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16. Abstract

This effort demonstrates business process modeling to describe the integration of particular planning and programming activities of a state highway agency. The motivations to document planning and programming activities are that: (i) resources for construction projects are used effectively; (ii) employees know where projects are in their construction life cycles and how projects may have been changed; (iii) the time of agency employees is used effectively; and (iv) the employees are working together to complete transportation projects in a reasonable time. The effort adopts the IDEF modeling capability of the BPWin software (also known as the AllFusion Process Modeler). IDEF modeling encourages consistent documentation of who generates what information, products, services; for whom; how; and for what reasons. Across the agency, the modeling is useful in prioritizing processes for change and maintenance. The modeling empowers employees at all levels, makes institutional knowledge relevant and accessible, and removes bottlenecks. It also encourages the development of integrated systems along functional lines, including administration, engineering, and operations, and focuses agency personnel on the *good* rather than the *perfect* system. Highway agencies have multiple business processes that can benefit from an integrated description of business and technology in process models. For example, the information technology division of a large highway agency maintains and develops around sixty software applications at any one time. Business process modeling helps the division improve their allocation of resources and priorities to these applications. This document provides the purpose and scope of the effort, the method behind IDEF modeling and the AllFusion software, the results and discussion of the effort, the deliverables, and the recommendations for future work.

The authors identify some significant benefits that can be realized by an implementing agency in exchange for modest costs.

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**FINAL CONTRACT REPORT**

# BUSINESS PROCESS MODELING FOR THE VIRGINIA DEPARTMENT OF TRANSPORTATION: A DEMONSTRATION WITH THE INTEGRATED SIX-YEAR IMPROVEMENT PROGRAM AND THE STATEWIDE TRANSPORTATION IMPROVEMENT PROGRAM: EXECUTIVE SUMMARY

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**NOTICE**

The effort that is the subject of this report was done under contract for the Virginia Department of Transportation, Virginia Transportation Research Council. The contents of this report reflect the views of the authors, who are responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official views or policies of the Virginia Department of Transportation, the Commonwealth Transportation Board, or the Federal Highway Administration. This report does not constitute a standard, specification, or regulation.

Each contract report is peer reviewed and accepted for publication by Research Council staff with expertise in related technical areas. Final editing and proofreading of the report are performed by the contractor.

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## ABSTRACT

This effort demonstrates business process modeling to describe the integration of particular planning and programming activities of a state highway agency. The motivations to document planning and programming activities are that (1) resources for construction projects are used effectively; (2) employees know where projects are in their construction life cycles and how projects may have been changed; (3) the time of agency employees is used effectively; and (4) the employees are working together to complete transportation projects in a reasonable time.

The effort adopts the IDEF modeling capability of the BPWin software (also known as the AllFusion Process Modeler). IDEF modeling encourages consistent documentation of who generates what information, products, services; for whom; how; and for what reasons. Across the agency, the modeling is useful in prioritizing processes for change and maintenance. The modeling empowers employees at all levels, makes institutional knowledge relevant and accessible, and removes bottlenecks. It also encourages the development of integrated systems along functional lines, including administration, engineering, and operations, and focuses agency personnel on the *good* rather than the *perfect* system. Highway agencies have multiple business processes that can benefit from an integrated description of business and technology in process models. For example, the information technology division of a large highway agency maintains and develops around sixty software applications at any one time. Business process modeling helps the division improve their allocation of resources and priorities to these applications. This document provides the purpose and scope of the effort, the method behind IDEF modeling and the AllFusion software, the results and discussion of the effort, the deliverables, and the recommendations for future work. Twelve appendices available in the full version of this report (Lambert et and Jenningsal., 2005) provide the technical results.

## INTRODUCTION

In automating many of their business processes, the information technology (IT) divisions of transportation agencies need to set priorities and allocate resources for the development and maintenance of their IT applications. Developing business process models can support the agencies in deciding which systems have the greatest impacts relative to their required investments of resources.

This research has been performed by the Center for Risk Management of Engineering Systems at the University of Virginia to support the Virginia Department of Transportation (VDOT), the Virginia Department of Rail and Public Transportation (VDRPT), the Federal Highway Administration (FHWA), and the Federal Transit Administration (FTA). Its purpose is to improve the business processes of the Virginia Transportation Six-Year Improvement Program (SYIP) for Construction and Development and the Statewide Transportation Improvement Program (STIP). Progress documentation was provided through an Internet web site at the University of Virginia (http://www.virginia.edu/crmes/stip). The effort is a logical sequel to the document, *Development and Financial Constraint of Virginia's STIP* (FHWA et al. 2002), which describes the federal interest in transforming the state's SYIP into the federal STIP.

This report is organized as follows. The *Purpose and Scope* section is an overview of the SYIP/STIP process and presents some recent challenges implementing the two documents. The *Methods* section describes the functionality of IDEF (Integrated Definition for Function) modeling, the development of an IDEF Worksheet, and the AllFusion/BPWin software that supports IDEF modeling. The *Results and Discussion* section provides an overview of the technical results that are presented in full detail in the appendices. The *Conclusions* section discusses the findings of the effort. The *Recommendations* section addresses implementation of the findings by three divisions of the highway agency: planning, programming, and information technology. Twelve *Appendices* provide the technical results of the effort.

## PURPOSE AND SCOPE

The purpose of this effort is to demonstrate Integrated Definition for Function (IDEF) modeling for understanding and reengineering the STIP/SYIP processes of a highway agency. The scope of this demonstration is described in this section. *The details of the STIP/SYIP processes presented in this report were accurate at the time of collection. Such details are realistic and sufficient to support demonstrating IDEF business-process modeling on a complex process of the highway agency. This report has not aimed to update and reconcile all details of the STIP/SYIP to a common point in time.*

In past years, the State Transportation Improvement Program (STIP), a three-year programming document required by federal regulations, was prepared by VDOT and VDRPT as an abridgment of the Six-Year Improvement Program (SYIP), which is required by Virginia law. The Virginia Department of Transportation (VDOT) and the Virginia Department of Rail and Public Transportation (VDRPT) would in turn receive a joint letter from the Federal Highway

Administration (FHWA) and the Federal Transit Administration (FTA) giving federal approval of the Virginia STIP. Virginia's approach to the STIP of past years has been inadequate to satisfy federal regulations, which require that VDOT/VDRPT declare to FHWA and the FTA the federal dollars to be allocated in each federal fiscal year by project. To be eligible for a federal funding allocation, an applicable project needed to appear in each of the following: (1) a long-range plan, (2) regional transportation improvement program (TIP), and (3) the Virginia STIP. In recent years, significant projects appearing in the SYIP, and consequently in the STIP, could not be undertaken because the financial constraint used in SYIP/STIP development was not meaningful. In programming, objective and technical evidence were increasingly dominated by short-term fiscal and other expediencies.

