Framework Programmable Platform for the Advanced Software Development Workstation

Demonstration Framework Document Volume I: Concepts and Activity Descriptions

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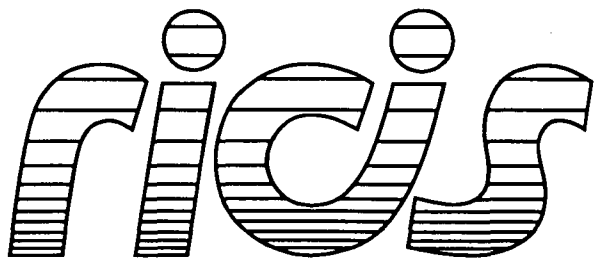

Research Institute for Computing and Information Systems
University of Houston-Clear Lake

TECHNICAL REPORT

The RICIS Concept

The University of Houston-Clear Lake established the Research Institute for Computing and Information Systems (RICIS) in 1986 to encourage the NASA Johnson Space Center (JSC) and local industry to actively support research in the computing and information sciences. As part of this endeavor, UHCL proposed a partnership with JSC to jointly define and manage an integrated program of research in advanced data processing technology needed for JSC's main missions, including administrative, engineering and science responsibilities. JSC agreed and entered into a continuing cooperative agreement with UHCL beginning in May 1986, to jointly plan and execute such research through RICIS. Additionally, under Cooperative Agreement NCC 9-16, computing and educational facilities are shared by the two institutions to conduct the research.

The UHCL/RICIS mission is to conduct, coordinate, and disseminate research and professional level education in computing and information systems to serve the needs of the government, industry, community and academia. RICIS combines resources of UHCL and its gateway affiliates to research and develop materials, prototypes and publications on topics of mutual interest to its sponsors and researchers. Within UHCL, the mission is being implemented through interdisciplinary involvement of faculty and students from each of the four schools: Business and Public Administration, Education, Human Sciences and Humanities, and Natural and Applied Sciences. RICIS also collaborates with industry in a companion program. This program is focused on serving the research and advanced development needs of industry.

Moreover, UHCL established relationships with other universities and research organizations, having common research interests, to provide additional sources of expertise to conduct needed research. For example, UHCL has entered into a special partnership with Texas A&M University to help oversee RICIS research and education programs, while other research organizations are involved via the "gateway" concept.

A major role of RICIS then is to find the best match of sponsors, researchers and research objectives to advance knowledge in the computing and information sciences. RICIS, working jointly with its sponsors, advises on research needs, recommends principals for conducting the research, provides technical and administrative support to coordinate the research and integrates technical results into the goals of UHCL, NASA/JSC and industry.

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RICIS Preface

This research was conducted under auspices of the Research Institute for Computing and Information Systems by Dr. Richard J. Mayer, Thomas M. Blinn, Dr. Paula S. deWitte, John W. Crump and Keith A. Ackley of Knowledge Based Systems, Inc. Dr. Charles McKay served as RICIS research coordinator.

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1 Introduction

The Framework Programmable Software Development Platform (FPP) is a project aimed at effectively combining tool and data integration mechanisms with a model of the software development process to provide an intelligent integrated software development environment. Guided by the model, this system development framework will take advantage of an integrated operating environment to automate effectively the management of the software development process so that costly mistakes during the development phase can be eliminated. This Platform is being developed under the Advanced Software Development Workstation (ASDW) Program sponsored by the Software Technology Branch at the NASA Johnson Space Center. The ASDW program is conducting research into development of advanced technologies for Computer Aided Software Engineering (CASE).

1.1 Motivations for the FPP

The FPP was conceived in response to difficulties of producing software systems. With the advent of more powerful and more economical computer hardware resources, the complexity of software systems has increased dramatically. As computer systems become more complicated, ensuring that systems are produced in a consistent manner, on time, and within budget, and ensuring that the system built is reliable and maintainable, requires a considerable management effort.

One characteristic of large software systems is the inability of a single person to fully understand the requirements, produce the design, and develop the system. Instead, the system development process must be executed by a team of managers and software engineers. Tasks within the development can occur concurrently, except where certain tasks depend on information produced by others. These interrelationships make the management of the development process very difficult. Regardless of how well a development project may be planned out, without some form of control over the actions of the development team, costly mistakes and setbacks are bound to occur during development. This is particularly true in multi-year projects that suffer from management and technical team leadership turnover.

One promise of Computer Aided Software Engineering (CASE) tools was to assist project managers in monitoring the progress of the development activities and in capturing the experiences of the development team. However, the existing CASE tools fail to cover the entire software development process and tend to concentrate instead on a particular aspect of the development process (i.e., project management, requirements analysis, code development and debugging). The result has usually been to use a piecemeal collection of various CASE tools that addresses only portions of the development process during the development of software systems.

Many of these tools are quite useful within their specified area of the system development process. However, a persistent problem with these tools has been in trying to use the tools in some organized fashion to fully automate the system development process. Incompatible data formats along with the misuse of tools make interaction among these different tools very difficult. As a result, development of CASE environments that effectively automate the software engineering process are nonexistent.

The recognition of these difficulties has spurred the development of the FPP. The focus of the FPP is the management, control, and integration of the software system development process. The major goals in this definition of the FPP have been to provide:

1) a realistic integration strategy that supports function and data integration of a suite of tools (distributed and covering the entire life-cycle);

2) integrated access to and update of life cycle artifact data;

3) control of life cycle activities and data evolution; and

4) a site-specific development process support environment, enforcing the rules and preferred methods of the organization.

The FPP is also expected to provide these capabilities in a distributed, heterogeneous computing environment. Developing a platform that meets these goals should result in (1) a reduction in the time required to produce software systems, (2) an increase in the quality of the resulting software systems, (3) a decrease in the maintenance effort for the resulting software systems, and (4) an increase in the consistency in the development process by which software systems are constructed.

1.2 Scope of this Document

Previous work on the FPP project focused on the development of an integration strategy and design of the mechanisms to support that strategy. The result has been the production of concept and design documents detailing the Integration Services approach to integration [FPP 90a], [FPP 91a]. With this service based approach, an application advertises the services it will provide, as well as the invocation procedures for that service. In essence, the advertisements define external interfaces that allow other tools or users to take advantage of the functionality provided by the new application. The underlying integration platform provides the required support for organizing and maintaining these interface definitions, as well as for routing the integration service requests.

Though much of the work on the FPP to this point has dealt with integrated development environments, the major focus throughout the project has

been on the *framework*. As will be discussed in more detail in Section 2, a framework provides a description of the entire system development process, and a goal of the FPP project is to use this description to guide users through and to manage that development process. The Framework Processor mechanism [FPP 91b] will provide the functionality to process and interpret the framework description to guide users through the development of systems. In a fully operational environment, the integrated environment is necessary to provide an underlying architecture upon which the framework processing can be layered. The flexibility of the integration services approach will give the integrated development environment the ability to support framework processing.

At this point in the FPP project, the design phase has now been completed and the FPP project is entering the demonstration prototyping stage. In this stage, work is progressing on the development of prototype systems that provide the type of functionality specified in the FPP Concept of Operations Document [FPP 90a] and the FPP Requirements Document [FPP 90b] and that adhere to the designs presented in [FPP 91a], [FPP 91b], and [FPP 91c]. Currently, the prototype under development addresses the framework processing capability defined in the Framework Processor Design Document [FPP 91b].

However, a requirement for the demonstration of this framework processing capability is the existence of a framework for the platform to manipulate and to use in guiding a development process. Since this framework is used to manage and control the system development process at a specific site, an organization should not take its production lightly. In recognition of the importance of the framework definition, a task to generate a demonstration framework for use in testing and running the prototype system was included in the FPP effort. The results of this task are the contents of this document.

1.3 Document Organization

The presentation of the demonstration framework has been broken up into two documents. This document, Volume I, provides a discussion of the concepts behind the FPP, the evolution and structure of the demonstration framework, and a description of each of the activities in the development process. Volume II presents the IDEF3 process descriptions that are a major part of the demonstration framework. These two volumes should be used in unison to get a full understanding of the demonstration framework.

The reader should begin, however, with this volume in Section 2, where a presentation of background concepts surrounding frameworks and the use of frameworks by the FPP is provided. Section 3 then presents the evolution that the demonstration framework has undergone since the development of the framework began. Section 3 also presents some interesting discoveries regarding frameworks in general made during the development of this framework.

It is in Section 4 that the definition of the framework actually begins. At this point, the user may want to read Volume II in conjunction with Section 4. While Section 4 describes each activity, Volume II presents the overall process in which the activity occurs. By examining both views at the same time, the reader can grasp the context in which the activity takes place along with an understanding of what takes place within that activity.

Finally, the document is concluded with a brief discussion of future directions. A bibliography of source material is also provided along with a development process comparison chart found in Appendix A.

2 Frameworks Background

In order for a development environment to provide intelligent coordination and control throughout the software development process, the environment must have some means of understanding the intended development process. The means by which the FPP will capture this knowledge is through the framework. This section will provide a brief explanation of the framework concept as well as a description of how the FPP will use the framework to manage the software development process.

2.1 Frameworks

In general, a *framework* is a structure for organizing knowledge about a system. With respect to the FPP, a framework is a structure for organizing knowledge about: (1) situations occurring in the evolution of a software system, (2) methods and tools available for use in developing the software system, (3) the circumstances under which particular methods and tools should be used in support of a situation within the development process, and (4) the users and user roles responsible for addressing a situation within the development process. Recently, much research has been performed in the area of frameworks, and different views and classes of frameworks have evolved from this work. Two views of frameworks are of particular interest to the FPP and will be discussed in the next two subsections.

2.1.1 Situation Classification Frameworks

The first view of a framework is as an organizing structure for the many representations of information pertaining to an information system. Under this view, the parts being structured are development situations in which particular representations of the problem or its solution are developed or used. This is the view of the original Zachman framework [Zachman 86].

In this context, the term framework refers to an organization of characterized situation types that are known to occur commonly during a system life cycle. Each characterization identifies the roles of the personnel in the organization involved in that situation type and the information that must be discovered, decided upon, or managed during that situation. For example, one situation may involve two system analysts deciding on how to implement data in an information system. Another situation may involve an analyst presenting to the business owners the type of data needed for their company's information system. In these two situations, the analysts are focusing on data, but from two different perspectives. Accordingly, the two different perspectives require different information about the information system. These two examples demonstrate how similar situations can vary drastically in scope and perspective.

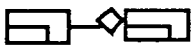
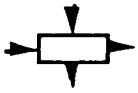
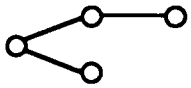
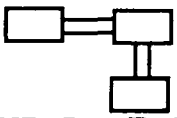
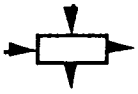
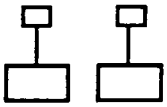
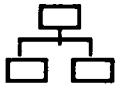
	DATA	FUNCTION	NETWORK
OBJECTIVES/ SCOPE	List of Things Important to the business  ENTITY = Class of Business Thing	List of Processes the Business performs  Process = Class of Business Activity	List of Locations in which the business operates 
MODEL OF THE BUSINESS	e.g., Entity/ Relation Diagram  ENT = Info. Entity ReIn = Bus. Rule	e.g., Function Flow Diagram 	e.g., Logistics Network  Node= Bus. Unit Link= Bus. Relatr
MODEL OF THE INFORMATION SYSTEM	e.g., Data Model  ENT = Data Entity ReIn = Data ReIn	e.g., Data Flow Diagram 	e.g., Distributed System Arch Node=I/S Func. Link=Line Char.
TECHNOLOGY MODEL	e.g., Data Design  ENT = Segment ReIn = Pointer	e.g., Structure Chart 	e.g., System Arch Node=Hardware Link=Line Spec.
DETAILED REPRESEN-TATIONS	e.g., Data Design Description  ENT = Field ReIn = Address	e.g., Program 	e.g., Network Architecture 
FUNCTIONING SYSTEM	e.g., Data	e.g., Functior	Communicatior

Figure 2-1. The Zachman Framework

This idea can be generalized. In the life cycle of an information system, different representations of information pertaining to the system are required at different stages of the development process. A Situation Classification Framework attempts to characterize the various development situations that require these different representations. John Zachman's original Situation Classification Framework is shown in Figure 2-1. This framework is represented as a matrix in which the six rows represent different *perspectives* (or views) and the three columns represent *focuses* of descriptions of an information system architecture.

The perspective organizes the descriptions of the system with respect to multiple viewpoints (e.g., the executive, the manager, the programmer, etc.). The focus organizes the descriptions with respect to the level at which the system will operate. Thus, each cell in the matrix represents a situation with a particular focus from the perspective of a user's viewpoint.

The power of the framework lies in the identification of these different situation types, since the characterization includes identification of the roles, responsibilities, conditions, prior commitments, and information involved in a situation that results in a need for a particular class of system representation. This necessary representation can then drive the selection of specific methods for capturing that representation and for managing the information critical to that development situation. We can also identify where information needs to be shared from one development situation to another. Therefore, once this classification framework has been established, the framework can help a project member select the most effective tool to guide the system developers from the concept of a solution to the reality of an implementation.

2.1.2 System Development Framework

While the Situation Classification Framework view attempts to categorize the development situations that arise during system development, the Situation Classification Framework provides no means for capturing temporal relationships between the various situations. In addition, there are no means for capturing the details of the processes and activities that occur within the situation types. However, with the second view of a framework, the intent is to capture these procedural aspects of an organization's system development process. In this respect, the second view of a framework is as an organizing structure for a system development process. Under this view, the parts being structured are not situations or methods but life cycle analysis, design, implementation, maintenance, or decision making activities. We refer to this view as the System Development Process Framework.

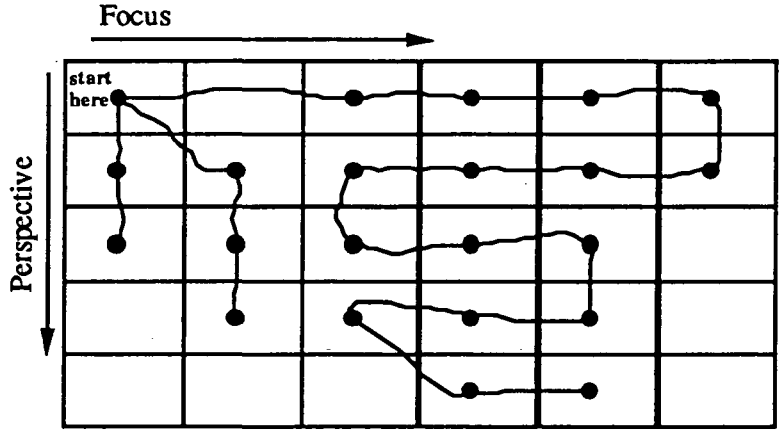


Figure 2-2. Precedence Relationships Between Situations

Conceptually, the System Development Framework can be layered on top of the Situation Classification Framework as reflected in Figure 2-2. The figure shows that the process description can capture the sequence of situations defined in the Situation Classification Framework that are encountered during the development process. The advantage, however, that the System Development Framework has over the Situation Classification Framework is that the development process description can "look" inside each cell of the framework to examine the activities that must occur to address the development situation represented by the cell in the framework. As a result, the development process description can be defined to a finer level of detail to include not only the sequencing of development situations, but also the definition of life cycle phases, development tasks, project milestones, and project documentation artifacts. This process analysis will also produce:

1. descriptions of the procedures for analysis, decision making, and configuration control;

2. calls for the application of specific methods to specific development tasks;

3. definition of common information/data across the different methods; and

4. development process user role definitions.

