A Model of Systems Integration to Facilitate ITS Deployment

FAST-TRAC

Phase IV Deliverable

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PROJECT BACKGROUND

The FAST-TRAC (Faster and Safer Travel through Traffic Routing and Advanced Controls) Intelligent Transportation Systems (ITS) Field Test in Oakland County, an urbanized county in metropolitan Detroit, represents a large and successful systems integration effort that ties together traffic surveillance, signal control, and traffic information systems that have not previously been integrated. The lessons learned through the successful FAST-TRAC integration process can be valuable to others engaged in, or contemplating ITS deployments.

A major emphasis of the FAST-TRAC Field Test was the development and implementation of a Traffic Information Management System (TIMS). The goal of TIMS is to integrate traffic-related information in pursuit of improving road operations and traveler services information within the project area. Upon integration, the various TIMS subsystems become interactively linked, and therefore allow TIMS to act as a central system for data collection and dissemination. TIMS enables RCOC to monitor traffic conditions throughout Oakland County and to provide real-time traffic information.

The Road Commission asked the University of Michigan to evaluate various aspects of TIMS. The evaluation consisted in part of a Systems Integration Study, which describes the systems engineering and integration process as applied to TIMS. This effort included a case study that identifies the process employed during the TIMS system integration effort in terms of timeline, milestones, activities, deliverables, and applicable decisions. A special focus of the case study is on difficulties encountered and solutions developed, i.e., lessons learned. The case study itself has been published as a separate report (1, 2). The lessons learned from the case study were combined with time-tested concepts from the literature (3, 4, 5) to develop a Model of Systems Integration to Facilitate ITS Deployment.

The goal of the Systems Integration Model is to help State and local transportation planners and managers deploy ITS by alerting them to potential systems integration issues and solutions. Moreover, staff in private systems integration houses should also find the Model useful in better understanding and meeting the needs of the public agencies. Simply put, the discussion spurred by the Model should promote a mutual understanding between the public agencies and private companies, which often have different perspectives on the integration process. The systems integration model is the topic of this report.

THE NEED FOR A MODEL OF SYSTEMS INTEGRATION

A significant number of Intelligent Transportation Systems (ITS) operational tests and deployments nationwide have been delayed, and in some cases jeopardized, due to systems integration problems, particularly in the software development area. The many difficulties faced in deploying ITS can be summarized in three main points:

- First of all, an ITS is composed of numerous disparate elements and so a systems integration effort is essential to deployment success. However, the systems integration process is complex in and of itself and involves numerous individual components that are dissimilar, e.g., in data flows, communications protocols, and physical connectivity.

- Second, the staff of the government transportation agencies that fund most ITS deployments often either have little background in and/or experience with ITS and/or the systems integration process.

- Third, in the past, public agencies and systems integrators have not dealt with one another on a regular basis, if at all. This lack of a history of working together can lead to miscommunication and perhaps mistrust, both of which hinder the success of integration efforts. An illustration of this concept is evident in the words of one participant in the FAST-TRAC process: "It is easy to integrate systems, but it is difficult to integrate companies." Institutional integration is key to successful system integration in a multi-organization project such as represented by ITS efforts.

Since major ITS deployments will continue to require a significant level of integration, public agency staff need guidance with the systems integration process so that they can successfully face these problems. At the same time, systems integration contractors need guidance as to how they can better understand and serve their public agency clients. In short, a disciplined approach that coordinates the traditions of traffic management with those of systems engineering and integration must be required by funding agencies and adhered to by project managers and systems integrators.

THE SYSTEMS INTEGRATION MODEL

The effort to develop the systems integration model began with a case study of the successful FAST-TRAC TIMS system integration efforts. As part of the case study, the authors identified a series of lessons learned from the TIMS deployment about prerequisites for a successful systems integration effort. These lessons, which are from the point of view of the government agency, were gleaned from the comments of project participants during a series of interviews and a focus group session. Comments were generalized to a certain extent, so the lessons represent a summary of issues that might be useful to future system integration projects. The lessons, which are further described in the TIMS Case Study (1, 2), are categorized as:

- Identify and empower (adequate staffing, funding, and political backing) a project champion,

- Get the right parties involved (sign up capable and committed partners; ensure that each partnering organization has compatible goals and a sufficiently powerful project champion),

- Secure long and short-term funding,

- Establish appropriate project control mechanisms to facilitate team communication, cooperation, and the integration process (during set up, to prepare timing and coordination of schedules, to establish rewards and punishments, and to ensure adequate documentation), and

- Follow standard systems integration practices (set clearly stated, realistic but visionary goals, agree on a philosophy and approach, plan in a disciplined way with a view to deployment, and emphasize interoperability).