The FHWA, FTA, VDOT, and VDRPT reviewed the development process of the Virginia STIP, with particular attention to the financial constraint specified by federal regulation (23 CFR 450) (FHWA 2002). First, the review documented the processes utilized to develop the Virginia SYIP and the Virginia STIP. Second, it provided a series of recommendations with accompanying implementation strategies in the categories of timing, technology, format, financial, education, and process. The recommendations of the review are presented in Table 1.

While the 2002 report of FHWA et al. is definitive in characterizing the past and future of the SYIP and STIP development processes, the following is some useful additional background on the research performed on this project.

The SYIP articulates an overall funding strategy for the Commonwealth; it does not allocate federal funding. The SYIP reflects six-year funding and financing strategies that are internal to the Commonwealth and which are typically not needed in the federal oversight of the annual allocations of federal funds. In contrast, the STIP articulates the intentions of VDOT and VDRPT to allocate federal funds to highways and transit by federal fiscal year. The STIP document compiles project listings of the eleven Metropolitan Planning Organization (MPO) transportation improvement programs (TIPs), the SYIP, the federally funded Secondary System programs, federally funded forest programs, and other participating programs. Federal regulations require STIPs to be submitted every two years, but the Virginia STIP has been submitted annually.

Currently, the TIPs are not generated in a common format, although some MPOs use the relevant sections of the SYIP as their TIP. A particular challenge to harmonizing the MPO TIPs is that the Northern Virginia MPO (the Metropolitan Washington Council of Governments) also encompasses parts of Maryland and the District of Columbia.

Beginning with fiscal year (FY) 2003, the Virginia SYIP and STIP were distinct documents. A SYIP developed in an electronic environment will contain the data needed for generating the STIP. The Virginia STIP would no longer include the future allocation of federal funds. For example, past STIP submissions showed the accrual of funds in each fiscal year, such as when $10 million was reserved in each of three years and relegated to an allocation of $30M in the 3rd year of the STIP. The STIP, a three-year program, is amended multiple times between its biennial submissions and approvals. Amendments to the STIP are straightforward when air quality is not affected. Typically, amendments are neutral in this respect: e.g., projects of

alignments and turning lanes. For FY 03, 2002 federal allocations were not ready for distribution until April 2003. Projects that had been removed in December 2002 due to financial constraints were hurriedly resubmitted in 2003 to address the revised allocations.

Efforts to revise the business processes of VDOT and VDRPT have been addressing issues such as:

- What is the best format for the compilation of the STIP, and its submission to the FHWA and FTA, from the former SYIP, the Secondary System programs, and the eleven MPO TIPs?
- How can the STIP submission, which had been a stack of separate documents in a variety of formats, be integrated and made available to the public?
- What can be learned from other states?
- How can the various planning and programming efforts be harmonized?
- How can the need for SYIP/STIP revision be balanced with the need for a stable platform in the near term?
- How will innovative financing techniques be accommodated by the SYIP and STIP processes?
- How can the process of amending the STIP be streamlined?

A committee of VDOT, VDRPT, FHWA, and FTA has been implementing the 21 recommendations of the FHWA 2002 report. There are three subcommittees: (1) Procedures, (2) Finance, and (3) Public Involvement/Education. An oversight group includes the Chief of Planning and the Environment, VDOT, and VDOT's Chief Financial Officer. In December 2002, VDOT and VDRPT submitted the first actual STIP to the FHWA and FTA for approval. In 2003, a member of the committee undertook to compile the STIP electronically and completed an initial version of an electronic SYIP. With respect to STIP development, a memorandum of agreement between Virginia and federal agencies was signed in late 2003. Pre-allocation hearings in the fall of 2003 served as test beds of the evolving SYIP/STIP public involvement process.

IDEF modeling will be useful to describe the SYIP/STIP because of its integrated perspective of business and technology. It allows employees to have increased control over their roles in the STIP/SYIP and to locate potential bottlenecks in them. IDEF modeling will help the Department of Transportation allocate adequate resources to STIP and SYIP activities.

**Table 1. 21 Recommendations of the FHWA/FTA/VDOT/VDRPT Review (FHWA 2002)**

**Timing:**

1. The schedule for the SYIP should be modified to better facilitate development of the STIP.
2. Develop a standard STIP/TIP/SYIP development cycle and consider implementing a two-year STIP/TIP cycle.

**Technology:**

3. Provide the SYIP to the MPOs in an easy-to-use electronic format.
4. Prepare the SYIP in an electronic environment that would facilitate development of the STIP and the demonstration of financial constraint.

**Format:**

5. Develop a standard STIP/TIP format in conjunction with Virginia MPOs.
6. Develop and incorporate into the STIP a financial summary table including a narrative discussion of the process and detailed annual allocations by program category and obligation. These annual allocations should align with project allocations and would support timely FHWA/FTA review and approval.
7. After development of an electronic format, consider the implementation of an e-STIP.

**Financial:**

8. VDRPT and transit operators need to provide three years of programming for STIP/TIPs as required in 23 CFR 450.
9. Demonstrate financial constraints of individual TIPs as well as the STIP.
10. Incorporate results of the VDOT Cost Estimate Task Force into the FY2004 STIP.
11. Account for innovative financial techniques in the STIP/TIPs (i.e., AC, FRANS, bonds, flex-funding, etc.) and their impacts on current and future funding.

**Education/Outreach:**

12. Educate the Commonwealth Transportation Board on the STIP process.
13. Develop an educational component of this review for FHWA, FTA, VDOT, VDRPT, and other partners.

**Process:**

14. Establish a VDOT/VDRPT STIP Working Group to maintain communication between divisions in the STIP process.
15. Revise public involvement policy regarding the STIP to align with revised STIP development procedures.
16. Strengthen the MPO and statewide planning processes to serve as the foundation for the programming process by establishing priorities for implementation.
17. Develop and maintain documented statewide planning and programming procedures.
18. Maximize programming of state-/district-wide "line item" or "grouped" projects, as eligible.
19. Develop standard STIP modification procedures to reduce FHWA/FTA involvement in minor STIP modifications and amendments.
20. Provide Virginia's MPOs with the information necessary to prepare an Annual Listing of Projects as required by 23 CFR 450.
21. Develop a three-year rather than a six-year STIP.

# METHODS

## Overview

This section describes the functionality of the IDEF (Integrated Definition for Function) modeling technique, its origin and several uses, the translation of IDEF models to simulation models, the development of an IDEF worksheet used to generate the models in the *AllFusion/BPWin* software created by Computer Associates (CA), and the details of that software.

