Acceptability Criteria (AC)

(Figure A-A4.2.2(e))

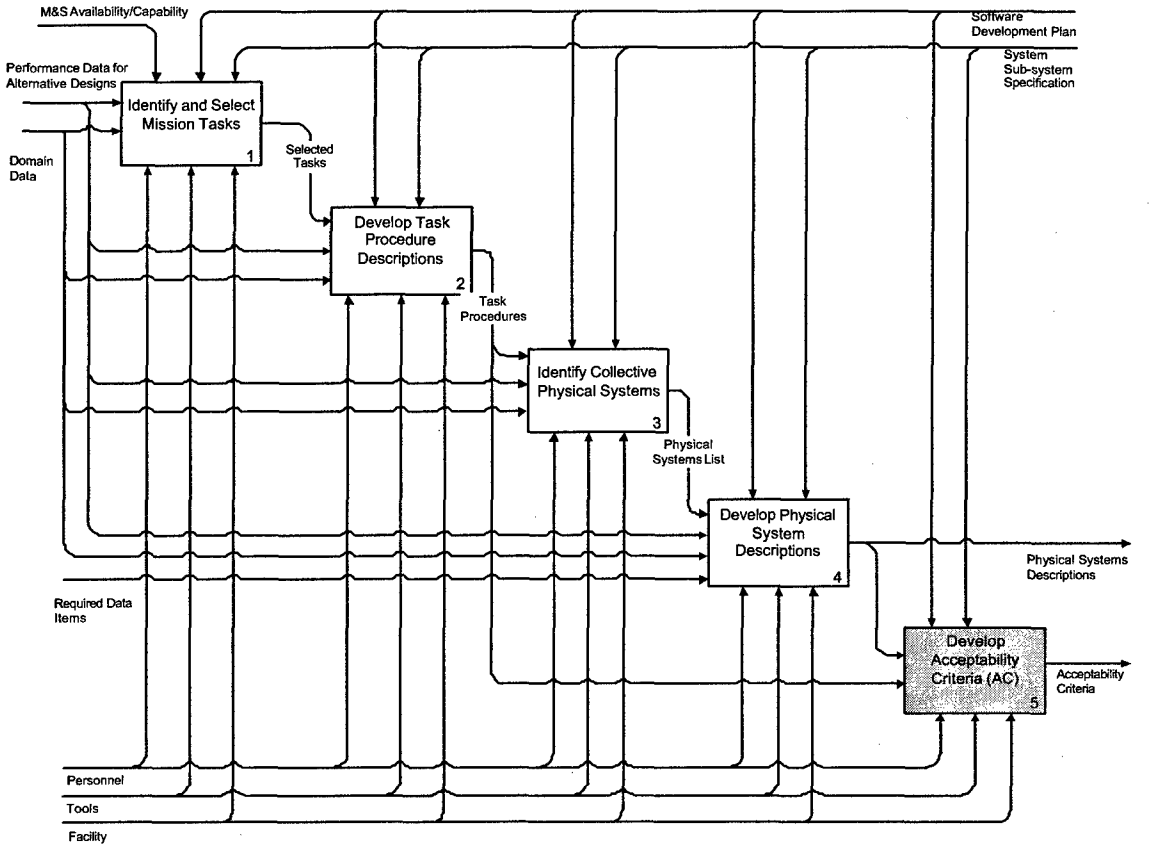


Figure A-A4.2.2(e) Perform M&S Knowledge Acquisition/Engineering

Inputs:

Physical System Description -

Task Procedures -

Controls:

Subsystem Specification (SSS) –Database of requirements from the System Requirements Document that allows for requirements traceability during system design/implementation/test.

Software Development Plan – Identifies software to be procured or written to conduct an experiment.

Outputs:

Acceptability Criteria (AC) – Testable requirements that are derived from "real world" capabilities based on intended use of the system being built.

Mechanisms:

Personnel – Government, contract employees, subject matter experts, systems engineers and analysts available to support using the WARCON process.

Tools – Previously validated methods, models and simulations, and COTS that support the modeling and analysis environments.

Facility -

A4.2.3 Develop Detailed Design for M&S System

Following a rigorous knowledge acquisition/engineering process to decompose requirements to a level capable of being written to a design that can be built in hardware or coded in software.

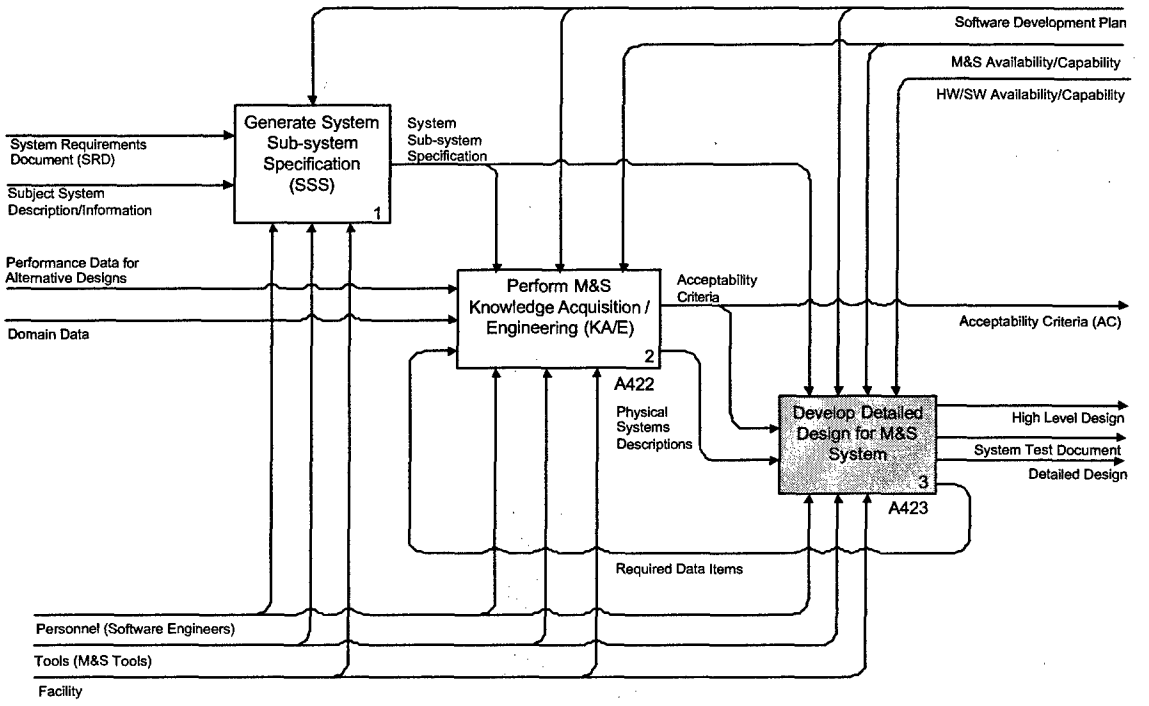


Figure A-A4.2(c) Design M&S Environment

Inputs:

Acceptability Criteria (AC) – Testable requirements that are derived from "real world" capabilities based on intended use of the system being built.

Physical System Description -

Controls:

Subsystem Specification (SSS) –Database of requirements from the System Requirements Document that allows for requirements traceability during system design/implementation/test.

Modeling and Simulation (M&S) Availability/Capability – Identification and assessment of the models and simulations available to support the analysis, and their capabilities, for potential inclusion into the integrated system/federation.

Software Development Plan – Identifies software to be procured or written to conduct an experiment.

HW/SW Availability/Capability -

Outputs:

High Level Design –

Required Data Items –

Detailed Design -

System Test Document -

Mechanisms:

Personnel – Government, contract employees, subject matter experts, systems engineers and analysts available to support using the WARCON process.

Tools – Previously validated methods, models and simulations, and COTS that support the modeling and analysis environments.

Facility -

A4.2.3.1 Develop System Requirements Specification (SRS)

(Figure A-A4.2.3(a))

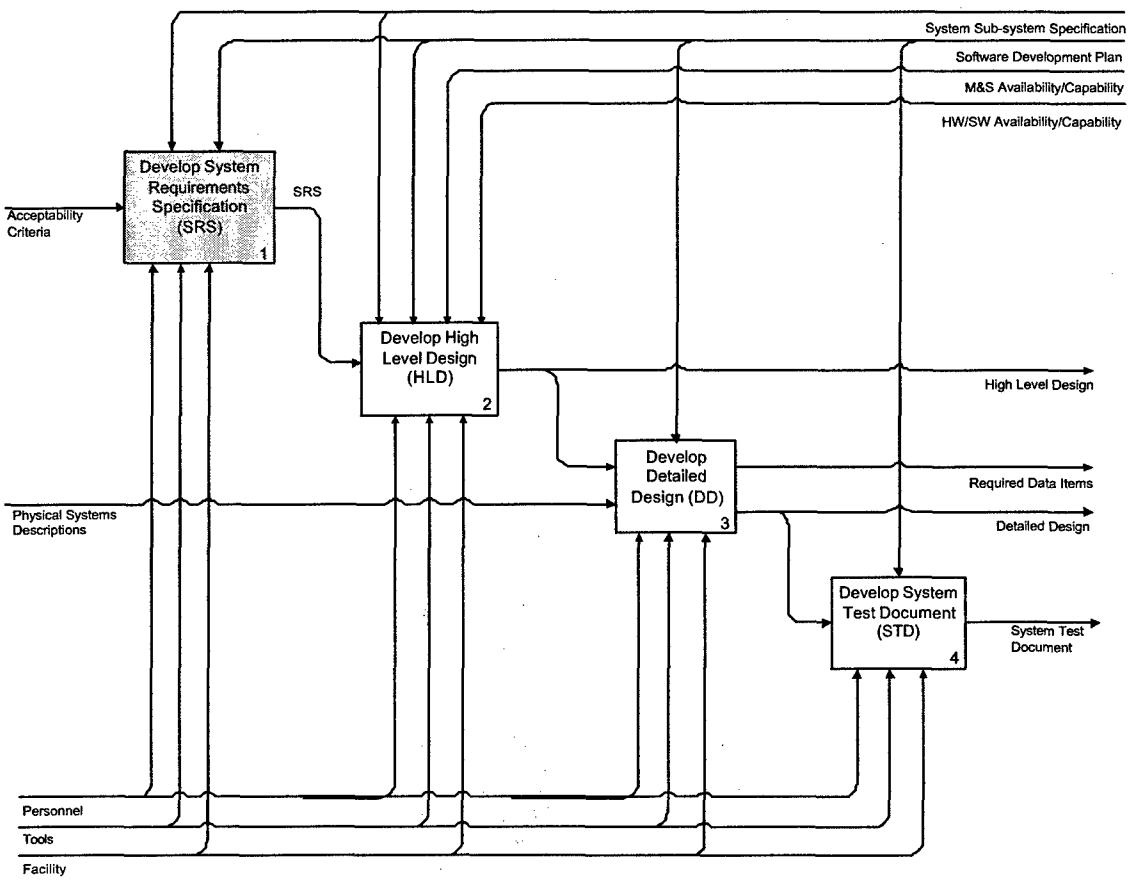


Figure A-A4.2.3(a) Develop Detailed Design For M&S System

Inputs:

Acceptability Criteria – Testable requirements that are derived from "real world" capabilities based on intended use of the system being built.

Controls:

Software Development Plan – Identifies software to be procured or written to conduct an experiment.

Subsystem Specification (SSS) –Database of requirements from the System Requirements Document that allows for requirements traceability during system design/implementation/test.

Outputs:

SRS -

Mechanisms:

Personnel – Government, contract employees, subject matter experts, systems engineers and analysts available to support using the WARCON process.

Tools – Previously validated methods, models and simulations that support the modeling and analysis environments.

Facility -

A4.2.3.2 Develop High Level Design (HLD)

Developing an architecture that is sufficient to describe the intended integrated system components and data requirements.

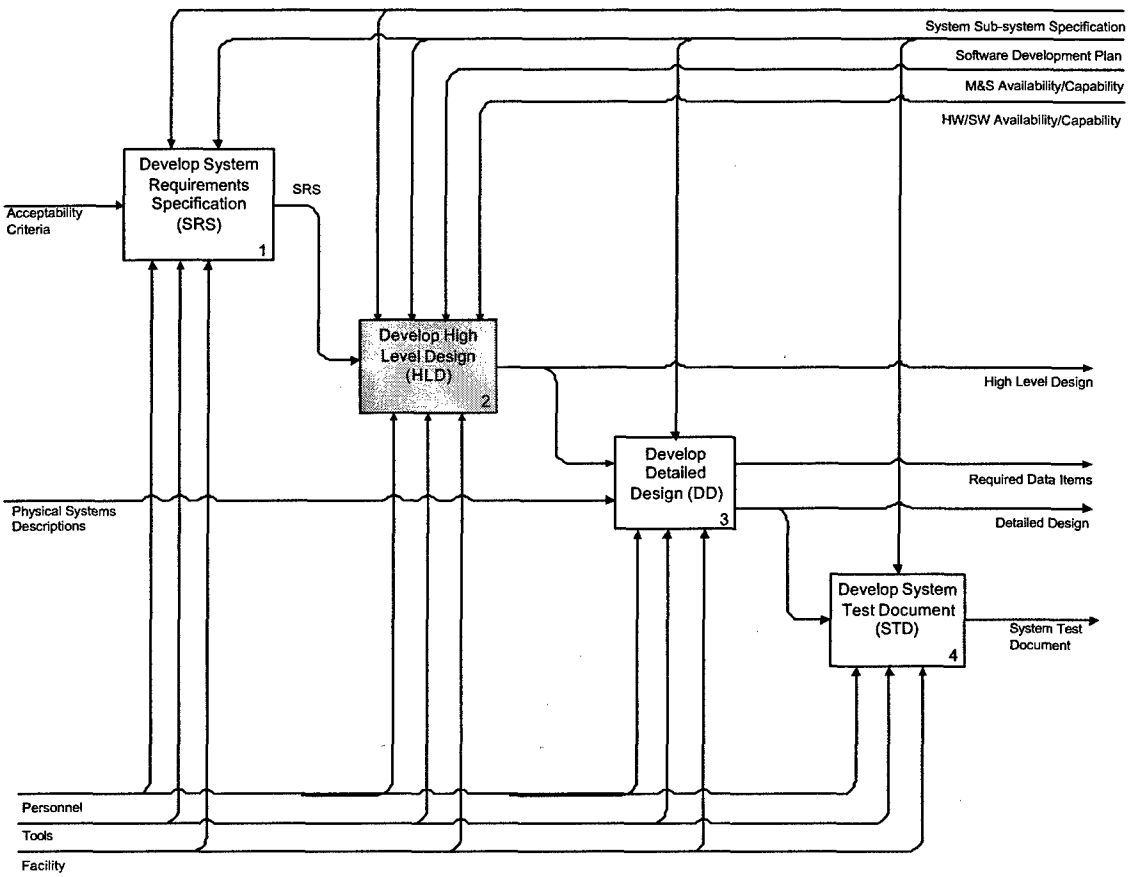


Figure A-A4.2.3(b) Develop Detailed Design For M&S System

Inputs:

SRS –

Controls:

Subsystem Specification (SSS) –Database of requirements from the System Requirements Document that allows for requirements traceability during system design/implementation/test.

Modeling and Simulation (M&S) Availability/Capability – Identification and assessment of the models and simulations available to support the analysis, and their capabilities, for potential inclusion into the integrated system/federation.

Software Development Plan – Identifies software to be procured or written to conduct an experiment.

Hardware/Software Availability/Capability –

Outputs:

High Level Design – Plan for building the Integrated System; requires program review approval.

Mechanisms:

Personnel – Government, contract employees, subject matter experts, systems engineers and analysts available to support using the WARCON process.

Tools – Previously validated methods, models and simulations that support the modeling and analysis environments.

Facility -

A4.2.3.3 Develop Detailed Design

Performing a further decomposition of the HLD that is of sufficient detail to describe the hardware and software components and how to build/code those components.

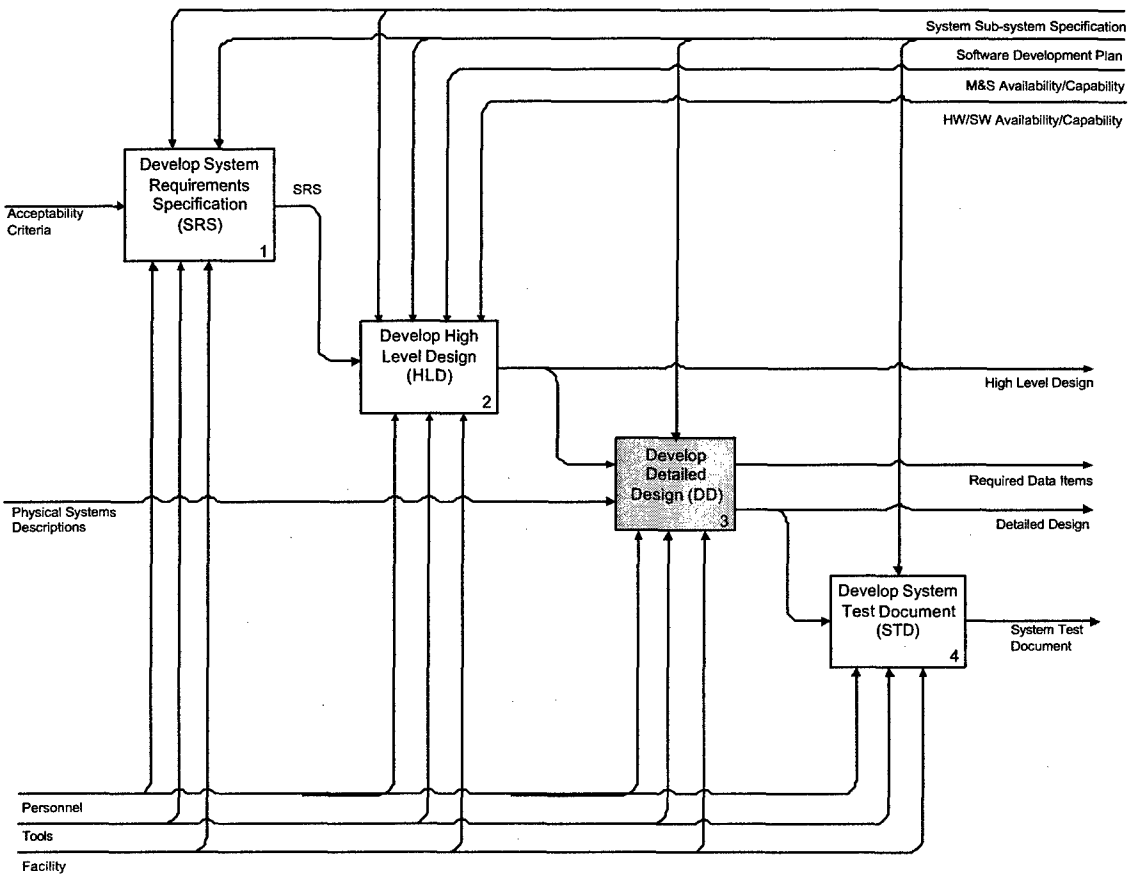


Figure A-A4.2.3(c) Develop Detailed Design For M&S System

Inputs:

High Level Design – Plan for building the Integrated System; requires program review approval.

Physical Systems Descriptions –

Controls:

Software Development Plan – Identifies software to be procured or written to conduct an experiment.

Outputs:

Required Data Item –

Detailed Design – contains the specific hardware, software components/algorithms, and data requirements for the integrated system..

Mechanisms:

Personnel – Government, contract employees, subject matter experts, systems engineers and analysts available to support using the WARCON process.

Tools – Previously validated methods, models and simulations that support the modeling and analysis environments.

Facility –

A4.2.3.4 Develop System Test Document (STD)

(Figure A-A4.2.3(d))

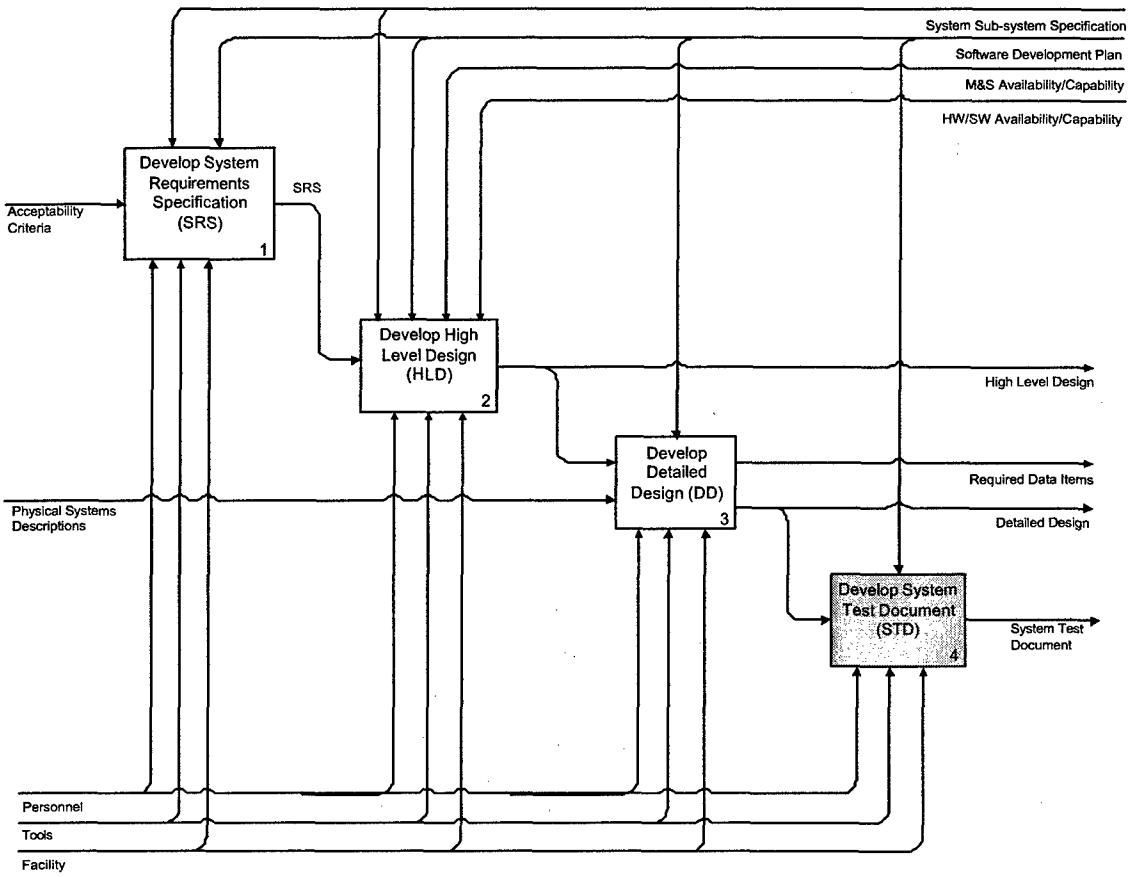


Figure A-A4.2.3(d) Develop Detailed Design For M&S System

Inputs:

Detailed Design – contains the specific hardware, software components/algorithms, and data requirements for the integrated system.

Controls:

Subsystem Specification (SSS) –Database of requirements from the System Requirements Document that allows for requirements traceability during system design/implementation/test.

Outputs:

System Test Document (STD) – Test criteria that are used to verify the built system against the detailed design and assist in validating the system against the acceptability criteria.

Mechanisms:

Personnel – Government, contract employees, subject matter experts, systems engineers and analysts available to support using the WARCON process.

Tools – Previously validated methods, models and simulations that support the modeling and analysis environments.

Facility –

A4.3 Implement and Test M&S Environment

Coding and building the software/hardware integrated system and associated testing.

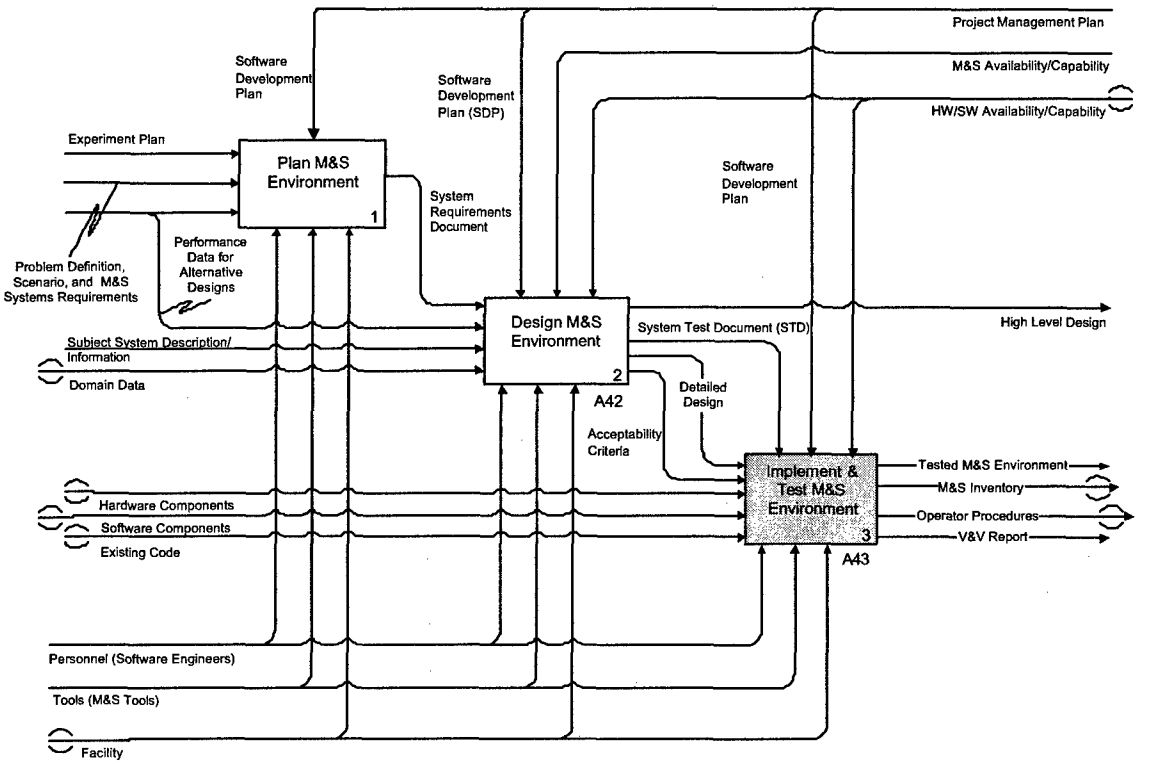


Figure A-A4(c) Build Integrated M&S Environment

Inputs:

Detailed Design – contains the specific hardware, software components/algorithms, and data requirements for the integrated system..

Software Components –

Hardware Components –

Acceptability Criteria – Testable requirements that are derived from "real world" capabilities based on intended use of the system being built.

Existing Codes -

Controls:

System Test Document – Test criteria that are used to verify the built system against the detailed design and assist in validating the system against the acceptability criteria.