Taken together, these data provide a complete description of the process by which an organization addresses the development situations occurring during the development of a system.

2.1.3 The FPP Framework and Its Role

The preceding discussion has presented the two framework views as being separate structures. In actuality, the two frameworks are closely linked. By moving down a level of abstraction from the Situation Classification Framework, it is apparent that each cell of the Situation Classification Framework points to more detailed information as shown in Figure 2-3. Part of this information is the process description that captures details of the activities involved in addressing the situation. Therefore, the System Development Framework is partitioned and distributed across the Situation Classification Framework. The FPP framework will take this approach towards the framework definition. The Situation Classification Framework will serve as an organizing structure for the information necessary to capture an organization's development process. As a result, the framework matrix will not necessarily be obvious in the definition of this demonstration framework. In actuality, the framework serves as a nice concept by which the definition of the process based framework can be generated.

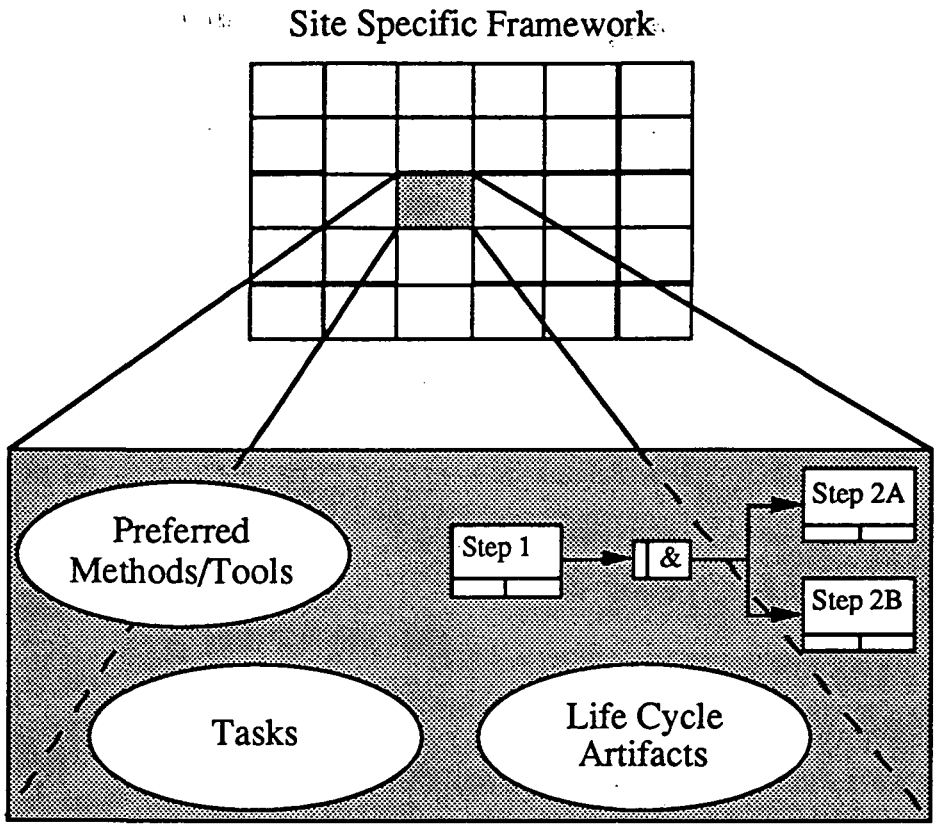


Figure 2-3. Framework Cell Contents

With the definition of a framework, the intent is to capture a representation of the system development process at a particular organization. This framework:

1. provides structure for the description of the software development process;
2. provides a "big picture" of the system development process;
3. provides a "road map" for the participants in the system development process;
4. identifies standard methods and tools;
5. specifies applicable tools and methods at a site;
6. assists in the planning and scheduling of the system development process;
7. orchestrates the use of integrated tools and methods; and
8. summarizes the standard development process at a site.

As a result, a framework provides a means to carry the experience base from one project to another within an organization. In addition, the framework can provide a degree of control over the system development and provide consistency between projects requiring multiple project coordination, management consistency, and personnel utilization.

But the framework can do more than just provide a description of the development process. As the FPP project intends to show, the representation of the framework can be used to drive and configure an automated development support environment. Some of the capabilities that will be possible through the use of this approach are:

1. Context Defined Tasking,
2. Life Cycle Data Management and Control,
3. Automated Project Status Reporting, and
4. Automatic Problem Notification.

These types of capabilities are possible because the framework completely defines the activities that will occur during the development process, the relationships between those activities, the objects (e.g., documents, code, and modules) that will be manipulated during a particular activity, and the roles of people that will be involved in the activity. In this environment, a Framework Processor [FPP 91b] component will serve as an interface to the framework definition for a project member. By logging into the system, the user will be presented with the framework definition. The user can then browse the framework in two modes. The first mode will allow the user to browse the entire framework so that the user could become familiar with the development process at a particular organization. In the second mode, the framework is presented to the user with respect to a specific project. With specific project information, the framework is capable of reflecting the current state of the project development (i.e., at what point in the process is development currently focused). The user can also use this mode to identify the tasks and activities in which they should be involved.

This idea might be made clearer by examining the operation of the Framework Processor more closely. The basic operational philosophy of the Framework Processor is to take a framework as input, translate the framework into a set of constraints and facts, and then use the facts and constraints to monitor and control the development process. During this process, the set of facts and constraints are continuously updated as a result of actions by users and messages from the development environment (i.e., the notification of the occurrence of certain events). This dynamic situation is continuously monitored to detect inconsistencies between the process specified in the framework and the actual events occurring during the system development. In this way, the framework is used to control the progression of a project development by enforcing the process defined in the framework.

Important to this framework processing ability is defining a framework in a form that is processable by computer. The information describing the development process must be structured in a format that will allow efficient processing by the Framework Processor. For this reason, the demonstration framework has been defined using the IDEF3 Process Flow Description Method [Mayer 90] augmented with certain definitional information with respect to software tools available to an organization, system users in the organization, and other organization resources. As a result, the IDEF3 descriptions and the additional resource definition information will provide the FPP with the information necessary to monitor and guide an organization's development process.

3.0 FPP Demonstration Framework Development

Having developed an understanding of how a framework could be used in a CASE environment and having designed a mechanism to process these frameworks, the next step is to define a demonstration framework that will serve to prove the concepts previously developed. The remainder of this document will be dedicated to describing the resulting framework along with the approach taken to define this framework. Describing the process taken in defining a framework is important as much discussion has taken place as to the benefits of a framework, but little work has been done towards actually defining a framework or documenting a procedure to define a framework. In this section, the process by which the NASA framework was developed is presented. No claims are made as to whether this is the proper way to define a framework. Instead, the process is discussed to provide future framework developers with information that might help in the definition of other frameworks.

3.1 Framework Comparison

The first step taken in the development of the demonstration framework was to gather various frameworks and compare them. This was done to try to gather the best qualities of each to use as the basis for the demonstration framework. Various sources have taken Zachman's original idea and expanded it to include other row perspectives and column focuses to fit best with the system architecture they are using. The sources for the frameworks used in this comparison and the abbreviations used to identify them are summarized below.

Abbreviation	Framework
Zachman	John Zachman [Zachman 86]
KBSL	Knowledge Based Systems Laboratory [Mathur 1989]
IUG	IDEF User's Group [Feldman 91]
BA/Ford	Booz Allen/Ford
BA/Ford 2	Booz Allen/Ford Extensions
KBSI	Knowledge Based Systems, Inc.

The comparison of these frameworks uncovered some interesting concepts. For example, the row names can be labeled in three ways:

1. by generic *role* of people involved with the cells of a row,

2. by generic *thing* produced in the cells of a row, and

3. by generic *activity* going on in the cells of a row.

The following table gives a comparison between the various frameworks for the row names. The final column labeled KBSI contains examples of all three ways of labeling the rows.

Zachman	KBSL	IUG	BA/Ford	KBSI
Objective/Scope	Objective/Scope	Scope	Planning	Owner Objective/ Scope Business Planing
Model of the Business	Domain/ Model of the Business			Bus. Community Domain/Ontology Harmonization
Model of the Information System	Model of the Information System	Owner	Analysis	Business Operator Models of Bus. Analysis/Bus.Sys. Design
Technology Model	Technology Model	Designer	Logical Design	IRM Model of Info.Sys. Analysis&Info. Sys. Design
Detailed Representation	Detailed Representation	Builder	Physical Design	Sys. Designer Technology Model Physical/ Implmntn Design
Functioning System	Functioning System	Worker	Implementation	Implementor Detailed Represent. Code&Test
		Target	Document	User Task Centered Rep. Use System
			Operate & Maintain	Maintainer ATA+Func. Sys. Operate&Maintain

Column labels did not vary as much in the ways they were labeled, but there are quite a few more columns than were in the original Zachman matrix. Zachman maintains that the original three columns contain the description of the entire system and that any other columns added to the framework must be taking descriptions from one of the other column. The reasons that one might want to split a column in this way might be to focus on a specific area of the system. Large complex matrices can be created with the splitting of columns in this manner. This may or may not be a problem depending upon the uses of the framework under consideration. The following table displays the comparison of frameworks with respect to columns.

Zachman	Data	Function	Network	People	Time	Values				
KBSL	Data	Function	Network	User	LifeCycle					
IUG	What	How	Where	Who	When	Why				
BA/Ford	Data	Function	Interface				Process			System Architecture
BA/Ford2	Data		Interface				Process	Control	Document	System
KBSI	Data	Function	Network/ Where	People/ Who	Life Cycle	Values	Process	Control	Document	System Structure

3.2 Framework Evolution

After completing the comparison of the various frameworks, work began on defining the actual structure of this demonstration framework. The first step in this process was to identify and define the rows and columns of a framework that would be pertinent to a NASA system development. The rows of this framework settled on essentially the same rows found in the frameworks described in the previous sections and are summarized below in relation to Zachman's original rows.

1. The *Program Manager* could serve as the Business Owner.
2. The *Chief Engineer* could serve as the Business Operator
3. The *Project Director* could serve as the IRM/System Manager
4. The *System Designer* perspective could remain the same.
5. The *Implementor* perspective could remain the same.

The columns, however, were selected from the superset of all the columns found in the various frameworks. The chosen columns are briefly describe below.

1. The *Data* column focuses on the data provided by, managed by, or necessary for the system.
2. The *Function/Process* column focuses on the functions provided by the system as well as the processes by which the system operates.

3. The *People* column focuses on the structures necessary for man/machine interfaces.

4. The *System Structures* column focuses on the representation of system architectures.

5. The *Lifecycle* column focuses on the life cycle of the system (e.g., funding periods, phase definitions, etc.).

6. The *Lifecycle Artifact Management* column focuses on the definition and configuration control of the artifacts that make up the system (e.g., requirements and design documents, code modules, etc.).

Having settled on these rows and columns, work began on defining the situations represented by each of the cells in the resulting framework. However, in attempting to bound the situations represented by each cell of this framework, the development team constantly encountered the problem of shifting viewpoint. Were we examining *data* with respect to (1) the process by which the system is being built (2) what was being built, or (3) how the system was going to be used?

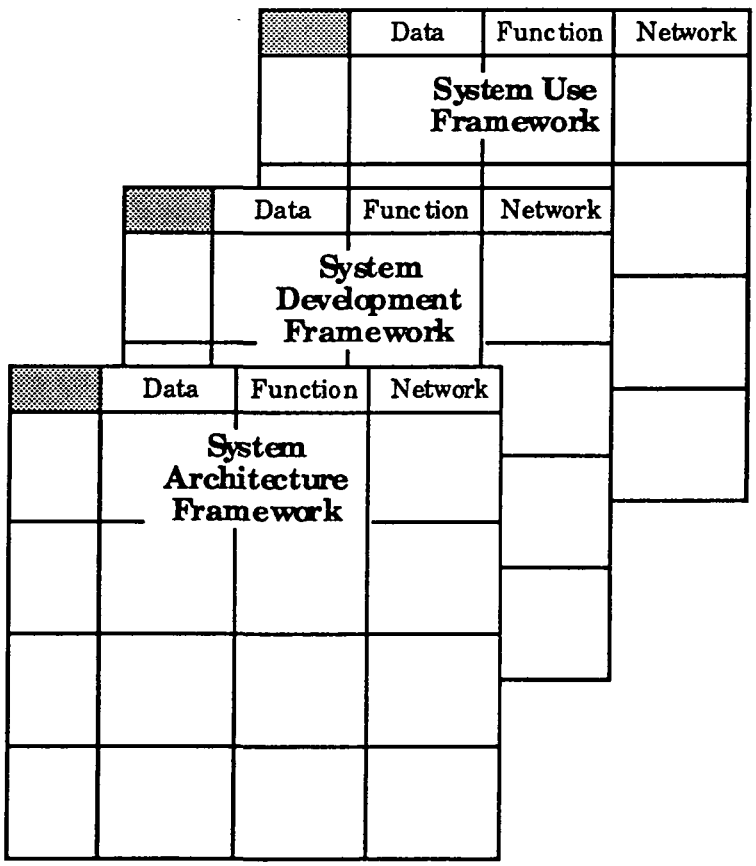


Figure 3-1. Situation Framework Types

With further examination, it became clear that a possible third axis could by added to the framework matrix. This idea is reflected in Figure 3-1 by showing that there exists multiple situation framework types for the same system. In this work, three framework types were identified:

1. the *System Architecture* framework captures the situations relevant to defining what the system is;

2. the *System Development* framework captures the situations relevant to how the system will be constructed; and

3. the *System Use* framework captures the situations relevant to how the system will be used and what will be required to use it.

It has been said in the past that different frameworks exist for different system types. Here is evidence that different frameworks could exist for not only the same system type, but also for the same system. This third axis of the framework has been given a label of 'Attitude,' as each of the framework types represents a certain attitude to which the system is directed.

Faced with the task of now defining three frameworks as opposed to one, the development team stepped back to reevaluate the situation. In this reevaluation, the team noticed that the Situation Classification Framework tended to ignore much of the process oriented aspects of system development and instead focused on certain instances of time within the process. As the FPP effort contends that the process represents a more fundamental view of system development and as the inherent complexity of the Situation Classification Framework became more obvious, work began to focus more on the development process and less on the development situation.

3.3 Source Material

Having decided to focus on the development process and to derive a framework for the development process, the next step was to gather source material on which to base the development framework. This section describes the various source materials that were used to define and develop the demonstration framework. After deciding to move away from the strict matrix form of the framework, the design team focused on actual software development methods that could be found in the literature. The basic processes that were examined are similar in nature, differing only in small details and occasionally in level of granularity or scope. Each tends toward the basic waterfall software life cycle which is prevalent throughout this area. In Appendix A, a chart is given that shows a comparison of the various development methodologies. The low level details are not covered by the chart as it was used only to give a general idea as to how the

methodologies measure up with one another. For a more detailed description, the reader is directed to the sources of the methodologies given.