## IDEF Functionality

Shown in Figure 1, the IDEF model breaks the activities or functions of the organization or system into its component parts. IDEF is a graphical language that assists in identifying the functions that are performed, the various elements needed to perform those functions, and what is efficient and inefficient about the system under study. Describing the SYIP and STIP processes in the *BPWin* software has several benefits. The high-level outputs of IDEF models are charts of activities and organizations. Underlying such charts are the characteristics of activities (objectives, titles of responsible individuals, inputs, rules/controls including relevant legislation, mechanisms for data acquisition, outputs, receiving individuals, key decisions, impacted activities, and days to complete). IDEF is thus consistently supporting a business analysis to describe STIP/SYIP and other processes (e.g., cost estimation). Once the processes are described in IDEF, their evolutions are more easily communicated to organizations such as highway agencies. IDEF is implemented in *BPWin* software. This comes from the same vendor as the model manager, data shopper, and related applications used by the highway agencies, and increasingly by the "data stewards" across agency divisions. A business process is generally of broader scope than the portion of it that is to be automated. Process description helps to set priorities and analyze the feasibility of what can be done toward automation. Use of the IDEF standards (implemented by *BPWin*) may evolve into a common practice across the highway agency. For now, it expects that these standards will assist with understanding the end users. The benefits of this project are that it prepares agency personnel to apply IDEF process descriptions to other critical processes of planning and finance.

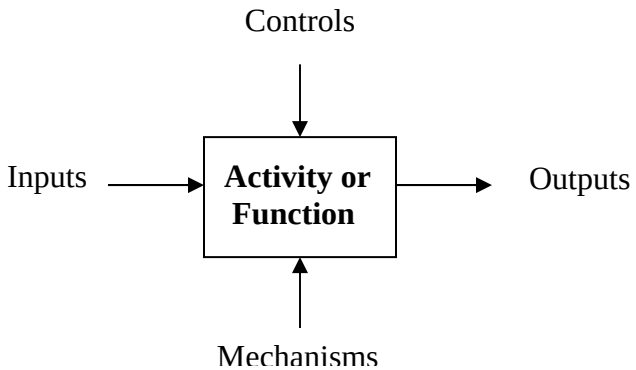


**Figure 1. IDEF Mapping Format.**

## Origin of IDEF

Specifically, IDEF was produced by the Integrated Information Support System (IISS), projects designed to create an information-processing environment that could be run in various physical computer settings. DeWitte et al. (1992) show that IDEF came about in hopes of creating general systems that could be understood by multiple parties, such as the US Air Force, the Department of Defense, and defense contractors. As breakthrough technology innovations emerge, IDEF is shifting towards utilizing process modeling techniques that also incorporate Java and Open Database Connectivity (ODBC). This will help the IDEF standard to continue to be versatile across various computing environments.

## Relationship of IDEF Modeling to Process Simulation

In the past five years, there has been a shift in business-process modeling to incorporate process simulation. According to Ding et al. (2003), there is a need and capability to build web-based simulation systems for enterprising business-process models. Instead of using standard components as IDEF does, this web-based simulation builds process models by describing the general architecture of the system, analyzing the principle design patterns of the key modules, and implementing the defined modules. Simulation allows for more flexibility in the types of business-process models that can be described, but it also leads to many complications. The key disadvantage is that these web-based mechanisms pursue more of an *ad hoc* approach instead of standardized one. Building process models using the IDEF standard will enable more people to understand a given model. Models shifting towards simulation would be designed using IDEF3, which has the capability to simulate business-process flow models. These models would encompass the process flow and the relationships among processes. Simulation of IDEF3 models is advantageous when gathering outcomes of hypothetical dynamic business-process scenarios. From such scenarios, descriptive statistics about the outcome of the process can be gathered without physically implementing it. Using simulation can help people predict the effectiveness of business processes before they are implemented.

## Uses of IDEF Modeling

The focus of IDEF modeling needs to extend to business-process reengineering. The first step in reengineering a process is to know what is currently being done, and the next is to analyze the process to see where it can be improved. There is a need for these processes to be analyzed and discussed by those people who actually perform the work. It is an effort to glean a lot of data from written sources and high-level employees, but there is a need to go into greater depth and discern the inner mechanisms of each sub-process.

Another use of IDEF modeling is determining the activities that should be examined in more detail. For example:

1. Determine the best way to calculate times for the completion of each activity.
2. Determine the cost of each activity.
3. If the cost is based on how long the process takes, determine the elements that go into each activity.

Recommendations should be made to convert all the processes electronically to arrive at a virtual picture. The entire system should be updated from the handling of documents, through the workflow, to approvals.

**An IDEF Worksheet for Data Collection and Synthesis**

A worksheet was developed to display information gained from interviews from persons working with the STIP/SYIP processes. The form of the worksheet allows its data to be transformed into the IDEF0 format in the *AllFusion* software. An example of this worksheet is provided in Appendix B in the full version of this report (Lambert and Jenningset al., 2005).

Each row in the IDEF worksheet represents a new activity or role in the STIP/SYIP process. Each column is a different component of the activity. Those used for the IDEF0 model in the *AllFusion* software are: Activity, Inputs, Controls, Mechanisms, and Outputs. The other characteristics of the activities (objectives, titles of responsible individuals, key decisions, impacted activities, days to complete) are gathered to help better understand the role and purpose of the activity in the STIP/SYIP process. The STIP/SYIP processes were classified into different groups, including: STIP Process, Amendment Process, Public Involvement, Construction Process, MPO Process, and Environmental Process. The classification of the STIP/SYIP process was undertaken for a better understanding of how the different tasks of each division at VDOT fit into the flow charts in the appendices of the *Development and Financial Constraint of Virginia's STIP* (FHWA 2002).

Information on the worksheet is collected through personal or telephone interviews with personnel working directly on the STIP/SYIP process in different divisions of the highway agency. The worksheet is an important tool for transferring the information gained from these interviews into the IDEF0 format before entering the data into the AllFusion software.

**Overview of *AllFusion/BPWin* Software**

IDEF0 is a function-modeling method for analyzing and communicating the functional perspective of a system; it is used in the Computer Associates (CA) *AllFusion* software. CA describes the IDEF process as one that "allows you to systematically analyze your business, focusing on normal day-to-day functions and the controls that support these functions."

CA claims that the following distinctive features set the *BPWin* software apart from competitors that offer IDEF0 process-modeling software:

1. It has an easy-to-use point-and-click, drag-and-drop interface.
2. It allows users to automate the design of IDEF0 models.
3. It provides integration with its Process-flow and Dataflow modeling portions of the *AllFusion* software applications.