Software Development Plan – Identifies software to be procured or written to conduct an experiment.

Hardware/Software Availability/Capability –

Outputs:

Tested M&S Environment – Integrated System after full testing.

Verification and Validation (V&V) Report – Results and assessment based on the acceptability criteria that the built system is verified and validated given the intended use.

Operator Procedures –

M&S Inventory –

Mechanisms:

Personnel – Government, contract employees, subject matter experts, systems engineers and analysts available to support using the WARCON process.

Tools – Previously validated methods, models and simulations that support the modeling and analysis environments.

Facility -

A4.3.1 Procure and Configure Hardware

(Figure A-A4.3(a))

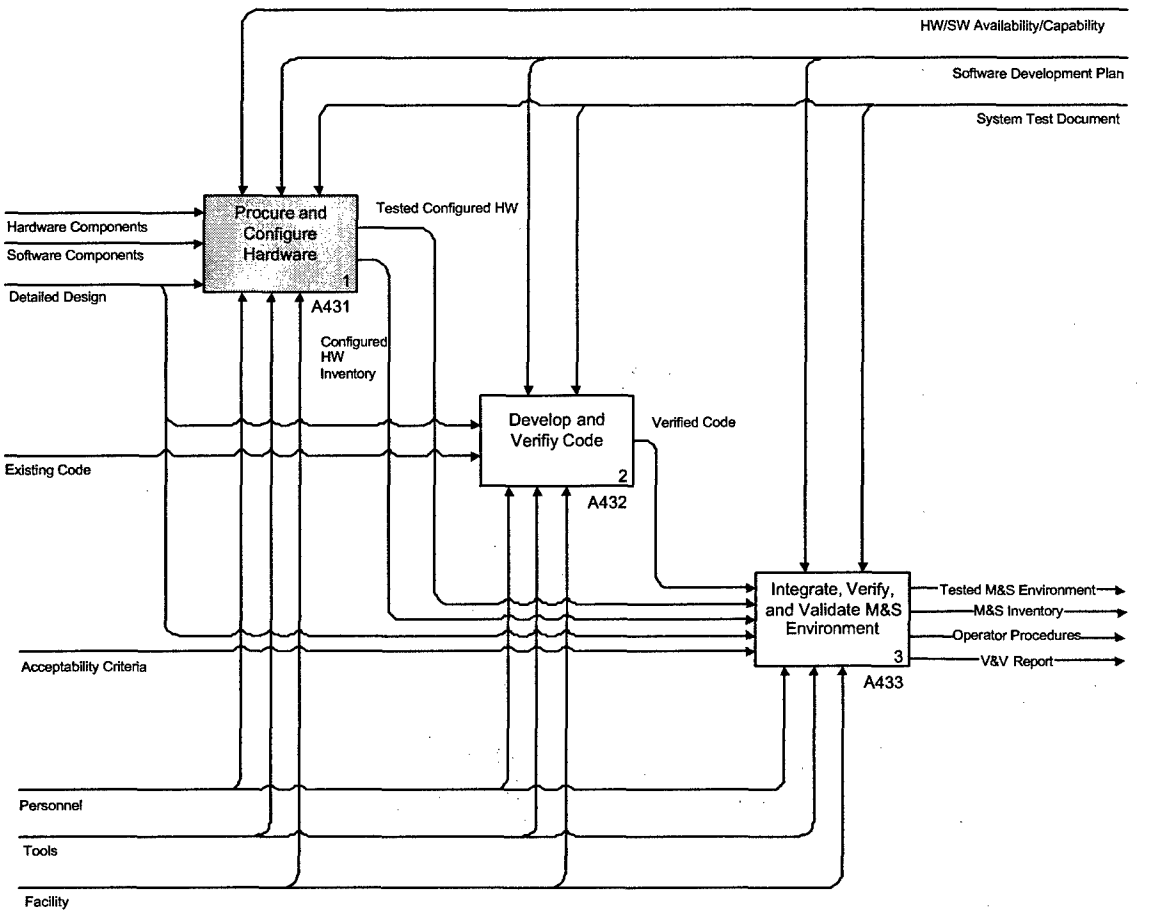


Figure A-A4.3(a) Implement and Test M&S Environment

Inputs:

Hardware Components –

Software Components –

Detailed Design – Contains the specific hardware, software components/algorithms, data requirements for the integrated system..

Controls:

Software Development Plan – Identifies software to be procured or written to conduct an experiment.

System Test Document (STD) – Test criteria that are used to verify the built system against the detailed design and assist in validating the system against the acceptability criteria.

HW/SW Availability/Capability -

Outputs:

Configured Hardware Inventory –

Configured Hardware -

Mechanisms:

Personnel – Government, contract employees, subject matter experts, systems engineers and analysts available to support using the WARCON process.

Tools – Previously validated methods, models and simulations that support the modeling and analysis environments.

Facility -

A4.3.1.1 Select and Procure Hardware/Software

(Figure A-A4.3(a))

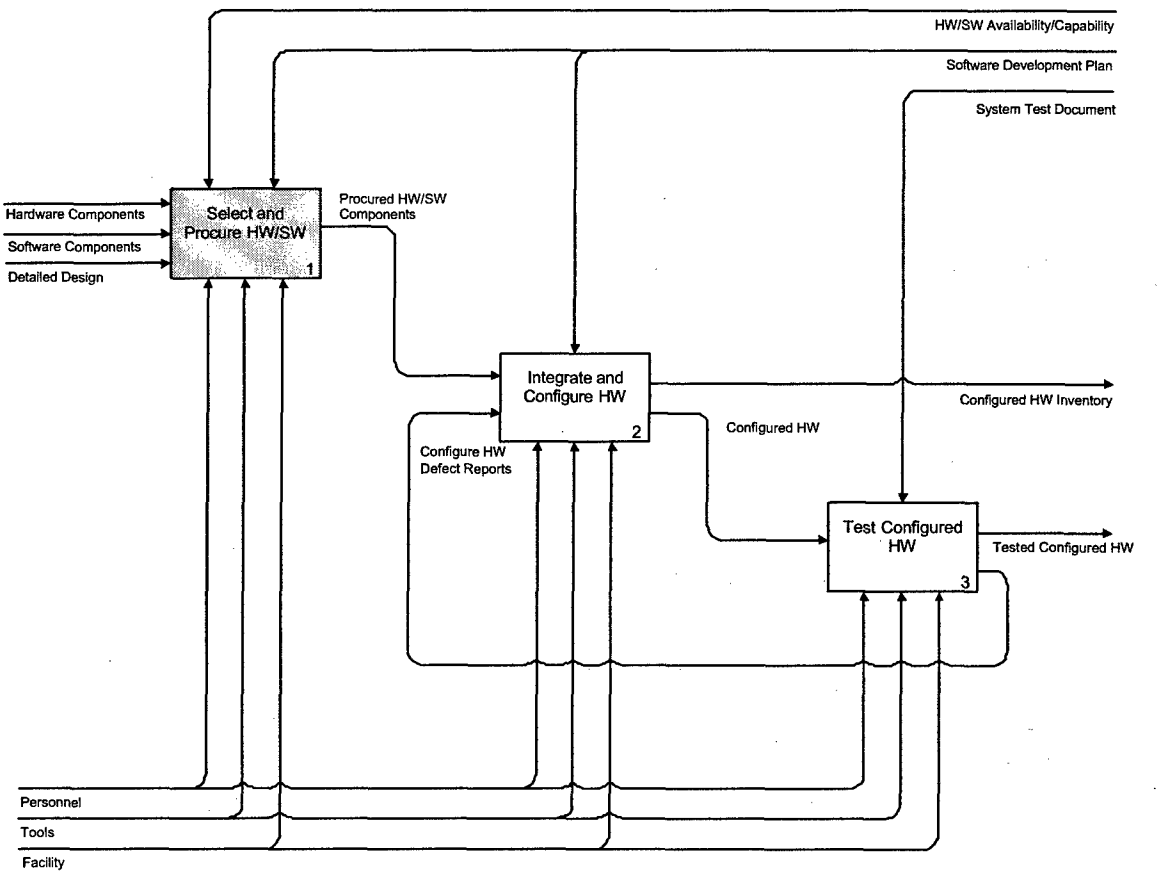


Figure A-A4.3(a) Procure and Configure Hardware

Inputs:

Hardware Components –

Software Components –

Detailed Design – Contains the specific hardware, software components/algorithms, data requirements for the integrated system..

Controls:

Software Development Plan – Identifies software to be procured or written to conduct an experiment.

HW/SW Availability/Capability –

Outputs:

Procured Hardware/Software Components –

Mechanisms:

Personnel – Government, contract employees, subject matter experts, systems engineers and analysts available to support using the WARCON process.

Tools – Previously validated methods, models and simulations that support the modeling and analysis environments.

Facility -

A4.3.1.2 Integrate and Configure Hardware

(Figure A-A4.3(b))

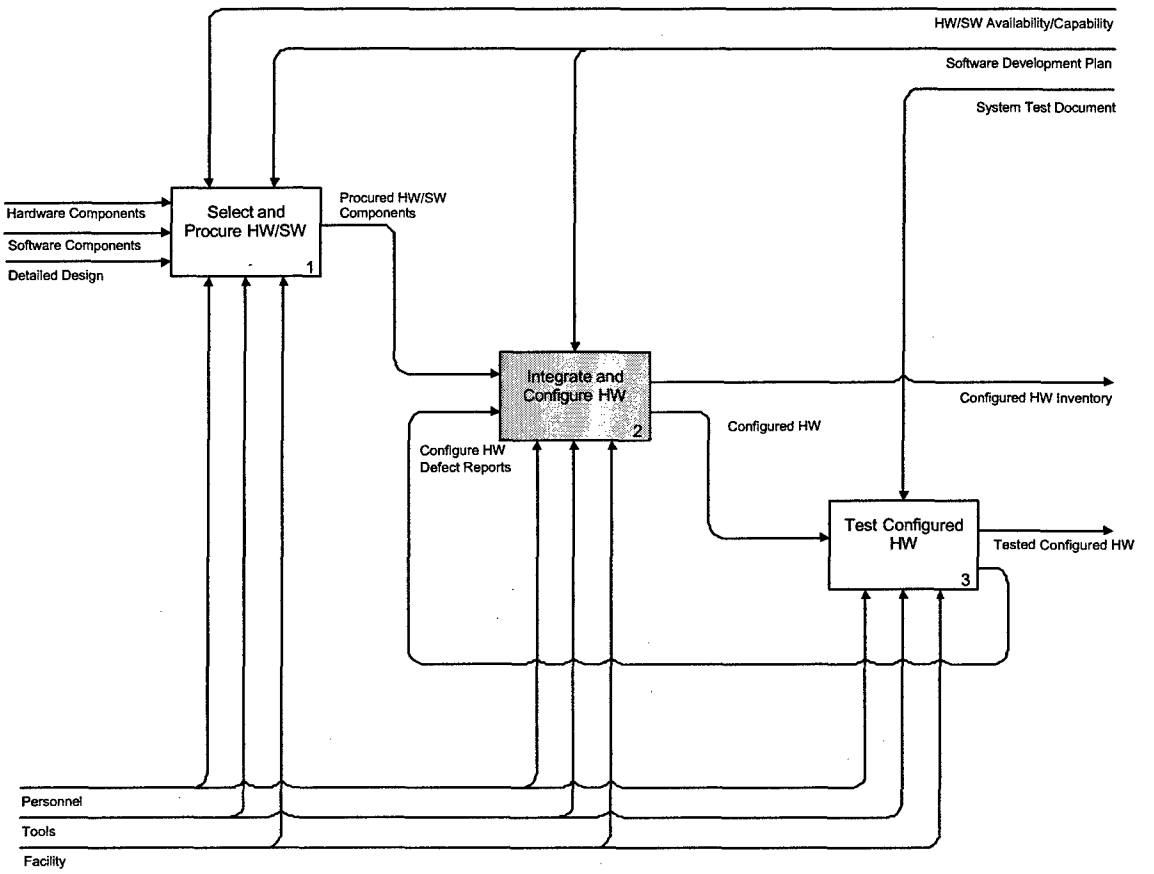


Figure A-A4.3(b) Procure and Configure Hardware

Inputs:

Procured Hardware/Software Components -

Configure Hardware Defects Report -

Controls:

Software Development Plan – Identifies software to be procured or written to conduct an experiment.

Outputs:

Configured Hardware Inventory -

Configured Hardware -

Mechanisms:

Personnel – Government, contract employees, subject matter experts, systems engineers and analysts available to support using the WARCON process.

Tools – Previously validated methods, models and simulations that support the modeling and analysis environments.

Facility -

A4.3.1.3 Test Configured Hardware

(Figure A-A4.3(c))

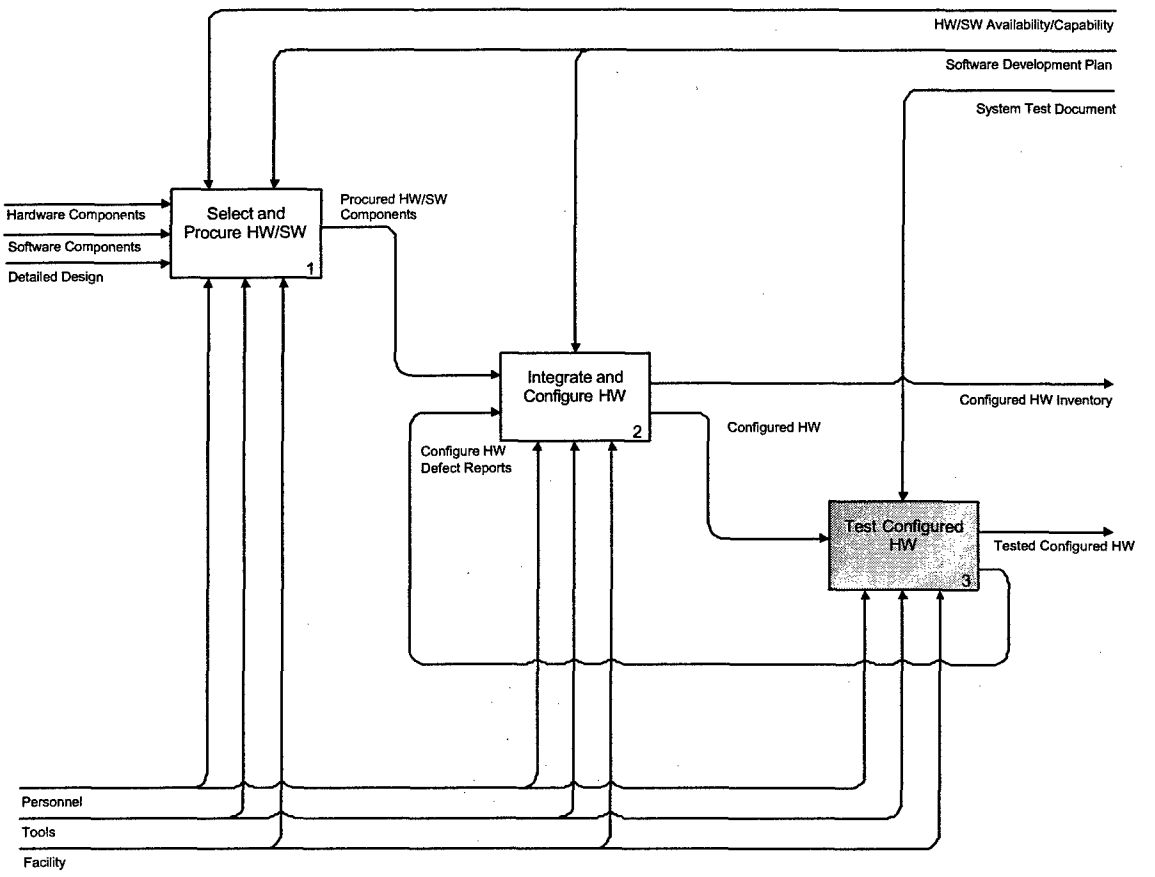


Figure A-A4.3(c) Procure and Configure Hardware

Inputs:

Configured Hardware -

Controls:

System Test Document –

Outputs:

Tested Configured Hardware -

Configure HW Defects Reports -

Mechanisms:

Personnel – Government, contract employees, subject matter experts, systems engineers and analysts available to support using the WARCON process.

Tools – Previously validated methods, models and simulations that support the modeling and analysis environments.

Facility -

A4.3.2 Develop and Verify Code

(Figure A-A4.3(b))

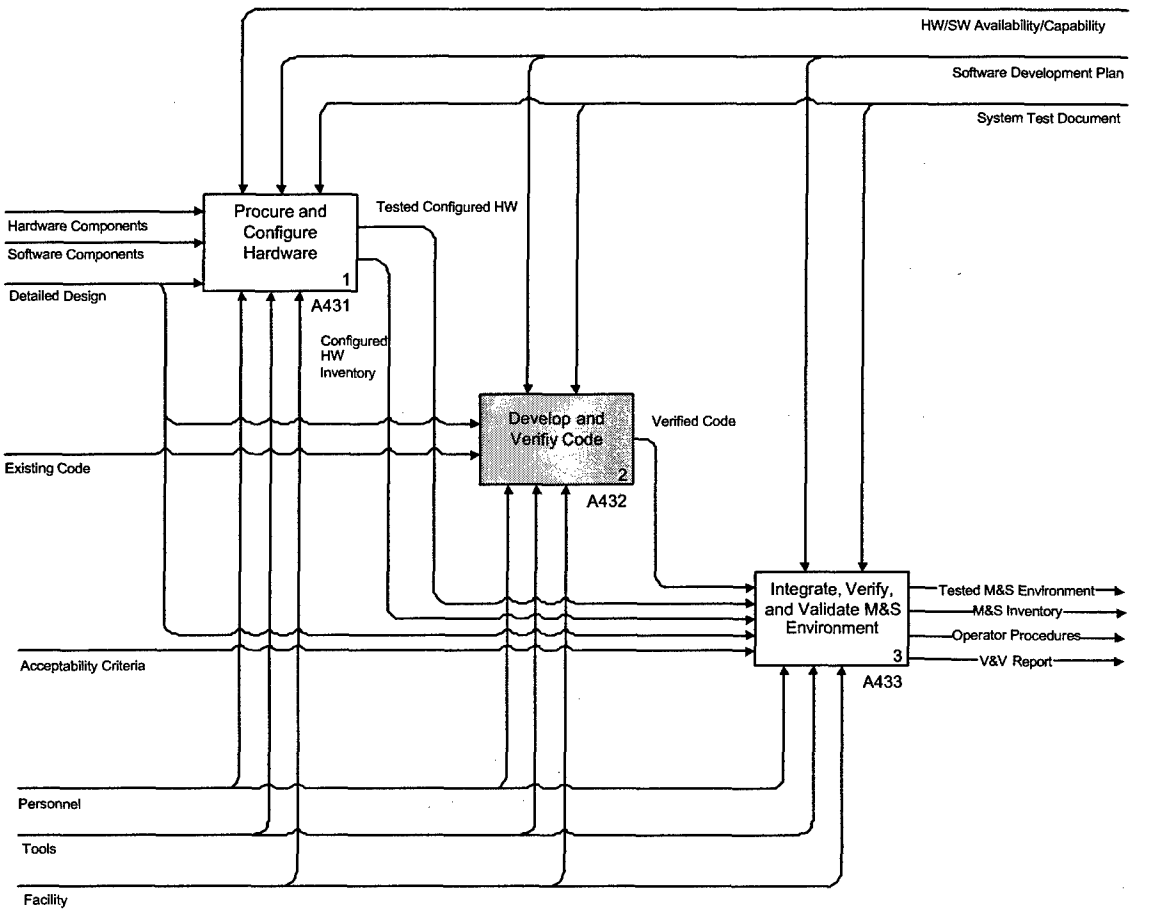


Figure A-A4.3(b) Implement and Test M&S Environment

Inputs:

Detailed Design – Contains the specific hardware, software components/algorithms, data requirements for the integrated system.

Existing Code –

Controls:

Software Development Plan – Identifies software to be procured or written to conduct an experiment.

System Test Document (STD) – Test criteria that are used to verify the built system against the detailed design and assist in validating the system against the acceptability criteria.

Outputs:

Verified Code -

Mechanisms:

Personnel – Government, contract employees, subject matter experts, systems engineers and analysts available to support using the WARCON process.

Tools – Previously validated methods, models and simulations that support the modeling and analysis environments.

Facility -

A4.3.2.1 Develop Code

(Figure A-A4.3.2(a))

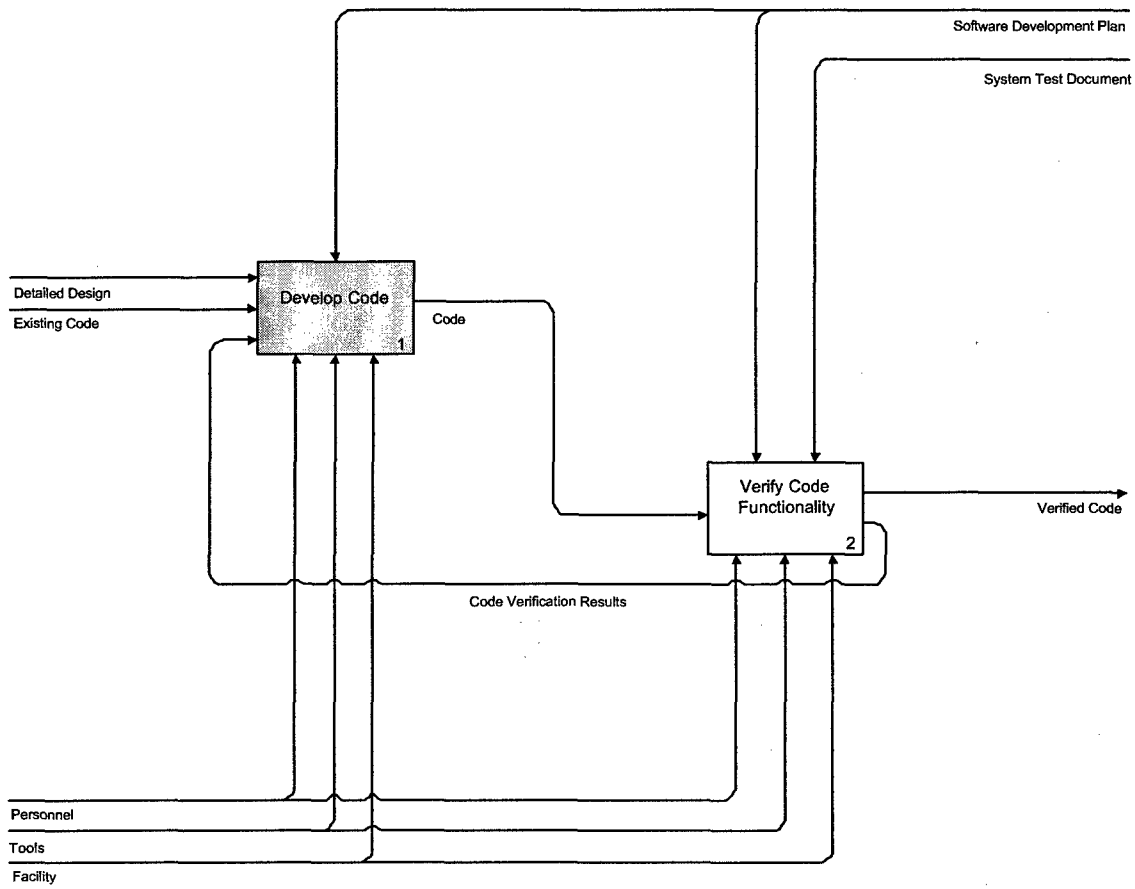


Figure A-A4.3.2(a) Develop and Verify Code

Inputs:

Detailed Design – Contains the specific hardware, software components/algorithms, data requirements for the integrated system.

Existing Code –

Code Verification Results -

Controls:

Software Development Plan – Identifies software to be procured or written to conduct an experiment.

Outputs:

Code -

Mechanisms:

Personnel – Government, contract employees, subject matter experts, systems engineers and analysts available to support using the WARCON process.

Tools – Previously validated methods, models and simulations that support the modeling and analysis environments.

Facility -

A4.3.2.2 Verify Code Functionality

(Figure A-A4.3.2(b))

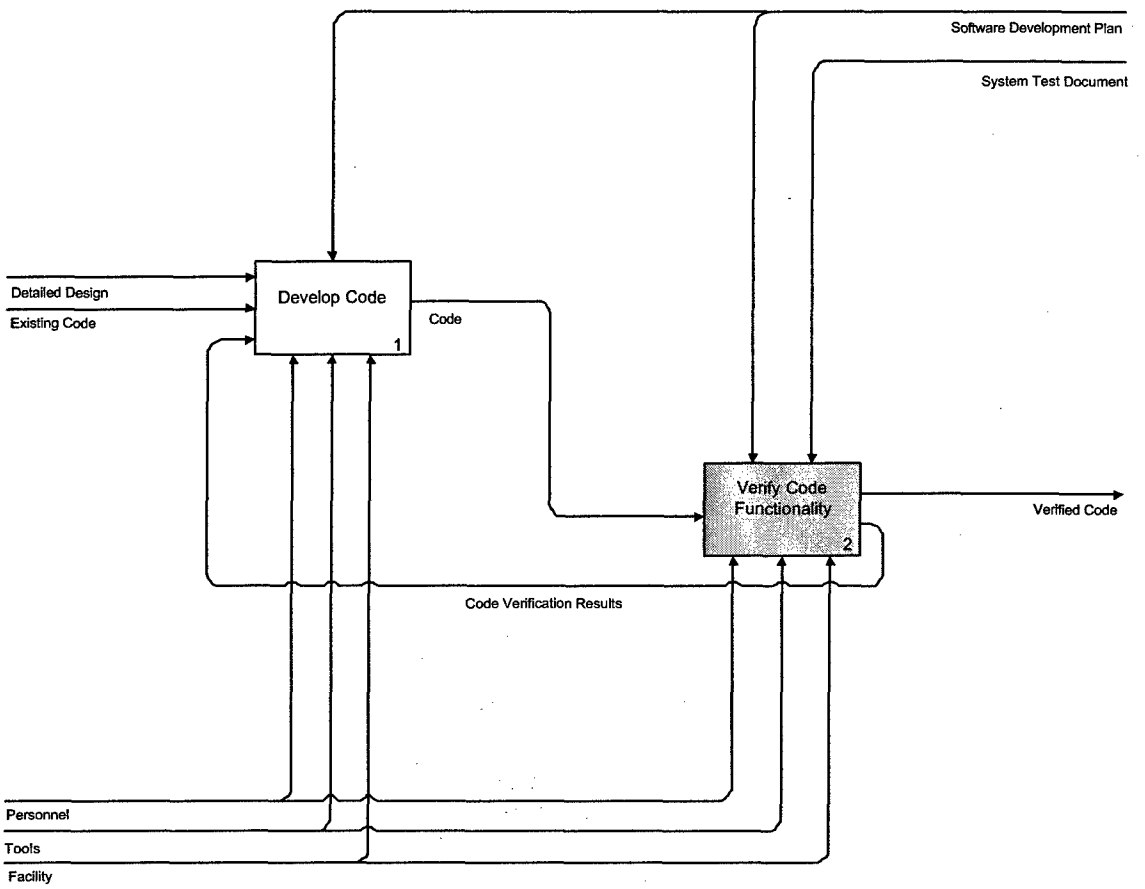


Figure A-A4.3.2(b) Develop and Verify Code

Inputs:

Code -

Controls:

Software Development Plan – Identifies software to be procured or written to conduct an experiment.