The following subsections provide an overview of the various methods and a discussion of why that particular method was a useful source of information. The methods are presented in roughly the order of most to least used. The SMAP documents were by far the most referenced source of information. As SMAP is a product of NASA, it was felt that a demonstration framework that was developed from the SMAP standards would be a more suitable example. The SEM document was another source that was used extensively. Although it was designed for the more general class of engineering development, it was useful in describing the software engineering development as well. The SDM from Westinghouse gives a superb outline of software development. This was almost used as the basis for the demonstration framework; however, there was not a large enough volume of information to develop a suitable demonstration framework.

The following subsections describe the various sources of process information used for this demonstration framework.

3.3.1 Software Management and Assurance Program (SMAP)

The SMAP document [Callendar 89] was used extensively in the development of the demonstration framework described in this document. The purpose of the SMAP is to define a standard life-cycle model and content for associated documentation. This standard provides an architecture to allow consistency across the agency using the SMAP. It also provides visibility into the completeness of the information recorded during the life-cycle. The only deficiency in using the SMAP was that it does not define specific role types to specific activities. The document states that this was intentional and that the assignment of specific tasks and roles should be decided by the project/program management. Other than this problem, the SMAP was very suitable to form into a demonstration framework.

3.3.2 Systems Engineering Methodology (SEM)

The SEM document is the result of research performed to support the orderly implementation of truly integrated manufacturing systems [Kemmel 83]. Even though this document focuses on manufacturing engineering methods and procedures, much of the information pertains to the development of software as well. The description of tools, role types, and methods that were lacking in the SMAP documentation can be found in this source. The IDEF0 model of the system development process for integrated manufacturing systems was also of great help in defining the demonstration framework in this document.

3.3.3 Systems Development Methodology (SDM)

The SDM, developed by Westinghouse Electric Corporation [Brunson 91], is a set of tools and techniques to assist in the recognition, assessment, and control of risk so that they may be acted upon at the earliest possible time. SDM provides an organized approach to project management. It is a methodology that is used in the planning and management of the systems development life cycle. The SDM booklet was useful in identifying roles and responsibilities during the software development life cycle.

3.3.4 Alternative Architecture Display System Development Methodology (Alt. SDM)

The goal of Alternate SDM [Peters 79] was to analyze the state of the art of system development in a manufacturing environment. This work was not as applicable as the previous despite the fact that the processes involved in manufacturing are often very similar when placed in a system development context. The study of methodologies from different domains, however, was helpful in completing the demonstration framework.

3.3.5 IE/IMPACT

IE/IMPACT, a product of Pacific Information Management [Coleman 90], is a comprehensive methodology that describes an approach to Enterprise Information Engineering that can be used to guide the achievement of Enterprise wide, integrated Information Resource Management. The philosophy of IE/IMPACT is to view the information of an enterprise as a resource and manage it in the same way as other enterprise assets. The steps of IE/IMPACT embody much more than the software development life cycle.

3.3.6 Others

The other system development process sources that were examined for this work played a more tangential role. Typical software engineering, structured design, and systems analysis textbooks were employed to provide information on roles, tools, and methods for software engineering. These sources were helpful, but not crucial to the development of the demonstration framework. They were included in Appendix A for completeness.

3.4 Development Activities

After performing an analysis of the various development processes documented in the materials just described, the generation of the development process framework began. Before developing an IDEF3 description of the augmented SMAP process, a partial IDEF0 activity model was produced. This model was used to capture relationships between the activities in the development process. More specifically, this model was

used to identify the flow of artifacts between activities in this development process.

Once the artifact relationships had been identified, the IDEF3 process description for the framework was generated. This description was generated using the prototype IDEF3 tool produced for NASA in 1990 and the resulting descriptions make up the contents of Volume II. The final step in the demonstration framework development was to merge the information captured in the IDEF0 model with the IDEF3 process descriptions. This final step is essentially the contents of Section 4. In this section, a description of each of the activities (UOBs) occurring in the process description is provided. This description is defined in terms of the artifacts manipulated by, user role types participating in, tools available for, and methods recommended for the activity. Also included in this description is the definition of the criteria that must be met in order to consider a particular activity complete.

4.0 Framework Activity Definition

This section begins the actual definition of the demonstration framework. To start off, definitions of the user roles, tools, methods, and artifacts used by the framework are provided. These definitions are then followed by descriptions of each activity in the development process.

4.1 Framework Resource Definitions

As documented in the Framework Processor Design Document [FPP 91b], definition of certain information relevant to the framework must be provided. This definition involves identifying the user roles, tools, methods, and artifacts that will be referenced at various points in the framework specification. The following subsections identify the resources that will be referenced by the demonstration framework.

4.1.1 Roles

Below are the user roles that participate in the development process defined in the demonstration framework.

Customer/Sponsor	Project Manager
Project Leader	Group Leader
Project Administrator	Financial Administrator
Technical Administrator	Configuration Control Administrator
Technical Analyst	Technical Support Analyst
System Analyst	System Designer
Subsystem Designer	Development Coder
Integration Coder	Maintenance Coder
Verification Tester	Validation Tester
Field Tester	Quality Assurance Tester
Quality Assurance Specialist	End User
End User Manager	Customer Service

4.1.2 Tools

Below are the candidate tools that can be used at various stages in the development process.

Management Tools

MS Project
Excel

Construction Tools

Emacs	C++	C	Lucid Lisp
Lex	Yacc	Motif	dbx
Lint	X Windows	MS Word	MacDraw Pro

MS Draw	Micrografix Designer	Excel	Lotus 123
ObjectVision			

Design Tools

AI4
Knowledgeware
Programmer's Workbench
Validation Prototyper

Database Design Tools

AI1X

Modeling Tools

AI0
AI1
AI3
IDefine

4.1.3 Methods

Below are the candidate methods that can be used during the development process.

IDEF0	IDEF1
IDEF1X	IDEF3
IDEF4	IDEF5
IDEF8	Business Systems Planning (BSP)
Structure Charts	Structured Analysis / Structured Design
Jackson System Development	Structured Programming
Gantt Charts	Decision Trees
Decision Tables	Flow Charts
Cost Analysis	Statistical Analysis

4.1.4 Artifacts

Below are the artifacts produced and manipulated during the development process. The column on the right indicates the Data Item Description (DID) that applies the each artifact.

Phase	Artifact	DID
A&D	Acceptance Test Results	SMAP-DID-A200
A&D	Discrepancy Reports	SMAP-DID-R004
A&D	Engineering Change Proposals	SMAP-DID-R005
A&D	Information System Post-Acceptance Test	SMAP-DID-P000-SY
A&D	Lessons Learned	SMAP-DID-R006

A&D	Performance/Metrics Reports	SMAP-DID-R007
A&D	Plan Updates	SMAP-DID-M000-SY
A&D	QA Specs, Procs, Criteria, & Results	SMAP-DID-A100
A&D	QEA Specs, Procs, Criteria, & Results	SMAP-DID-A300
A&D	Review Reports	SMAP-DID-R008
A&D	SA Specs, Procs, Criteria, & Results	SMAP-DID-A400
A&D	SPA Specs, Procs, Criteria, & Results	SMAP-DID-A500
A&D	Status Reports	SMAP-DID-R007
A&D	Training Materials update	SMAP-DID-P000-SY
A&D	User's Guide update	SMAP-DID-P500
A&D	Ver. & Val. Results	SMAP-DID-A600
A&D	Version Description update	SMAP-DID-P400
C&I	Acquisition Plan	SMAP-DID-M100-SY
C&I	Concept Document	SMAP-DID-P100
C&I	Quality Assurance	SMAP-DID-A100
C&I	Lessons Learned	SMAP-DID-R006
C&I	Review Reports	SMAP-DID-R008
C&I	Status Reports	SMAP-DID-R007
DES	Acceptance Test Procedures & Criteria	SMAP-DID-A200
DES	Design Specification	SMAP-DID-P300-SY
DES	Discrepancy Reports	SMAP-DID-R004
DES	Engineering Change Proposals	SMAP-DID-R005
DES	Integration Test Specs, Procs, & Criteria	SMAP-DID-A200
DES	Lessons Learned	SMAP-DID-R006
DES	Performance/Metrics Reports	SMAP-DID-R007
DES	Plan Updates	SMAP-DID-M000-SY
DES	QA Specs, Procs, Criteria, & Results	SMAP-DID-A100
DES	QEA Specs, Procs, Criteria, & Results	SMAP-DID-A300
DES	Review Reports	SMAP-DID-R008
DES	SA Specs, Procs, Criteria, & Results	SMAP-DID-A400
DES	SPA Specs, Procs, Criteria, & Results	SMAP-DID-A500
DES	Status Reports	SMAP-DID-R007
DES	Val. Specs, Procs, Criteria, & Results	SMAP-DID-A600
DES	Ver. Specs, Procs, Criteria, & Results	SMAP-DID-A600
I&T	Discrepancy Reports	SMAP-DID-R004
I&T	Engineering Change Proposals	SMAP-DID-R005
I&T	Information System Post-Integration Tests	SMAP-DID-P000-SY
I&T	Integration Test Results	SMAP-DID-A200
I&T	Lessons Learned	SMAP-DID-R006
I&T	Maintenance Manual	SMAP-DID-P600-SY
I&T	Performance/Metric Reports	SMAP-DID-R007
I&T	Plan Updates	SMAP-DID-M00-SY
I&T	QA Specs, Procs, Criteria, & Results	SMAP-DID-A100
I&T	QEA Specs, Procs, Criteria, & Results	SMAP-DID-A300
I&T	Review Reports	SMAP-DID-R008
I&T	SA Specs, Procs, Criteria, & Results	SMAP-DID-A400
I&T	SPA Specs, Procs, Criteria, & Results	SMAP-DID-A500
I&T	Status Reports	SMAP-DID-R007
I&T	Training Materials	SMAP-DID-P000-SY

I&T	User's Guide	SMAP-DID-P500
I&T	Ver. Specs, Procs, Criteria, & Results	SMAP-DID-A600
I&T	Version Description Document	SMAP-DID-P400
IMPC	Acceptance Test Cases	SMAP-DID-A200
IMPC	Discrepancy Reports	SMAP-DID-R004
IMPC	Engineering Change Proposals	SMAP-DID-R005
IMPC	Integration Test Procs, Criteria, & Cases	SMAP-DID-A200
IMPC	Lessons Learned	SMAP-DID-R006
IMPC	Performance/Metrics Reports	SMAP-DID-R007
IMPC	Plan Updates	SMAP-DID-MOOO-SY
IMPC	QA Specs, Procs, Criteria, & Results	SMAP-DID-A100
IMPC	QEA Specs, Procs, Criteria, & Results	SMAP-DID-A300
IMPC	Review Reports	SMAP-DID-R008
IMPC	SA Specs, Procs, Criteria, & Results	SMAP-DID-A400
IMPC	SPA Specs, Procs, Criteria, & Results	SMAP-DID-A500
IMPC	Status Reports	SMAP-DID-R007
IMPC	Updates	SMAP-DID-P000-SY
IMPC	Val. Specs, Procs, Criteria, & Results	SMAP-DID-A600
IMPC	Ver. Specs, Procs, Criteria, & Results	SMAP-DID-A600
RQTS	Acceptance Test Specifications	SMAP-DID-A200
RQTS	Development Plan	SMAP-DID-M200-SY
RQTS	Discrepancy Reports	SMAP-DID-R004
RQTS	Engineering Change Proposals	SMAP-DID-R005
RQTS	Evolutionary Acquisition Plan	SMAP-DID-M400-SY
RQTS	Independent Val. & Ver. Plan	SMAP-DID-M936
RQTS	Lessons Learned	SMAP-DID-R006
RQTS	Performance/Metric Reports	SMAP-DID-R007
RQTS	Preliminary User's Guide	SMAP-DID-P500
RQTS	Procurement Package	SMAP-DID-
RQTS	QA Specs, Procs, Criteria, & Results	SMAP-DID-A100
RQTS	QEA Specs, Procs, Criteria, & Results	SMAP-DID-A300
RQTS	Requirements Specification	SMAP-DID-P200-SY
RQTS	Review Reports	SMAP-DID-R008
RQTS	SA Specs, Procs, Criteria, & Results	SMAP-DID-A400
RQTS	SPA Specs, Procs, Criteria, & Results	SMAP-DID-A500
RQTS	Status Reports	SMAP-DID-R007
RQTS	Sustaining Engineering & Operations Plan	SMAP-DID-M300
RQTS	Val. Specs, Procs, Criteria, & Results	SMAP-DID-A600
RQTS	Ver. Specs, Procs, Criteria, & Results	SMAP-DID-A600
SEO	Discrepancy Reports	SMAP-DID-R004
SEO	Engineering Change Proposals	SMAP-DID-R005
SEO	Performance/Metrics Reports	SMAP-DID-R007
SEO	Review Reports	SMAP-DID-R008
SEO	Status Reports	SMAP-DID-R007
SEO	Updates	SMAP-DID-A000-SY
SEO	Updates	SMAP-DID-M000-SY
SEO	Updates	SMAP-DID-P000-SY

Phase Abbreviations

A&D	Acceptance & Delivery
C&I	Concept & Initiation
DES	Design
I&T	Integration & Test
IMPC	Implementation Coordination
RQTS	Requirements
SEO	Sustaining Engineering & Operations

Artifact Abbreviations

SA	Safety Assurance
SPA	Security & Privacy Assurance
Val	Validation
Ver	Verification
QA	Quality Assurance
QEA	Quality Engineering Assurance
Procs	Procedures
Specs	Specifications

4.2 Framework Processes Definition

The following is a breakdown of the Demonstration Framework based partly on the SMAP Documents. Normally, the framework is in an electronic form and is much easier to view and explore. However, for inclusion in this document, an alternate structure was required. In the following section, the UOBs are listed linearly, although they are not always so in the actual process model. The descriptions of these UOBs should be read in conjunction with Volume II of this document, where the actual process model is given. The UOB descriptions in this section are listed in roughly the same order as they occur in the process descriptions in Volume II.

Each UOB is described briefly as to what process is represented by the UOB. For UOBs which are the leaf nodes of the model (i.e., UOBs which do not have a decomposition), a table is given which defines the user roles, artifacts, methods, and tools which are affected by that particular UOB. In the electronic form, a UOB which has a decomposition actually contains all of the user roles, artifacts, methods, and tools from the lower level UOBs within its decomposition. The framework processor can easily collect this information from the leaf nodes and roll up the sets to the higher level. This was not done in this report because the collections of objects becomes confusing at the highest levels. Therefore, only the leaf nodes have the role, artifact, method, and tool information. Furthermore, following each table is the completion criteria that will be used to determine when a UOB is considered finished.

1 Perform Information System Concept & Initiation

The software development process begins with the Concept & Initiation Phase. This phase's objectives are to determine the feasibility of the project and, if feasible, to set in place the assurance and management plans. Also, the initial ideas are flushed out and reviewed before proceeding to define the requirements for the system.

2 Develop Information System Requirements

The second major phase is the requirements definition phase. At this point the general concepts have been determined and what is needed is formal requirements for the system. In addition, decisions are made as to acquiring the system. If procurement is selected, then steps are taken to procure the system, as well as verification and validation, from independent sources. The development process is documented and mechanisms for controlling risk and management issues are placed in effect, which is exactly what the FPP is designed to help automate.

3 Design Information System

In this phase, the third major phase, the design of the information system is created. This is a crucial phase as most errors are introduced in the

design and not found until much later. For this reason, the design is reviewed thoroughly during the execution of this process.