The basic capabilities of IDEF0 in *BPWin* are represented by boxes and arrows. A box represents one activity, while an arrow's meaning varies, based on where it is connected to the

model. An activity can be described with a single action verb plus a common noun, for example: "Approves Budget." Four types of arrows are used in *BPWin:*

1. *Input:* An Input arrow is anything that is consumed or transformed by the given activity. For example, some inputs to "Approve Budget" could be the draft budget documents.
2. *Control:* A *Control* arrow is anything that is a constraint in the activity. Examples are the amount of money available for allocation, or the laws and regulations that define how government money may be spent.
3. *Output:* An *Output* arrow is anything that results from the activity, such as an approved or rejected budget.
4. *Mechanism:* A *Mechanism* arrow shows how the activity is completed, but is not in itself consumed by the process. Examples would include the person who has final say in the approval, or the public input process, or project-cost support documents.

The *inputs*, *controls*, *outputs*, and *mechanisms* should be straightforward, derived from interviews with the people involved in each activity.

The following are the three basic elements of creating an IDEF0 model. According to Computer Associates, once these are defined, the model should be easy to build:

1. Identify the purpose.
2. Define the viewpoint.
3. Find the appropriate depth and scope of the project.

There are other IDEF0 modeling products that can be evaluated for use. *AI0 WIN* by KBSI is one of the software packages that mirror the capabilities of *AllFusion/BPWin.*

IDEF3, also referred to as Process Flow or Workflow modeling, is used to graphically represent and document all aspects of a business process. It captures information on process flow, inter-process relationships, and other vital factors that interact in the business flow process. Using IDEF3 is particularly useful for reengineering business processes, developing a methodology to complete deliverables, and collecting information on policies and procedures in the business.

IDEF3 allows the user to create real-world scenarios. This application is particularly functional for any type of business in the sense that the user can shape the model to directly fit the needs of a company. For example, the user can map out all parts of the process to develop a plan to implement an alternative traffic pattern in a given urban area. These mapped scenarios not only organize processes in a reader-friendly fashion for department staff, they also open communication pathways between departments within the company.

IDEF3, like IDEF0, allows the user to create an activity called a Unit of Work, or UOW. However, IDEF3 broadens the use of the word "activity" to include a process, action, decision, or other procedure performed in a system or business within an IDEF3 model.

IDEF3 has the ability to create junctions, in which more than one process can merge into another process *(fan-in junction)* and conversely, more than one process can result from a single process *(fan-out junction).* Junctions in process-flow diagrams allow the user to create such events. Different types of *in* junctions include Asynchronous AND, Synchronous AND, Asynchronous OR, and XOR (Exclusive OR). In *fan-in,* Asynchronous AND means that all preceding processes must be complete, and in *fan-out,* it means that all following processes must start. In *fan-in,* Synchronous AND means that all preceding processes complete simultaneously, and in *fan-out,* it means that all following processes start simultaneously. In *fan-in,* Asynchronous OR means that one or more preceding processes must be completed, and in *fan-out,* it means that one or more of the following processes must start. In *fan-in,* Synchronous OR means that one or more of the preceding processes complete simultaneously, and in *fan-out,* it means that one or more following processes start simultaneously. In *fan-in,* XOR, or Exclusive OR, means that exactly one preceding process completes, and in *fan-out,* it means that exactly one of the following processes starts.

The steps to build an IDEF3 model are similar to those for an IDEF0 model. The most distinctive difference in the IDEF3 models is the use of the junctions. Junctions add depth to the diagram and allow for more complex process structures.

Another tool includes the *use referents,* or objects in an IDEF3 diagram where additional information is stored outside the process flow. For example, if the air quality has to be checked before a new road can be built; the results of the check would be stored in a component of this model.

Data Flow Diagrams, or DFD, are used to complement IDEF0 models. The DFD lays out a blueprint of a company's development tasks, thus documenting the movement and processing of information within the firm. The DFD describes data-process functions, the data involved, and the entities that interact with sales and data processing tables. DFD components include activities, arrows, data stores, and external references.

The visualization tool for BPWin supports imported graphics of the bitmap type. If the graphic is not in bitmap form, the image can be converted from most common extensions into the correct bitmap format. Importing bitmaps allows the user to apply them to diagram objects along with various display options.

AllFusion/BPWin also allows the user to export models to Arena, a simulation software tool of Systems Modeling Corp. Simulation is useful for visualizing what is happening in a complex business model. Simulation enables the modeler to generate statistical information about the business process.

## RESULTS AND DISCUSSION

The major categories of results are (1) development of the IDEF Worksheet, (2) displays of STIP/SYIP in IDEF format, (3) tutorials for transforming interviews to the integrated

definition (IDEF) standard using case studies of metropolitan planning organizations, urban programs, secondary roads, and the public involvement process, and (4) software packages relevant to future automation of the business processes of the highway agency.

Appendices A through J, available in the full version of this report (Lambert et and Jennings,al., 2005), present the details and results of this project, as follows:

- **Appendix A** provides the IDEF Worksheet Questions Webpage, the IDEF Worksheet Questions Coding, and the IDEF Worksheet Questions Methodology. These questions were used during interviews to better organize the information gained into IDEF format.
- **Appendix B** provides the IDEF Worksheet that was compiled containing all the different sub-processes involved in the SYIP/STIP. The IDEF Worksheet was created to retain all the information gathered during interviews with VDOT personnel. This worksheet provided an intermediate format that enabled the team to transform this information into the IDEF format.
- **Appendix C** provides examples of planning and programming activities displayed in IDEF format and data-flow diagrams. The *AllFusion* software outputs were created by integrating the data-flow diagrams found in the appendices of the FHWA 2002 Report and the IDEF Worksheet. The decomposition of the STIP development process is shown below in Figure 2.