- Although not raised during the fact-finding portion of the lessons learned study, and taken as a "given" in most work, the most basic of all lessons is the need to collaborate with all stakeholders to recognize the true nature of the problem. Moreover, public outreach is needed, if not to promote the project, then at least to avoid public confusion about the goals and methods of the project. The latter point came home early on in FAST-TRAC when the public attributed an unpopular change in the left turn regulation at traffic lights (from permissive to protected) to the FAST-TRAC effort.

The model development effort combined these lessons learned with principles of systems integration from the literature (3, 4, 5) to produce a model that describes a generalized approach to systems integration. Specifically, the model illustrates the systems engineering process and highlights specific issues that may need to be dealt with and potential dependencies (temporal and substantive) that may be faced.

As illustrated in Table I, four Phases and eight Steps define the Systems Integration Model. Moreover, Steps 1 through 4 can be called the Preparation Stage of the process and Steps 5 through 8 can be called the Integration Stage. The intersection of Steps and Phases define 32 individual "cells". Each cell describes an activity required at a given point in the systems integration process.

The Model can also be laid out in a perhaps more intuitively appealing spiral, as shown in Figure 1 where the four Phases are depicted as (pseudo) rings labeled with Roman Numerals and the eight Steps are depicted as pie slices labeled with Arabic numerals. The activities represented by the cells are thus laid out in a sequential manner along the spiral. That is to say, the model is "read" as a sequential set of activities (the 8 Steps repeated in each of 4 Phases) that spiral into the bulls-eye of a successfully operating system. However, many portions of the integration process are interwoven and both simultaneous activity between cells and cycling between cells are common. To follow the process, start at the bottom left side of the systems integration spiral and proceed clockwise.

Table I: Contents of the Systems Integration Model

Stage	Step	Phase			
		I. Planning	II. Design	III. Deployment	IV. Operations
Preparation Stage	Step 1. Situation Audit	Cell 1	Cell 9	Cell 17	Cell 25
	Step 2. Needs Analysis	Cell 2	Cell 10	Cell 18	Cell 26

	Step 3. Approach Identification	Cell 3	Cell 11	Cell 19	Cell 27
	Step 4. Resource Identification	Cell 4	Cell 12	Cell 20	Cell 28
Integration Stage	Step 5. Semantic Integration	Cell 5	Cell 13	Cell 21	Cell 29
	Step 6. Functional Integration	Cell 6	Cell 14	Cell 22	Cell 30
	Step 7. Technical Integration	Cell 7	Cell 15	Cell 23	Cell 31
	Step 8. User Integration	Cell 8	Cell 16	Cell 24	Cell 32