System Test Document (STD) – Test criteria that are used to verify the built system against the detailed design and assist in validating the system against the acceptability criteria.

Outputs:

Verified Code -

Code Verification Results -

Mechanisms:

Personnel – Government, contract employees, subject matter experts, systems engineers and analysts available to support using the WARCON process.

Tools – Previously validated methods, models and simulations that support the modeling and analysis environments.

Facility -

A4.3.3 Integrate, Verify and Validate M&S Environment

(Figure A-A4.3(c))

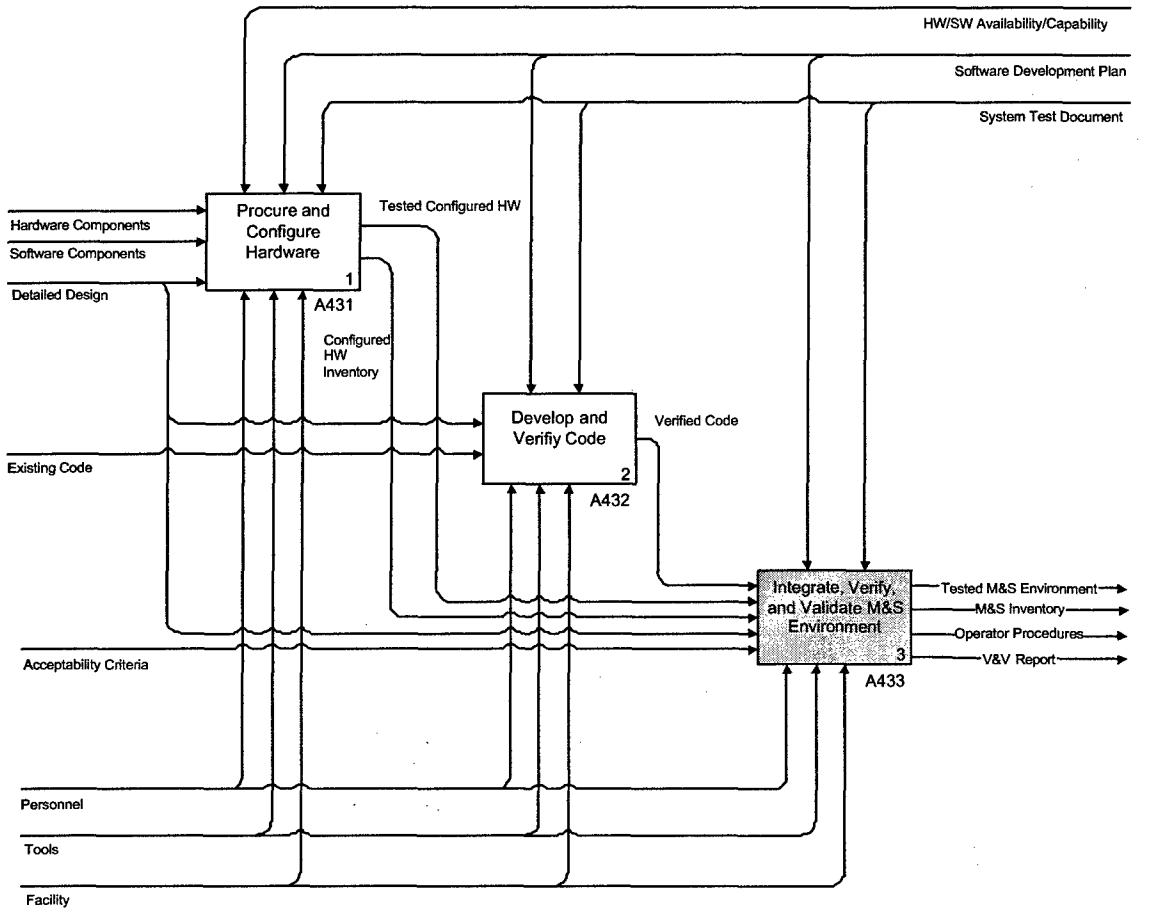


Figure A-A4.3(c) Implement and Test M&S Environment

Inputs:

Tested Configured Hardware –

Verified Code –

Detailed Design – Contains the specific hardware, software components/algorithms, data requirements for the integrated system.

Configured Hardware Inventory–

Acceptability Criteria (AC) – Testable requirements that are derived from "real world" capabilities based on intended use of the system being built.

Controls:

Software Development Plan – Identifies software to be procured or written to conduct an experiment.

System Test Document (STD) – Test criteria that are used to verify the built system against the detailed design and assist in validating the system against the acceptability criteria.

Outputs:

Tested M&S Environment – Integrated System after full testing.

M&S Inventory –

Operator Procedures –

Validation and Verification Report –

Mechanisms:

Personnel – Government, contract employees, subject matter experts, systems engineers and analysts available to support using the WARCON process.

Tools – Previously validated methods, models and simulations that support the modeling and analysis environments.

Facility -

A4.3.3.1 Install Code

(Figure A-A4.3.3(a))

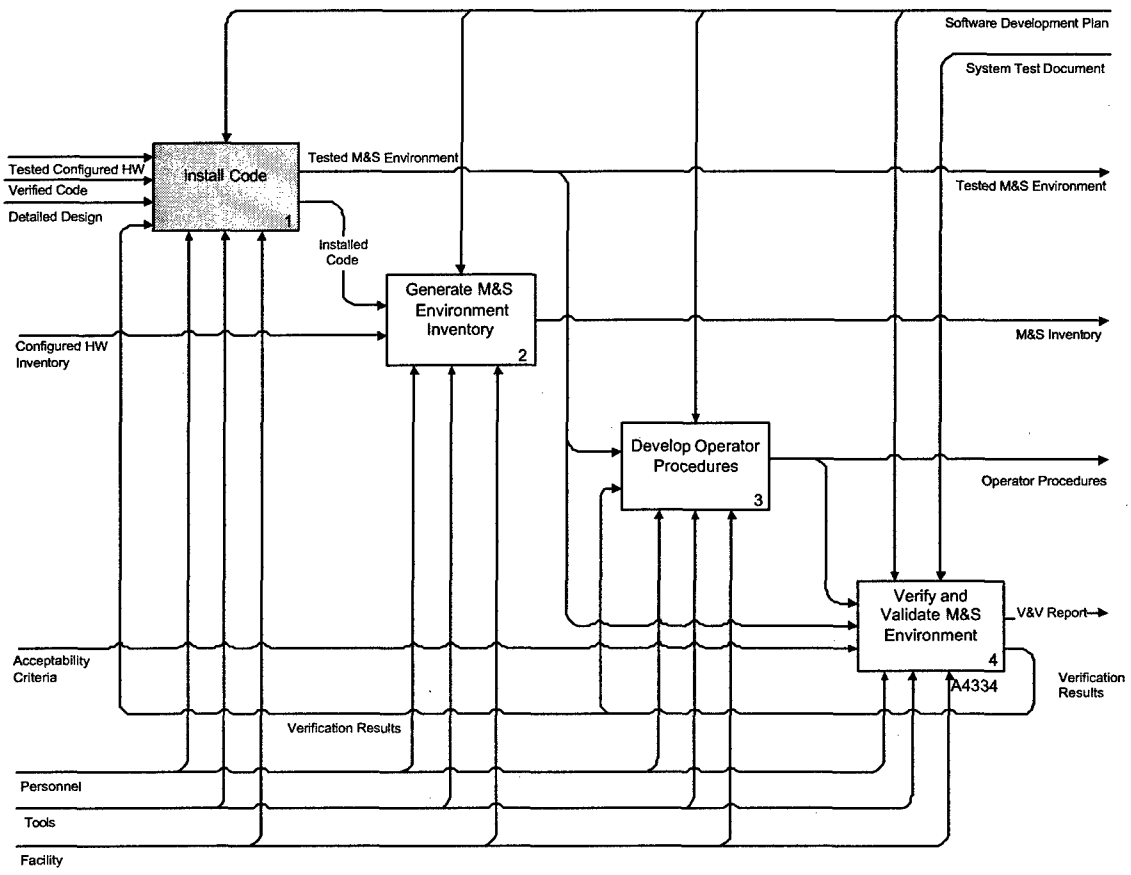


Figure A-A4.3.3(a) Integrate, Verify and Validate M&S Environment

Inputs:

Tested Configured Hardware –

Verified Code –

Detailed Design – Contains the specific hardware, software components/algorithms, data requirements for the integrated system.

Controls:

Software Development Plan – Identifies software to be procured or written to conduct an experiment.

Outputs:

Tested M&S Environment – Integrated System after full testing.

Installed Code -

Mechanisms:

Personnel – Government, contract employees, subject matter experts, systems engineers and analysts available to support using the WARCON process.

Tools – Previously validated methods, models and simulations that support the modeling and analysis environments.

Facility –

A4.3.3.2 Generate M&S Environment Inventory

(Figure A-A4.3.3(b))

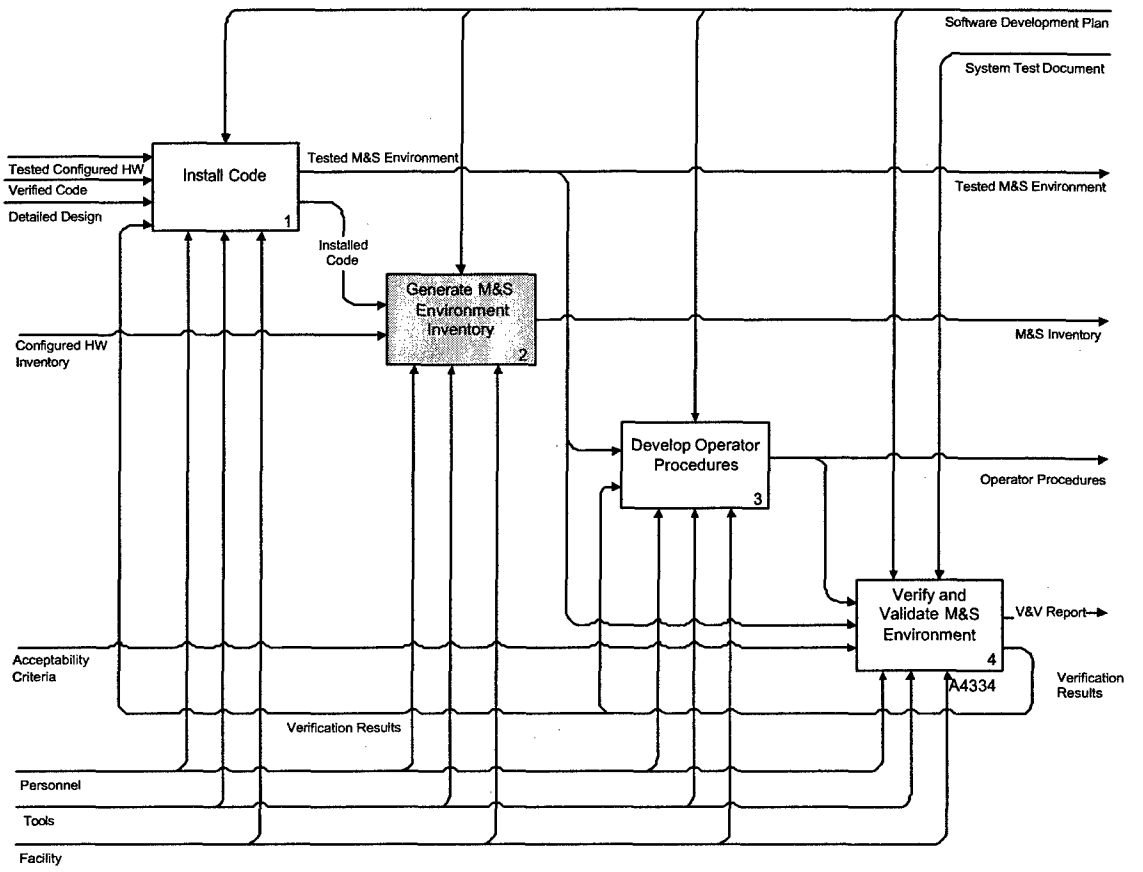


Figure A-A4.3.3(b) Integrate, Verify and Validate M&S Environment

Inputs:

Installed Code –

Configured HW Inventory -

Controls:

Software Development Plan – Identifies software to be procured or written to conduct an experiment.

Outputs:

M&S Inventory –

Mechanisms:

Personnel – Government, contract employees, subject matter experts, systems engineers and analysts available to support using the WARCON process.

Tools – Previously validated methods, models and simulations that support the modeling and analysis environments.

Facility -

A4.3.3.3 Develop Operator Procedures

(Figure A-A4.3.3(c))

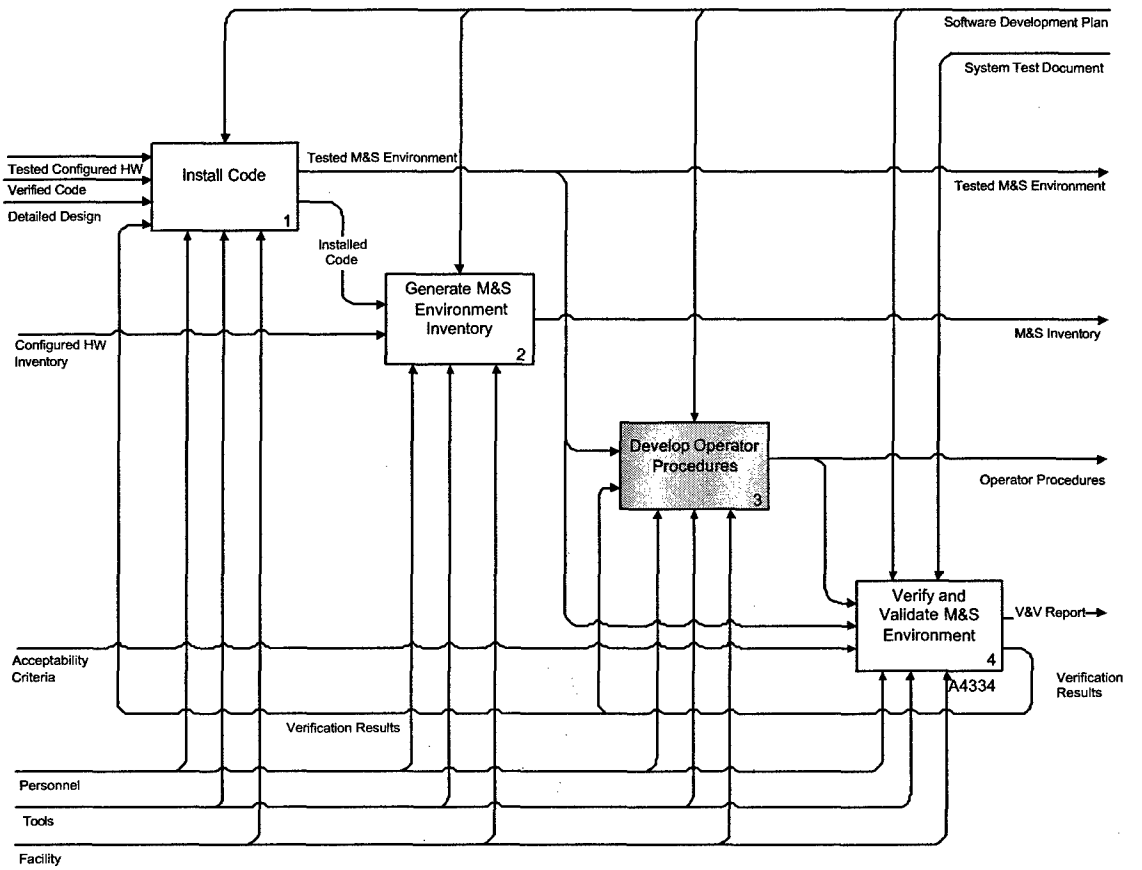


Figure A-A4.3.3(c) Integrate, Verify and Validate M&S Environment

Inputs:

Tested M&S Environment – Integrated System after full testing.

Verification Results -

Controls:

Software Development Plan – Identifies software to be procured or written to conduct an experiment.

Outputs:

Operator Procedures -

Mechanisms:

Personnel – Government, contract employees, subject matter experts, systems engineers and analysts available to support using the WARCON process.

Tools – Previously validated methods, models and simulations that support the modeling and analysis environments.

Facility -

A4.3.3.4 Verify and Validate M&S Environment

(Figure A-A4.3.3(d))

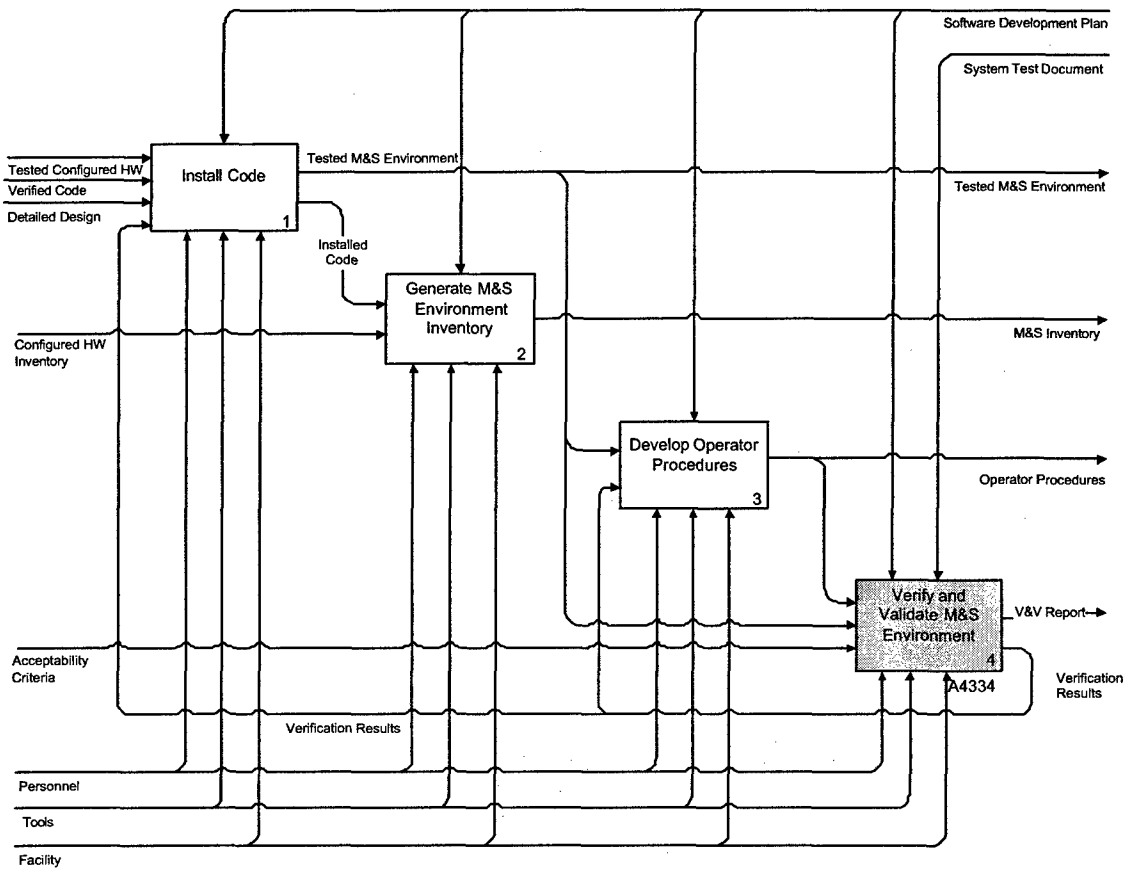


Figure A-A4.3.3(d) Integrate, Verify and Validate M&S Environment

Inputs:

Operator Procedures -

Tested M&S Environment – Integrated System after full testing.

Acceptability Criteria (AC) – Testable requirements that are derived from "real world" capabilities based on intended use of the system being built.

Controls:

Software Development Plan – Identifies software to be procured or written to conduct an experiment.

System Test Document (STD) – Test criteria that are used to verify the built system against the detailed design and assist in validating the system against the acceptability criteria.

Outputs:

Validation and Verification Report – Results and assessment based on the acceptability criteria that the built system is validated and verified given the intended use.

Verification Results -

Mechanisms:

Personnel – Government, contract employees, subject matter experts, systems engineers and analysts available to support using the WARCON process.

Tools – Previously validated methods, models and simulations that support the modeling and analysis environments.

Facility -

A4.3.3.4.1 Verify M&S Environment Functionality

(Figure A-A4.3.3.4(a))

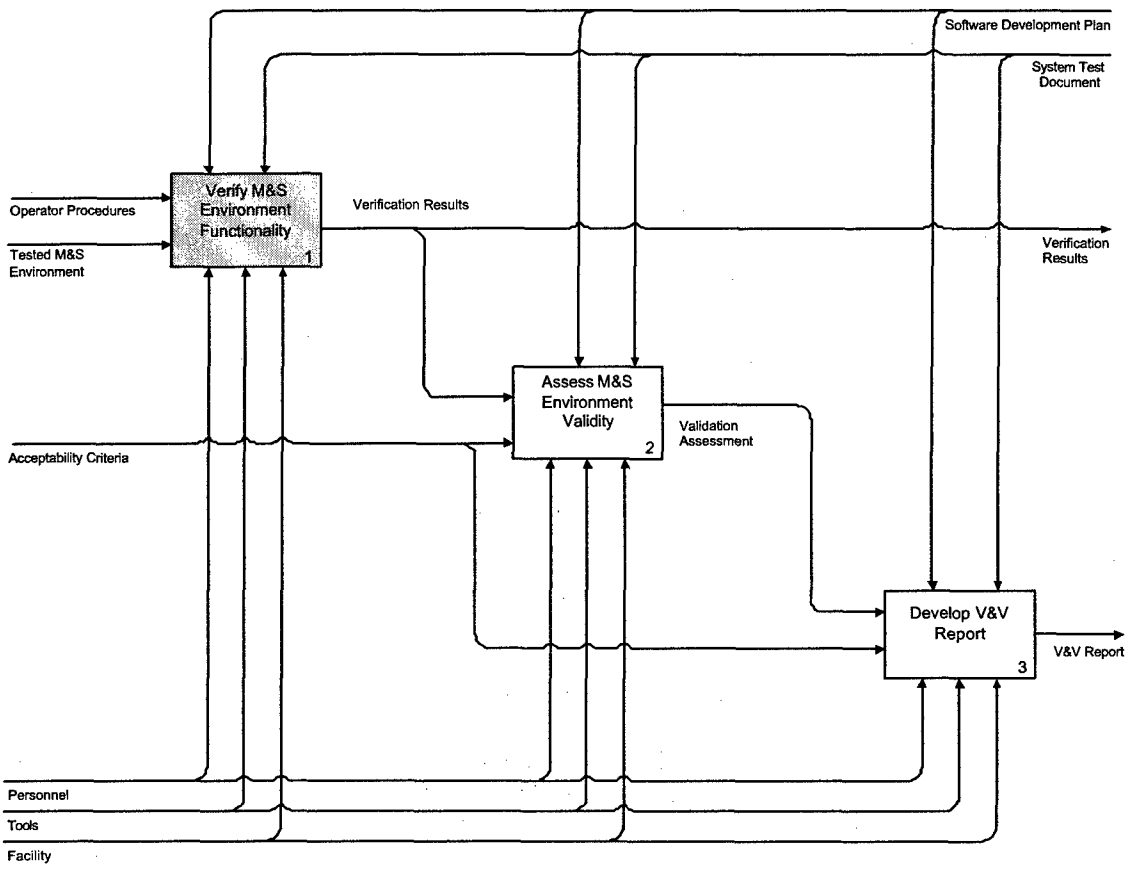


Figure A-A4.3.3.4(a) Validate and Verify M&S Environment

Inputs:

Tested M&S Environment – Integrated System after full testing.

Operator Procedures -

Controls:

Software Development Plan – Identifies software to be procured or written to conduct an experiment.

System Test Document (STD) – Test criteria that are used to verify the built system against the detailed design and assist in validating the system against the acceptability criteria.

Outputs:

Verification Results -

Mechanisms:

Personnel – Government, contract employees, subject matter experts, systems engineers and analysts available to support using the WARCON process.

Tools – Previously validated methods, models and simulations that support the modeling and analysis environments.

Facility -

A4.3.3.4.2 Assess M&S Environment Validity

(Figure A-A4.3.3.4(b))

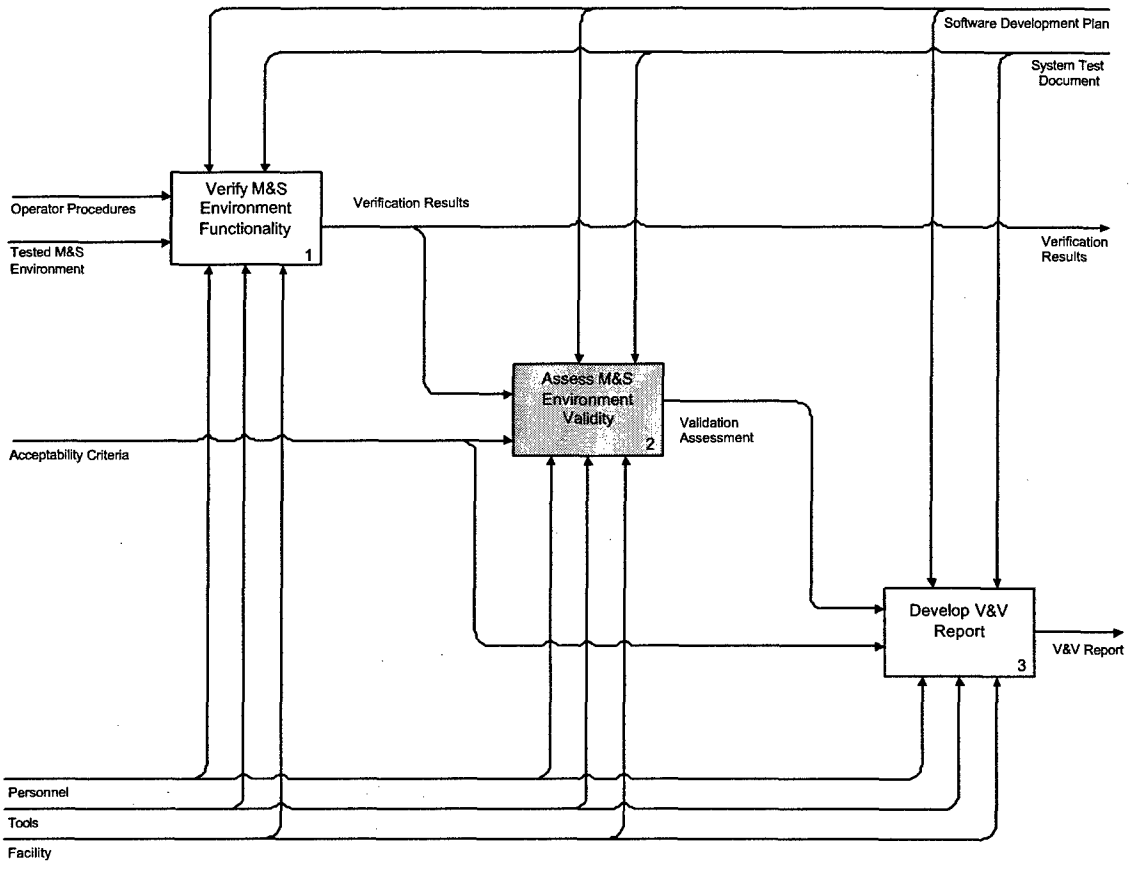


Figure A-A4.3.3.4(b) Validate and Verify M&S Environment

Inputs:

Verification Results –

Acceptability Criteria (AC) – Testable requirements that are derived from "real world" capabilities based on intended use of the system being built.