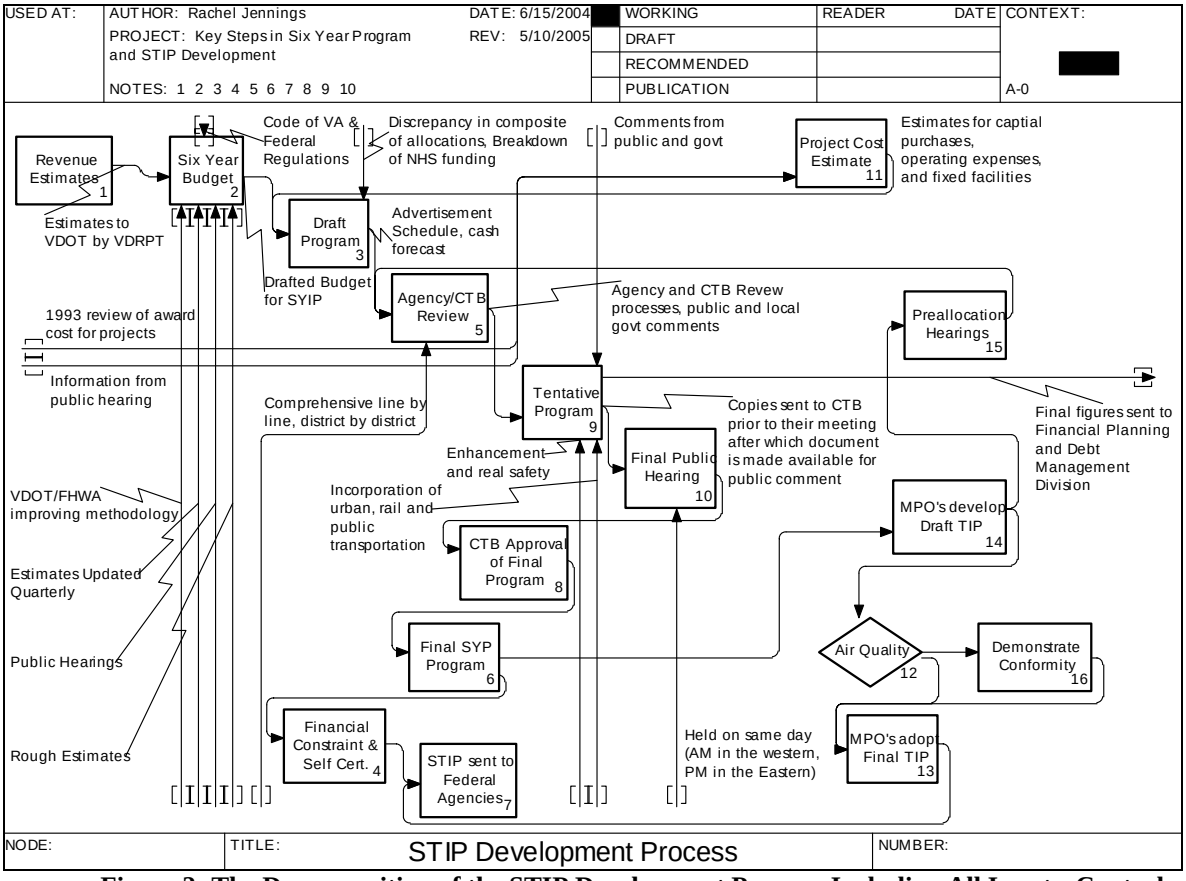


**Figure 2: The Decomposition of the STIP Development Process, Including All Inputs, Controls, Mechanisms, and Outputs for Each Activity.**

- **Appendix D** describes *AllFusion's* compatibility with simulation software and gives an example of exporting a model from *AllFusion* into this software. Figure 3 shows how the model looks in IDEF3 format and Figure 4 shows how it appears after being exported into *Arena*. Appendix D also provides details of how the transformation is performed.

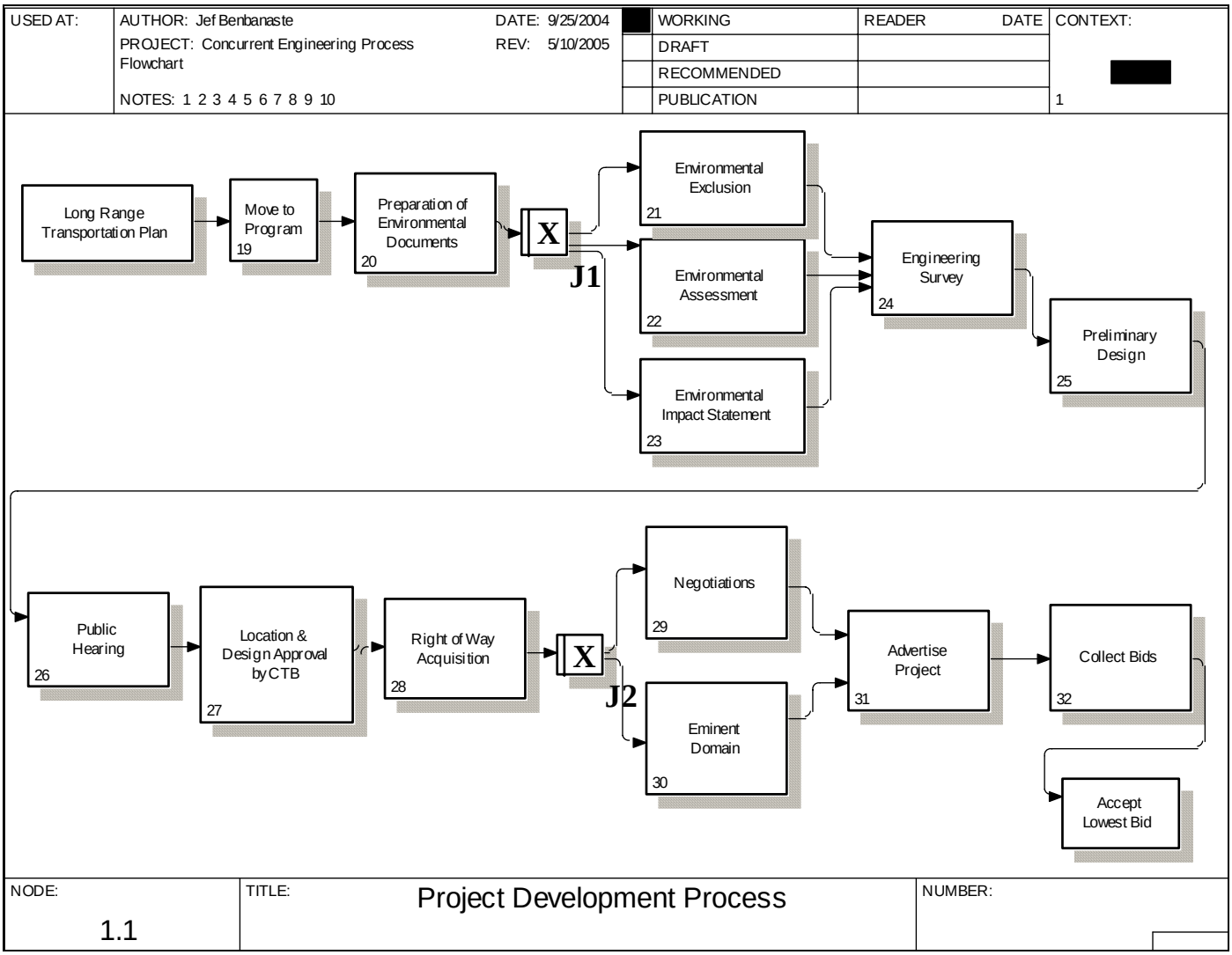


**Figure 3: Demonstration of *AllFusion* Capabilities: IDEF3 Model of VDOT Flowchart, Fact Sheet, and an Interview with a VDOT Employee.**