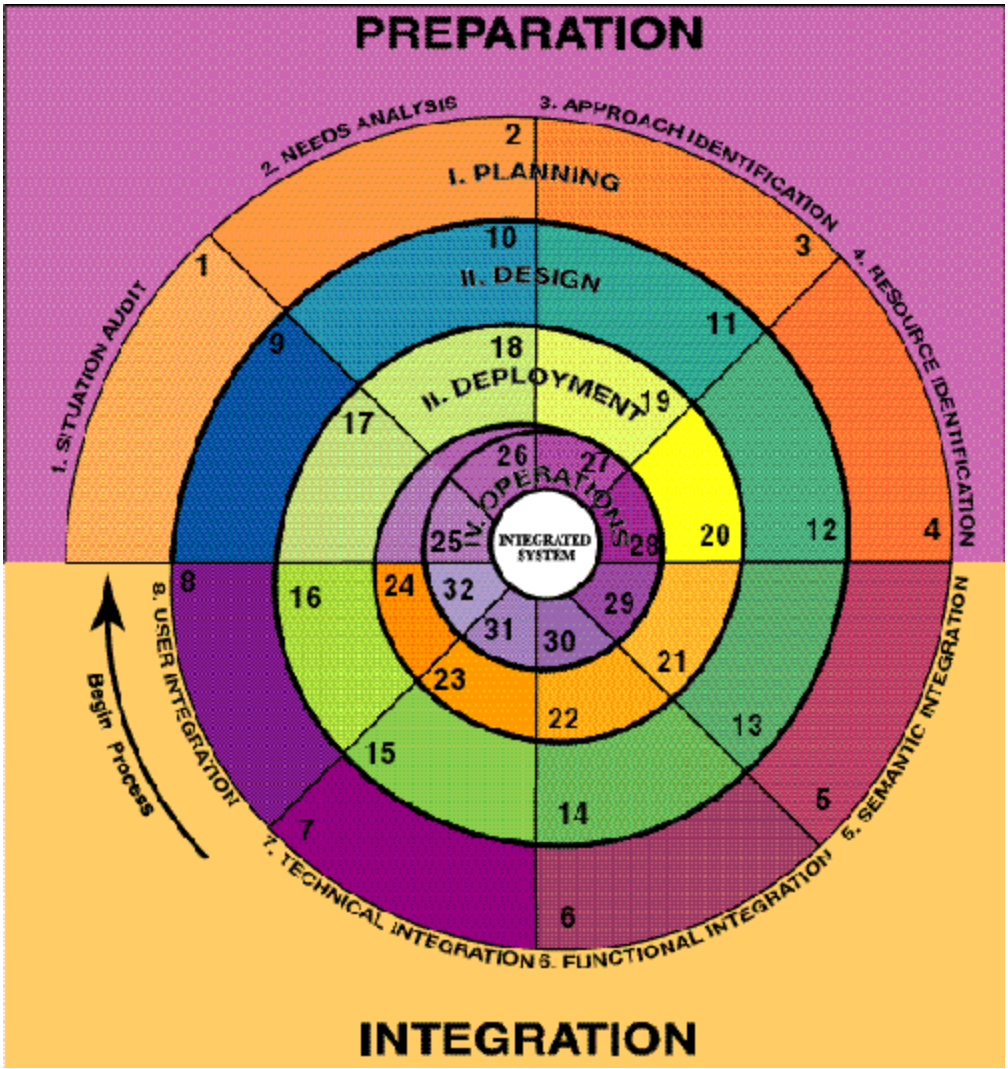

Figure 1: Graphical Spiral Form the Systems Integration Model

The following three sections will detail the Phases, Steps, and Process (in terms of the activity within cells) of the systems integration model. Before moving on, however, a brief word needs to be said on "overarching" issues and stakeholders, which are two topics that are closely linked to the model.

In addition to the 32 cells portrayed, the model also includes three significant overarching issues: champions, communication, and cooperation. The concept of champions includes project vision and

goal setting, planning, and the ability to acquire adequate resources and maintain relationships and timelines. The need for communication should be obvious, but this need also includes clear and concise documentation in a format accessible to and understandable and easily used by all parties involved. Similarly, cooperation is essential and requires an explicit and mutually agreeable project organization and management approach (contract management plan), including statements of budgets, staffing requirements, delivery schedules, and other project control mechanisms, such as tracking and accounting requirements and incentives and penalties. These issues affect each cell of the model and must receive due consideration throughout the process for the systems integration effort to be successful.

The model also includes the three levels of stakeholders that are involved in the systems integration process. These stakeholders are illustrated in Figure 2. First, the operating agency (or agencies), the systems integrator, and the vendors are directly involved. These are the organizations that put the system together and make it work. Second, service providers (public or private), other local agencies, and state and regional agencies are also involved. The service providers may be essential channels for the distribution of project information or may wish to purchase data generated by the project. Similarly, other local agencies, e.g., other parts of the county government implementing the project or an agency within an adjacent county, may wish to use the system or data. An opportunity may also exist for the project to set a foundation for broader developments, such as establishing a common geographic information system that a wide spectrum of related agencies can use. The state and/or regional agencies may have been the original (or pass through) source of project funding, and these agencies may wish to either have a hand in deployment decisions and/or have access to the systems and data. The third level of stakeholders is the citizenry, whether directly or indirectly affected by the system being implemented. Input from this group is also an essential component of the process.