Controls:

Software Development Plan – Identifies software to be procured or written to conduct an experiment.

System Test Document (STD) – Test criteria that are used to verify the built system against the detailed design and assist in validating the system against the acceptability criteria.

Outputs:

Validation Assessment -

Mechanisms:

Personnel – Government, contract employees, subject matter experts, systems engineers and analysts available to support using the WARCON process.

Tools – Previously validated methods, models and simulations that support the modeling and analysis environments.

Facility -

A4.3.3.4.3 Develop V&V Report

(Figure A-A4.3.3.4(c))

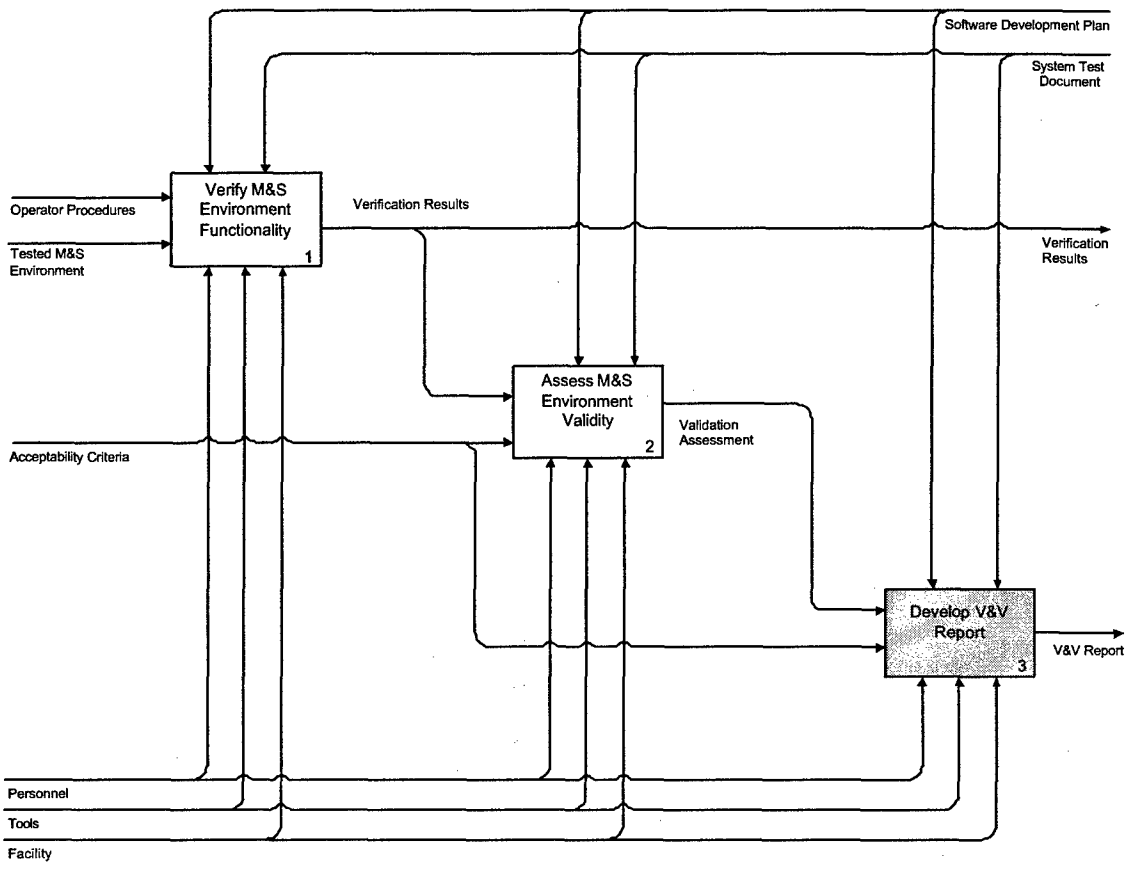


Figure A-A4.3.3.4(c) Validate and Verify M&S Environment

Inputs:

Validation Assessment –

Acceptability Criteria (AC) – Testable requirements that are derived from "real world" capabilities based on intended use of the system being built.

Controls:

Software Development Plan – Identifies software to be procured or written to conduct an experiment.

System Test Document (STD) – Test criteria that are used to verify the built system against the detailed design and assist in validating the system against the acceptability criteria.

Outputs:

V&V Report -

Mechanisms:

Personnel – Government, contract employees, subject matter experts, systems engineers and analysts available to support using the WARCON process.

Tools – Previously validated methods, models and simulations that support the modeling and analysis environments.

Facility -

A5 Conduct Experiment

Performing the experiment in accordance with the Project Management Plan and Experiment Plan (Figure A-A0(e)).

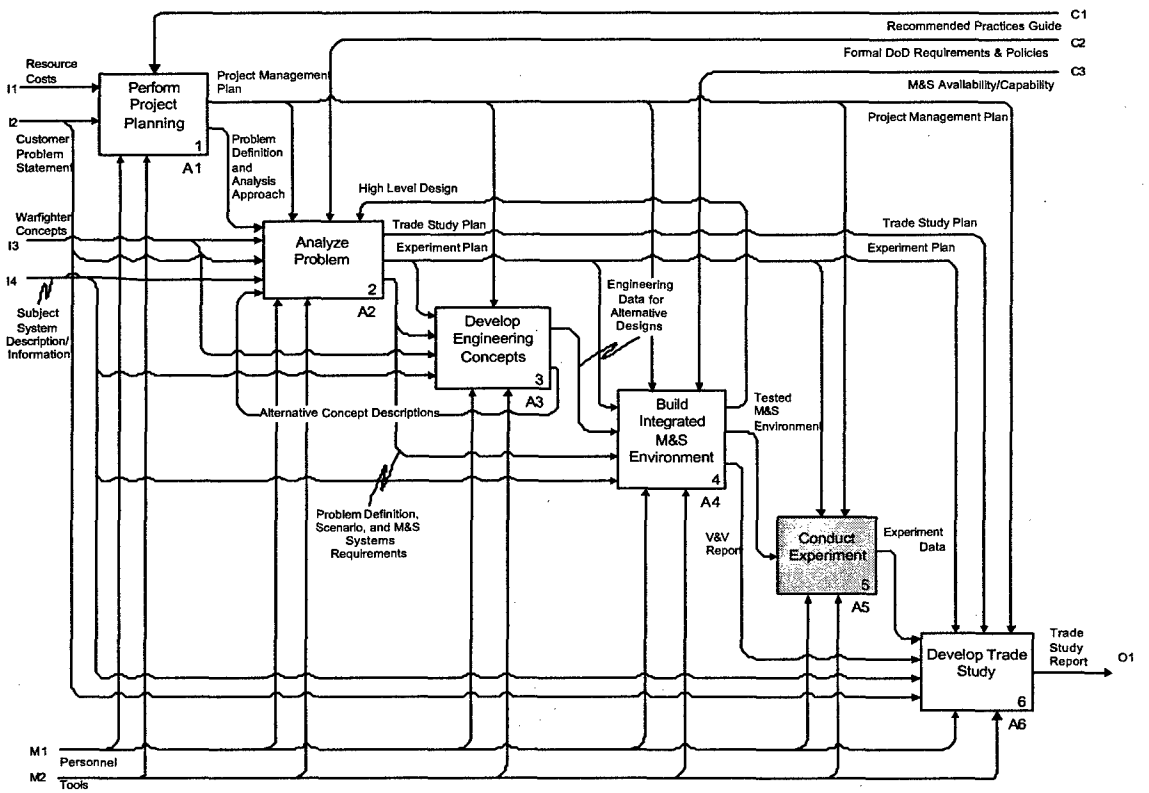


Figure A-A0(e) Execute WARCON Process

Inputs:

Resource Availability Data – The access to time, people, equipment and facilities required to conduct the experiment(s).

Resource Requirements Data – The time, people, equipment and facilities necessary to conduct the experiment(s).

M&S Inventory –M&S hardware and software required for experiment execution.

Tested M&S Environment – Integrated System after full testing.

Operator Procedures – Procedures used by M&S operators during experiment execution.

Controls:

Project Management Plan – The overall direction for all phases of the WARCON process to include tasks, organization, program resources and costs, software development, products, schedules and milestones. The Software Development Plan is included within this Plan.

Experiment Plan – Document that defines the experiment approach, objectives, hypotheses, measures of performance and effectiveness (MOPs/MOEs), analysis methods, data extraction and collection requirements, scenarios, and explicit procedures for conducting the experiment.

Outputs:

Experiment Data – Results of the experiment for all parts of the experiment as directed by the Experiment Plan. Includes performance and cost data for each experiment excursion.

Mechanisms:

Personnel – Government, contract employees, subject matter experts, systems engineers and analysts available to support using the WARCON process.

Tools – Previously validated methods, models and simulations that support the modeling and analysis environments.

Facility – Buildings and equipment necessary to support personnel and tools in the conduct of the activities.

A5.1 Plan Experiment Execution

Identifying requirements, availability and resources (personnel, Integrated M&S System) required to perform the experiment, develop a detailed experiment concept of operations (CONOPS), and produce an experiment schedule (Figure A-A5(a)).

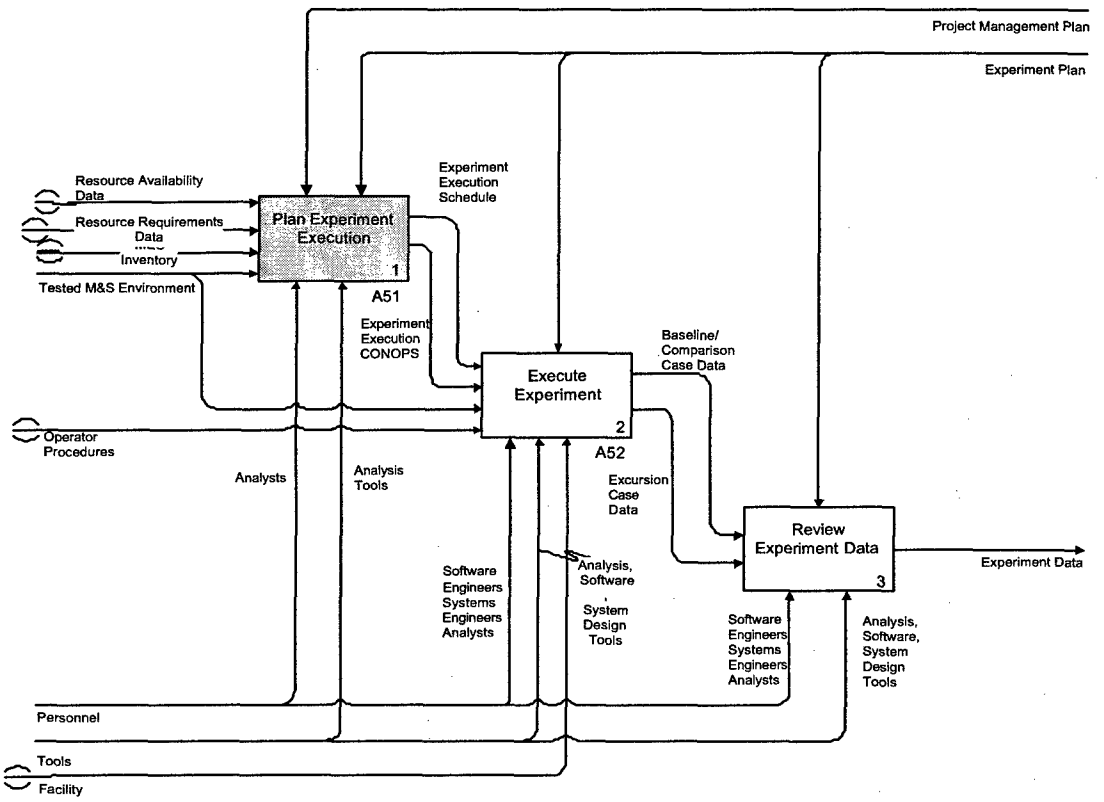


Figure A-A5(a) Conduct Experiment

Inputs:

Resource Availability Data – The access to time, people, equipment and facilities required to conduct the experiment(s).

Resource Requirements Data – The time, people, equipment and facilities necessary to conduct the experiment(s).

M&S Inventory – M&S hardware and software required for experiment execution.

Tested M&S Environment – Integrated System after full testing.

Controls:

Project Management Plan – The overall direction for all phases of the WARCON process to include tasks, organization, program resources and costs, software development, products, schedules and milestones. The Software Development Plan is included within this Plan.

Experiment Plan – Document that defines the experiment approach, objectives, hypotheses, measures of performance and effectiveness (MOPs/MOEs), analysis methods, data extraction and collection requirements, scenarios, and explicit procedures for conducting the experiment.

Outputs:

Experiment Execution CONOPS – The concept of operations for experiment scheduling and execution.

Experiment Execution Schedule – Detailed schedule identifying the timeline for all the resources required to perform the experiment.

Mechanisms:

Personnel – Government, contract employees, subject matter experts, systems engineers and analysts available to support using the WARCON process.

Tools – Previously validated methods, models and simulations that support the modeling and analysis environments.

Facility – Buildings and equipment necessary to support personnel and tools in the conduct of the activities.

A5.1.1 Develop Experiment CONOPS

Developing a concept of operations for experiment scheduling and execution, using the Experiment Plan, to include a sequence of experiment events for Integrated M&S System Data Production Runs and Quick-Look Analysis (Figure A-A5.1(a)).

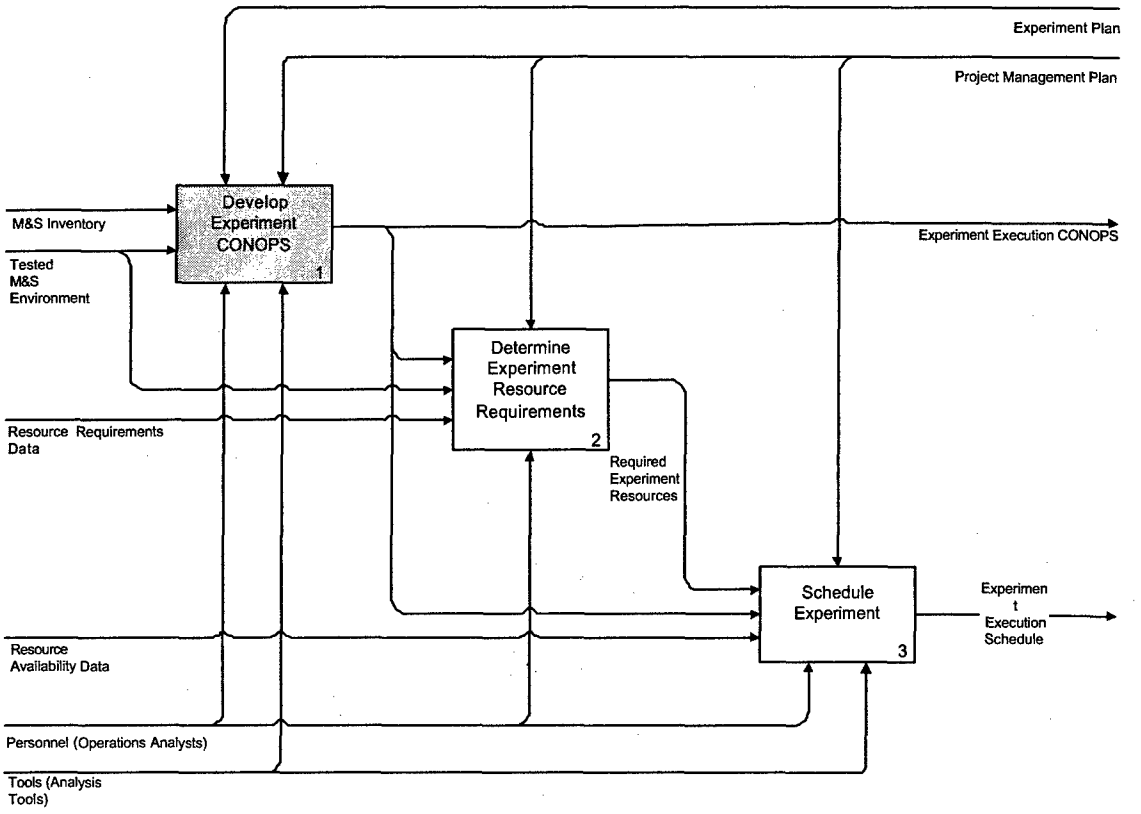


Figure A-A5.1(a) Plan Experiment Execution

Inputs:

M&S Inventory – Hardware and software required for experiment execution.

Tested M&S Environment – Integrated System after full testing.

Controls:

Experiment Plan – Document that defines the experiment approach, objectives, hypotheses, measures of performance and effectiveness (MOPs/MOEs),

analysis methods, data extraction and collection requirements, scenarios, and explicit procedures for conducting the experiment.

Project Management Plan – The overall direction for all phases of the WARCON process to include tasks, organization, program resources and costs, software development, products, schedules and milestones. The Software Development Plan is included within this Plan.

Outputs:

Experiment Execution CONOPS – The concept of operations for experiment scheduling and execution.

Mechanisms:

Personnel – Government, contract employees, subject matter experts, systems engineers and analysts available to support using the WARCON process.

Tools – Previously validated methods, models and simulations that support the modeling and analysis environments.

Facility - Buildings and equipment necessary to support personnel and tools in the conduct of the activities.

A5.1.2 Determine Experiment Resource Requirements

Identifying all resources, such as personnel and tools, required to perform the experiment. Resource requirements will include facilities, numbers of analysts, systems engineers and operators, experiment subject matter experts (if required in the Experiment Plan) and the estimated sequence and length of time each is required (Figure A-A5.1(b)).

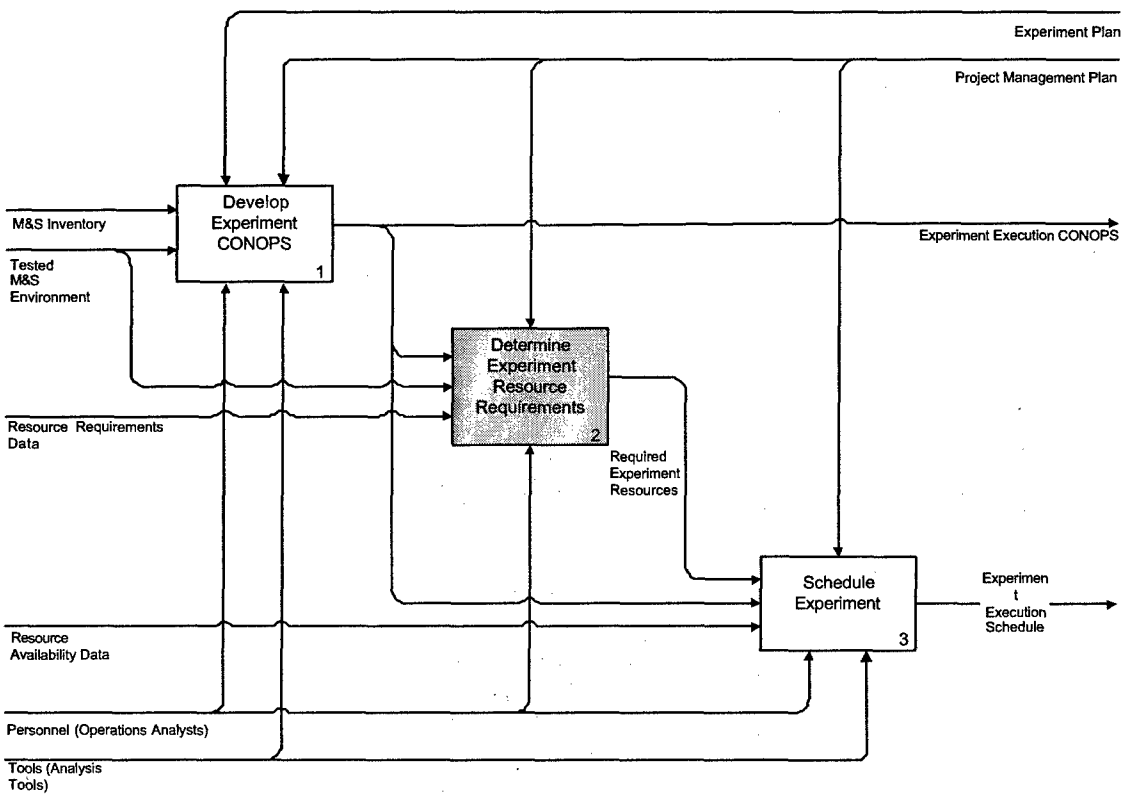


Figure A-A5.1(b) Plan Experiment Execution

Inputs:

Experiment Execution CONOPS – The concept of operations for experiment scheduling and execution.

Tested M&S Environment – Integrated System after full testing.

Resource Requirements Data – The time, people, equipment and facilities necessary to conduct the experiment(s).

Controls:

Project Management Plan – The overall direction for all phases of the WARCON process to include tasks, organization, program resources and costs, software development, products, schedules and milestones. The Software Development Plan is included within this Plan.

Outputs:

Required Experiment Resources – List resources required for experiment execution.

Mechanisms:

Personnel – Government, contract employees, subject matter experts, systems engineers and analysts available to support using the WARCON process.

A5.1.3 Schedule Experiment

Developing a schedule, to include availability of system engineers, analysts, SMEs, and modeling and simulation run time for the experiment (Figure A-A5.1(c)).

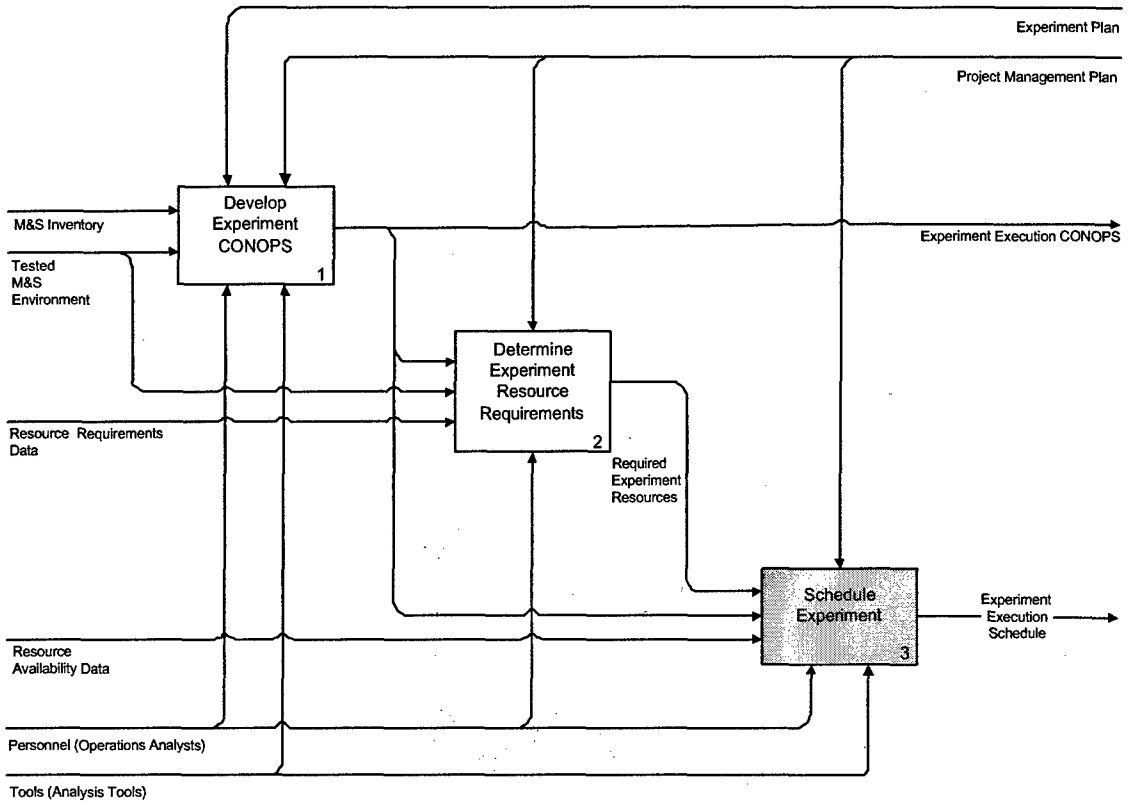


Figure A-A5.1(c) Plan Experiment Execution

Inputs:

Experiment Execution CONOPS – The concept of operations for experiment scheduling and execution.

Required Experiment Resources – List resources required for experiment execution.

Resource Availability Data – The access to time, people, equipment and facilities required to conduct the experiment(s).

Controls:

Project Management Plan – The overall direction for all phases of the WARCON process to include tasks, organization, program resources and costs, software development, products, schedules and milestones. The Software Development Plan is included within this Plan.

Outputs:

Experiment Execution Schedule – Detailed schedule identifying the timeline for all the resources required to perform the experiment.

Mechanisms:

Personnel – Government, contract employees, subject matter experts, systems engineers and analysts available to support using the WARCON process.

Tools – Previously validated methods, models and simulations that support the modeling and analysis environments.

A5.2 Execute Experiment

Employing the Tested Integrated System to perform the experiment. Will include quick-look analysis of experiment data and multiple model runs for Baseline/Comparison and all Excursion Cases (Figure A-A5(b)).