4 Coordinate Information System Implementation

This process begins the actual implementation of the information system. The lower level subsystems and components of the whole system begin their lifecycles at this time. The pieces of the system are tested and brought together to form the finished system. The next stage is begun when the subcomponents are linked together.

5 Integrate & Test Information System Components

This stage of development begins the testing of the components as well as the testing of the system as a whole. Any problems with the coordination of the subsystems are investigated and resolved during this stage of development.

6 Deliver Information System

This stage prepares the system for delivery to the customer/sponsor. Final reviews are conducted and the system is installed at the site. The system now moves into the maintenance stage.

7 Maintain Information System

After the system is put into everyday use, this stage begins. Any changes and updates are performed during the Maintenance Phase. When the system has been modified, some or all of the previous stages must be repeated. In addition, this stage also has steps to determine if the system should be retired and an improved system built to replace it.

Decomposition: Perform Information System Concept & Initiation

1.1 Conduct Feasibility Study

The first step in system development is to conduct a feasibility study. The following table shows the agents involved.

Artifacts	User Roles	Tools	Methods
C&I Concept Document C&I Lessons Learned C&I Review Reports C&I Status Reports	System Analyst Customer/ Sponsor End User End User Manager	MS Word MS Draw MacDraw Pro MicroGraphix Designer AI0 AI1 AI3	IDEF0 IDEF1 IDEF3

Completion: Sign-off by Customer/Sponsor.

1.2 Compile User Requirements

To build a system that is to be effective, the user's needs and requirements must be recorded and analyzed.

Artifacts	User Roles	Tools	Methods
C&I Concept Document	System Analyst Customer/ Sponsor End User End User Manager	MS Word MS Draw MacDraw Pro MicroGraphix Designer AI0 AI1 AI3	Critical Success Factors Business Area Analysis IDEF0 IDEF1 IDEF3

Completion: Sign-off by System Analyst and Customer/Sponsor.

1.3 Define Operational Scenarios

The process of using the system must be defined so that the final software system will match the needs and solve the problems that it is intended to solve.

Artifacts	User Roles	Tools	Methods
C&I Concept Document	System Analyst Customer/ Sponsor End User End User Manager	MS Word MS Draw MacDraw Pro MicroGraphix Designer AI3	IDEF3

Completion: Sign-off by System Analyst and Customer/Sponsor.

1.4 Develop Management Strategy & Constraints

This process is where the basic management plans are defined, as well as any plans for procurement.

1.5 Define Assurance Strategy

Plans and procedures for assuring the quality of the system are developed and documented in this process.

1.6 Define System Concept & Scope

The first steps toward defining the system are conducted during the system concept and scope process. The table following lists the agents involved with this process.

Artifacts	User Roles	Tools	Methods
C&I Concept Document	System Analyst Customer/ Sponsor End User End User Manager	MS Word MS Draw MacDraw Pro MicroGraphix Designer AI0	IDEF0

Completion: Sign-off by System Analyst and Customer/Sponsor.

1.7 Document Results

The results of the concept and scope process are documented during this step for future reference.

Artifacts	User Roles	Tools	Methods
C&I Concept Document	System Analyst	MS Word MS Draw MacDraw Pro MicroGraphix Designer	

Completion: Artifact Concept Document is in state Completed.

Decomposition: Define Assurance Strategy

1.4.1 Define Assurance Process Requirements

Like the define development process requirements, this process defines the assurance processes that are to be used during the system development.

Artifacts	User Roles	Tools	Methods
C&I Quality Assurance	Configuration Control Administrator Quality Assurance Specialist Technical Administrator Customer/ Sponsor System Analyst	MS Word MS Draw MacDraw Pro MicroGraphix Designer AI3	IDEF3

Completion: Sign-off by Technical Administrator and Customer/Sponsor.

1.4.2 Define Assurance Plan

In this process, the Assurance Plan is defined.

Artifacts	User Roles	Tools	Methods
Assurance Specification	Configuration Control Administrator Quality Assurance Specialist Technical Administrator Customer/ Sponsor System Analyst	MS Word MS Draw MacDraw Pro MicroGraphix Designer AI0	IDEF0

Completion: Sign-off by Technical Administrator and Customer/Sponsor.

1.4.3 Document Assurance Plan

In this process, the Assurance Plan is documented.

Artifacts	User Roles	Tools	Methods
C&I Quality Assurance SMAP-DID-A100 Assurance Specification SMAP-DID-A000-SY	System Analyst	MS Word MS Draw MacDraw Pro MicroGraphix Designer	

Completion: Artifact Assurance Specification is in state Completed.

Decomposition: Develop Management Strategy & Constraints

1.5.1 Perform Tracking Activities

Throughout the life cycle of the system, the development activities are closely tracked to insure the quality of the final product.

1.5.2 Conduct Procurement Activities

If the system is to be procured or if the verification and validation is to be procured, then this process is performed.

Artifacts	User Roles	Tools	Methods
C&I Acquisition Plan	Technical Administrator	MS Word MS Draw MacDraw Pro MicroGraphix Designer Excel Lotus 123	

Completion: Sign-off by Technical Administrator.

1.5.3 Define Activities of the Acquirer

The purpose of any software system is to assist the users of the system in doing their jobs more efficiently. The activities of the enterprise must be properly modeled if their is any hope of the system solving the problems it is intended to solve.

Artifacts	User Roles	Tools	Methods
Management Plan	Technical Administrator System Analyst	MS Word MS Draw MacDraw Pro MicroGraphix Designer AI0 AI3 Auto SADT IDefine	IDEF0 IDEF3

Completion: Sign-off by Technical Administrator.

1.5.4 Define Structure of the Acquirer

To structure a system for a particular organization, the structure of the enterprise acquiring the software must be defined. This process defines and documents the structure of the sponsor for the system.

Artifacts	User Roles	Tools	Methods
Management Plan	Technical Administrator System Analyst	MS Word MS Draw MacDraw Pro MicroGraphix Designer AI1 AI1X	IDEF1 IDEF1X

Completion: Sign-off by Technical Administrator.

1.5.5 Define Development Process Requirements

The requirements for the actual development of the system are documented in the Management Plan during this process.

Artifacts	User Roles	Tools	Methods
Management Plan	Technical Administrator System Analyst	MS Word MS Draw MacDraw Pro MicroGraphix Designer AI3	IDEF3

Completion: Sign-off by Technical Administrator.

1.5.6 Define Management Plan

The management of the system development is outlined and recorded during this process.

Artifacts	User Roles	Tools	Methods
Management Plan	Technical Administrator System Analyst	MS Word MS Draw MacDraw Pro MicroGraphix Designer AI0 AI3 MS Project	IDEF0 IDEF3

Completion: Sign-off by Technical Administrator.

Decomposition: Perform Tracking Activities

1.5.1.1 Specify Reviews

Tracking Activities are managed by specifying and documenting how the reviews should be organized. This step handles the specification of the reviews.

Artifacts	User Roles	Tools	Methods
C&I Quality Assurance C&I Lessons Learned C&I Review Reports C&I Status Reports	Technical Administrator Configuration Control Administrator	MS Word MS Draw MacDraw Pro MicroGraphix Designer MS Project	

Completion: Sign-off by Technical Administrator.

1.5.1.2 Conduct Reviews

In this process, the reviews are actually carried out.

Artifacts	User Roles	Tools	Methods
C&I Quality Assurance C&I Lessons Learned C&I Review Reports C&I Status Reports	Technical Administrator System Analyst Customer/ Sponsor	MS Word MS Draw MacDraw Pro MicroGraphix Designer	

Completion: Sign-off by Technical Administrator and Customer/Sponsor.

1.5.1.3 Document Reviews

After a review has been conducted, the results are recorded in the appropriate artifacts.

Artifacts	User Roles	Tools	Methods
C&I Quality Assurance C&I Lessons Learned C&I Review Reports C&I Status Reports	Technical Administrator	MS Word MS Draw MacDraw Pro MicroGraphix Designer	

Completion: Artifact Quality Assurance is in state Completed.

Decomposition: Develop Information System Requirements

2.1 Establish Risk & Management Control Mechanisms

This process is conducted to establish mechanisms which will insure the quality of the final system throughout the development process.

2.2 Procure Development of System

If the system or verification and validation are to be procured, then this process is performed. Otherwise, it is skipped.

2.3 Define Development Processes

All activities performed by the provider of the information system are defined and documented in this process.

2.4 Perform Requirements Analysis

The processes to support the requirements definition are done in this process.

2.5 Decide Whether to Proceed

The decision to continue to the next phase or to repeat steps in this phase is made at this point.

Decomposition: Establish Risk & Management Control Mechanisms

2.1.1 Collect & Document Metric Information

In this process, the metric information that is used to track the performance of the system is collected and documented.

Artifacts	User Roles	Tools	Methods
RQTS Performance/ Metric Reports	System Analyst Verification Tester Validation Tester Field Tester Quality Assurance Tester	MS Word MacDraw Pro MicroGraphix Designer Test Tools	

Completion: Artifact Performance/Metric Reports is in state Completed.

2.1.2 Develop & Document Acceptance Test Specification

The specifications for accepting or rejecting the system are defined and recorded.

Artifacts	User Roles	Tools	Methods
RQTS Acceptance Test Specifications	Quality Assurance Specialist	MS Word MacDraw Pro MicroGraphix Designer	

Completion: Artifact Acceptance Test Specifications is in state Completed.

2.1.3 Review Assurance Specifications

After the assurance specifications are developed, they are reviewed in this process to insure the quality of the final system.

Artifacts	User Roles	Tools	Methods
Assurance Specification RQTS Review Reports	Technical Analyst Quality Assurance Tester Quality Assurance Specialist	MS Word MacDraw Pro MicroGraphix Designer	

Completion: Sign-off by Technical Analyst.

2.1.4 Prepare Discrepancy & Deficiency Reports

Any discrepancies or deficiencies found during the review are documented in this process.

Artifacts	User Roles	Tools	Methods
RQTS Discrepancy Reports	System Analyst Technical Analyst	MS Word MacDraw Pro MicroGraphix Designer	

Completion: Sign-off by Technical Analyst.

2.1.5 Document Reviews

In the Document Reviews process, documents are examined and evaluations are recorded in the review reports.

Artifacts	User Roles	Tools	Methods
RQTS Review Reports	Technical Analyst Quality Assurance Tester Quality Assurance Specialist System Analyst Verification Tester Validation Tester Field Tester Quality Assurance Tester	MS Word MacDraw Pro MicroGraphix Designer	

Completion: Artifact Review Reports is in state Completed.

2.1.6 Conduct Verification Activities

In this process, V&V activities are conducted to insure the quality of the final product.

Decomposition: Conduct Verification Activities

2.1.6.1 Define Validation Specifications

The specifications for validating the information system are defined during this process.

Artifacts	User Roles	Tools	Methods
RQTS Val. Specs, Procs, Criteria, & Results Validation Specifications, Procedures, Criteria, & Results	Quality Assurance Specialist	MS Word MacDraw Pro MicroGraphix Designer	

Completion: Sign-off by Quality Assurance Specialist.

2.1.6.2 Procure Independent V&V

If independent V&V is requested, this process is performed to procure it.

2.1.6.3 Develop Verification Activities

The specifications for verifying the information system are produced in this process.

Artifacts	User Roles	Tools	Methods
RQTS Ver. Specs, Procs, Criteria, & Results Verification Specifications, Procedures, Criteria, and Results	Quality Assurance Specialist	MS Word MacDraw Pro MicroGraphix Designer AI0	Gantt Charts IDEF0

Completion: Sign-off by Quality Assurance Specialist.

2.1.6.4 Document Expected V&V Results

In this process, the expected results from the V&V activities are recorded for comparison with the actual results later in the development process.

Artifacts	User Roles	Tools	Methods
RQTS Val. Specs, Procs, Criteria, & Results Validation Specifications, Procedures, Criteria, & Results RQTS Ver. Specs, Procs, Criteria, & Results Verification Specifications, Procedures, Criteria, and Results	Quality Assurance Tester Quality Assurance Specialist Verification Tester Validation Tester	MS Word MacDraw Pro MicroGraphix Designer Test Tools	

Completion: Artifacts are in state Completed.

2.1.6.5 Assign Resolution Responsibility

Assignments are given to the individuals who are responsible for the resolution of discrepancies and deficiencies.

Artifacts	User Roles	Tools	Methods
RQTS Engineering Change Proposals	Project Manager	MS Word MacDraw Pro MicroGraphix Designer	

Completion: Sign-off by Project Manager.

Decomposition: Procure Independent V&V

2.1.6.2.1 Define V&V Approach

The plans for verification and validation of the system are outlined in this process.

Artifacts	User Roles	Tools	Methods
RQTS Val. Specs, Procs, Criteria, & Results Validation Specifications, Procedures, Criteria, & Results RQTS Ver. Specs, Procs, Criteria, & Results Verification Specifications, Procedures, Criteria, and Results	Quality Assurance Specialist	MS Word MacDraw Pro MicroGraphix Designer AI0	Gantt Charts IDEF0

Completion: Sign-off by Quality Assurance Specialist.

2.1.6.2.2 Define V&V Methods

If new methods are needed for the V&V activities, they are defined in this activity.

Artifacts	User Roles	Tools	Methods
RQTS Val. Specs, Procs, Criteria, & Results Validation Specifications, Procedures, Criteria, & Results RQTS Ver. Specs, Procs, Criteria, & Results Verification Specifications, Procedures, Criteria, and Results	Quality Assurance Specialist	MS Word MacDraw Pro MicroGraphix Designer AI0	IDEF0

Completion: Sign-off by Quality Assurance Specialist.

2.1.6.2.3 Document in V&V Plan

V&V approaches and methods are documented in the V&V plan at this point in the development.

Artifacts	User Roles	Tools	Methods
RQTS Val. Specs, Procs, Criteria, & Results Validation Specifications, Procedures, Criteria, & Results RQTS Ver. Specs, Procs, Criteria, & Results Verification Specifications, Procedures, Criteria, and Results	Quality Assurance Specialist	MS Word MacDraw Pro MicroGraphix Designer	

Completion: Artifacts are in state Completed.

Decomposition: Procure Development of System

2.2.1 Prepare RFP

The RFP is prepared in this process.

Artifacts	User Roles	Tools	Methods
RQTS Procurement Package	Customer/ Sponsor Project Manager Project Leader	MS Word MacDraw Pro MicroGraphix Designer	

Completion: Artifact Procurement Package is in state Completed.

2.2.2 Prepare SOW

If the system is to be procured from external sources, then the SOW is prepared at this point.

Artifacts	User Roles	Tools	Methods
RQTS Procurement Package	Customer/ Sponsor Project Manager Project Leader	MS Word MacDraw Pro MicroGraphix Designer	

Completion: Artifact Procurement Package is in state InProgress.

2.2.3 Evaluate Source

The sources for the procurement of the system are evaluated to determine the best source.

Artifacts	User Roles	Tools	Methods
RQTS Review Reports	Customer/ Sponsor Project Manager Project Leader Technical Analyst System Analyst	MS Word MacDraw Pro MicroGraphix Designer Excel Lotus 123	

Completion: Sign-off by Technical Analyst and System Analyst.

2.2.4 Select Source

The source for the development is selected in this process.

Artifacts	User Roles	Tools	Methods
RQTS Procurement Package	Project Manager	MS Word MacDraw Pro MicroGraphix Designer	

Completion: Sign-off by Project Manager.