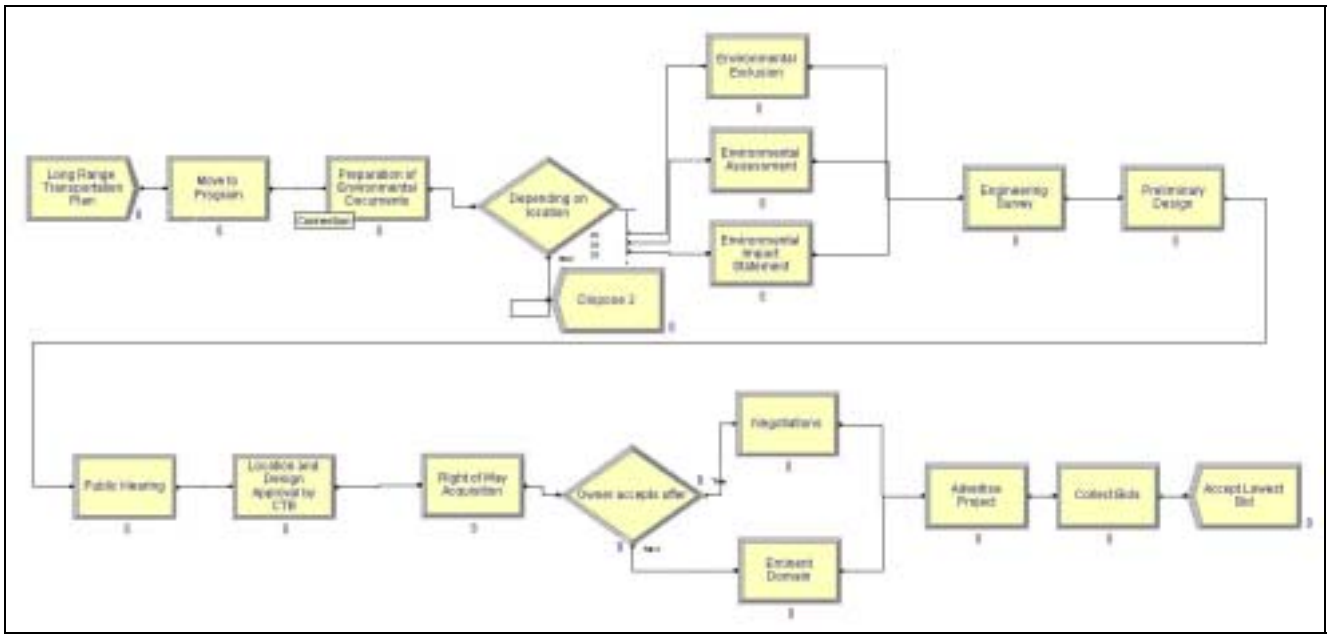

**Figure 4: Demonstration of *AllFusion* Capabilities: Simulation Model in Arena Imported from AllFusion IDEF3.**

- **Appendix E** provides a tutorial on transforming narrative interviews to the integrated definition (IDEF) standard: a case study on the Metropolitan Planning Organization (MPO). The results in Appendix E describe the methods used to conduct the interviews with individuals working on the MPOs and then to convert those interviews into IDEF0 format. Figure 5 shows a decomposition of the MPO process into three main activities.

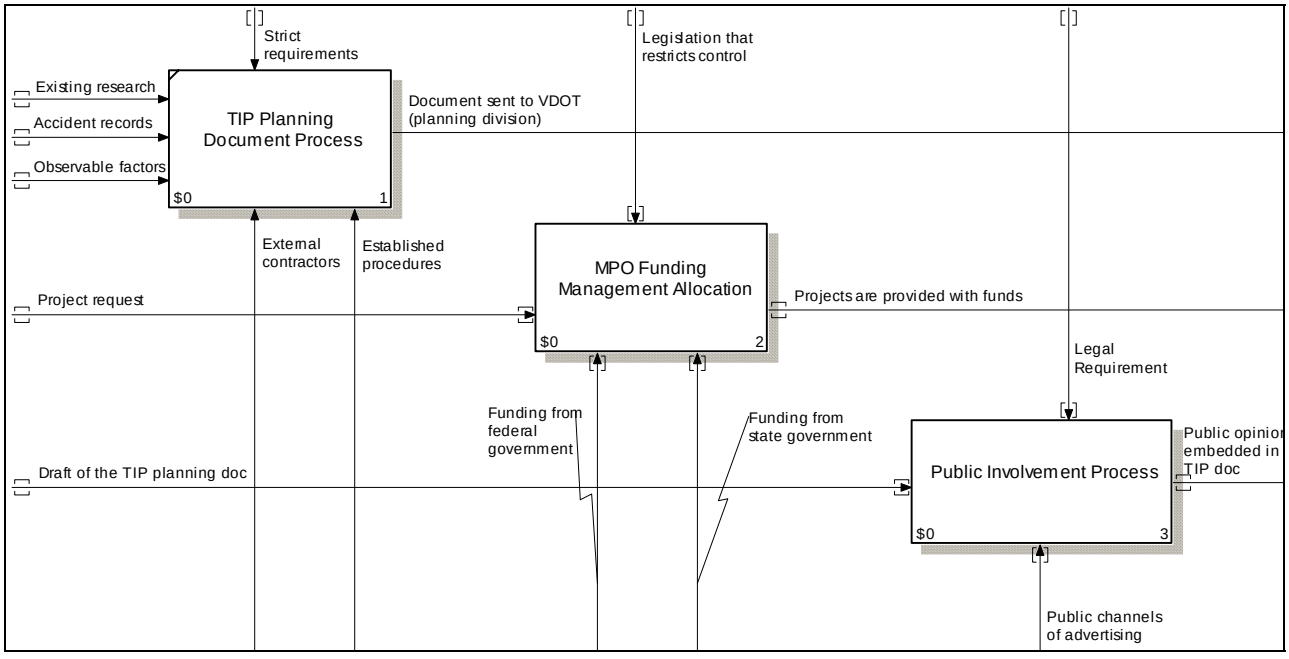


**Figure 5: IDEF0 Model of Subordinate Activities for MPO Processes.**

- **Appendix F** provides a tutorial on transforming interviews to the integrated definition standard: *A Case Study on Urban Programs.* The results in Appendix F describe the methods used to conduct interviews with employees of VDOT working in the urban programs process, and then to convert those interviews into IDEF0 format. Figure 6 displays the comprehensive IDEF0 model for urban programs.
- **Appendix G** provides a tutorial on transforming interviews to the integrated definition standard: *A Case Study on Secondary Roads.* The results in Appendix G describe the methods used to conduct interviews with employees of VDOT working in the secondary roads process, and then to convert those interviews into IDEF0 format. Figure 7 displays the second level of the secondary roads process.