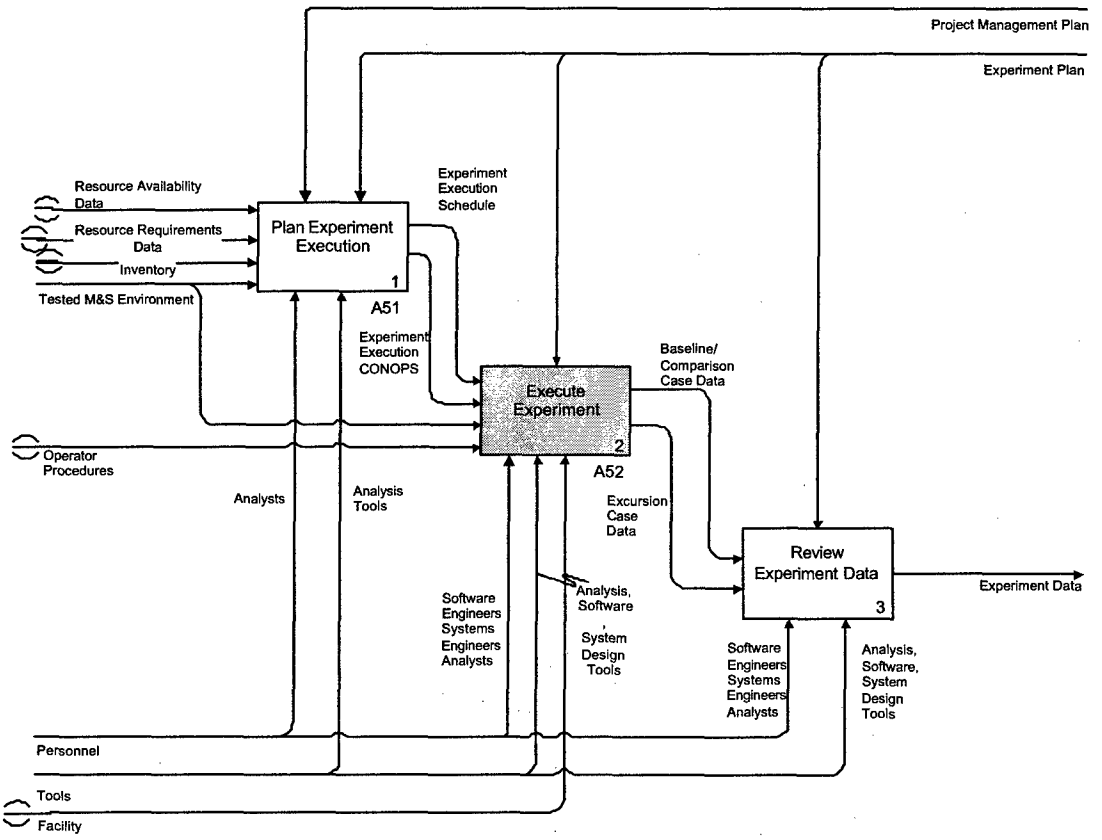


Figure A-A5(b) Conduct Experiment

Inputs:

Experiment Execution Schedule – Detailed schedule identifying the timeline for all the resources required to perform the experiment.

Experiment Execution CONOPS – The concept of operations for experiment scheduling and execution.

Tested M&S Environment – Integrated System after full testing.

Operator Procedures – Procedures used by M&S operators during experiment execution.

Controls:

Experiment Plan – Document that defines the experiment approach, objectives, hypotheses, measures of performance and effectiveness (MOPs/MOEs), analysis methods, data extraction and collection requirements, scenarios, and explicit procedures for conducting the experiment.

Outputs:

Baseline/Comparison Case Data – Experiment data produced by the Integrated M&S System for all combinations of variables and scenario excursions for the Baseline/Comparison Case as directed in the Experiment Plan.

Excursion Case Data – Experiment data produced by the Integrated M&S System for all combinations of variables and scenario variations for all experiment excursion cases as directed in the Experiment Plan.

Mechanisms:

Personnel – Government, contract employees, subject matter experts, systems engineers and analysts available to support using the WARCON process.

Tools – Previously validated methods, models and simulations that support the modeling and analysis environments.

Facility – Buildings and equipment necessary to support personnel and tools in the conduct of the activities.

A5.2.1 Review Experiment Plan and CONOPS

Reviewing the Experiment Plan and CONOPS with experiment personnel at the beginning of the experiment execution session, and revise as required to factor in unexpected constraints or schedule changes (Figure A-A5.2(a)).

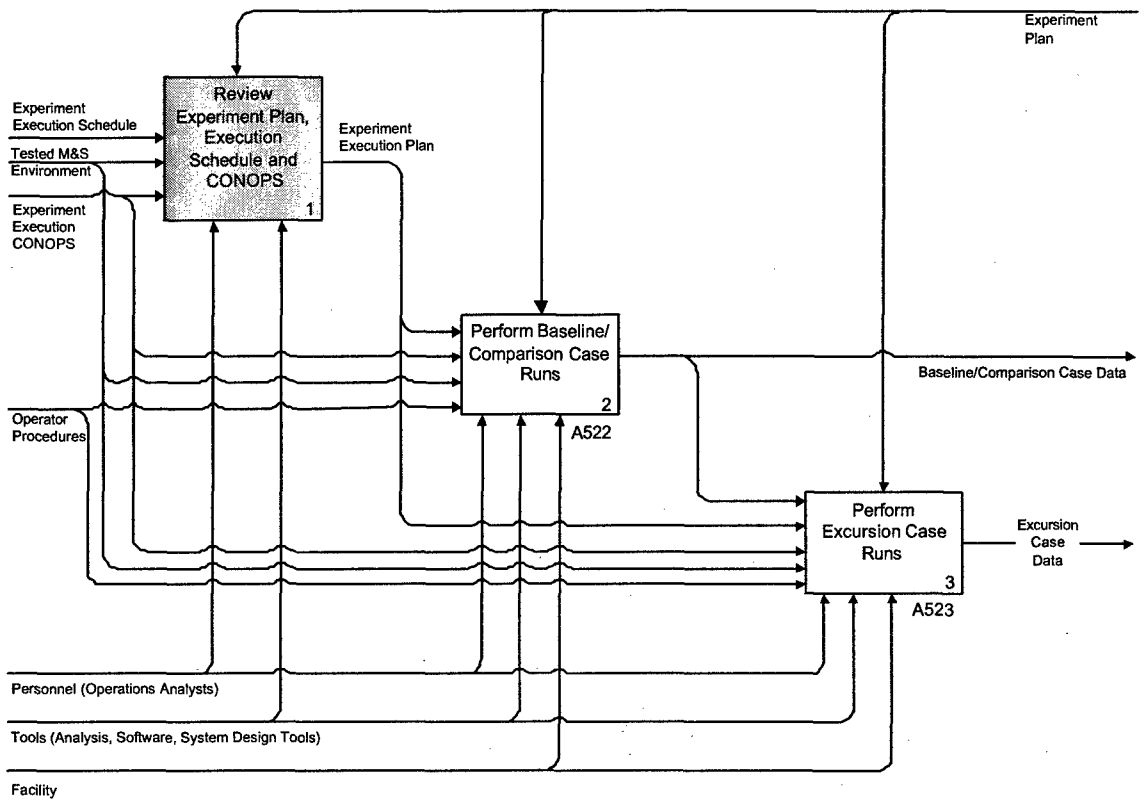


Figure A-A5.2(a) Execute Experiment

Inputs:

Experiment Excursion Schedule – Detailed schedule identifying the timeline for all the resources required to perform the experiment.

Experiment Execution CONOPS – The concept of operations for experiment scheduling and execution.

Tested M&S Environment – Integrated System after full testing.

Controls:

Experiment Plan – Document that defines the experiment approach, objectives, hypotheses, measures of performance and effectiveness (MOPs/MOEs), analysis methods, data extraction and collection requirements, scenarios, and explicit procedures for conducting the experiment.

Outputs:

Experiment Execution Plan – Document that defines how the execution of the experiment will be conducted.

Mechanisms:

Personnel – Government, contract employees, subject matter experts, systems engineers and analysts available to support using the WARCON process.

Tools – Previously validated methods, models and simulations that support the modeling and analysis environments.

A5.2.2 Perform Baseline/Comparison Case Runs

Conducting the experiment as defined in the Experiment Plan for all combinations of variables and scenario excursions (Figure A-A5.2(b)).

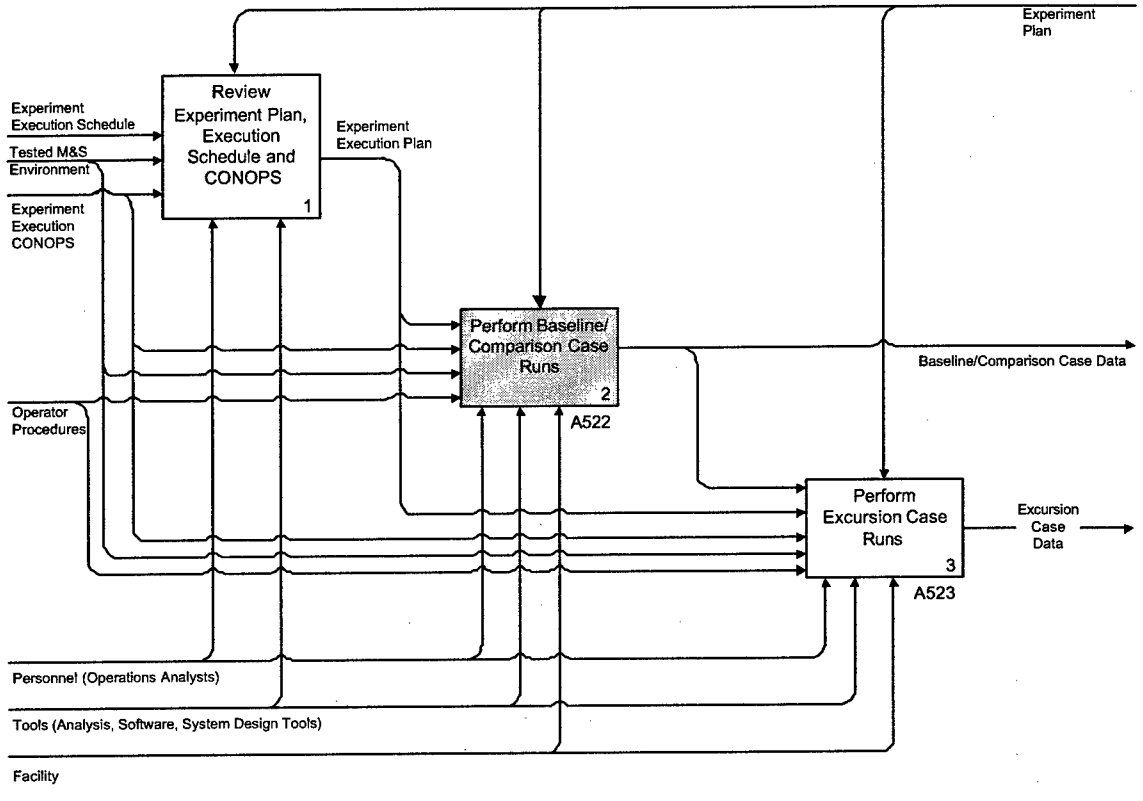


Figure A-A5.2(b) Execute Experiment

Inputs:

Experiment Execution Plan – Document that defines how the execution of the experiment will be conducted.

Experiment Execution CONOPS – The concept of operations for experiment scheduling and execution.

Tested M&S Environment – Integrated System after full testing.

Operator Procedures – Procedures used by M&S operators during experiment execution.

Controls:

Experiment Plan – Document that defines the experiment approach, objectives, hypotheses, measures of performance and effectiveness (MOPs/MOEs), analysis methods, data extraction and collection requirements, scenarios, and explicit procedures for conducting the experiment.

Outputs:

Baseline/Comparison Case Data – Experiment data produced by the Integrated M&S System for all combinations of variables and scenario excursions for the Baseline/Comparison Case as directed in the Experiment Plan.

Mechanisms:

Personnel – Government, contract employees, subject matter experts, systems engineers and analysts available to support using the WARCON process.

Tools – Previously validated methods, models and simulations that support the modeling and analysis environments.

Facility – Buildings and equipment necessary to support personnel and tools in the conduct of the activities.

A5.2.2.1 Review Input Data for Baseline/Comparison Case

Reviewing experiment input data by Analysts and M&S System personnel for experiment data production runs (Figure A-A5.2.2(a)).

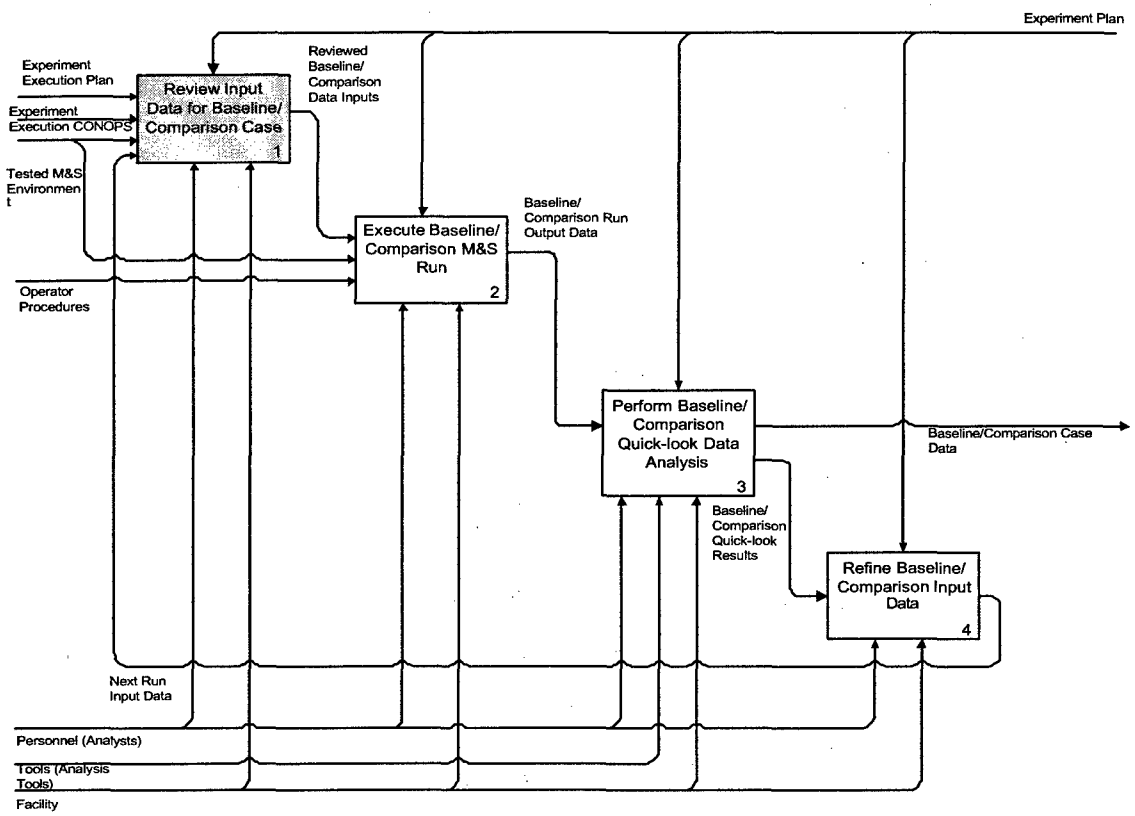


Figure A-A5.2.2(a) Perform Baseline/Comparison Case Runs

Inputs:

Experiment Execution Plan – Document that defines how the execution of the experiment will be conducted.

Experiment Execution CONOPS – The concept of operations for experiment scheduling and execution.

Tested M&S Environment – Integrated System after full testing.

Next Run Input Data – List of input data for the next Baseline/Comparison Case Data Production Run.

Controls:

Experiment Plan – Document that defines the experiment approach, objectives, hypotheses, measures of performance and effectiveness (MOPs/MOEs), analysis methods, data extraction and collection requirements, scenarios, and explicit procedures for conducting the experiment.

Outputs:

Reviewed Baseline/Comparison Data Inputs – List of reviewed Baseline/Comparison Data Inputs for upcoming experiment data production runs.

Mechanisms:

Personnel – Government, contract employees, subject matter experts, systems engineers and analysts available to support using the WARCON process.

Facility – Buildings and equipment necessary to support personnel and tools in the conduct of the activities.

A5.2.2.2 Execute Baseline/Comparison M&S Run

Performing a Baseline/Comparison Case Data Production Run in accordance with the Experiment Plan and Experiment Execution CONOPS (Figure A-A5.2.2(b)).

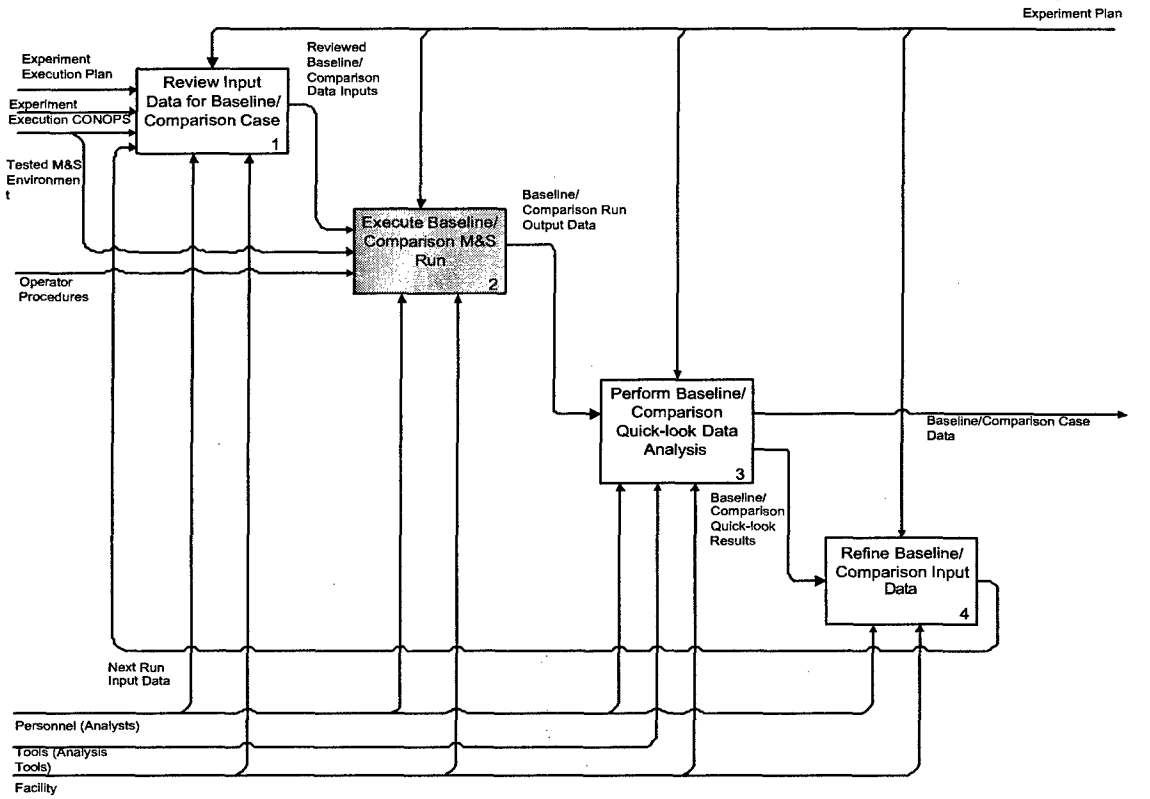


Figure A-A5.2.2(b) Perform Baseline/Comparison Case Runs

Inputs:

Reviewed Baseline/Comparison Data Inputs – List of reviewed Baseline/Comparison Data Inputs for upcoming experiment data production runs.

Tested M&S Environment – Integrated System after full testing.

Operator Procedures – Procedures used by M&S Operators during experiment execution.

Controls:

Experiment Plan – Document that defines the experiment approach, objectives, hypotheses, measures of performance and effectiveness (MOPs/MOEs), analysis methods, data extraction and collection requirements, scenarios, and explicit procedures for conducting the experiment.

Outputs:

Baseline/Comparison Run Output Data – Baseline/Comparison Experiment Run Output Data.

Mechanisms:

Personnel – Government, contract employees, subject matter experts, systems engineers and analysts available to support using the WARCON process.

Facility – Buildings and equipment necessary to support personnel and tools in the conduct of the activities.

A5.2.2.3 Perform Baseline/Comparison Quick Look Data Analysis

Reviewing the output data from each data production run by analysts and M&S personnel to determine if experiment data requirements have been met for the Baseline/Comparison Case and to determine if subsequent data production runs are required (Figure A-A5.2.2(c)).

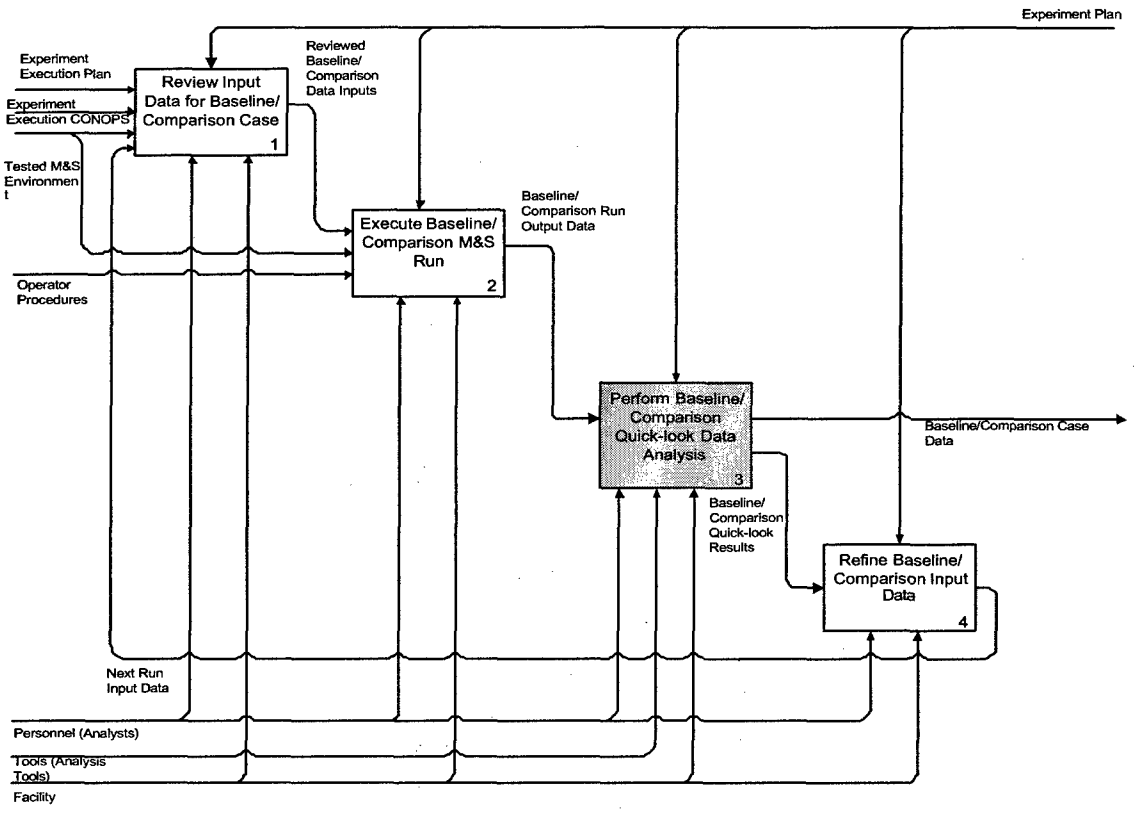


Figure A-A5.2.2(c) Perform Baseline/Comparison Case Runs

Inputs:

Baseline/Comparison Run Output Data – List Baseline/Comparison Experiment Run Output Data.

Controls:

Experiment Plan – Document that defines the experiment approach, objectives, hypotheses, measures of performance and effectiveness (MOPs/MOEs), analysis methods, data extraction and collection requirements, scenarios, and explicit procedures for conducting the experiment.

Outputs:

Baseline/Comparison Quick Look Results – Results of the Baseline/Comparison Quick-Look Analysis determining if additional Baseline/Comparison Case Data Production Runs are required.

Baseline/Comparison Case Data – Experiment data produced by the Integrated M&S System for all combinations of variables and scenario excursions for the Baseline/Comparison Case as directed in the Experiment Plan.

Mechanisms:

Personnel – Government, contract employees, subject matter experts, systems engineers and analysts available to support using the WARCON process.

Tools – Previously validated methods, models and simulations that support the modeling and analysis environments.

Facility – Buildings and equipment necessary to support personnel and tools in the conduct of the activities.

A5.2.2.4 Refine Baseline/Comparison Input Data

Identifying input parameters for the next Baseline/Comparison Case Experiment Data Production Run (Figure A-A5.2.2(d)).

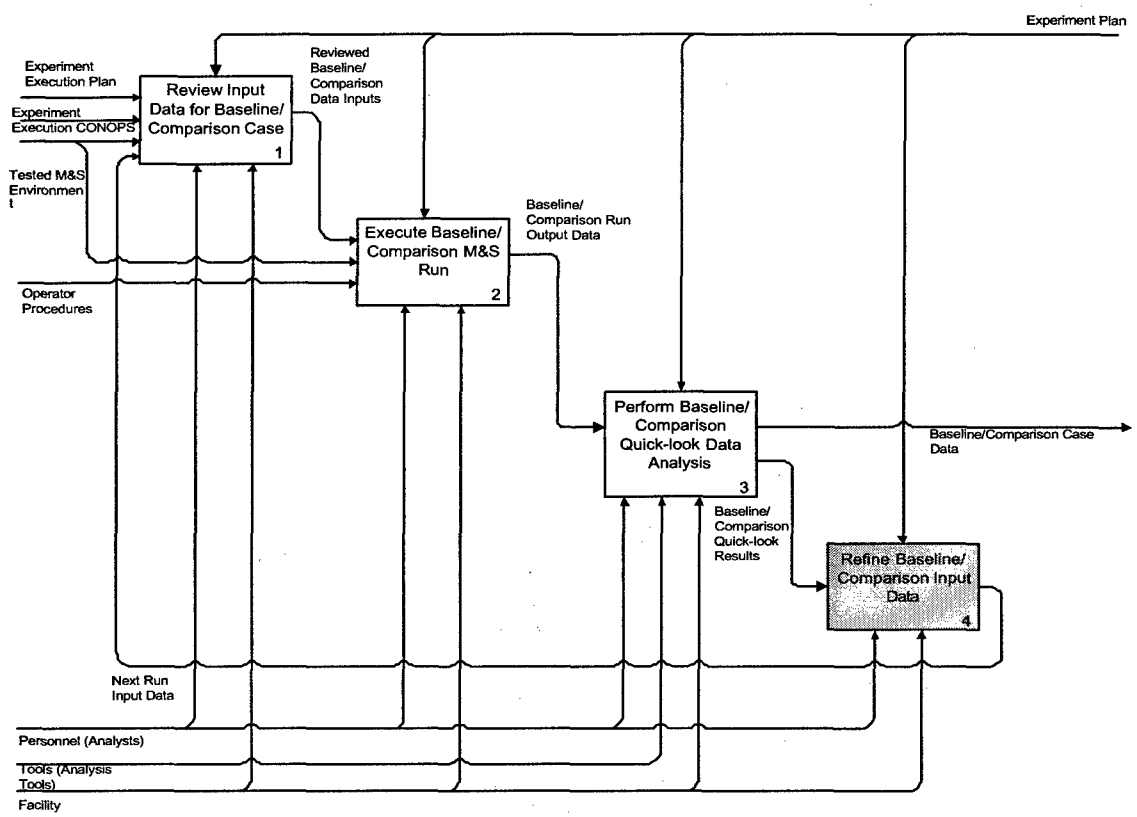


Figure A-A5.2.2(d) Perform Baseline/Comparison Case Runs

Inputs:

Baseline/Comparison Quick Look Results – List results of the Baseline/Comparison Quick-Look.