2.2.5 Negotiate Contract

The contract is negotiated and development is started in this process.

Artifacts	User Roles	Tools	Methods
RQTS Procurement Package	Project Administrator	MS Word MacDraw Pro MicroGraphix Designer Excel Lotus 123	Cost Analysis Statistical Analysis

Completion: Sign-off by Project Administrator.

Decomposition: Define Development Processes

2.3.1 Define New Procedures & Standards

Any new procedures or standards that are necessary for development are determined at this point.

2.3.2 Define Sustaining Engineering Processes

The processes for maintaining the information system are defined and documented in this process.

Artifacts	User Roles	Tools	Methods
RQTS Sustaining Engineering & Operations Plan	Project Manager System Analyst Technical Administrator	MS Word MS Draw MacDraw Pro MicroGraphix Designer AI0 AI3	IDEF0 IDEF3

Completion: Sign-off by Project Manager.

2.3.3 Identify Approach

The first process which must be done in defining the development process is to determine the approach to be taken.

Artifacts	User Roles	Tools	Methods
Assurance Specification Management Control & Status Reports Management Plan	Project Manager Project Leader Group Leader Technical Support Analyst System Analyst	MS Word MacDraw Pro MicroGraphix Designer	

Completion: Sign-off by Project Manager.

2.3.4 Define Methods for Activities

In this process, the methods to be used are documented.

Artifacts	User Roles	Tools	Methods
Management Plan	Configuration Control Administrator	MS Word MacDraw Pro MicroGraphix Designer AI0 AI3	

Completion: Sign-off by Configuration Control Administrator.

2.3.5 NOP

Due to the limitations of the IDEF3 tool used to create this framework, occasionally a NOP UOB is introduced into the model to indicate a branch in which nothing happens.

2.3.6 Define Incremental Development Processes

If incremental development is specified in the Management Plan, this process is conducted.

2.3.7 Review Management Plan

At this time, the management plans are reviewed and evaluated.

Artifacts	User Roles	Tools	Methods
Management Plan	Customer/ Sponsor End User Manager	MS Word MacDraw Pro MicroGraphix Designer	

Completion: Sign-off by Project Manager.

Decomposition: Define New Procedures & Standards

2.3.1.1 Develop Standards

If new standards are required to perform the development of the system, those standards are defined in this process.

Artifacts	User Roles	Tools	Methods
RQTS Requirements Specification	System Analyst System Designer Subsystem Designer Development Coder Technical Administrator	MS Word MacDraw Pro MicroGraphix Designer	

Completion: Sign-off by Technical Administrator.

2.3.1.2 Develop Procedures

If new procedures are required for the implementation of the system, they are developed in this process.

Artifacts	User Roles	Tools	Methods
RQTS Requirements Specification	System Analyst System Designer Subsystem Designer Development Coder Technical Administrator	MS Word MacDraw Pro MicroGraphix Designer AI0 AI3	IDEF0 IDEF3

Completion: Sign-off by Technical Administrator.

2.3.1.3 Document New Procedures and Standards

This process is conducted after the new procedures or standards are defined.

Artifacts	User Roles	Tools	Methods
RQTS QA Specs, Procs, Criteria, & Results RQTS QEA Specs, Procs, Criteria, & Results RQTS SA Specs, Procs, Criteria, & Results Safety Assurance Specifications, Procedures, Criteria, and Results RQTS SPA Specs, Procs, Criteria, & Results Security and Privacy Assurance Specifications, Procedures, Criteria, and Results	System Analyst System Designer Subsystem Designer Development Coder Project Administrator Customer/ Sponsor Project Manager	MS Word MacDraw Pro MicroGraphix Designer	

Completion: Artifacts are in state Completed.

Decomposition: Define Incremental Development Processes

2.3.6.1 Define Specific Increments

This process is only conducted if the system is to be an incremental delivery system. At this time the specific increments are delineated in the Evolutionary Acquisition Plan.

Artifacts	User Roles	Tools	Methods
RQTS Evolutionary Acquisition Plan	Project Manager Technical Administrator System Analyst	MS Word MacDraw Pro MicroGraphix Designer AI0 AI3	IDEF0 IDEF3

Completion: Sign-off by Customer/Sponsor.

2.3.6.2 Prioritize Approach

The development of the various increments defined in the previous step are prioritized in this process.

Artifacts	User Roles	Tools	Methods
RQTS Evolutionary Acquisition Plan	Customer/ Sponsor Project Manager	MS Word MacDraw Pro MicroGraphix Designer Excel Lotus 123	Gantt Charts Business Systems Planning

Completion: Sign-off by Customer/Sponsor.

2.3.6.3 Document Incremental Processes

The plans for developing the information system in incremental steps are documented in the Evolutionary Acquisition Plan in this activity.

Artifacts	User Roles	Tools	Methods
RQTS Evolutionary Acquisition Plan	Project Manager Technical Administrator	MS Word MacDraw Pro MicroGraphix Designer	Gantt Charts

Completion: Artifact Evolutionary Acquisition Plan is in state Completed.

Decomposition: Perform Requirements Analysis

2.4.1 Develop User Scenarios

Each possible user scenario is recorded and evaluated in this process.

Artifacts	User Roles	Tools	Methods
RQTS Requirements Specification	System Analyst End User End User Manager System Designer	MS Word MacDraw Pro MicroGraphix Designer AI3 Knowledgeware SymMod	IDEF3

Completion: Sign-off by System Analyst.

2.4.2 Investigate User Needs

In this process, the user's needs are evaluated to specify the requirements that are to be met in the final implementation.

Artifacts	User Roles	Tools	Methods
RQTS Requirements Specification	System Analyst End User End User Manager	MS Word MacDraw Pro MicroGraphix Designer AI0 AI1 AI3	IDEF0 IDEF1 IDEF3

Completion: Sign-off by System Analyst.

2.4.3 Prototype System

As a way of providing a proof of concept, a prototype of the system is created in this process.

Artifacts	User Roles	Tools	Methods
RQTS Discrepancy Reports RQTS Engineering Change Proposals	System Designer Subsystem Designer Development Coder	Emacs C++ Motif dbx X Windows ObjectVision Knowledgeware Validation Prototyper AI1X	Structured Programming

Completion: Sign-off by System Designer.

2.4.4 Evaluate External Interface

After the external interfaces are defined, they are evaluated to insure that the end user will be satisfied.

Artifacts	User Roles	Tools	Methods
RQTS Requirements Specification	System Designer End User End User Manager	MS Word MacDraw Pro MicroGraphix Designer ObjectVision	

Completion: Sign-off by System Designer and End User.

2.4.5 Define External Interface

This process is performed to define the external interfaces to the information system. A process that is as important as the design of the internal components of the system.

Artifacts	User Roles	Tools	Methods
RQTS Requirements Specification	System Designer End User	MS Word MacDraw Pro MicroGraphix Designer AI3	IDEF3 IDEF8

Completion: Sign-off by System Designer.

2.4.6 Analyze Requirements

The requirements are examined for correctness in this activity.

Artifacts	User Roles	Tools	Methods
RQTS Requirements Specification	Project Manager Project Leader Group Leader	MS Word MacDraw Pro MicroGraphix Designer Excel Lotus 123	

Completion: Sign-off by Project Manager.

2.4.7 Synthesize Requirements

In the process, the actual requirements for the information system are defined.

Artifacts	User Roles	Tools	Methods
RQTS Requirements Specification	Customer/ Sponsor Project Manager Project Leader System Analyst System Designer	MS Word MacDraw Pro MicroGraphix Designer AI0 AI1 AI1X AI3	IDEF0 IDEF1 IDEF1X IDEF3

Completion: Sign-off by Customer/Sponsor.

2.4.8 Partition Requirements into Increments

If the system is to be delivered in incremental steps, then the requirements are partitioned in to the various increments during this step.

Artifacts	User Roles	Tools	Methods
RQTS Status Reports RQTS Review Reports RQTS Evolutionary Acquisition Plan RQTS Lessons Learned	Project Manager Project Leader Group Leader	MS Word MacDraw Pro MicroGraphix Designer Excel Lotus 123	Gantt Charts

Completion: Sign-off by Project Manager.

2.2.9 Review Requirements Changes

After the requirements are examined, any changes must be reviewed before the modifications are made to the requirements documents.

Artifacts	User Roles	Tools	Methods
RQTS Status Reports RQTS Review Reports RQTS Lessons Learned	Project Manager Project Leader Group Leader	MS Word MacDraw Pro MicroGraphix Designer	

Completion: Sign-off by Project Manager.

Decomposition: Decide Whether to Proceed

2.5.1 Review Requirements of Product Specification

After the requirements for the information system have been completed, they are reviewed in this step of the development.

Artifacts	User Roles	Tools	Methods
RQTS Requirements Specification	Customer/ Sponsor Project Manager	MS Word MacDraw Pro MicroGraphix Designer	

Completion: Sign-off by Customer/Sponsor and Project Manager.

2.5.2 Evaluate Requirements Review & Status Reports

All review and status reports are evaluated to prepare for moving to the next stage in the development lifecycle.

Artifacts	User Roles	Tools	Methods
RQTS Status Reports RQTS Review Reports	Customer/ Sponsor Project Manager	MS Word MacDraw Pro MicroGraphix Designer	

Completion: Sign-off by Customer/Sponsor and Project Manager.

2.5.3 Document Results

The results of all requirement activities are documented at this time.

Artifacts	User Roles	Tools	Methods
RQTS Discrepancy Reports RQTS Engineering Change Proposals RQTS Lessons Learned RQTS Performance/ Metric Reports	Project Manager Project Leader Quality Assurance Specialist	MS Word MacDraw Pro MicroGraphix Designer	

Completion: Artifacts are in state Completed.

Decomposition: Design Information System

3.1 Manage Design Phase

During this step of the design phase all management activities are carried out.

3.2 Conduct Engineering Design

The actual design steps are performed during this process of the development.

3.3 Conduct Risk & Management Control Activities

While the other activities of the design are being performed, this process makes certain that the development is proceeding without introducing errors into the system.

3.4 Decide Whether To Proceed

After the design has been created, reviews are conducted in this step. Acceptance or rejection of the design is made after the products of this phase are evaluated. If the design is acceptable, the development proceeds to the next stage. If not, the design steps are repeated until an acceptable design is reached.

Decomposition: Manage Design Phase

3.1.1 Evaluate Metric Information

In this process, the metrics for measuring the status of the information system is evaluated. This information is used for tracking and modifying the resource estimation.

Artifacts	User Roles	Tools	Methods
DES Performance/ Metrics Reports	Project Leader	MS Word MacDraw Pro MicroGraphix Designer Excel Lotus 123	Cost Analysis Statistical Analysis

Completion: Sign-off by Project Leader.

3.1.2 Re-evaluate Risk Areas

Risk areas are re-evaluated as directed by the management plan, to determine what planning modifications are needed.

Artifacts	User Roles	Tools	Methods
DES Lessons Learned	Customer/ Sponsor Project Manager	MS Word MacDraw Pro MicroGraphix Designer Excel Lotus 123	Cost Analysis Statistical Analysis

Completion: Sign-off by Project Manager.

3.1.3 Modify & Update Plans

Modifications and updates to the plans are made as suggested by the previous process.

Artifacts	User Roles	Tools	Methods
DES Plan Updates	Project Manager	MS Word MacDraw Pro MicroGraphix Designer	

Completion: Artifact Plan Updates is in state Completed.

3.1.4 Conduct Procurement & Selection Process

This process is conducted only if the entire system is to be procured.

Decomposition: Conduct Procurement & Selection Process

3.1.4.1 Initiate Identification Process

The identification of suitable off-the-shelf information systems is performed in this step.

Artifacts	User Roles	Tools	Methods
Management Plan	Project Administrator	MS Word MacDraw Pro MicroGraphix Designer Excel Lotus 123	Decision Tables

Completion: Sign-off by Project Administrator.

3.1.4.2 Initiate Evaluation Process

An evaluation of the suitable information systems is conducted.

Artifacts	User Roles	Tools	Methods
Management Plan	Project Administrator System Analyst	MS Word MacDraw Pro MicroGraphix Designer Excel Lotus 123	Decision Tables

Completion: Sign-off by Project Administrator.

3.1.4.3 Initiate Selection Process

The information system is selected in this process.

Artifacts	User Roles	Tools	Methods
Management Plan	Project Administrator Customer/ Sponsor Project Manager	MS Word MS Draw MacDraw Pro MicroGraphix Designer	

Completion: Sign-off by Project Administrator.

Decomposition: Conduct Engineering Design

3.2.1 Define Interface

The interface to the information system is defined at this time.

Artifacts	User Roles	Tools	Methods
DES Design Specification	System Designer Subsystem Designer	MS Word MS Draw MacDraw Pro MicroGraphix Designer AI3	IDEF8

Completion: Sign-off by System Designer.

3.2.2 Define System Architecture

In this process, the entire system architecture is developed and recorded.

3.2.3 Allocate Requirements To Subsystems

The individual requirements for the system are assigned to various subsystems in this process.

Artifacts	User Roles	Tools	Methods
DES Design Specification	Project Leader System Designer Subsystem Designer	MS Word MacDraw Pro MicroGraphix Designer Excel Lotus 123	

Completion: Sign-off by Project Leader.

3.2.4 Conduct V&V Activities

The verification and validation activities that can be performed at this point in the development are conducted in this process.

Decomposition: Allocate Requirements To Subsystems

3.2.2.1 Develop Requirements Traceability

Requirements traceability is developed to guarantee an implementation that is consistent with the original requirements.

Artifacts	User Roles	Tools	Methods
DES Plan Updates	Quality Assurance Tester Quality Assurance Specialist	MS Word MacDraw Pro MicroGraphix Designer Excel Lotus 123	

Completion: Sign-off by Quality Assurance Specialist.

3.2.2.2 Document Requirements Traceability

The previous step's information is documented in this process.

Artifacts	User Roles	Tools	Methods
DES Plan Updates	Quality Assurance Tester Quality Assurance Specialist	MS Word MacDraw Pro MicroGraphix Designer	

Completion: Artifact Plan Updates is in state InProgress.

3.2.2.3 Partition Design into Increments

If an incremental development approach is used, then the design is partitioned into the various increments in this process.

Artifacts	User Roles	Tools	Methods
DES Design Specification	System Designer	MS Word MacDraw Pro MicroGraphix Designer	Structured Analysis/Structured Design Jackson System Development DSSD(Nassi-Shneiderman)

Completion: Sign-off by System Designer.

3.2.2.4 Initiate Integration Test Procedures

The integration test specification is detailed at this time.

Artifacts	User Roles	Tools	Methods
DES Integration Test Specs, Procs, & Criteria	Quality Assurance Tester	MS Word MacDraw Pro MicroGraphix Designer AI0 AI3	IDEF0 IDEF3

Completion: Sign-off by Quality Assurance Tester.

3.2.2.5 Document Integration Tests

The integration test specifications developed in the previous step are now documented in the integration test specification section of the assurance plan.

Artifacts	User Roles	Tools	Methods
DES Integration Test Specs, Procs, & Criteria	Quality Assurance Tester	MS Word MacDraw Pro MicroGraphix Designer	

Completion: Artifact Integration Test Specs, Procs, & Criteria is in state Completed.

Decomposition: Conduct V&V Activities

3.2.4.1 Conduct Verification of Design

The design is verified against the requirements in this procedure.