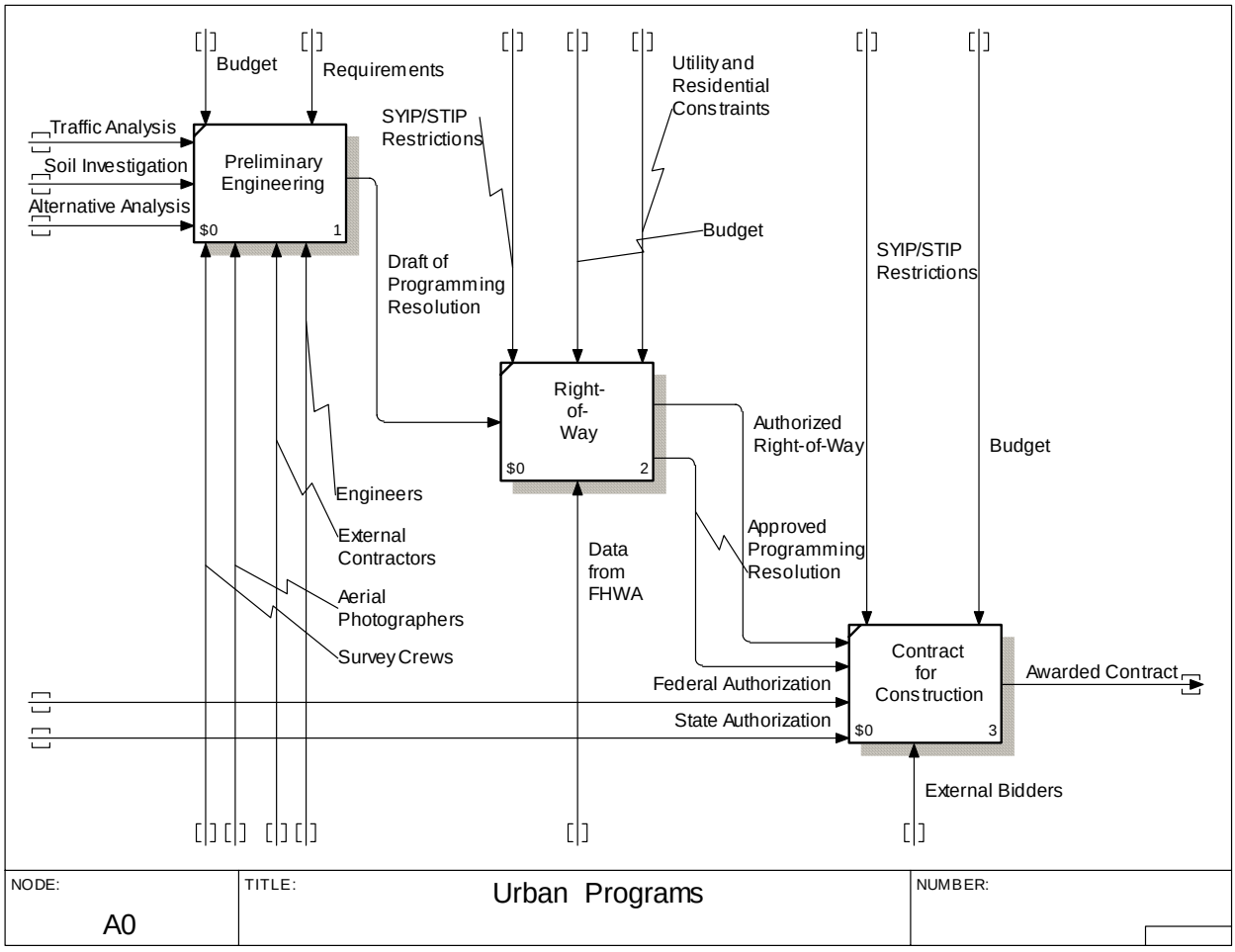


**Figure 6: Comprehensive IDEF0 Model of Urban Programs Processes.**

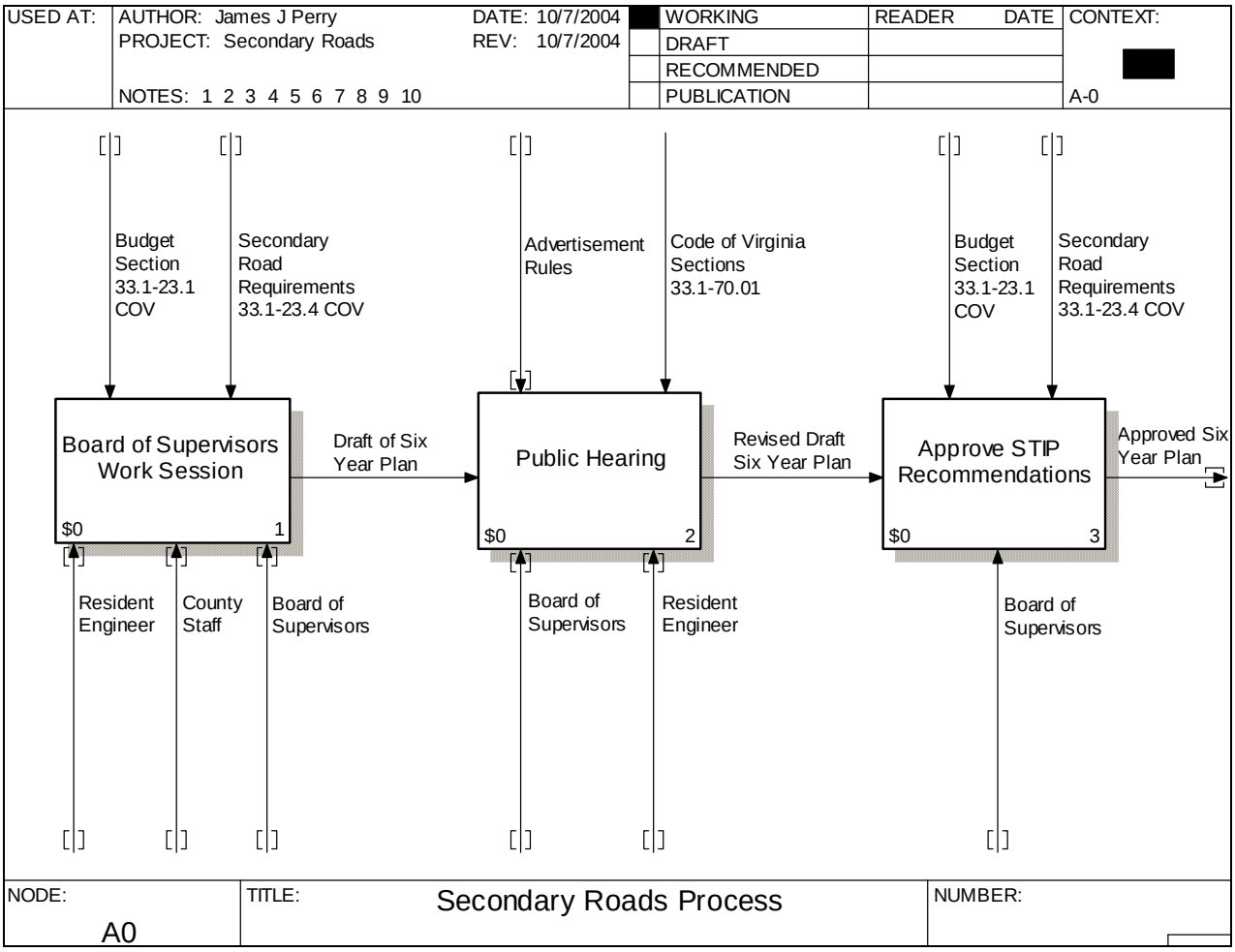


**Figure 7: Second Level of Secondary Roads Process.**

- **Appendix H** provides a tutorial on transforming interviews to the integrated definition standard**:** a case study on VDOT's public involvement process. The results in Appendix H describe the methods used to conduct interviews with the VDOT employees working on the public involvement process, and then to convert those interviews into IDEF0 format. Figure 8 displays the IDEF0 model of VDOT's public involvement process.