Controls:

Experiment Plan – Document that defines the experiment approach, objectives, hypotheses, measures of performance and effectiveness (MOPs/MOEs), analysis methods, data extraction and collection requirements, scenarios, and explicit procedures for conducting the experiment.

Outputs:

Next Run Input Data – List of input data for the next Baseline/Comparison Case Data Production Run.

Mechanisms:

Personnel – Government, contract employees, subject matter experts, systems engineers and analysts available to support using the WARCON process.

Facility – Buildings and equipment necessary to support personnel and tools in the conduct of the activities.

A5.2.3 Perform Excursion Case Runs

Conducting initial experiment Excursion Case Runs in accordance with the Experiment Plan and Experiment Execution CONOPS using the Integrated M&S System (Figure A-A5.2(c)).

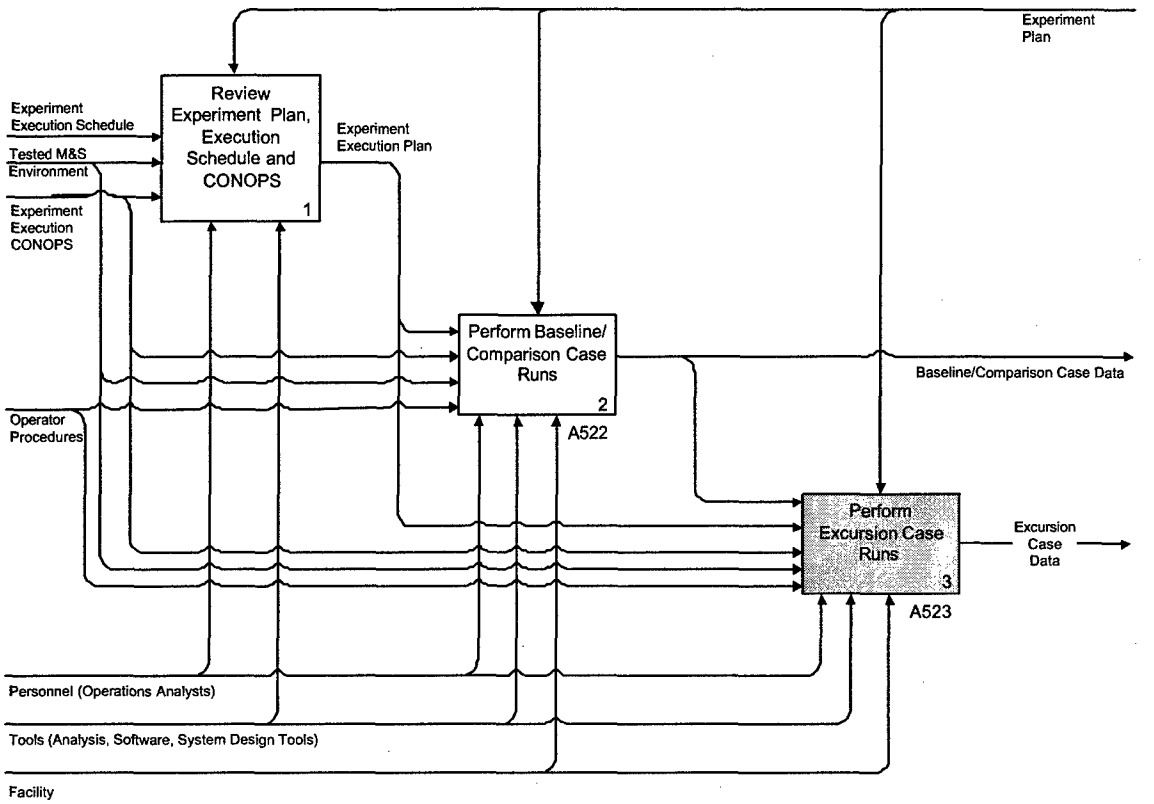


Figure A-A5.2(c) Execute Experiment

Inputs:

Baseline/Comparison Case Data – Experiment data produced by the Integrated M&S System for all combinations of variables and scenario excursions for the Baseline/Comparison Case as directed in the Experiment Plan.

Experiment Execution Plan – Document that defines how the execution of the experiment will be conducted.

Experiment Execution CONOPS – The concept of operations for experiment scheduling and execution.

Tested M&S Environment – Integrated System after full testing.

Operator Procedures – Procedures used by M&S operators during experiment execution.

Controls:

Experiment Plan – Document that defines the experiment approach, objectives, hypotheses, measures of performance and effectiveness (MOPs/MOEs), analysis methods, data extraction and collection requirements, scenarios, and explicit procedures for conducting the experiment.

Outputs:

Excursion Case Data – Experiment data produced by the Integrated M&S System for all combinations of variables and scenario variations for all experiment excursion cases as directed in the Experiment Plan.

Mechanisms:

Personnel – Government, contract employees, subject matter experts, systems engineers and analysts available to support using the WARCON process.

Tools – Previously validated methods, models and simulations that support the modeling and analysis environments.

Facility – Buildings and equipment necessary to support personnel and tools in the conduct of the activities.

A5.2.3.1 Review Input Data for Excursion Cases

Reviewing and fine-tuning Excursion Case Input Data (Figure A-A5.2.3(a)).

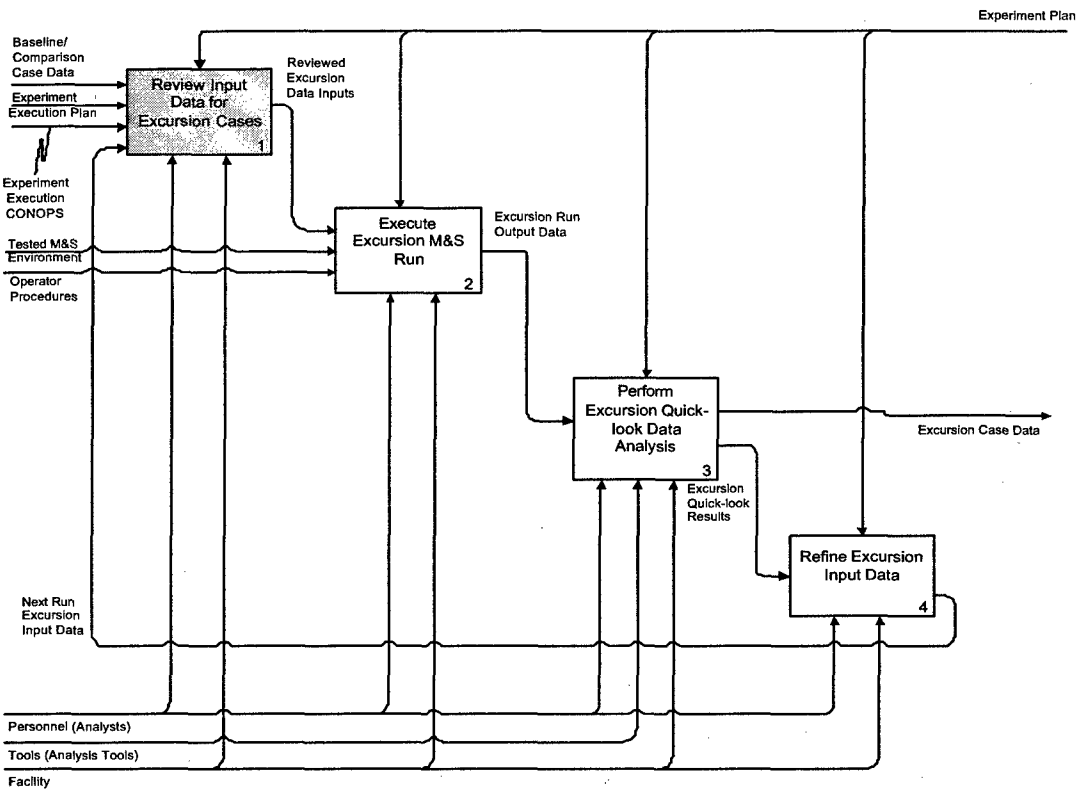


Figure A-A5.2.3(a) Perform Excursion Case Runs

Inputs:

Experiment Execution Plan – Document that defines how the execution of the experiment will be conducted.

Experiment Execution CONOPS – The concept of operations for experiment scheduling and execution.

Baseline/Comparison Case Data – Experiment data produced by the Integrated M&S System for all combinations of variables and scenario excursions for the Baseline/Comparison Case as directed in the Experiment Plan.

Next Run Excursion Input Data – List of input data for the next Excursion Case Data Production Run.

Controls:

Experiment Plan – Document that defines the experiment approach, objectives, hypotheses, measures of performance and effectiveness (MOPs/MOEs), analysis methods, data extraction and collection requirements, scenarios, and explicit procedures for conducting the experiment.

Outputs:

Reviewed Excursion Data Inputs – List of input parameters for an Excursion Case Data Production Run.

Mechanisms:

Personnel – Government, contract employees, subject matter experts, systems engineers and analysts available to support using the WARCON process.

Facility – Buildings and equipment necessary to support personnel and tools in the conduct of the activities.

A5.2.3.2 Execute Excursion M&S Run

Perform Excursion Data Production Run using the Integrated M&S System in accordance with the Experiment Plan and Experiment Execution CONOPS (Figure A-A5.2.3(b)).

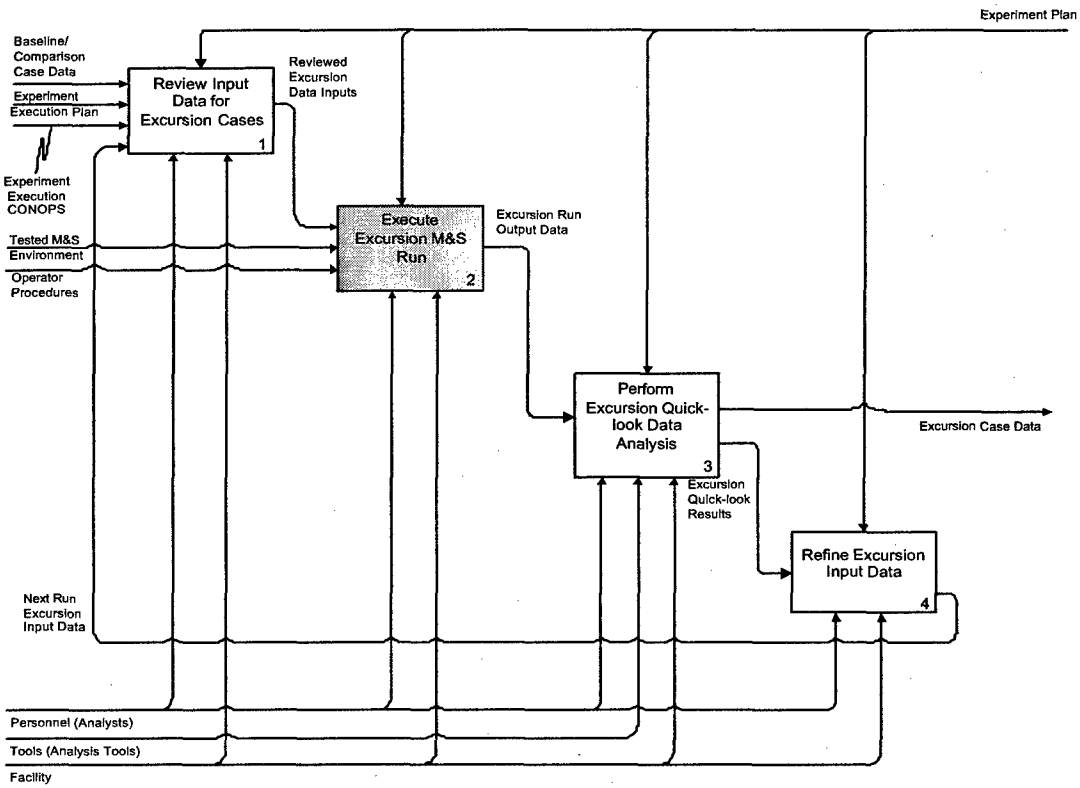


Figure A-A5.2.3(b) Perform Excursion Case Runs

Inputs:

Reviewed Excursion Data Inputs – List of input parameters for an Excursion Case Data Production Run.

Tested M&S Environment – Integrated System after full testing.

Operator Procedures – Procedures used by M&S operators during experiment execution.

Controls:

Experiment Plan – Document that defines the experiment approach, objectives, hypotheses, measures of performance and effectiveness (MOPs/MOEs), analysis methods, data extraction and collection requirements, scenarios, and explicit procedures for conducting the experiment.

Outputs:

Excursion Run Output Data – Data resulting from the Excursion Data Production Run.

Mechanisms:

Personnel – Government, contract employees, subject matter experts, systems engineers and analysts available to support using the WARCON process.

Facility – Buildings and equipment necessary to support personnel and tools in the conduct of the activities.

A5.2.3.3 Perform Excursion Quick-Look Data Analysis

Reviewing the output data from each Excursion Case Data Production Run by analysts and M&S personnel to determine if experiment data requirements have been met for the Excursion Case and to determine if subsequent data production runs are required (Figure A-A5.2.3(c)).

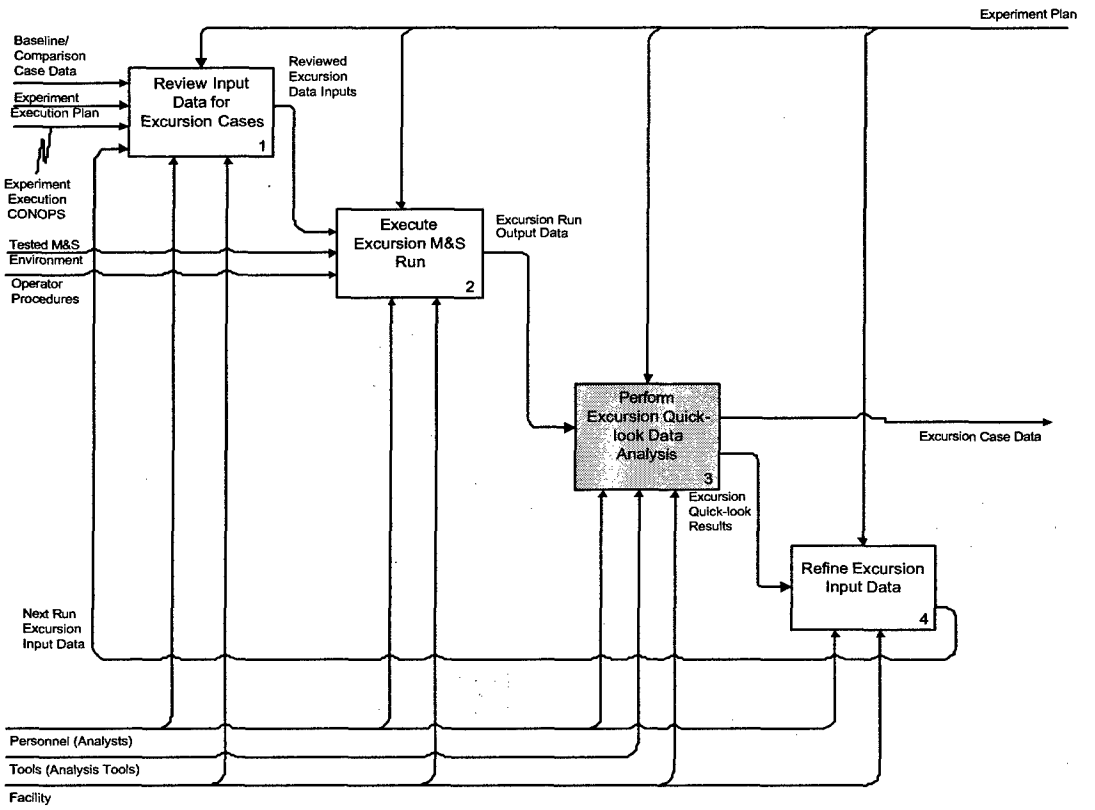


Figure A-A5.2.3(c) Perform Excursion Case Runs

Inputs:

Excursion Run Output Data – Data resulting from the Excursion Run.

Controls:

Experiment Plan – Document that defines the experiment approach, objectives, hypotheses, measures of performance and effectiveness (MOPs/MOEs), analysis methods, data extraction and collection requirements, scenarios, and explicit procedures for conducting the experiment.

Outputs:

Excursion Case Data – Experiment data produced by the Integrated M&S System for all combinations of variables and scenario variations for all experiment excursion cases as directed in the Experiment Plan.

Excursion Quick-Look Results – Results of the Excursion Case Quick-Look Analysis determining if additional Excursion Case Data Production Runs are required.

Mechanisms:

Personnel – Government, contract employees, subject matter experts, systems engineers and analysts available to support using the WARCON process.

Tools – Previously validated methods, models and simulations that support the modeling and analysis environments.

Facility – Buildings and equipment necessary to support personnel and tools in the conduct of the activities.

A5.2.3.4 Refine Excursion Input Data

Identifying input parameters for the next Excursion Case Experiment Data Production Run (Figure A-A5.2.3(d)).

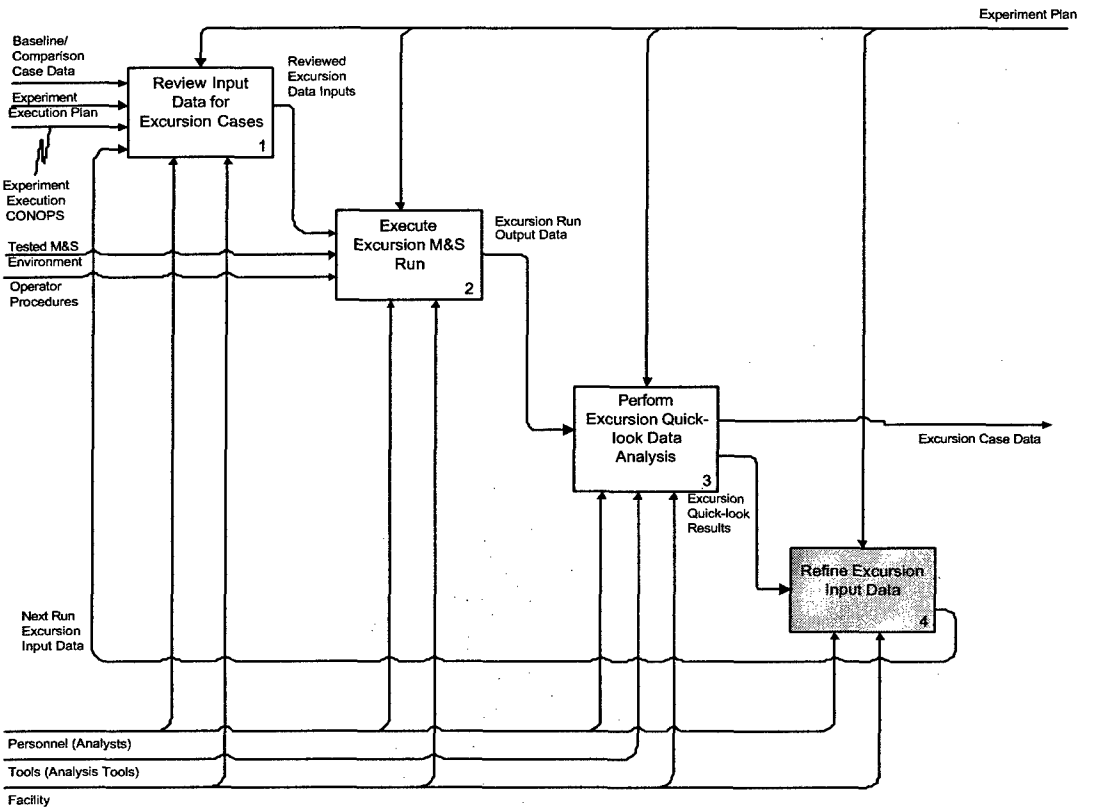


Figure A-A5.2.3(d) Perform Excursion Case Runs

Inputs:

Excursion Quick-Look Results – Results of the Excursion Case Quick-Look Analysis determining if additional Excursion Case Data Production Runs are required.

Controls:

Experiment Plan – Document that defines the experiment approach, objectives, hypotheses, measures of performance and effectiveness (MOPs/MOEs), analysis methods, data extraction and collection requirements, scenarios, and explicit procedures for conducting the experiment.

Outputs:

Next Run Excursion Input Data – List of Input Data for the next Excursion Case Data Production Run.

Mechanisms:

Personnel – Government, contract employees, subject matter experts, systems engineers and analysts available to support using the WARCON process.

Facility – Buildings and equipment necessary to support personnel and tools in the conduct of the activities.

A5.3 Review Experiment Data

Reviewing all data from Baseline/Comparison Case and Excursion Case Data Production Runs and comparing the results with the Experiment Plan and Execution CONOPS to ensure all required experiment data have been produced (Figure A-A5(c)).

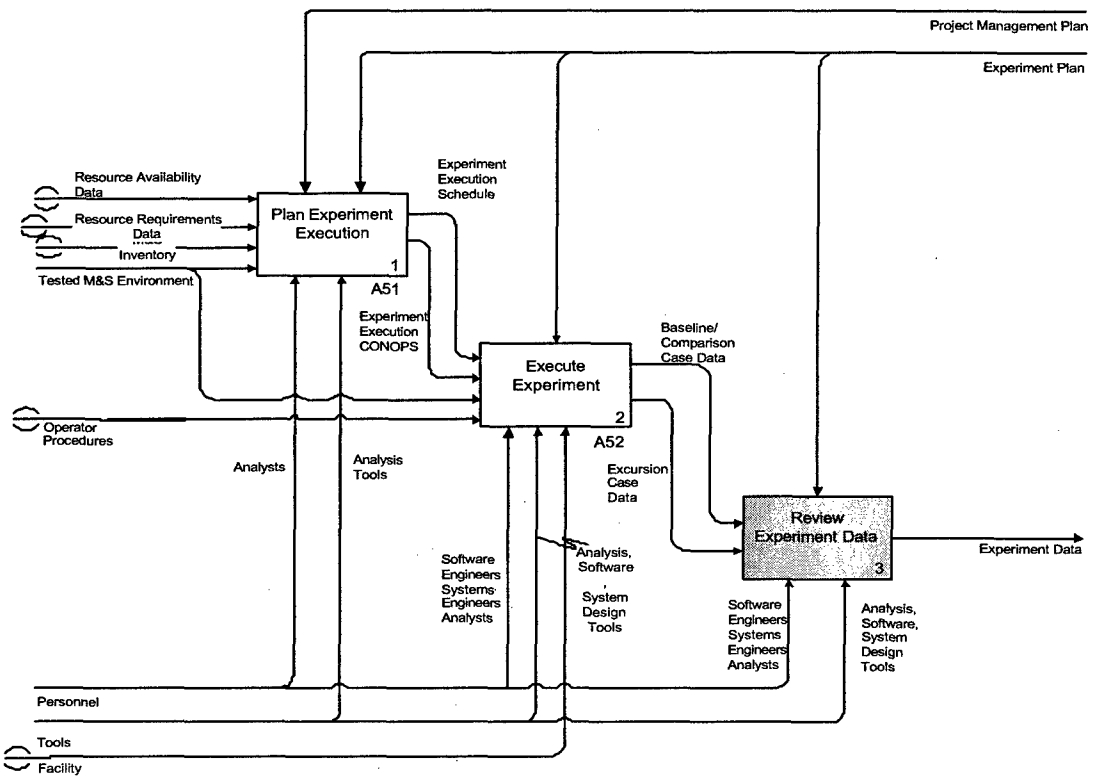


Figure A-A5(c) Conduct Experiment

Inputs:

Baseline/Comparison Case Data – Experiment data produced by the Integrated M&S System for all combinations of variables and scenario excursions for the Baseline/Comparison Case as directed in the Experiment Plan.

Excursion Case Data – Experiment data produced by the Integrated M&S System for all combinations of variables and scenario variations for all experiment excursion cases as directed in the Experiment Plan.

Controls:

Experiment Plan – Document that defines the experiment approach, objectives, hypotheses, measures of performance and effectiveness (MOPs/MOEs), analysis methods, data extraction and collection requirements, scenarios, and explicit procedures for conducting the experiment.

Outputs:

Experiment Data – Results of the experiment for all parts of the experiment as directed by the Experiment Plan. Includes performance and cost data for the Baseline/Comparison Case and each Experiment Excursion.

Mechanisms:

Personnel – Government, contract employees, subject matter experts, systems engineers and analysts available to support using the WARCON process.

Tools – Previously validated methods, models and simulations that support the modeling and analysis environments.

A6 Develop Trade Study

Producing the WARCON product that presents the project results to the acquisition decision maker. The Trade Study summarizes project data and presents the results of the performance-cost trade-off analysis for each subject system improvement option analyzed using the Integrated M&S System (Figure A-A0(f)).

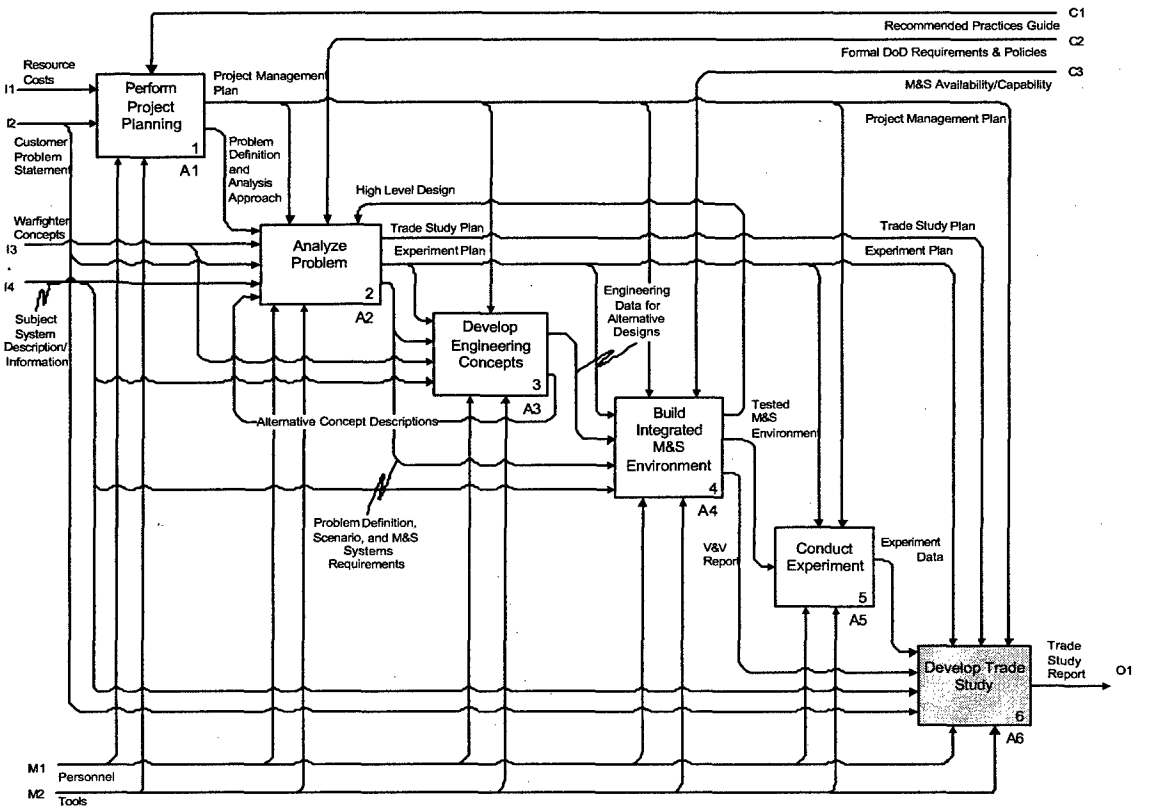


Figure A-A0(f) Execute WARCON Process

Inputs:

Subject System Description/Information – Information and data available from external sources about the current and future warfare system being analyzed that is required to plan and perform the experiment and analysis.