Artifacts	User Roles	Tools	Methods
DES Ver. Specs, Procs, Criteria, & Results	System Designer Subsystem Designer	MS Word MacDraw Pro MicroGraphix Designer	

Completion: Sign-off by System Designer.

3.2.4.2 Document Verification of Design Results

The results of the design verification are documented in this activity.

Artifacts	User Roles	Tools	Methods
DES Ver. Specs, Procs, Criteria, & Results	System Designer Subsystem Designer	MS Word MacDraw Pro MicroGraphix Designer	

Completion: Artifact Ver. Specs, Procs, Criteria, & Results is in state InProgress.

3.2.4.3 Develop Validation Procedures

Validation procedures are defined in this step of the V&V activities process.

Artifacts	User Roles	Tools	Methods
DES Val. Specs, Procs, Criteria, & Results	Quality Assurance Tester Quality Assurance Specialist	MS Word MacDraw Pro MicroGraphix Designer AI0 AI3	IDEF0 IDEF3

Completion: Sign-off by System Designer.

3.2.4.4 Develop Validation Criteria

Validation criteria are defined in this step of the V&V activities process.

Artifacts	User Roles	Tools	Methods
DES Val. Specs, Procs, Criteria, & Results	System Designer Subsystem Designer	MS Word MacDraw Pro MicroGraphix Designer	

Completion: Sign-off by System Designer.

3.2.4.5 Document V&V Reports

Finally, all of the V&V information that has been produced is documented in the assurance plan.

Artifacts	User Roles	Tools	Methods
DES Val. Specs, Procs, Criteria, & Results DES Ver. Specs, Procs, Criteria, & Results	Quality Assurance Tester Quality Assurance Specialist System Designer Subsystem Designer	MS Word MacDraw Pro MicroGraphix Designer	

Completion: Artifacts are in state Completed.

Decomposition: Conduct Risk & Management Control Activities

3.3.1 Develop & Document Acceptance Test Criteria

Acceptance test criteria are also developed and documented in this process.

Artifacts	User Roles	Tools	Methods
DES QA Specs, Procs, Criteria, & Results DES QEA Specs, Procs, Criteria, & Results	Quality Assurance Tester Quality Assurance Specialist	MS Word MacDraw Pro MicroGraphix Designer	

Completion: Artifacts are in state Completed.

3.3.2 Develop & Document Acceptance Test Procedures

The acceptance test procedures continue with the development of the acceptance test section of the assurance specification.

Artifacts	User Roles	Tools	Methods
DES Acceptance Test Procedures & Criteria	Quality Assurance Tester Quality Assurance Specialist	MS Word MacDraw Pro MicroGraphix Designer	

Completion: Artifact Acceptance Test Procedures & Criteria is in state Completed.

3.3.3 Collect & Document Metric Information

Metric information is collected and documented for the tracking and evaluation of the information system .

Artifacts	User Roles	Tools	Methods
DES Performance/ Metrics Reports	System Analyst System Designer Subsystem Designer	MS Word MacDraw Pro MicroGraphix Designer Excel Lotus 123	Cost Analysis Statistical Analysis

Completion: Artifact Performance/Metrics Reports is in state Completed.

3.2.4 Assign Resolution Responsibility

Any discrepancies or deficiencies are assigned to individuals for resolution during this step.

Artifacts	User Roles	Tools	Methods
DES Discrepancy Reports DES Engineering Change Proposals	Project Leader	MS Word MacDraw Pro MicroGraphix Designer	

Completion: Sign-off by Project Leader.

Decomposition: Decide Whether To Proceed

3.4.1 Conduct Reviews

Reviews of the design documents is conducted at this time.

Artifacts	User Roles	Tools	Methods
DES Review Reports	System Analyst System Designer Customer/ Sponsor Project Manager Project Leader	MS Word MacDraw Pro MicroGraphix Designer	

Completion: Sign-off by Customer/Sponsor and Project Manager.

3.4.2 Evaluate Status Reports

All status reports from the design phase are evaluated to assist in determining whether to proceed.

Artifacts	User Roles	Tools	Methods
DES Status Reports	System Analyst System Designer Customer/ Sponsor Project Manager Project Leader	MS Word MacDraw Pro MicroGraphix Designer	

Completion: Sign-off by Customer/Sponsor and Project Manager.

3.4.3 Evaluate Reviews

All reviews of the system's design are evaluated to assist in determining whether to start the next phase of development or to repeat some or all of the steps of the design.

Artifacts	User Roles	Tools	Methods
DES Review Reports	System Analyst System Designer Customer/ Sponsor Project Manager Project Leader	MS Word MacDraw Pro MicroGraphix Designer	

Completion: Sign-off by Customer/Sponsor and Project Manager.

3.4.4 Complete Design Review

The final design review is conducted before accepting or rejecting the design.

Artifacts	User Roles	Tools	Methods
DES Design Specification DES Discrepancy Reports DES Engineering Change Proposals DES Lessons Learned DES Plan Updates DES Review Reports	System Analyst System Designer Customer/ Sponsor Project Manager Project Leader	MS Word MacDraw Pro MicroGraphix Designer	

Completion: Sign-off by Customer/Sponsor and Project Manager.

Decomposition: Coordinate Information System Implementation

4.2 Manage Coordination Phase

In this process, all of the management planning activities are conducted for the coordination of the implementation.

4.1 Conduct Risk & Management Control Activities

Throughout the implementation phase, risk and management control processes are performed to insure the quality and make certain the development is proceeding according to the plans.

4.3 Prepare for Integration Test Activities

During this activity, plans for the testing of the integrated system are developed and reviewed.

4.4 Review Design of Subsystems and Components

The lower level components and subsystems are reviewed at this point to insure that they will perform as they should.

4.5 Initiate Subsystem Lifecycle

This process is actually a place holder for the Software Component Lifecycle Model. When the Information System development reaches this point, the Software Component Lifecycle begins for each major component of the Information System.

4.6 Coordinate Interaction & Implementation of Components

After the subsystems are created and tested thoroughly as individual components, they are brought together in this process to test for incompatibilities between the components.

4.7 Decide Whether To Proceed

As with the previous stages, this process is conducted to determine the status of the current implementation and to make the decision to proceed to the next stage or repeat some or all of the step in this stage.

Decomposition: Conduct Risk & Management Control Activities

4.1.1 Collect Metric Information

Metric information is collected for tracking and evaluating the information system.

Artifacts	User Roles	Tools	Methods
IMPC Performance/ Metrics Reports	System Designer	MS Word MS Draw MacDraw Pro MicroGraphix Designer	

Completion: Sign-off by System Designer.

4.1.2 Document Metric Information

The metric information collected in the previous step is documented at this time.

Artifacts	User Roles	Tools	Methods
IMPC Performance/ Metrics Reports	System Designer	MS Word MS Draw MacDraw Pro MicroGraphix Designer	

Completion: Artifact Performance/Metrics Reports is in state Completed.

4.1.3 Assign Resolution Responsibility

Any discrepancies or deficiencies are assigned to individuals for resolution during this step.

Artifacts	User Roles	Tools	Methods
IMPC Discrepancy Reports IMPC Engineering Change Proposals	Project Leader	MS Word MS Draw MacDraw Pro MicroGraphix Designer	

Completion: Sign-off by Project Leader.

Decomposition: Manage Coordination Phase

4.2.1 Evaluate Metric Information

In this process, the metrics for measuring the status of the information system is evaluated. This information is used for tracking and modifying the resource estimation.

Artifacts	User Roles	Tools	Methods
IMPC Performance/ Metrics Reports	Customer/ Sponsor Project Manager	MS Word MS Draw MacDraw Pro MicroGraphix Designer	

Completion: Sign-off by Project Manager.

4.2.2 Re-evaluate Risk Areas

Risk areas are re-evaluated as directed by the management plan to determine what planning modifications are needed.

Artifacts	User Roles	Tools	Methods
IMPC Lessons Learned	Customer/ Sponsor Project Manager	MS Word MS Draw MacDraw Pro MicroGraphix Designer	

Completion: Sign-off by Project Manager.

4.2.3 Modify & Update Plans

Modifications and updates to the plans are made as suggested by the previous process.

Artifacts	User Roles	Tools	Methods
Management Plan	Customer/ Sponsor Project Manager	MS Word MS Draw MacDraw Pro MicroGraphix Designer	

Completion: Artifact Management Plan is in state Completed.

4.2.4 Conduct Final Procurement & Selection

If the system is to be acquired entirely off-the-shelf, then the final procurement and selection is performed at this time.

Artifacts	User Roles	Tools	Methods
Management Plan	Project Administrator	MS Word MS Draw MacDraw Pro MicroGraphix Designer	

Completion: Sign-off by Project Administrator.

Decomposition: Prepare for Integration Test Activities

4.3.1 Develop Test Cases

Test cases are defined at this point.

Artifacts	User Roles	Tools	Methods
IMPC Acceptance Test Cases	Quality Assurance Tester Quality Assurance Specialist	MS Word MS Draw MacDraw Pro MicroGraphix Designer Test Tools	

Completion: Sign-off by Quality Assurance Specialist.

4.3.2 Develop Test Criteria

Criteria for the test results are developed in this step.

Artifacts	User Roles	Tools	Methods
IMPC QA Specs, Procs, Criteria, & Results IMPC QEA Specs, Procs, Criteria, & Results	Quality Assurance Tester Quality Assurance Specialist	MS Word MS Draw MacDraw Pro MicroGraphix Designer Test Tools	

Completion: Sign-off by Quality Assurance Specialist.

4.3.3 Develop Test Procedures

In this process, test procedures are defined.

Artifacts	User Roles	Tools	Methods
IMPC QA Specs, Procs, Criteria, & Results IMPC QEA Specs, Procs, Criteria, & Results	Quality Assurance Tester Quality Assurance Specialist	MS Word MS Draw MacDraw Pro MicroGraphix Designer AI0 AI3	IDEF0 IDEF3

Completion: Sign-off by Quality Assurance Specialist.

4.3.4 Document Integration Test Procedures, Criteria, & Cases

The results of the previous activities are documented in the assurance plan during this process.

Artifacts	User Roles	Tools	Methods
IMPC Integrat. Test Procs, Criteria, & Cases	Quality Assurance Tester Quality Assurance Specialist	MS Word MS Draw MacDraw Pro MicroGraphix Designer	

Completion: Artifact Integrat. Test Procs, Criteria, & Cases is in state Completed.

Decomposition: Review Design of Subsystems and Components

4.4.1 Review Lower-level Components

When the lower-level components are completed, they are reviewed in this process.

Artifacts	User Roles	Tools	Methods
IMPC Review Reports	System Designer Subsystem Designer	MS Word MS Draw MacDraw Pro MicroGraphix Designer	

Completion: Sign-off by System Designer.

4.4.2 Conduct Verification of Lower-level Systems

Verification of lower-level components is conducted at this point in the development of the information system.

Artifacts	User Roles	Tools	Methods
IMPC Ver. Specs, Procs, Criteria, & Results	Quality Assurance Tester	MS Word MS Draw MacDraw Pro MicroGraphix Designer Test Tools	

Completion: Sign-off by Quality Assurance Tester.

4.4.3 Document Review Findings

The results of the reviews of the lower-level components are documented in this step.

Artifacts	User Roles	Tools	Methods
IMPC Review Reports	System Designer Quality Assurance Tester	MS Word MS Draw MacDraw Pro MicroGraphix Designer	

Completion: Artifact Review Reports is in state Completed.

4.4.4 Prepare for Validation

Preparations are made for the validation of the system are completed in this step.

Artifacts	User Roles	Tools	Methods
IMPC Val. Specs, Procs, Criteria, & Results	Validation Tester	MS Word MS Draw MacDraw Pro MicroGraphix Designer	

Completion: Sign-off by Validation Tester.

Decomposition: Coordinate Interaction & Implementation of Components

4.6.1 Review Designs for Subsystems & Components

The designs for the subsystems are reviewed at this time.

Artifacts	User Roles	Tools	Methods
IMPC Review Reports	System Designer	MS Word MS Draw MacDraw Pro MicroGraphix Designer	

Completion: Sign-off by System Designer.

4.6.2 Review Requirements for Subsystems & Components

The requirements of the subsystems are reviewed at this time.

Artifacts	User Roles	Tools	Methods
IMPC Review Reports SMAP-DID-R008	System Analyst	MS Word MS Draw MacDraw Pro MicroGraphix Designer	

Completion: Sign-off by System Analyst.

4.6.3 Review Interface Specifications

The interface specifications for the component systems are reviewed to insure that they operate in conjunction with each other as specified.

Artifacts	User Roles	Tools	Methods
IMPC Review Reports	Integration Coder	MS Word MS Draw MacDraw Pro MicroGraphix Designer	

Completion: Sign-off by Integration Coder.

4.6.4 Document Review Findings

All review findings are recorded in the appropriate sections of the documentation for the information system.

Artifacts	User Roles	Tools	Methods
Management Plan Product Specification Document Assurance Specification Management Control & Status Reports	Project Manager Project Leader	MS Word MS Draw MacDraw Pro MicroGraphix Designer	

Completion: Artifacts are in state Completed.

Decomposition: Decide Whether To Proceed

4.7.1 Conduct Reviews

Reviews of the implementation documents are conducted at this time.

Artifacts	User Roles	Tools	Methods
IMPC Review Reports IMPC Discrepancy Reports IMPC Lessons Learned IMPC Status Reports	Customer/ Sponsor Project Manager Project Leader	MS Word MS Draw MacDraw Pro MicroGraphix Designer	

Completion: Sign-off by Project Manager.

4.7.2 Evaluate Reviews

Evaluations of the implementation reviews are performed.

Artifacts	User Roles	Tools	Methods
IMPC Review Reports	Customer/ Sponsor Project Manager Project Leader	MS Word MS Draw MacDraw Pro MicroGraphix Designer	

Completion: Sign-off by Customer/Sponsor.

4.7.3 Document All Review Findings

All review findings are documented in the appropriate plan documents and reports.

Artifacts	User Roles	Tools	Methods
Assurance Specification Management Control & Status Reports Management Plan Product Specification Document	Project Manager Project Leader	MS Word MS Draw MacDraw Pro MicroGraphix Designer	

Completion: Artifacts are in state Completed.

4.7.4 Accept or Reject System

The decision to accept or reject the system is made at this point in the implementation phase.

Artifacts	User Roles	Tools	Methods
IMPC Discrepancy Reports IMPC Lessons Learned IMPC Plan Updates IMPC Updates IMPC Status Reports	Customer/ Sponsor Project Manager	MS Word MS Draw MacDraw Pro MicroGraphix Designer	

Completion: Sign-off by Customer/Sponsor.

Decomposition: Integrate & Test Information System Components

5.1 Manage Integrate & Test Phase

During this step of the integrate and test phase, all management activities are carried out.

5.2 Conduct Risk & Management Control Activities

This process makes certain that the development is proceeding without introducing errors into the system.

5.3 Integrate Subsystems & Components

The subsystems and components of the information system are integrated into the final product in the processes of this step.

5.4 Conduct Integration Tests & Reviews

The actual tests and reviews of the information system are carried out in this activity.

5.5 Decide Whether To Proceed

After the entire information system is integrated and tested, acceptance or rejection of the system is decided during this step of the integrate and test phase.

Decomposition: Manage Integrate & Test Phase

5.1.1 Evaluate Metric Information

Metric information is collected and evaluated to track the resource estimation to this point in the development.