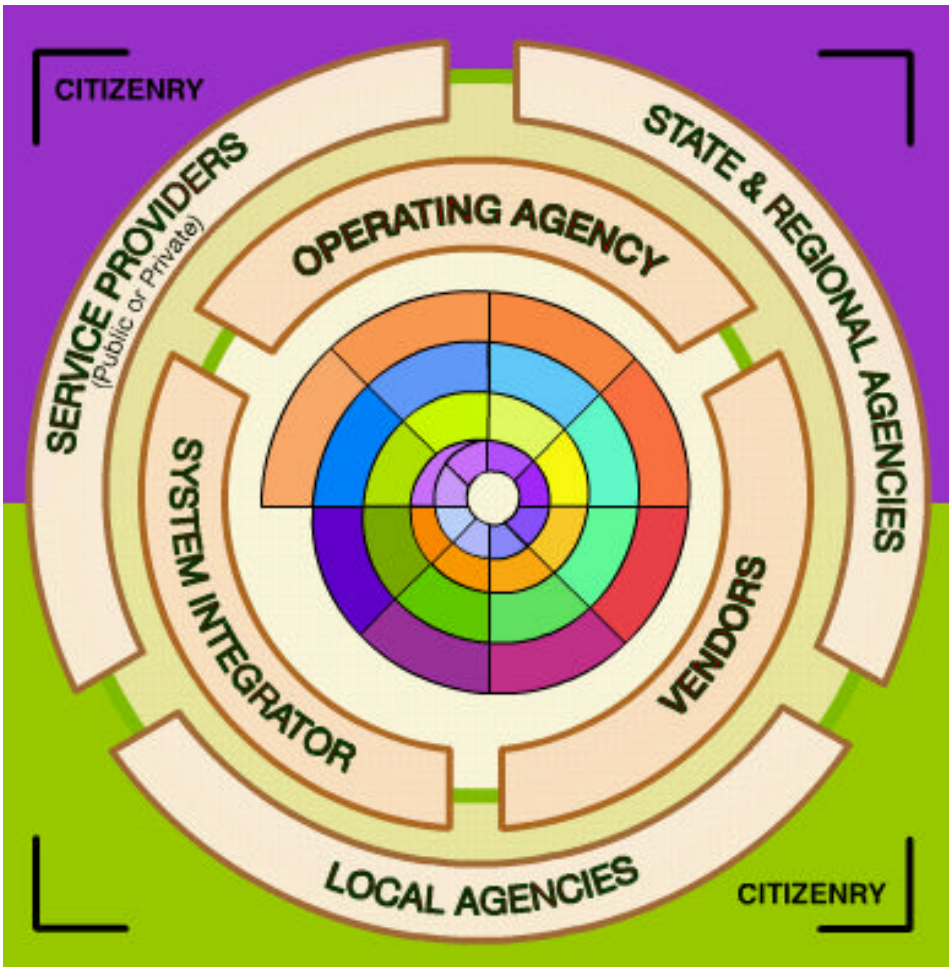

Figure 2: Stakeholders in the Systems Integration Process

SYSTEMS INTEGRATION PHASES

As noted above the Systems Integration Model is divided into four phases: Planning, Design, Deployment, and Operations. Each Phase is divided into a Preparation Stage (top half of the spiral model) and an Integration Stage (bottom half of the spiral model). The Preparation Stage is composed of the first four Steps of the integration process (Situation Audit, Needs Analysis, Approach Identification, and Resource Identification), which lay the foundation for the Integration Stage. The Integration Stage is composed of the last four Steps of the integration process (Semantic Integration, Functional Integration, Technical Integration, and User Integration), which bring the efforts of the Preparation Stage to fruition. The Deployment and Operations Phases are separated by a System Kickoff, which in essence covers the Situation Audit and Needs Analysis Steps. The System Kickoff is the time of adjustment and shakedown that commonly follows deployment of a new system. The four phases are described below.