Experiment Data – Results of the experiment for all parts of the experiment as directed by the Experiment Plan. Includes performance and cost data for each experiment excursion.

Customer Problem Statement – Tasking from the customer that defines the acquisition decision that application of the WARCON process will support.

Validation and Verification Report – Results and assessment based on the acceptability criteria that the built system is validated and verified given the intended use.

Controls:

Experiment Plan – Document that defines the experiment approach, objectives, hypotheses, Measures of Performance and Effectiveness (MOPs/MOEs), analysis methods, data extraction and collection requirements, scenarios, and explicit procedures for conducting the experiment.

Trade Study Plan – Document that defines the approach, methods, and performance measures to be used to assess trade-offs among alternate weapon system designs and total ownership costs.

Project Management Plan – The overall direction for all phases of the WARCON process to include tasks, organization, program resources and costs, software development, products, schedules and milestones. The Software Development Plan is included within this Plan.

Outputs:

Trade Study Report – The primary product resulting from the WARCON process to support acquisition decision makers. This formal report summarizes cost-performance trade-offs among the different options for future weapon system designs.

Mechanisms:

Personnel – Government, contract employees, subject matter experts, systems engineers and analysts available to support using the WARCON process.

Tools – Previously validated methods, models and simulations that support the modeling and analysis environments.

A6.1 Analyze Combined Cost Data

Analyzing the combined engineering level cost data (derived from conducting experiment) and any external data needed to determine Total Ownership Cost (TOC) for each alternative subject system design (Figure A-A6(a)).

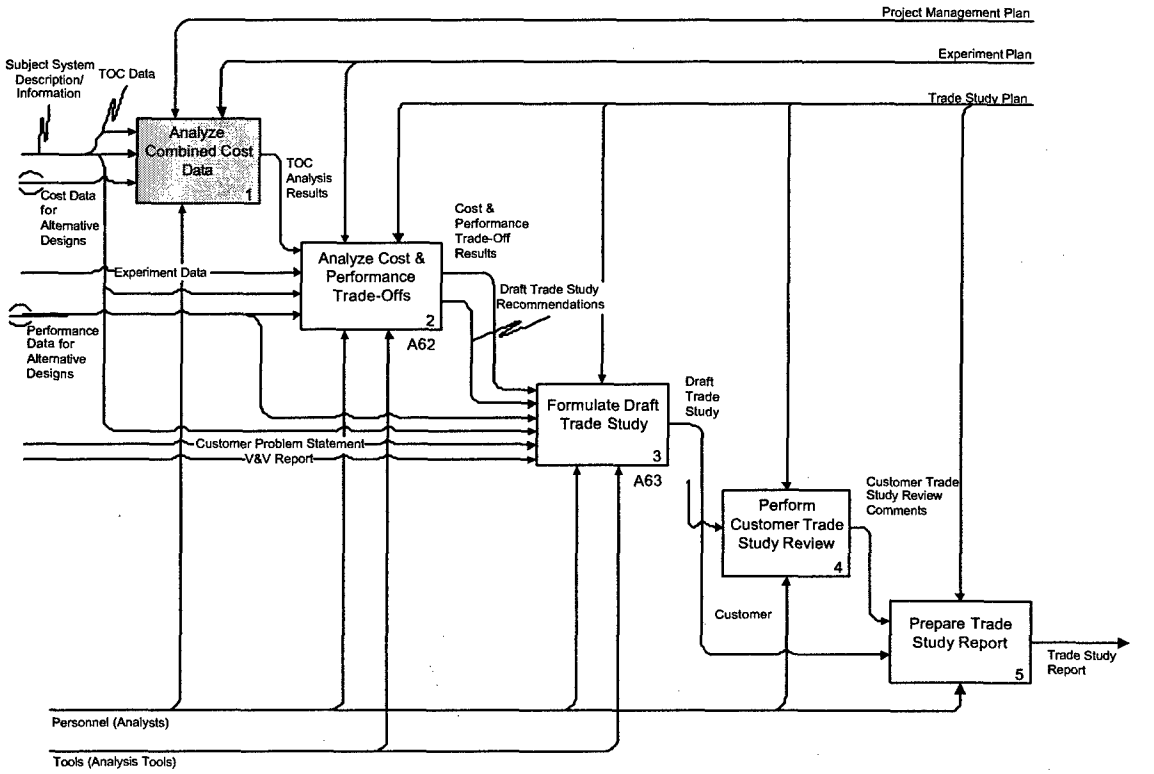


Figure A-A6(a) Develop Trade Study

Inputs:

Subject System Description/Information – Information and data available from external sources about the current and future warfare system being analyzed that is required to plan and perform the experiment and analysis.

TOC Data – External financial resource data required to support the WARCON process regarding equipping, sustaining, and operating military forces sufficient to meet national goals.

Cost Data for Alternative Designs – Rough order of magnitude estimates of acquisition costs in relative terms, as well as estimates of total ownership costs of the subject concept systems under study.

Controls:

Experiment Plan – Document that defines the experiment approach, objectives, hypotheses, Measures of Performance and Effectiveness (MOPs/MOEs), analysis methods, data extraction and collection requirements, scenarios, and explicit procedures for conducting the experiment.

Project Management Plan – The overall direction for all phases of the WARCON process to include tasks, organization, program resources and costs, software development, products, schedules and milestones. The Software Development Plan is included within this Plan.

Outputs:

TOC Analysis Results – TOC data analysis results for each alternative subject system design.

Mechanisms:

Personnel – Government, contract employees, subject matter experts, systems engineers and analysts available to support using the WARCON process.

A6.2 Analyze Cost and Performance Trade-Offs

Comparing TOC and performance data as derived from Measures of Performance and Effectiveness, along with alternate system descriptions and parameters, to determine detailed trade-offs associated with each alternate system design (Figure A-A6(b)).

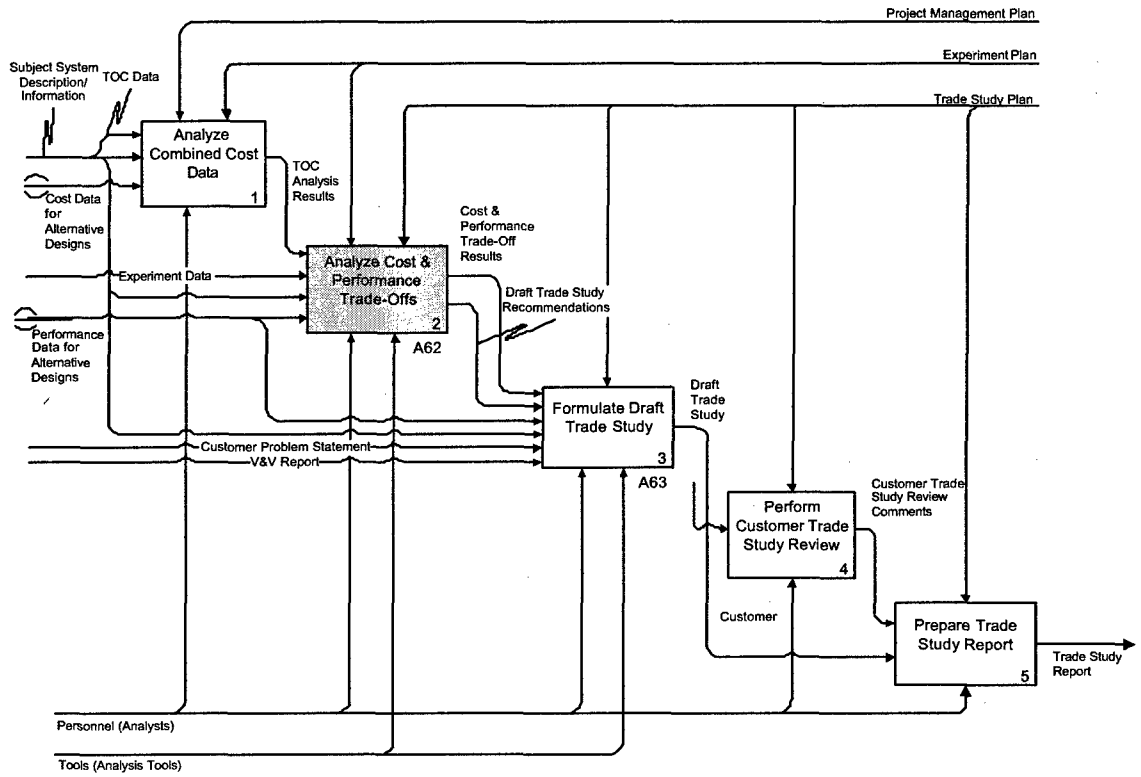


Figure A-A6(b) Develop Trade Study

Inputs:

TOC Analysis Results – TOC data analysis results for each alternative subject system design.

Experiment Data – Results of the experiment for all parts of the experiment as directed by the Experiment Plan. Includes performance and cost data for each experiment excursion.

Subject System Description/Information – Information and data available from external sources about the current and future warfare system being analyzed that is required to plan and perform the experiment and analysis.

Performance Data for Alternative Designs – Design information (design concept, description and associated cost) for alternate subject system designs to be analyzed.

Controls:

Experiment Plan – Document that defines the experiment approach, objectives, hypotheses, Measures of Performance and Effectiveness (MOPs/MOEs), analysis methods, data extraction and collection requirements, scenarios, and explicit procedures for conducting the experiment.

Trade Study Plan – Final version of the Draft Trade Study Plan.

Outputs:

Cost and Performance Trade-Off Results – Trade-Off analysis results for use in the Trade Study.

Draft Trade Study Recommendations – Ranking of system designs based on TOC and performance data as derived from Measures of Performance and Effectiveness.

Mechanisms:

Personnel – Government, contract employees, subject matter experts, systems engineers and analysts available to support using the WARCON process.

Tools – Previously validated methods, models and simulations that support the modeling and analysis environments.

A6.2.1 Assess Quantitative Trade-Offs

Analyzing and comparing the quantitative operational performance and cost data for each subject system improvement option analyzed using the Integrated M&S System (Figure A-A6.2(a)).

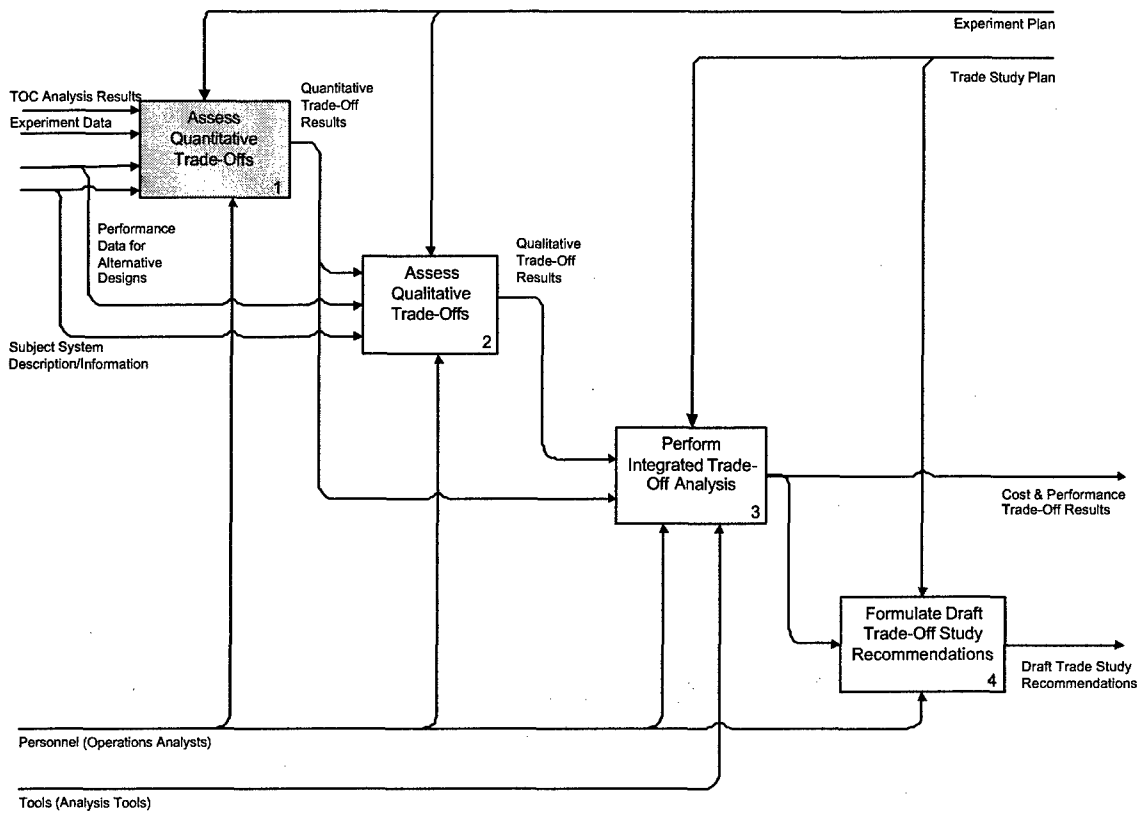


Figure A-A6.2(a) Analyze Cost and Performance Trade-Offs

Inputs:

TOC Analysis Results – TOC data analysis results for each alternative subject system design.

Experiment Data – Results of the experiment for all parts of the experiment as directed by the Experiment Plan. Includes performance and cost data for each experiment excursion.

Performance Data for Alternative Designs – Design information (design concept, description and associated cost) for alternate subject system designs to be analyzed.

System Description/Information – Information and data available from external sources about the current and future warfare system being analyzed that is required to plan and perform the experiment and analysis.

Controls:

Experiment Plan – Document that defines the experiment approach, objectives, hypotheses, Measures of Performance and Effectiveness (MOPs/MOEs), analysis methods, data extraction and collection requirements, scenarios, and explicit procedures for conducting the experiment.

Outputs:

Quantitative Trade-Offs Results – Summary of results of the quantitative performance-cost trade-off analysis for the subject system improvement options.

Mechanisms:

Personnel – Government, contract employees, subject matter experts, systems engineers and analysts available to support using the WARCON process.

A6.2.2 Assess Qualitative Trade-Offs

Analyzing and comparing the non-quantitative operational performance and cost factors and considerations for each subject system improvement option analyzed (Figure A-A6.2(b)).

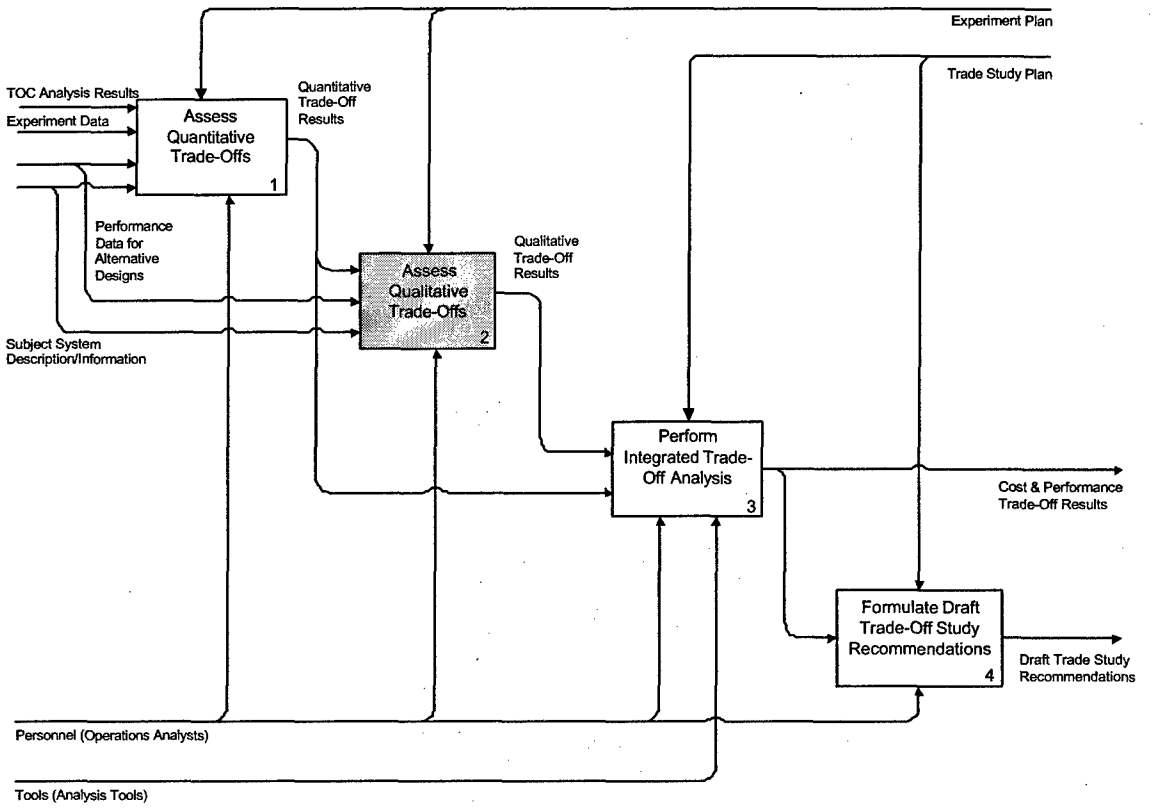


Figure A-A6.2(b) Analyze Cost and Performance Trade-Offs

Inputs:

Qualitative Trade-Off Results – Summary of analysis of the comparison of non-quantitative factors and considerations for the subject system improvement options.

Performance Data for Alternative Designs – Design information (design concept, description and associated cost) for alternate subject system designs to be analyzed.

System Description/Information – Information and data available from external sources about the current and future warfare system being analyzed that is required to plan and perform the experiment and analysis.

Controls:

Experiment Plan – Document that defines the experiment approach, objectives, hypotheses, measures of Performance and Effectiveness (MOPs/MOEs), analysis methods, data extraction and collection requirements, scenarios, and explicit procedures for conducting the experiment.

Outputs:

Qualitative Trade-Off Results – Summary of analysis of the comparison of non-quantitative factors and considerations for the subject system improvement options.

Mechanisms:

Personnel – Government, contract employees, subject matter experts, systems engineers and analysts available to support using the WARCON process.

A6.2.3 Perform Integrated Trade-Off Analysis

Combining and analyzing the quantitative and qualitative trade-off analysis data and factors for the subject system improvement options (Figure A-A6.2(c)).

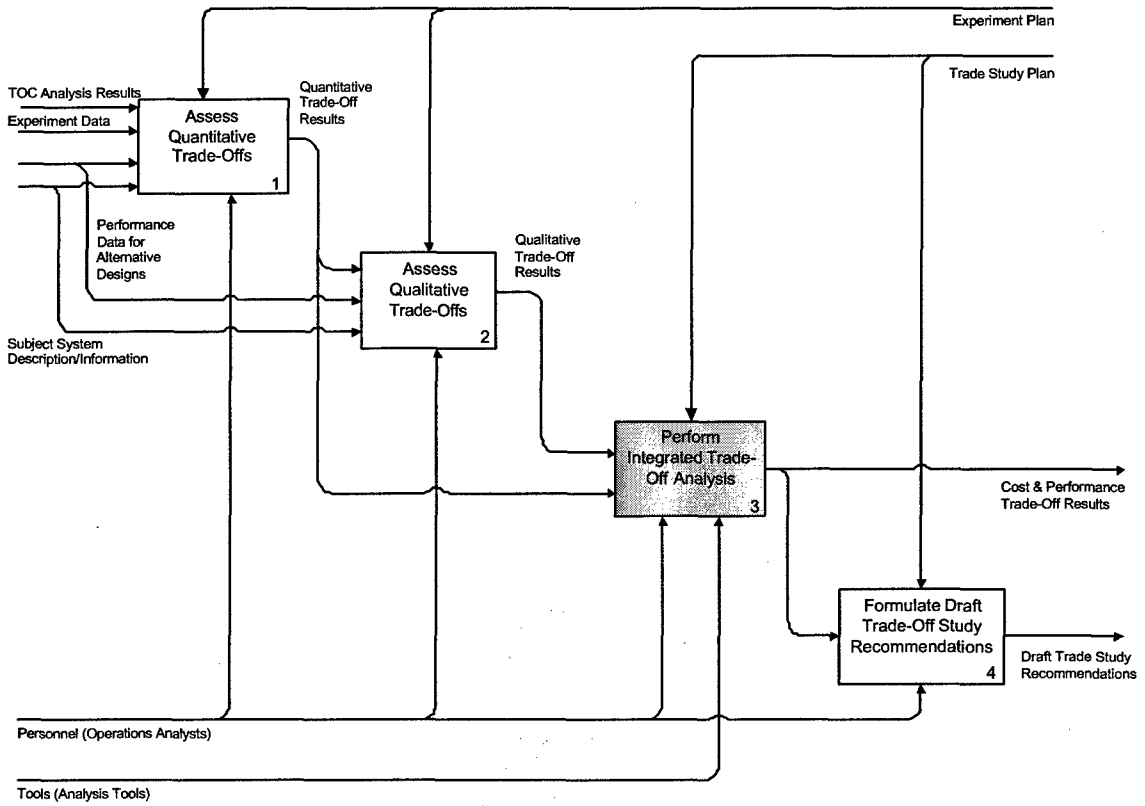


Figure A-A6.2(c) Analyze Cost and Performance Trade-Offs

Inputs:

Qualitative Trade-Off Results – Summary of analysis of the comparison of non-quantitative factors and considerations for the subject system improvement options.

Quantitative Trade-Offs Results – Summary of results of the quantitative performance-cost trade-off analysis for the subject system improvement options.

Controls:

Trade Study Plan – Document that defines the approach, methods, and performance measures to be used to assess trade-offs among alternate weapon system designs and total ownership costs.

Outputs:

Cost and Performance Trade-Off Results – Summary of combined and integrated trade-off analysis results.

Mechanisms:

Personnel – Government, contract employees, subject matter experts, systems engineers and analysts available to support using the WARCON process.

Tools – Previously validated methods, models and simulations that support the modeling and analysis environments.

A6.2.4 Formulate Draft Trade-Off Study Recommendations

Developing Trade Study recommendations based on the integrated trade-off analysis (Figure A-A6.2(d)).

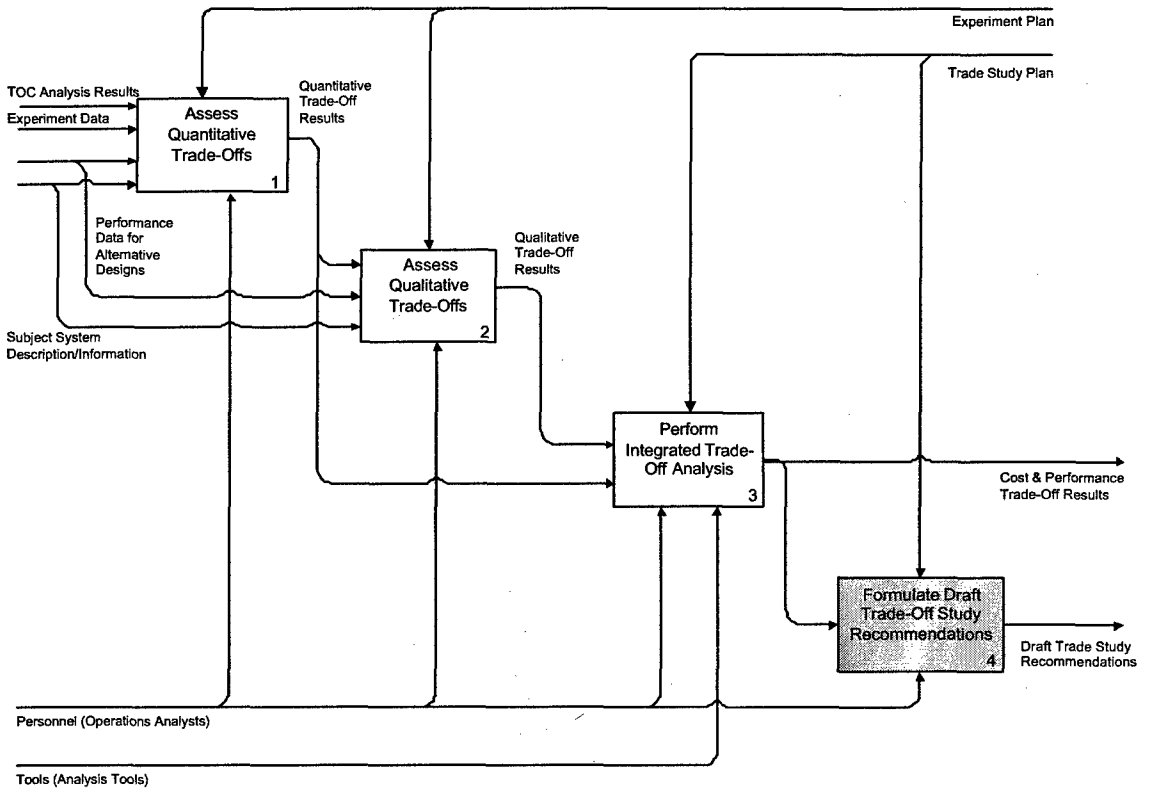


Figure A-A6.2(d) Analyze Cost and Performance Trade-Offs

Inputs:

Cost and Performance Trade-Off Results – Summary of combined and integrated trade-off analysis results.

Controls:

Trade Study Plan – Document that defines the approach, methods, and performance measures to be used to assess trade-offs among alternate weapon system designs and total ownership costs.

Outputs:

Draft Trade Study Recommendations – Draft recommendations for the Trade Study derived from the integrated trade-off analysis of subject system options.

Mechanisms:

Personnel – Government, contract employees, subject matter experts, systems engineers and analysts available to support using the WARCON process.