Artifacts	User Roles	Tools	Methods
I&T Performance/ Metric Reports	Customer/ Sponsor Project Manager	MS Word MS Draw MacDraw Pro MicroGraphix Designer Excel Lotus 123	Cost Analysis Statistical Analysis

Completion: Sign-off by Project Manager.

5.1.2 Re-evaluate Risk Areas

Risk areas are re-evaluated as directed by the management plan to determine what planning modifications are needed.

Artifacts	User Roles	Tools	Methods
I&T Lessons Learned	Customer/ Sponsor Project Manager	MS Word MS Draw MacDraw Pro MicroGraphix Designer Excel Lotus 123	Cost Analysis Statistical Analysis

Completion: Sign-off by Project Manager.

5.1.3 Document Changes to Plans

Status and change reports are created to reflect changes to the plans.

Artifacts	User Roles	Tools	Methods
I&T Plan Updates	Project Manager	MS Word MS Draw MacDraw Pro MicroGraphix Designer	

Completion: Artifact Plan Updates is in state Completed.

5.1.4 Modify & Update Plans

Modifications and updates are made to the appropriate sections of the plan documentation.

Artifacts	User Roles	Tools	Methods
Management Plan	Project Manager	MS Word MS Draw MacDraw Pro MicroGraphix Designer	

Completion: Artifact Management Plan is in state InProgress.

Decomposition: Conduct Risk & Management Control Activities

5.2.1 Collect Metric Information

Metric information is collected for the evaluation and tracking of the information system.

Artifacts	User Roles	Tools	Methods
I&T Performance/ Metric Reports	System Designer Subsystem Designer	MS Word MS Draw MacDraw Pro MicroGraphix Designer Excel Lotus 123	Cost Analysis Statistical Analysis

Completion: Sign-off by System Designer.

5.2.2 Document Metric Information

The metric information collected in the previous step is documented in this process.

Artifacts	User Roles	Tools	Methods
I&T Performance/ Metric Reports	System Designer Subsystem Designer	MS Word MS Draw MacDraw Pro MicroGraphix Designer Excel Lotus 123	Cost Analysis Statistical Analysis

Completion: Artifact Performance/Metric Reports is in state Completed.

5.2.3 Assign Responsibility for Change Proposals

Resolution for change proposals is assigned in this process.

Artifacts	User Roles	Tools	Methods
I&T Engineering Change Proposals	Project Leader	MS Word MS Draw MacDraw Pro MicroGraphix Designer	

Completion: Sign-off by Project Leader.

5.2.4 Assign Responsibility for Deficiency Reports

Resolution responsibility for deficiency reports is assigned in this process.

Artifacts	User Roles	Tools	Methods
I&T Status Reports	Project Leader	MS Word MS Draw MacDraw Pro MicroGraphix Designer	

Completion: Sign-off by Project Leader.

5.2.5 Assign Responsibility for Discrepancy Reports

Resolution responsibility for discrepancies is assigned in this process.

Artifacts	User Roles	Tools	Methods
I&T Discrepancy Reports	Project Leader	MS Word MS Draw MacDraw Pro MicroGraphix Designer	

Completion: Sign-off by Project Leader.

Decomposition: Integrate Subsystems & Components

5.3.1 Test Subsystems & Components

Each component and subsystem is thoroughly tested during this step of the integrate and test phase.

Artifacts	User Roles	Tools	Methods
I&T QA Specs, Procs, Criteria, & Results I&T QEA Specs, Procs, Criteria, & Results	Verification Tester Validation Tester Field Tester Quality Assurance Tester	Test Tools	

Completion: Sign-off by Quality Assurance Tester.

5.3.2 Integrate Next lower-level Component

This process is repeated until all of the components are integrated into the whole system.

Artifacts	User Roles	Tools	Methods
I&T Integration Test Results SMAP-DID-A200	Integration Coder		

Completion: Sign-off by Integration Coder.

5.3.3 Prepare Documentation

The documents for the integrate and test phase are prepared in this process.

Artifacts	User Roles	Tools	Methods
I&T SA Specs, Procs, Criteria, & Results I&T SPA Specs, Procs, Criteria, & Results	Integration Coder Verification Tester Validation Tester Field Tester Quality Assurance Tester	MS Word MS Draw MacDraw Pro MicroGraphix Designer	

Completion: Artifacts are in state Completed.

Decomposition: Conduct Integration Tests & Reviews

5.4.1 Conduct Verification Of Product vs Design Specs

The integrated information system is verified against the design specifications to insure the resulting system is consistent with the design.

Artifacts	User Roles	Tools	Methods
I&T Ver. Specs, Procs, Criteria, & Results	Verification Tester Subsystem Designer	MS Word MS Draw MacDraw Pro MicroGraphix Designer	

Completion: Sign-off by Verification Tester.

5.4.2 Prepare for Validation

If the validation procedures have not yet been completed, then they are completed at this time.

Artifacts	User Roles	Tools	Methods
Assurance Specification	Validation Tester	MS Word MS Draw MacDraw Pro MicroGraphix Designer	

Completion: Sign-off by Validation Tester.

5.4.3 Document V&V Activities

Results from all V&V activities are recorded in the documentation.

Artifacts	User Roles	Tools	Methods
Assurance Specification	Verification Tester Subsystem Designer Validation Tester	MS Word MS Draw MacDraw Pro MicroGraphix Designer AI0 AI3	IDEF0 IDEF3

Completion: Artifact Assurance Specification is in state Completed.

Decomposition: Decide Whether To Proceed

5.5.1 Evaluate Reviews

Reviews of the integration tests are evaluated at this time.

Artifacts	User Roles	Tools	Methods
I&T Review Reports	Project Manager Project Leader	MS Word MS Draw MacDraw Pro MicroGraphix Designer	

Completion: Sign-off by Project Manager.

5.5.2 Evaluate Status Reports

The status reports that were generated during this phase are evaluated.

Artifacts	User Roles	Tools	Methods
I&T Status Reports	Project Manager Project Leader	MS Word MS Draw MacDraw Pro MicroGraphix Designer	

Completion: Sign-off by Project Manager.

5.5.3 Perform Test Readiness Review

The test readiness review is conducted and the conclusion of the integrate and test phase is completed in this process.

Artifacts	User Roles	Tools	Methods
I&T Status Reports I&T Integration Test Results I&T Information System Post-Integration Tests	Customer/ Sponsor Project Manager	MS Word MS Draw MacDraw Pro MicroGraphix Designer	

Completion: Sign-off by Customer/Sponsor.

Decomposition: Deliver Information System

6.1 Manage Deliver Information System Phase

In this process, all of the management planning activities are conducted for the coordination of the delivery phase of the development.

6.2 Conduct Formal Testing

Formal tests of the completed information system are conducted in the step of the delivery phase. If any deficiencies or discrepancies are discovered, the steps to rectify them are taken before making delivery of the system.

6.3 Conduct Configuration Audits

The final configuration audits are made before the delivery. This step is to insure that the actual performance of the information system, as determined through tests, complies with the requirements.

6.4 Decide Whether to Proceed

The accept or reject decision is made at this point in the delivery phase.

6.5 Assign Responsibility for Change Proposals

Any change proposals that have been created during the delivery phase are assigned to those responsible for making the changes during this step.

6.6 Assign Responsibility for Deficiency Reports

Any deficiency reports are assigned to individuals for correction.

6.7 Assign Responsibility for Discrepancy Reports

Any discrepancy reports are likewise assigned to those responsible for making appropriate changes to the system.

6.8 Generate Version Description Document

A version description document is created that details the specifics about the current version of the information system. This document is updated as newer versions come in to use.

6.9 Generate User's Guide

A user's guide, detailing all of the functionality of the system, is created and documented.

6.10 Perform User Training

At this point, the end users of the system are trained in the operation of the system.

Decomposition: Manage Deliver Information System Phase

6.1.1 Collect Metric Information

Metric information is collected for the tracking and evaluation of the information system.

Artifacts	User Roles	Tools	Methods
A&D Performance/ Metrics Reports	System Designer	MS Word MS Draw MacDraw Pro MicroGraphix Designer Excel Lotus 123	Cost Analysis Statistical Analysis

Completion: Sign-off by System Designer.

6.1.2 Document Metric Information

Metric information is documented in this step of the delivery phase.

Artifacts	User Roles	Tools	Methods
A&D Performance/ Metrics Reports	System Designer	MS Word MS Draw MacDraw Pro MicroGraphix Designer Excel Lotus 123	Cost Analysis Statistical Analysis

Completion: Artifact Performance/Metrics Reports is in state Completed.

6.1.3 Evaluate Metric Information

The metric information that was documented in the previous step is evaluated to track the status of the information system.

Artifacts	User Roles	Tools	Methods
A&D Performance/ Metrics Reports A&D Status Reports	Customer/ Sponsor Project Manager	MS Word MS Draw MacDraw Pro MicroGraphix Designer Excel Lotus 123	Cost Analysis Statistical Analysis

Completion: Sign-off by Customer/Sponsor.

6.1.4 Re-evaluate Risk Areas

Risk areas are re-evaluated as directed by the management plan to determine what planning modifications are necessary.

Artifacts	User Roles	Tools	Methods
A&D Lessons Learned SMAP-DID-R006	Customer/ Sponsor Project Manager	MS Word MS Draw MacDraw Pro MicroGraphix Designer Excel Lotus 123	Cost Analysis Statistical Analysis

Completion: Sign-off by Project Manager.

6.1.5 Document Changes to Plans

Any changes necessary from the previous step are recorded in change reports.

Artifacts	User Roles	Tools	Methods
A&D Discrepancy Reports A&D Review Reports A&D Engineering Change Proposals A&D Lessons Learned	Project Manager	MS Word MS Draw MacDraw Pro MicroGraphix Designer	

Completion: Artifacts are in state Completed.

6.1.6 Modify & Update Plans

The changes suggested in the previous process are made to the appropriate planning documents.

Artifacts	User Roles	Tools	Methods
Management Plan	Project Manager	MS Word MS Draw MacDraw Pro MicroGraphix Designer AI0 AI3	IDEF0 IDEF3

Completion: Artifact Management Plan is in state InProgress.

Decomposition: Conduct Formal Testing

6.2.1 Conduct Testing of System

Formal testing of the system is performed and the test results recorded.

Artifacts	User Roles	Tools	Methods
A&D Acceptance Test Results	Verification Tester Validation Tester Field Tester Quality Assurance Tester	Test Tools MS Word MS Draw MacDraw Pro MicroGraphix Designer	

Completion: Sign-off by Quality Assurance Tester.

6.2.2 Analyze Acceptance Test Results

The test results from the formal testing procedures are analyzed in this process.

Artifacts	User Roles	Tools	Methods
A&D Lessons Learned A&D Engineering Change Proposals A&D Status Reports	Quality Assurance Tester Quality Assurance Specialist	MS Word MS Draw MacDraw Pro MicroGraphix Designer Excel Lotus 123	Statistical Analysis

Completion: Sign-off by Quality Assurance Specialist.

6.2.3 Conduct Acceptance Review

The acceptance review is held and any problems with the information system are discovered.

Artifacts	User Roles	Tools	Methods
A&D Review Reports	Customer/ Sponsor Project Manager	MS Word MS Draw MacDraw Pro MicroGraphix Designer	

Completion: Sign-off by Customer/Sponsor.

6.2.4 Document Acceptance Review

The results of the acceptance review are recorded in this step.

Artifacts	User Roles	Tools	Methods
A&D Acceptance Test Results A&D Review Reports	Project Manager	MS Word MS Draw MacDraw Pro MicroGraphix Designer	

Completion: Artifact Acceptance Test Results is in state Completed.

6.2.5 Perform V&V Activities

The verification and validation activities that can be performed at this point in the development are conducted in this process.

Decomposition: Perform V&V Activities

6.2.5.1 Conduct Verification Activities

All verification activities specified in the assurance specification are conducted at this point.

Artifacts	User Roles	Tools	Methods
A&D Ver. & Val. Results	Verification Tester	MS Word MS Draw MacDraw Pro MicroGraphix Designer Test Tools	

Completion: Sign-off by Verification Tester.

6.2.5.2 Conduct Validation Testing

Validation testing is performed on the information system in this process.

Artifacts	User Roles	Tools	Methods
A&D Ver. & Val. Results	Validation Tester	MS Word MS Draw MacDraw Pro MicroGraphix Designer Test Tools	

Completion: Sign-off by Verification Tester.

6.2.5.3 Document V&V Findings

Results of the V&V activities are documented in the assurance specifications and the management control and status reports.

Artifacts	User Roles	Tools	Methods
A&D Review Reports A&D Status Reports	Validation Tester Verification Tester Quality Assurance Tester Field Tester	MS Word MS Draw MacDraw Pro MicroGraphix Designer	

Completion: Artifacts Status Reports and Review Reports are in state Completed.

Decomposition: Conduct Configuration Audits

6.3.1 Accept or Reject System

Based upon the results of the two previous audits, the information system is accepted or rejected.

Artifacts	User Roles	Tools	Methods
A&D Status Reports	Customer/ Sponsor	MS Word MS Draw MacDraw Pro MicroGraphix Designer	

Completion: Sign-off by Customer/Sponsor.

6.3.2 Perform Physical Configuration Audit

The Physical Configuration Audit is likewise conducted at the end of this phase.

Artifacts	User Roles	Tools	Methods
A&D Information System Post-Acceptance Test	Customer/ Sponsor Project Manager	MS Word MS Draw MacDraw Pro MicroGraphix Designer	

Completion: Sign-off by Project Manager.

6.3.3 Perform Functional Configuration Audit

The Functional Configuration Audit is conducted at the end of this phase.

Artifacts	User Roles	Tools	Methods
A&D Information System Post-Acceptance Test	Customer/ Sponsor Project Manager	MS Word MS Draw MacDraw Pro MicroGraphix Designer	

Completion: Sign-off by Project Manager.

Decomposition: Maintain Information System

7.1 Collect Metric Information

Measurements/benchmarks are made on the system in this process.

Artifacts	User Roles	Tools	Methods
SEO Performance/ Metrics Reports	Maintenance Coder Field Tester	Test Tools MS Word	Cost Analysis Statistical Analysis

Completion: Sign-off by Field Tester

7.2 Document Metric Information

The measurements are documented and performance problems are identified.

Artifacts	User Roles	Tools	Methods
SEO Performance/ Metrics Reports	Maintenance Coder Field Tester	MS Word MS Draw MacDraw Pro MicroGraphix Designer	Cost Analysis Statistical Analysis

Completion: Artifact Performance/Metrics Reports is in state Completed.

7.3 Evaluate Discrepancy Reports

Like engineering change proposals, discrepancy reports are examined and evaluated against the requirements and design documents to determine whether changes should be made.

Artifacts	User Roles	Tools	Methods
SEO Discrepancy Reports	Project Leader System Designer Subsystem Designer	MS Word MS Draw MacDraw Pro MicroGraphix Designer	

Completion: Sign-off by Project Leader.

7.4 Evaluate Change Proposals

In this process, the Engineering Change Proposals are examined and evaluated to determine whether the changes should be incorporated into the system.

Artifacts	User Roles	Tools	Methods
SEO Engineering Change Proposals	Project Leader System Designer Subsystem Designer Maintenance Coder Field Tester	MS Word MS Draw MacDraw Pro MicroGraphix Designer	

Completion: Sign-off by Project Leader.