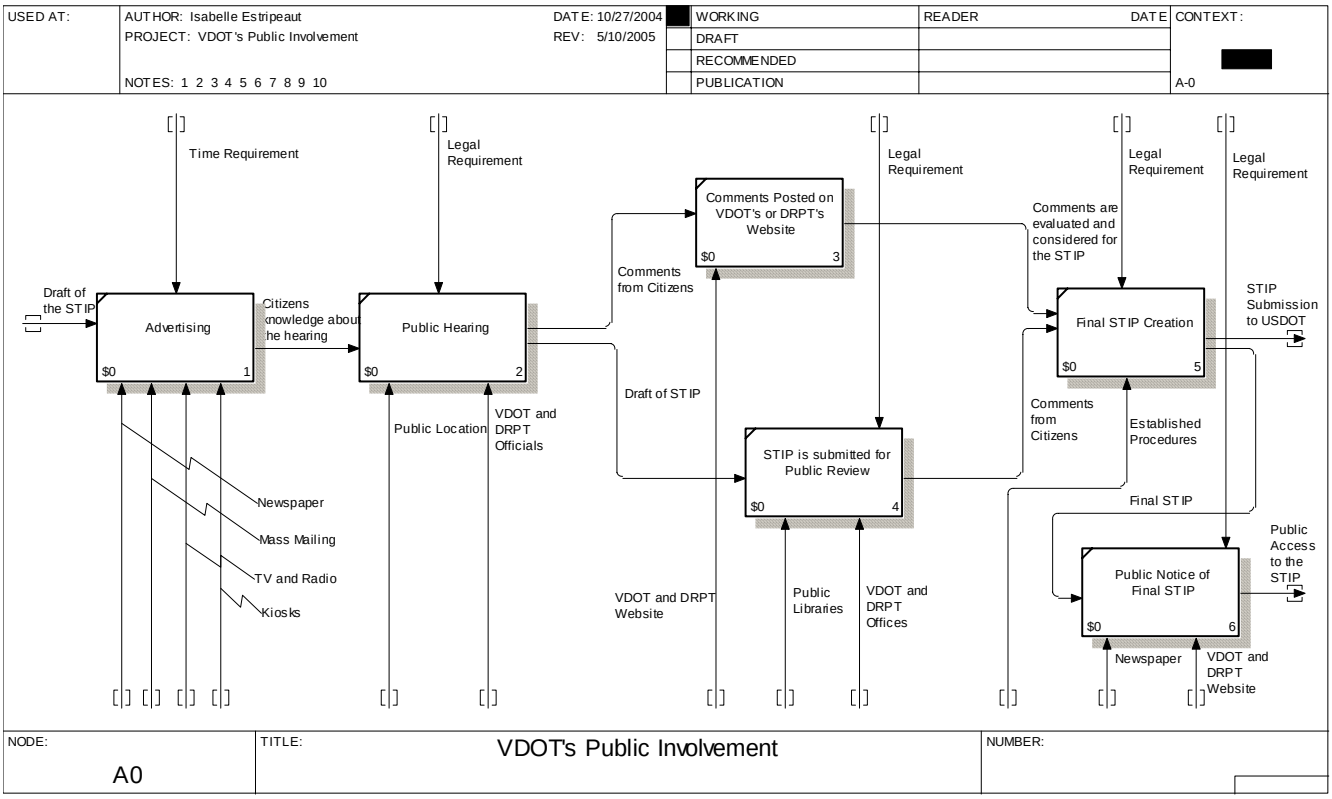


**Figure 8: IDEF0 Model of VDOT's Public Involvement Process.**

- **Appendix I** describes and recommends locating the Statewide Transportation Improvement Program (STIP) and Six-Year Improvement Program (SYIP) business process models at the Central Office Website (COWEB) at VDOT.
- **Appendix J** describes some software packages relevant to future automation of STIP/SYIP project management. These include document management software, planning and programming software, and business-process management software for business-process modeling.

## CONCLUSIONS

This research demonstrated the use of business-process models to understand and support the reengineering of the STIP/SYIP development processes at VDOT. The findings were as follows:

1. Previous efforts to model the STIP and SYIP were incomplete and less formal.
2. Business-process modeling is an effective method for describing who does what, how, and why in major business processes for highway agencies.
3. Process modeling can support priority setting for aid and resource allocation to automate business processes using information technologies.

4. There are potential uses of business-process modeling for other complex processes of the transportation agency.

## RECOMMENDATIONS

The following recommendations for implementing the results of the research should be considered by three divisions of the highway agency: Planning, Programming, and Information Technology. The agency should consider:

1. Using IDEF methodology (and the *AllFusion* software or its equivalent) to document a variety of business processes;
2. Training selected personnel to develop and interpret IDEF models; and
3. Implementing software to streamline collecting information for IDEF models. An interface software application would allow the user to bypass the task of transcribing interviews by entering that information into the developed Excel worksheet, and then transferring that same information into the *AllFusion* software.

## COSTS AND BENEFITS ASSESSMENT

This study has demonstrated the use of business process modeling to understand and improve transportation agency processes associated with the six-year improvement program and the statewide transportation improvement program. Adoption of business process modeling across the agency provides documentation of who does what, with what authorization or mandate, with what inputs and outputs, and with what mechanisms. The potential benefits of business process modeling in the transportation agency include: (1) reduced costs associated with training of employees, (2) reduced costs in the generation of requirements and elsewhere in the development lifecycle for information technology applications that support particular business processes, and (3) improved communication of agency business processes with agency stakeholders and partners including private contractors, metropolitan planning organizations and planning district commissions, local governments, and the federal government.

The costs of increasing the adoption of business process modeling in the transportation agency are minimal and include (1) possible but not obligatory purchase of software to assist in the modeling, and (2) brief introduction of the methodology to relevant staff using the report developed in the current study.

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