A6.3 Formulate Draft Trade Study

Reviewing the Customer Problem Statement and synthesizing trade-off analysis results to formulate a concise summary to document WARCON project results for customer review (Figure A-A6(c)).

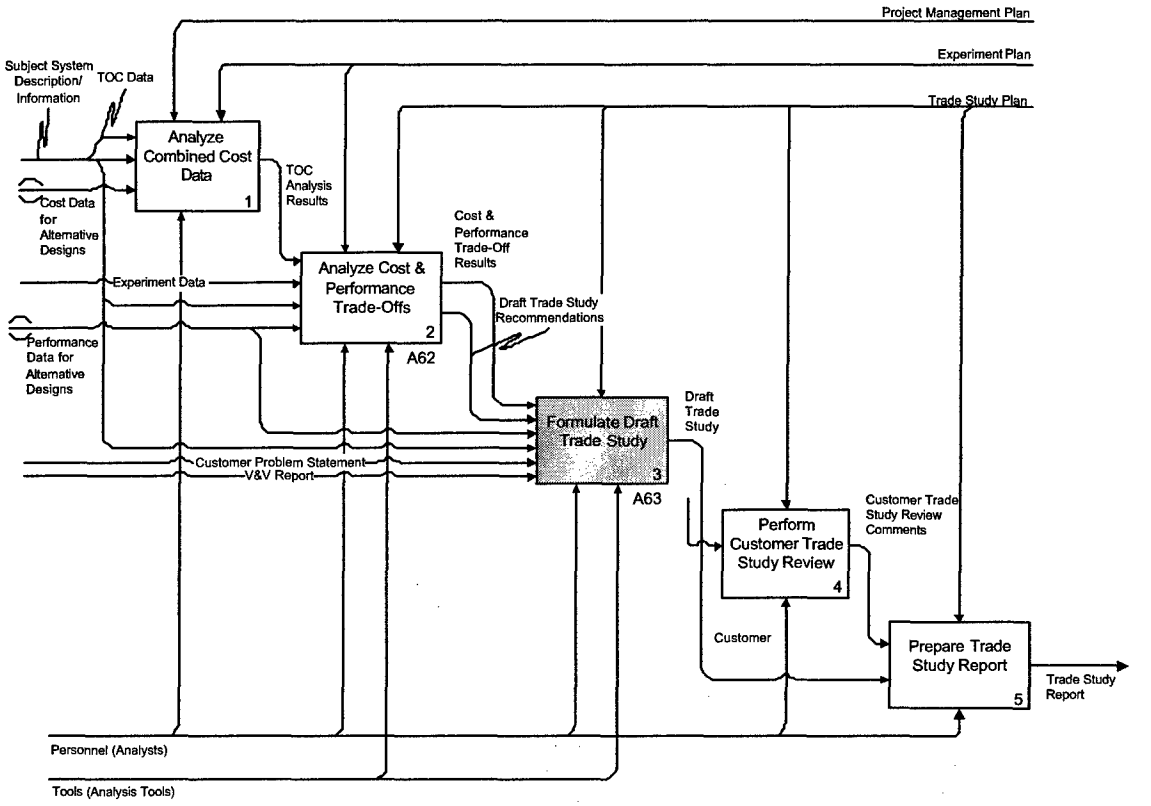


Figure A-A6(c) Develop Trade Study

Inputs:

Customer Problem Statement – Tasking from the customer that defines the acquisition decision that application of the WARCON process will support.

System Description/Information – Information and data available from external sources about the current and future warfare system being analyzed that is required to plan and perform the experiment and analysis.

Cost and Performance Trade-Off Results – Trade-Off analysis results for use in the Trade Study.

Draft Trade Study Recommendations – Draft recommendations for the Trade Study derived from the integrated trade-off analysis of subject system options.

Validation and Verification Report – Results and assessment based on the acceptability criteria that the built system is validated and verified given the intended use.

Performance Data for Alternative Designs – Design information (design concept, description and associated cost) for alternate subject system designs to be analyzed.

Controls:

Trade Study Plan – Document that defines the approach, methods, and performance measures to be used to assess trade-offs among alternate weapon system designs and total ownership costs.

Outputs:

Draft Trade Study – Document presenting the Trade Study and results for customer review.

Mechanisms:

Personnel – Government, contract employees, subject matter experts, systems engineers and analysts available to support using the WARCON process.

Tools – Previously validated methods, models and simulations that support the modeling and analysis environments.

A6.3.1 Review Customer Problem Statement

Reviewing the customer problem statement and interpreting trade-off analysis results in the context of the original Customer Problem Statement (Figure A-A6.3(a)).

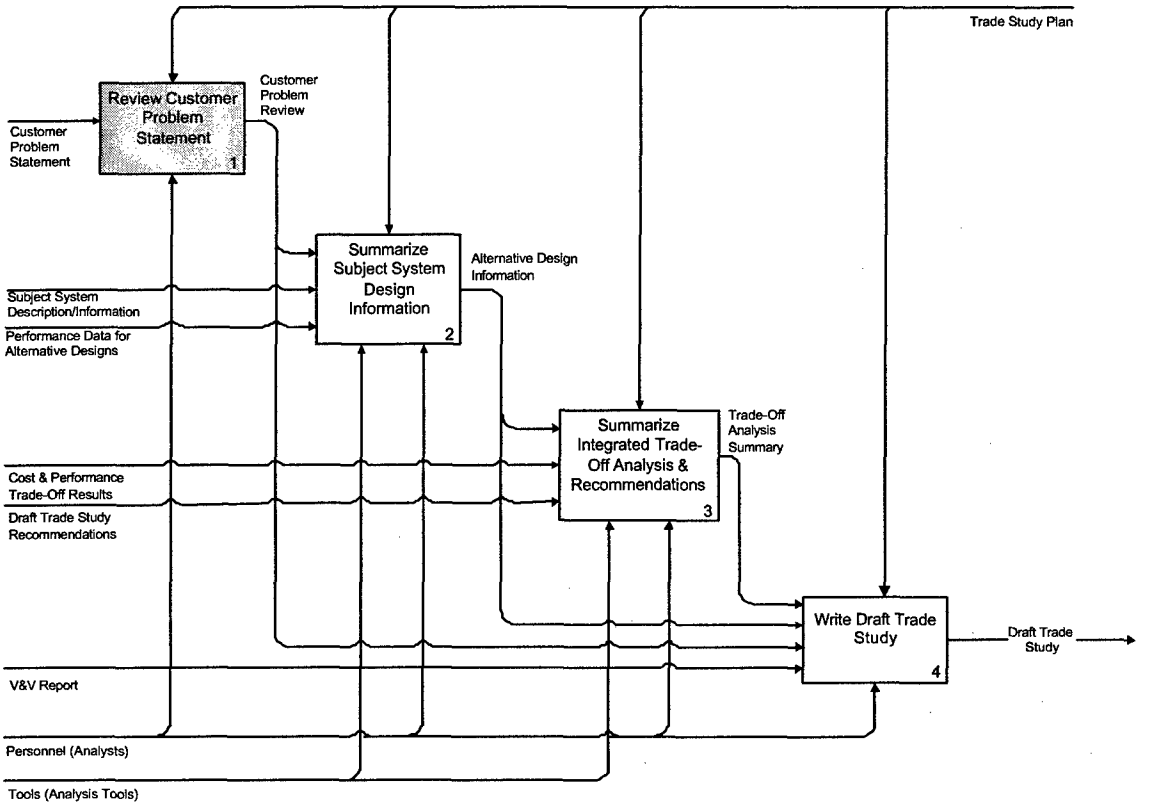


Figure A-A6.3(a) Formulate Draft Trade Study

Inputs:

Customer Problem Statement – Tasking from the customer that defines the acquisition decision that application of the WARCON process will support.

Controls:

Trade Study Plan – Document that defines the approach, methods, and performance measures to be used to assess trade-offs among alternate weapon system designs and total ownership costs.

Outputs:

Customer Problem Review – Results of interpreting trade-off analysis results in the context of the original Customer Problem Statement and producing concise summary to document final project results.

Mechanisms:

Personnel – Government, contract employees, subject matter experts, systems engineers and analysts available to support using the WARCON process.

A6.3.2 Summarize Subject System Design Information

Summarizing aspects of descriptive information and data and for subject system designs relevant for inclusion in the Draft Trade Study (Figure A-A6.3(b)).

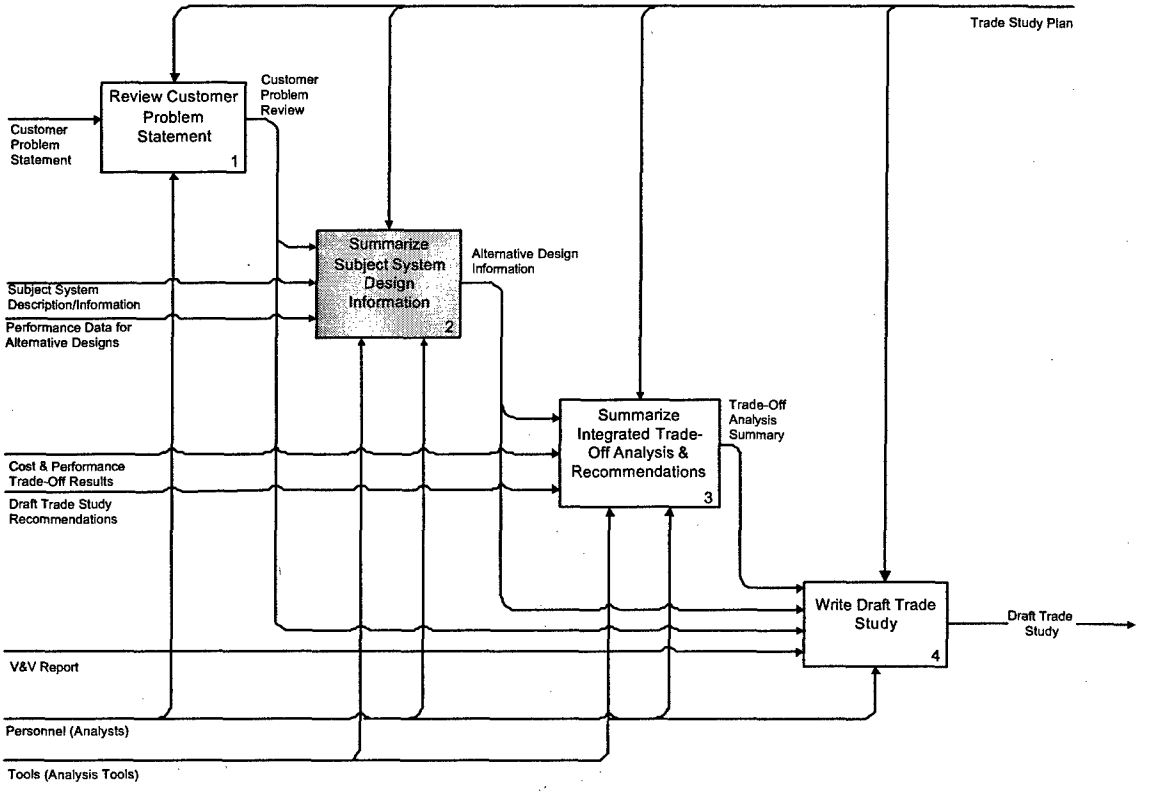


Figure A-A6.3(b) Formulate Draft Trade Study

Inputs:

Customer Problem Review – Results of interpreting trade-off analysis results in the context of the original customer problem statement and producing concise summary to document final project results.

Subject System Description/Information – Information and data available from external sources about the current and future warfare system being analyzed that is required to plan and perform the experiment and analysis.

Performance Data for Alternative Designs – Design information (design concept, description and associated cost) for alternate subject system designs to be analyzed.

Controls:

Trade Study Plan – Document that defines the approach, methods, and performance measures to be used to assess trade-offs among alternate weapon system designs and total ownership costs.

Outputs:

Alternative Design Information – Summarized design description information and data for alternative subject system design options.

Mechanisms:

Personnel – Government, contract employees, subject matter experts, systems engineers and analysts available to support using the WARCON process.

Tools – Previously validated methods, models and simulations that support the modeling and analysis environments.

A6.3.3 Summarize Integrated Trade-Off Analysis and Recommendations

Preparing a written summary of Trade Study analysis and recommendations for inclusion in the Draft Trade Study (Figure A-A6.3(c)).

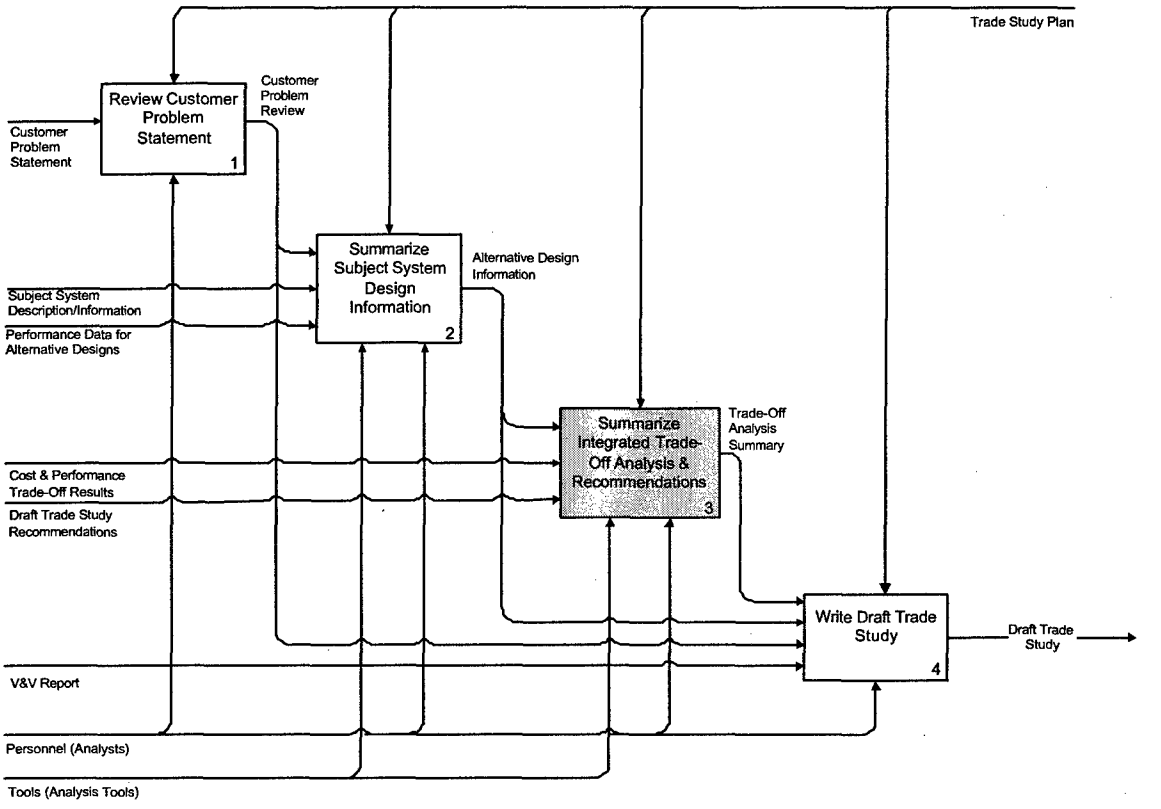


Figure A-A6.3(c) Formulate Draft Trade Study

Inputs:

Alternative Design Information – Summarized design description information and data for alternative subject system design options.

Cost and Performance Trade-Off Results – Trade-Off analysis results for use in the Trade Study.

Draft Trade Study Recommendations – Draft recommendations for the Trade Study derived from the integrated trade-off analysis of subject system options.

Controls:

Trade Study Plan – Document that defines the approach, methods, and performance measures to be used to assess trade-offs among alternate weapon system designs and total ownership costs.

Outputs:

Trade-Off Analysis Summary– Written summary of Trade Study analysis and recommendations for inclusion in the Draft Trade Study.

Mechanisms:

Personnel – Government, contract employees, subject matter experts, systems engineers and analysts available to support using the WARCON process.

A6.3.4 Write Draft Trade Study

Writing a concise summary of all components of Trade Study background, analysis and recommendations into a draft Trade Study document for customer review (Figure A-A6.3(d)).

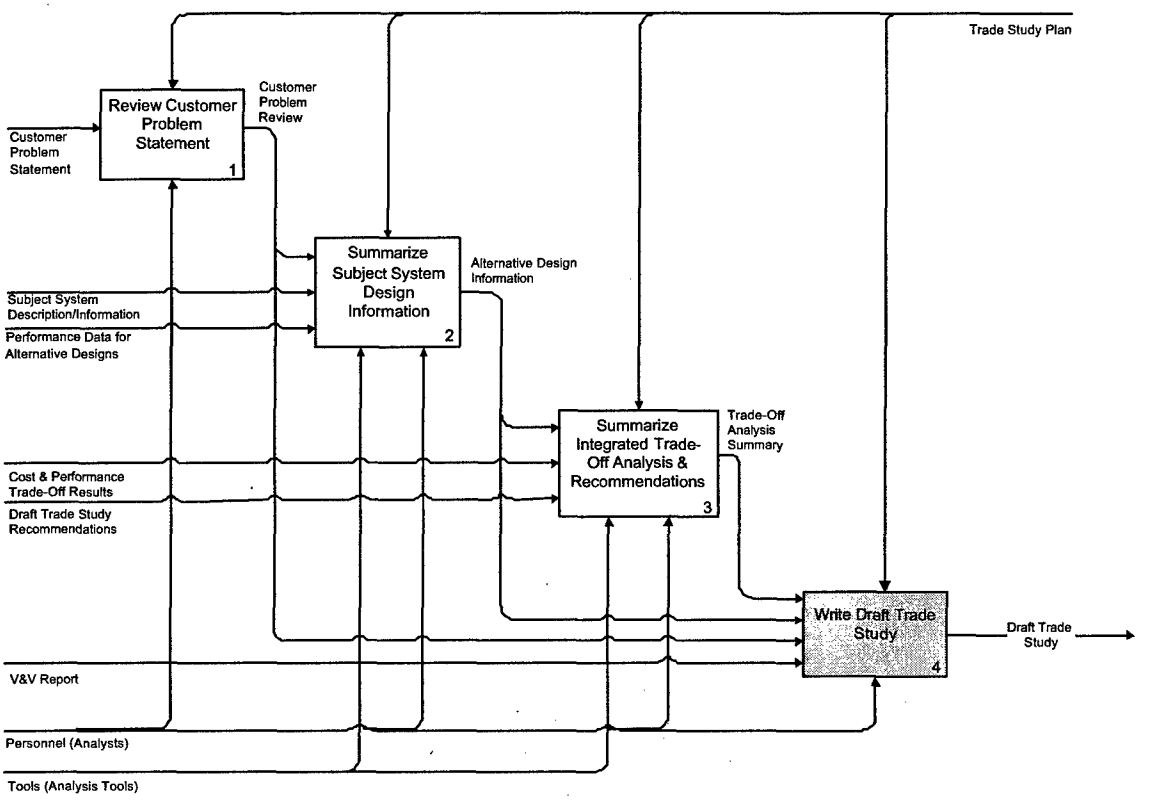


Figure A-A6.3(d) Formulate Draft Trade Study

Inputs:

Trade-Off Analysis Summary– Written summary of Trade Study analysis and recommendations for inclusion in the Draft Trade Study.

Alternative Design Information – Summarized design description information and data for alternative subject system design options.

Customer Problem Review – Results of interpreting trade-off analysis results in the context of the original Customer Problem Statement and producing concise summary to document final project results.

Validation and Verification Report – Results and assessment based on the acceptability criteria that the built system is validated and verified given the intended use.

Controls:

Trade Study Plan – Document that defines the approach, methods, and performance measures to be used to assess trade-offs among alternate weapon system designs and total ownership costs.

Outputs:

Draft Trade Study – Draft document presenting the Trade Study results for customer review.

Mechanisms:

Personnel – Government, contract employees, subject matter experts, systems engineers and analysts available to support using the WARCON process.

A6.4 Perform Customer Trade Study Review

Meeting with the customer to review the Draft Trade Study and to discuss customer comments and recommendations (Figure A-A6(d)).

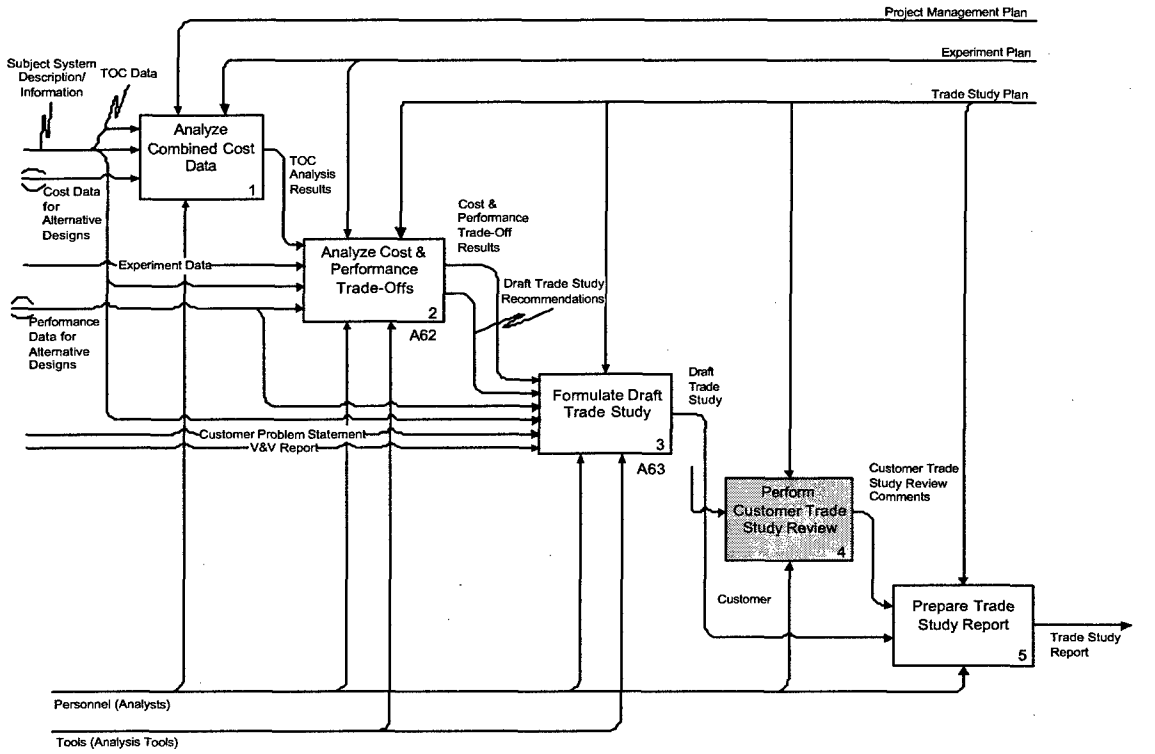


Figure A-A6(d) Develop Trade Study

Inputs:

Draft Trade Study – Document presenting the Trade Study and results for customer review.

Controls:

Trade Study Plan – Document that defines the approach, methods, and performance measures to be used to assess trade-offs among alternate weapon system designs and total ownership costs.

Outputs:

Customer Trade Study Review Comments – Comments received from the customer during the review process.

Mechanisms:

Personnel – Government, contract employees, subject matter experts, systems engineers and analysts available to support using the WARCON process.

A6.5 Prepare Trade Study Report

Incorporating customer comments and recommendations into the draft Trade Study to prepare the final Trade Study Report (Figure A-A6(e)).

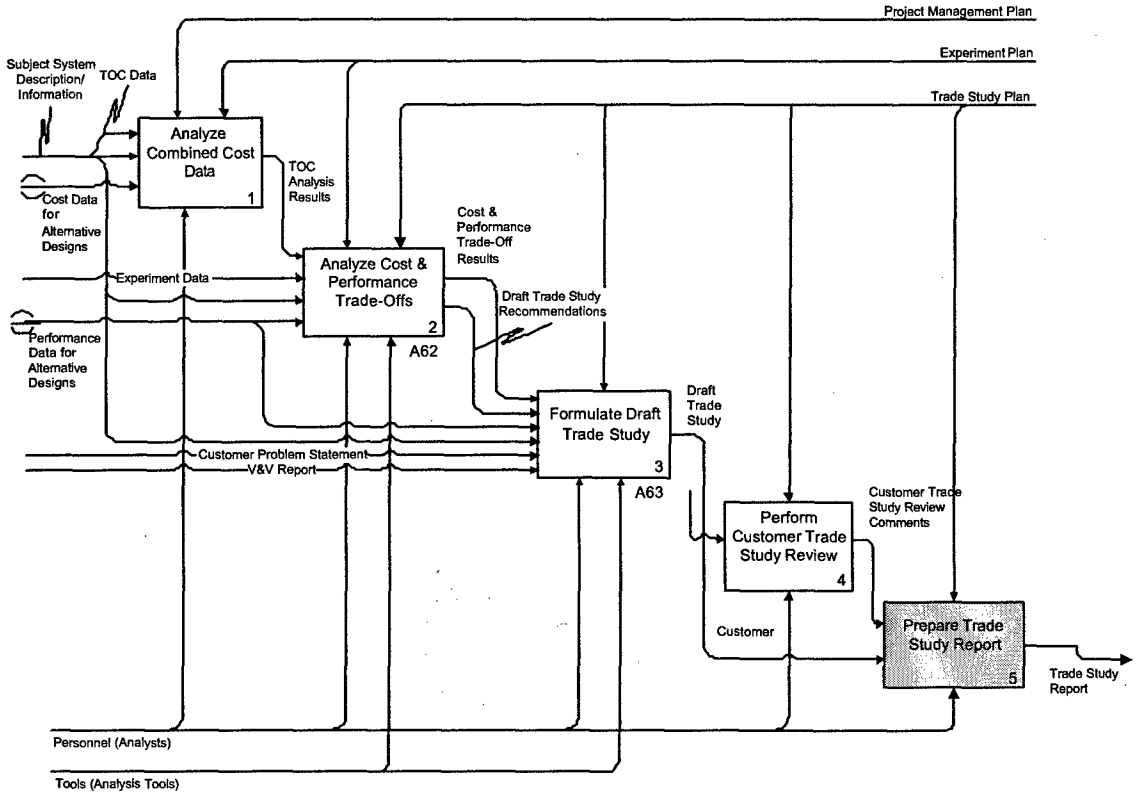


Figure A-A6(e) Develop Trade Study

Inputs:

Customer Trade Study Review Comments – Comments received from the customer during the review process.

Draft Trade Study – Draft document presenting the Trade Study results for customer review.

Controls:

Trade Study Plan – Document that defines the approach, methods, and performance measures to be used to assess trade-offs among alternate weapon system designs and total ownership costs.

Outputs:

Trade Study Report – The primary product resulting from the WARCON process to support acquisition decision makers. This formal report summarizes cost-performance trade-offs among the different options for future weapon system designs.

Mechanisms:

Personnel – Government, contract employees, subject matter experts, systems engineers and analysts available to support using the WARCON process.

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