Phase 1 – Planning

The end result of Preparation Stage of this phase is a strategic plan, including identified funding sources, and the release of a Request for Proposal. The end result of Integration Stage of this phase is a deployment team and one or more signed contract(s).

Preparation Stage – Develop Strategic Plan and Request For Proposal (RFP): Activities in this stage lay out the problem, goals, and resources in broad terms. The four steps in this stage are: perform initial situation audit, set goals and acceptance requirements, research and identify available approaches to solving the problem, and secure long and short term funding.

Integration Stage – Build Team: Activities in this stage include reviewing responses to the RFP and negotiating with potential partners. The four steps in this stage are: identify and sound-out potential team members, structure team roles and relationships, define procedures and duties, and sign contract(s) between public agency/agencies and systems integrator(s).

Phase 2- Design

The end result of this phase is a final decision on approach (Preparation Stage) and a complete set of system specifications and detailed work plan (Integration Stage).

Preparation Stage – Select System Approach: Activities in this stage focus on careful definition of system requirements and potential solutions. The four steps in this stage are: assess problem in detail, specify goals in detail, specify approach in detail, and establish procurement procedures.

Integration Stage - Define the System: Activities in this stage focus on the development of system design specifications. The four steps in this stage are: define the data, terminology and uses, create functional specifications, create technical specifications, and create user group specifications.

Phase 3 – Deployment

The end result of this phase is a fully functional, operating system that has passed the Systems Acceptance Test and a group of staff trained to operate the system.

Preparation Stage - Approve Design and Select Components: Activities in this stage culminate in an approved system design ready for implementation. The four steps in this stage are: review and approve the final system design, develop detailed implementation schedule, select procurement approaches, and select hardware/software.

Integration Stage - Prototype and Deploy System: Activities in this stage culminate in deployment of a completed system including all needed hardware and software. The four steps in this stage are: integrate

data within and across functions and organizations, specify operation and maintenance procedures, develop, install, and integrate subsystems, and train staff and educate users.

System Kickoff

The System Kickoff is the time of adjustment and shakedown that commonly follows deployment of a new system. During this period, which in essence covers the Situation Audit and Needs Analysis Steps, staff put their new training into practice and integrate the new system into the day-to-day operations of the organization.

Phase 4 – Operations

The ongoing result of this phase is an operational system that fulfills day-to-day needs while adapting/expanding to meet changing organizational and public needs. Note that the system is now integrated into the organization and so the temporal distinction between the preparation and integration stages is somewhat blurred.

Preparation Stage – Operate System with an Eye to Improvement: Activities in this stage involve system validation and ongoing system operations. The four steps is this stage are: evaluate system, reassess goals, reassess approaches, and reassess resources.

Integration Stage - Maintain and Upgrade System: Activities in this stage center on identifying and making adjustments to meet changing needs and disseminating information to the public. The four steps in this stage are: adapt to new data needs and uses, maintain and update procedures and services, maintain and upgrade equipment, and reach out to users.

SYSTEMS INTEGRATION STEPS

The eight Steps in the Systems Integration Model are briefly described here. Each of these steps is undertaken during each of the four Phases. As noted above, the first four steps can be described as a Preparation Stage within a Phase and the last four steps can be described as an Integration Stage. A description of these steps on a phase-by-phase basis is provided during a general discussion of the Systems Integration Process, which follows. In general, these steps will be followed sequentially. However, many portions of the integration process are interwoven and both simultaneous activity between steps and cycling between steps are common.

Step 1 - Situation Audit

The purpose of the Situation Audit is to define the current state of the system and problem environment (customer needs, legacy systems, geographic scope, inter-jurisdictional scope, political environment, etc.). The Situation Audit provides the groundwork for setting long and short-term system goals and lays the foundation for the work in the Phase.

Step 2 - Needs Analysis

The purpose of this step is to investigate and prioritize needs identified through the Situation Audit of Step 1.