7.5 Document Discrepancy Reports

The results of the evaluation of the discrepancy reports are documented in this process.

Artifacts	User Roles	Tools	Methods
SEO Discrepancy Reports	System Designer Subsystem Designer Project Leader	MS Word MS Draw MacDraw Pro MicroGraphix Designer	

Completion: Artifact Discrepancy Reports is in state Completed.

7.6 Document Change Proposal Report

The results of the evaluation of the change proposals are documented at this stage.

Artifacts	User Roles	Tools	Methods
SEO Engineering Change Proposals SMAP-DID-R005	Project Leader System Designer Subsystem Designer	MS Word MS Draw MacDraw Pro MicroGraphix Designer	

Completion: Artifact Engineering Change Proposals is in state Completed.

7.7 Review Discrepancy Reports

After changes to the system are made as a result of the discrepancy reports, a review is conducted to make certain that the system is in conformance with the design and requirements.

Artifacts	User Roles	Tools	Methods
SEO Discrepancy Reports SMAP-DID-R004 SEO Review Reports SMAP-DID-R008	System Designer Subsystem Designer Project Leader	MS Word MS Draw MacDraw Pro MicroGraphix Designer	

Completion: Sign-off by Project Leader.

7.8 Review Change Proposal Reports

After the changes have been made, the change proposals are compared to the updated system to insure that the quality of the system is maintained.

Artifacts	User Roles	Tools	Methods
SEO Engineering Change Proposals SEO Review Reports	System Designer Subsystem Designer Project Leader	MS Word MS Draw MacDraw Pro MicroGraphix Designer	

Completion: Sign-off by Project Leader.

7.9 Make Changes to Information System

Once the reports for change have been completed and reviewed, the Information System is modified to reflect those changes.

Artifacts	User Roles	Tools	Methods
SEO Updates	Maintenance Coder	Emacs MS Word MS Draw MacDraw Pro MicroGraphix Designer C++ Motif dbx Lint X Windows	

Completion: Sign-off by Maintenance Coder.

7.10 Acceptance Testing

The updated system must now be checked to insure that it is operating correctly. This process is performed to complete this step in the development.

Artifacts	User Roles	Tools	Methods
SEO Updates	Field Tester Quality Assurance Tester	Test Tools MS Word MS Draw MacDraw Pro MicroGraphix Designer	

Completion: Sign-off by Quality Assurance Tester.

7.11 Perform V&V Activities

The new system must pass through the V&V process before being used in the field.

Artifacts	User Roles	Tools	Methods
SEO Discrepancy Reports SEO Engineering Change Proposals SEO Performance/ Metrics Reports SEO Review Reports SEO Status Reports	Verification Tester Validation Tester	Test Tools MS Word MS Draw MacDraw Pro MicroGraphix Designer	

Completion: Sign-off by Verification Tester and Validation Tester.

7.12 Perform Regression Testing

Regression testing of the system is done in this step.

Artifacts	User Roles	Tools	Methods
SEO Status Reports	Field Tester	Test Tools MS Word MS Draw MacDraw Pro MicroGraphix Designer	Statistical Analysis

Completion: Sign-off by Field Tester.

7.13 Update Documentation

All of the documentation associated with the old version of the system must be updated to reflect the changes that have been added.

Artifacts	User Roles	Tools	Methods
SEO Updates	Project Leader	MS Word	IDEF0
SEO Updates	System Designer	MS Draw	IDEF1
SEO Updates	Subsystem Designer	MacDraw Pro	IDEF1X
	Maintenance Coder	MicroGraphix Designer	IDEF3
	Field Tester	Excel	Gantt Charts
		Lotus 123	
		AI0	
		AI1	
		AI1X	
		AI3	

Completion: Artifacts are in state Completed.

7.14 Review All Products

All products that were modified during this maintenance iteration must be reviewed before being put in to everyday use.

Artifacts	User Roles	Tools	Methods
Assurance Specification	Project Leader	MS Word	
Management Control & Status Reports	Customer/ Sponsor	MS Draw	
Management Plan		MacDraw Pro	
Product Specification Document		MicroGraphix Designer	

Completion: Sign-off by Customer/Sponsor.

7.15 Document Review Results

The results of the product review are recorded at this time to provide the required traceability of the development of the system.

Artifacts	User Roles	Tools	Methods
SEO Review Reports	Project Leader	MS Word MS Draw MacDraw Pro MicroGraphix Designer	

Completion: Artifact Review Reports is in state Completed.

7.16 Determine Readiness to Proceed

This process is the final review before putting the new system in to operation.

Artifacts	User Roles	Tools	Methods
SEO Updates	Customer/ Sponsor Project Manager Project Leader	MS Word MS Draw MacDraw Pro MicroGraphix Designer	

Completion: Sign-off by Customer/Sponsor.

7.17 Assign Resolution Responsibility

If any problems with the new system are found, then individuals are assigned to resolve the problems and the Maintenance Phase is repeated.

Artifacts	User Roles	Tools	Methods
SEO Engineering Change Proposals	Group Leader	MS Word MS Draw MacDraw Pro MicroGraphix Designer	

Completion: Sign-off by Group Leader.

7.18 Conduct User and Operations Training & Support

In this process, the users of the system are trained in the use of the new functionality of the system.

Artifacts	User Roles	Tools	Methods
SEO Updates	Customer Service End User End User Manager	MS Word MS Draw MacDraw Pro MicroGraphix Designer	

Completion: Sign-off by Customer Service.

5 Status and Future Directions

With the completion of this demonstration framework, the "code" with which the Framework Programmable Platform will be "programmed" has been completed. The next logical step is to test the concept of framework programming by building a demonstration system. As this framework was being developed, concurrent work was focusing on the development of a demonstration FPP to do just that. This demonstration system is being built off of the designs produced at earlier stages of the FPP project and will be demonstrated in the very near future.

The purpose of this demonstration FPP will be to demonstrate a proof of concept of the framework programming concept and to highlight the advantages that can be gained by using a process description to control and manage a development process. Indirectly, this proof of concept will also show that the effort required to build a framework will be well worth the effort as the development experience of an organization can be captured and maintained.

Upon completion of the demonstration FPP, effort should focus on scaling the functionality up to produce a production environment. This effort could be directed in two ways. The first is to attempt to build an entire environment from scratch that will result in a fully integrated system over which the FPP has complete control. The second strategy involves building modules that can be integrated with existing environments to incorporate portions of the FPP functionality. As the demonstration FPP represents the end of this phase of FPP development, the choice of implementation strategy will have to wait for the definition of the next phase.

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A Appendix A - System Development Processes Comparison

In the following pages, a chart relating the various activities of several system development processes is provided. The columns of the chart represent the various sources surveyed. The bold words in the chart represent a Major Phase of a particular development process. With this chart, an attempt was made to have the rows represent similar activities within each of the different processes. These common activities would then serve as a reference point from which to compare and contrast the other activities found in the processes. The cells that are empty do not necessarily indicate that the step or similar steps are not performed for a particular method, but instead reflect that the materials used describe the processes to different levels of detail.

SW Engineering	*Info Sys. Man.*	*Struct. Design*	*IE/IMPACT*	*SMAP*	*SDM*	*Alt. SDM*	*SEM*	*Sys. Evolution*
Project Planning and Estimation	**Concept**	**Idea**	**Planning & Control**	**Software Concept & Initiation**	**Initial Survey**	**Needs Analysis**	**Define Problem**	**Scoping**
Identify Needs					Initiate Project	Assessment of Area of Impact	Analyze Needs	Situation Assessment
					Gather Data	Assessment of Capabilities	1)Analyze Existing System	Business Area Assessment
			IRM Situation Assessment		Recommend Project Direction	Conceptualize Problem	2)Validate Symptoms & Concerns	Symptom Collection
				Develop review/test procedures	Plan Feasibility Study	Identify Cost Driver	3)Bound Problem Domain	Problem Hypothesis
Establish scope, resources, cost, schedule					Prepare Initial Survey Report	Assess Cost/Benefit	4)Assess Technology	Solution Approaches
Prepare Software Plan						Analyze Return on Investment	5)Identify Needs	Participant Identification
Feasibility Study	**Feasibility Study**				**Feasibility Study**		6)Evaluate Needs	**Business Strategy Definition**
Management Review			Information Strategy Planning		Project/Phase Planning & Control			Business Goal Definition
					Analysis of Bus. Fun., Environ., and Plans		Define Requirements	Goal Distribution
System Engineering Analysis		**Structured Analysis**			Analysis of Current System		1)Assess Technology Options	Organization Objectives
					Analysis of Current Operating costs and Projections		2)Partition Problem Domain	Critical Success Factor Analysis
					Define General Systems Requirements		3)Identify Requirements	Information Impact Assessment
					Refine Alt. Solutions		4)Perform Trial & Error Evaluation of Requirements	Business Function Definition
					Verify Feasibility and Evaluate Risks		5)Evaluate Requirements	Team Development

					Select Best Alt.			Information System Strategic Planning
					Plan Requirements Definition			Control Arch. Audits
				Software Quality Assurance	Prepare Feasibility Study Report and Review			Information Systems Audits
Requirements Analysis	Requirements Definition		Requirements Engineering	Software Requirements	Requirements Definition	Requirements Definition	Devise Solution	Information Arch. Audits
				Create Acceptance Test Plan	Project/Phase Planning & Control	Develop Function Model	Establish Design Structure	Problem Analysis
			Business Area Analysis		Define Current System	Develop Information Model	1)Examine Requirements	Enterprise Data Object Models
Determine information domain, functions, interfaces, design constraints, validations criteria				Criticality Analysis Specification Analysis Timing, Sizing, & Throughput Analysis	Assess Current System	Develop User Interface Model	2)Decompose Solutions	Enterprise Information Model
Build prototype to establish requirements	Specifications Definition		Business System Design	Software Quality Assurance	Define Proposed System Requirements	Requirements Specification	3)Assess Applicability of Technology	Logical System Definition
							4)Perform Trade-off Analyses of Solution Alternatives	
							5)Allocate Technology to System Elements	
							6)Evaluate Design Structure	
Technical Review				Analyze Software Requirements Assure Requirements are testable	Assess Proposed System Requirements	Analyze Requirements	Develop Specifications	Information Integration Mechanism Decision
Plan Review				Develop test beds and test data	Plan Functional System Design and Remaining Phases	Simulate Requirements	1)Define Internal Interfaces	Policies Procedures
							2)Identify Subsystems & Components	

							3)Analyze Subsystems	
							4)Package Components	
							5)Establish Component	
Revise resources cost, schedule, and justify				Software Requirements Review	Prepare Requirements Definition Report		6)Evaluate Component Specifications	Users Systems Functions
Define software and data structure; establish module interfaces; identify constraints	Design	Structured Design	System Engineering	Software Architectural Design	Functional System Design	Preliminary Design	Build System	Technology Forecast
Review					Project/Phase Planning & Control	Model Desired System -Function, Information, User Interface.	1)Construct Components prepare design for implementation. plan component construction fabricate parts assemble parts assure component quality	User Typing Roles
Specify procedural aspects of each module			Technical Design		Design the Functional System	Analyze Design	2)Verify System Elements prepare test environment exercise verification test cases evaluate verification measurements establish verification conformance	Architectural Definition

Review				Update Acceptance Test Plan	Develop Functional Test and Acceptance Criteria	Simulate Design	3)Integrate System Elements plan system integration assemble system elements integrate other system aspects record as-built configurations prepare system elements for delivery	Tactical Planning
				Assure design is under configuration control	Invoke Change Control Procedure	Verify Consistency w/ Requirements	4)Validate System Elements prepare validation test environment exercise validation test cases evaluate validation measurements establish validation conformance	Enterprise Ontology Definition/ Evolution
				Assure adherence to design standards, allocation of SW requirements to components, existence of verification matrix	Review and Evaluate Functional System Design	Verify Consistency of Interfaces		Common Data Definition/ Evolution
					Develop Implementation Plan	Provide Traceability		Information Requirements/ Design
				Design logic analysis, design data analysis, design interface analysis, design constraint analysis	Plan & Estimate Computer System Design & Implementation Phases	Assess Capabilities		System Requirements/ Design

					Document Functional System Design	Calculate Return on Investment (ROI)		User Interface Requirements/ Design
				Preliminary Design Review		Analyze Cost/Time Tradeoff		Process Requirements/ Design
				Software Detailed Design	**Computer System Design**	**Detailed Design**		Integration Mechanism Design/ Development/ Evolution
					Project/Phase Planning & Control	Verify Consistency w/Preliminary Design		Distributed Database Design & Evolution
					Distributed Data Processing Design	Analyze Detailed Design		**Plan Execution**
					Develop Outline Design	Simulate Detailed Design		
					Determine Capabilities, Constraints, Configurations	Provide Traceability		
					Perform Application System Design			
					Prepare System Conversion Requirements			
					Develop System Test Procedure			
				Assure design standards are followed, inclusion of modules, inclusion of design inspections Conduct reviews, walkthroughs, or inspections	Review and Evaluate Computer System Design			
				Complete Acceptance Test Plan	Develop System Acceptance Procedure			

				Critical Design Review	Determine Budget and Schedule for Programming Phase			
Coding	**Coding & Checkout**	**Structured Programming**		**Software Implementation**	**Programming**	**Construction & Verification Testing**		
				Develop test procedures	Project/Phase Planning & Control			
				Code Analysis	Establish Programming Environment			
Code walk through				Review, Inspect, and Walk through	Establish Program Test Strategy			
				Audit results of coding & design, deliverables, config. management, non conformance & corrective action system	Program Specification and Design			
		Coding	Construction & Test	**Software Integration & Test**	Program Coding			
Testing	**Testing**			Conduct & Document test performance	Program Test	**Integration & Validation Testing**		
Configuration review	**Integration**			Assure testing of all deliverables, completion of all test procedures, resolution of all non conformances	System Test			
Define maintenance organization & responsibilities				Test Readiness Review	Documentation			
			Implementation & Assimilation	**Software Acceptance & Delivery**	**Installation**	**Implementation & User Acceptance**	**Implement System**	
Develop reporting scheme				Demonstrate system meets requirements	Project/Phase Planning & Control		Establish System	
					Prepare User Organization and Finalize User Procedures		1)Prepare Environment	

User communication					Educate and Train Users		2)Install System	
					Plan & Commit Computer Services		3)Train Users	
					Install System		4)Initiate Maintenance Subsystem	
					Final Documentation Revision		5)Evaluate as-installed System	
					Acquire User Signoff		6)Obtain User Acceptance	
					Initiate System Operation			
			System Evolution	**Software Sustaining Engineering & Operations**	**Evaluation**		Maintain System	
					Plan Project Review		1)Make System Modifications	
					Review Documentation		2)Record Operational System Configuration	
					Evaluate User Satisfaction		3)Identify Symptoms & Concerns	
	Operational Test and Evaluation				Evaluate Operational Effectiveness		4)Analyze Problems	
Corrective measures			Tuning & Operational Enhancement		Identify Problems and Opportunities			
					Evaluate Estimated/Actual Cost Effectiveness			
				Review, Inspect, and Walk through	Perform Audit Review			
					Analyze System Design			
Review					Write Reports and Present Recommendations			

Maintenance	**Deployment**					**Maintenance & Support**		
	Maintenance		Knowledge Worker Computing					

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