Step 3 - Approach Identification

The purpose of this step is to discover options available to the systems integration team and performing a preliminary cost/benefit assessment of each approach to evaluate how well they meet each need. (The line between an approach and a resource — see Step 4 — is often blurred and can include funding sources, technologies, legal/political avenues, and so on.)

Step 4 - Resource Identification

The purpose of this step is to discover resources necessary to execute approaches identified in Step 3. These resources include funding, skills and know-how, political authority, technology, hardware, software, standards, training, and labor. Potential barriers should also be identified at this time. (The line between an approach— see Step 3 — and a resource is often blurred and can include funding sources, technologies, legal/political avenues, and so on.)

Step 5 - Semantic Integration

The purpose of this step is to co-ordinate understanding among and between human networks and mechanical networks. Identification, definition (when possible), and integration of personal incentives, organizational incentives, personalities, organizational culture, terminology, institutional protocol, mechanical protocol, mechanical compatibilities, internal relations, and pubic relations are considered.

Step 6 - Functional Integration

The purpose of this step is to identify functional specifications, both human and mechanical, and determine how they should be integrated. Procedures for operations and maintenance, services, team roles and relationships, data flows, and functional architectures are considered.

Step 7 - Technical Integration

The purpose of this step is to create detailed technical specifications for design and installation of integrated systems, both human and mechanical.

Step 8 - User Integration

The purpose of this step is to help ensure that the system is accessible and user friendly, both internally and externally to the organization. Examples of user integration issues include contractual agreements, user specifications and training, as well as public outreach.

SYSTEMS INTEGRATION PROCESS

The 32 cells (activities) of the systems integration process (8 Steps repeated for each of 4 Phases) are described here. As previously noted, in general, these cells will be followed sequentially. However, many portions of the integration process are interwoven and both simultaneous activity between cells and cycling between cells are common.

Phase 1 – Planning

Cell 1 – Perform Initial Situation Audit (Planning Phase, Situation Audit Step): The goal of this cell is to define the parameters of the problem environment, including the geographic, inter-jurisdictional, and political scope of the problem environment as well as the political environment and public values and behaviors within the defined scope.

Cell 2 - Set Goals and Acceptance Requirements (Planning Phase, Needs Analysis Step): The goal of this cell is to identify and prioritize the needs that the deployed integrated system should address. Moreover, goals with respect to these needs must be set and system acceptance specifications generated, in the form of a preliminary systems acceptance test, as a test to show when a system has met the identified needs.

Cell 3 - Identify and Research Available Approaches to Solving the Problem (Planning Phase, Approach Identification Step): The goal of this cell is to identify available technologies, systems, incentive programs, public outreach programs, zoning and other practices currently in use or conceptually available and applicable to the needs identified in Cell 2. The impact of existing laws, policies, standards, data, heritage systems, taxes, etc. should also be considered. Cost-benefit analyses should be undertaken to assess how well the identified approaches satisfy the identified needs. The risk of failed deployment due to technical or political complexity should be included in the assessment. A request for information (RFI) might be useful at this point.

Cell 4 -Secure Long and Short Term Funding (Planning Phase, Resource Identification Step): The goal of this cell is to identify all the elements that are needed for deployment (e.g., skills and knowledge, organization, funding, technology, political support, and public support) and potential internal and external sources for those elements (e.g., potential systems integrators, potential contractors, available in-house skills, political authorities, models of contractual relations). Plans/goals should be written into

the Transportation Improvement Plan. A Request for Proposals (RFP) should also be developed and published at this time if the intent is to have an outside systems integrator perform the work.

Cell 5 - Identify and Sound-out Potential Team Members (Planning Phase, Semantic Integration Step): The goal of this cell is to identify and communicate needs, desires, motives, values, and behaviors of all potential team members and to create a common language among the diverse disciplines involved in systems integration. If an RFP was published, then proposals in response to the RFP would be evaluated as the first activity in this cell. Following that, a glossary of terms and acronyms should be compiled and distributed along with a description of each organization, which includes personnel and their respective responsibilities. Finally, a dialogue to discuss formally and informally the project vision and personal and organizational motivations, expectations, and concerns needs to be opened, i.e., working groups with regular meetings need to be established.

Cell 6 - Structure Team Roles and Relationships (Planning Phase, Functional Integration Step): The goal of this cell is to define and create the incentive and organizational structure of the systems integration team. First, team roles, responsibilities, and relationships are defined. Second, accountability and incentive structures are created. This process may involve considerable negotiation among the parties involved.

Cell 7 - Define Procedures and Duties (Planning Phase, Technical Integration Step): The goal of this cell is to create and define logistics, benchmarks, contractual agreements, duties, procedures, meeting schedules, and the like. This task should be a mutual effort on the part of all parties to increase understanding and team support of the project. The effort must include the accountability, incentive and disincentive structures set out in Cell 6.

Cell 8 - Sign Contract(s) Between Public Agency/Agencies and Systems Integrator(s) (Planning Phase, User Integration Step): The goal of this cell is to review, confirm and sign key contractual agreements necessary to begin deployment. This includes hiring additional staff within the public organization if needed.

Phase 2 - Design

Cell 9 - Assess Problem in Detail (Design Phase, Situation Audit Step): The goal of this cell is to assess in detail the specific functional and technical issues, both human and mechanical, of the system as it currently exists and as it is intended to exist. These issues should be related to the greater environment assessed during the Situation Audit in the Planning Phase. Assessment of issues related to execution of available approaches (identified in Step 3 of the Planning Phase) should be emphasized.

Cell 10 - Specify Goals in Detail (Design Phase, Needs Analysis Step): The goal of this cell is to complete in detail the assessment of needs that was begun in the Planning Phase and to specify goals in detail. Needs related to the process of transferring the current system into a new integrated system using the approaches identified during the Planning Phase should be emphasized.

Cell 11 - Specify Approach in Detail (Design Phase, Approach Identification Step): The goal of this cell is to complete the cost, benefit, and risk assessments of the most promising approaches (technological, political, educational, etc.) identified during the Planning Phase and to select and specify in detail one or more approaches to be applied in the project. Possible modifications to and merging of available approaches should be considered.

Cell 12 - Establish Procurement Procedures (Design Phase, Resource Identification Step): The goal of this cell is select specific suppliers, internal personnel, and sub-contractors needed to deliver executables. Functional and technical specifications should be used along with specifications of the most promising approaches to assist during bid requests and internal assessment of capabilities.

Cell 13 - Define Data, Terminology, and Uses (Design Phase, Semantic Integration Step): The goal of this cell is to define in detail the data, terminology, and data uses anticipated in the project. This activity represents a continuation of the work begun in the Semantic Integration Step of the Planning Phase. Issues such as use of data for planning should be finalized.

Cell 14 - Create Functional Specifications (Design Phase, Functional Integration Step): The goal of this cell is to identify potential synergies, identify data flows (both human and mechanical), and create functional specifications for the system.

Cell 15 - Create Technical Specifications (Design Phase, Technical Integration Step): The goal of this cell is to pursue design synergies, create Technical Specifications for each approach, and finalize Interface Control Documents.

Cell 16 - Create User Group Specifications (Design Phase, User Integration Step): The goal of this cell is to create User Group Specifications for both system operators and end users.

Phase 3 – Deployment

Cell 17 - Review and Approve Final System Design (Deployment Phase, Situation Audit Step): The goal of this cell is to match all the identified needs of the situation with the functions of the new system design. Designers must identify functional elements to be changed within the new design to better address the needs. If significant changes are needed, the activities in the Planning Phase should be repeated.

Cell 18 - Develop Detailed Implementation Schedule (Deployment Phase, Needs Analysis Step): The goal of this cell is to synchronize deployment schedule and funding availability. Effort should be made to identify synergistic opportunities between deployment desires and subcontractor availability and skills. The systems acceptance test should also be finalized at this point. This test should compare the system against the functional, technical, and user group specifications developed during the Design Phase. The test should also seek to identify whether or not the system appears to have the capability to meet the needs identified in the Planning Phase.

Cell 19 - Select Procurement Approaches (Deployment Phase, Approach Identification Step): The goal of this cell is to finalize procurement approaches, e.g., phased purchasing and funding.

Cell 20 – Select Hardware/Software (Deployment Phase, Resource Identification Step): The goal of this cell is to finalize hardware and software pricing, as well as delivery, installation, and service contracts.

Cell 21 - Integrate Data Within and Across Functions and Organizations (Deployment Phase, Semantic Integration Step): The goal of this cell is to review data definitions and terminologies and to translate them into complete, concise, and intelligible terms. Issues of interdepartmental use within an organization must be addressed. Inter-jurisdictional use issues must also be addressed.

Cell 22 - Specify Operation and Maintenance Procedures (Deployment Phase, Functional Integration Step): The goal of this cell is to specify Operations and Maintenance procedures in complete, concise, and intelligible terms and to integrate them with other administrative functions.

Cell 23 - Develop, Install, and Integrate Subsystems (Deployment Phase, Technical Integration Step): The goal of this cell is to procure, install, and integrate hardware and software systems. Integration with other administrative functions is also to be undertaken at this time. The integrated system must pass the Systems Acceptance Test to complete this activity. That is, the systems integrator must be able to successfully operate the system at this point.

Cell 24 - Train Staff and Educate Users (Deployment Phase, User Integration Step): The goal of this cell is for the systems integrator to train the agency staff who must operate the system and then hand off the system operation to them. Training for other system users and maintenance staff must be included.

System Kickoff

The System Kickoff is the time of adjustment and shakedown that commonly follows deployment of a new system. During this period, which in essence is a combination of the Situation Audit and Needs Analysis Steps, the system is debugged to ensure that it operates as designed and staff put their new training into practice and integrate the new system into the day-to-day operations of the organization. At the end of the kickoff period, the systems integration model spiral curves into an ongoing circle of activity.

Phase 4 - Operations

Cell 25 - Evaluate System (Operations Phase, Situation Audit Step): The goal of this cell is to determine whether or not the fully functional system actually resolves the list of needs identified during Planning and Design Phases. (If the integrated system successfully passed the systems acceptance test, then it can be said to work as it was designed to work. However, due to uncertainties regarding the system, human, and organizational behavior, etc., a system that meets all specifications still might not meet the felt need.)

Cell 26 – Reassess Goals (Operations Phase, Needs Analysis Step): The goal of this cell is to revisit the original goals and determine if they are still valid and/or sufficient.

Cell 27 - Reassess Approaches (Operations Phase, Approach Identification Step): The goal of this cell is to continue to research and identify approaches to maintain and improve the system. The question to be asked: Is there a new and better way to accomplish the goals? (The line between an approach and a resource is often blurred and can include new funding sources, emerging technologies and approaches, new legal/political avenues, and so on.)

Cell 28 - Reassess Resources (Operations Phase, Resource Identification Step): The goal of this cell is to continue to research and identify resources to maintain and improve the system. The question to be asked: Is there a new and better way to accomplish the goals? (The line between an approach and a resource is often blurred and can include new funding sources, emerging technologies and approaches, new legal/political avenues, and so on.)

Cell 29 - Adapt to New Data Needs and Uses (Operations Phase, Semantic Integration Step): The goal of this cell is to be actively aware of changing needs and emerging opportunities and flexible enough to adapt to new data needs and uses.

Cell 30 - Maintain and Update Procedures and Services (Operations Phase, Functional Integration Step): The goal of this cell is to continue maintaining and updating procedures and services.

Cell 31 - Maintain and Upgrade Equipment (Operations Phase, Technical Integration Step): The goal of this cell is to continue maintaining and upgrading equipment.

Cell 32 - Reach Out to Users (Operations Phase, User Integration Step): The goal of this cell is continued outreach to all current and potential (direct or indirect) users of the system.

APPLICATION OF THE SYSTEMS INTEGRATION MODEL

The Systems Integration Model laid out in this report provides a disciplined approach that coordinates the traditions of traffic management with those of systems engineering and integration. The Model is intended as a guide to help State and local transportation planners and managers deploy complex systems, such as ITS, by alerting them to potential systems integration issues and solutions. Private systems integrators, or private planners under contract to help the public agency select and monitor a systems integrator, should also find the guide useful as a mechanism to better understand and communicate with their public agency clients. Simply put, the model can act as a platform for conveying systems integration to public officials and for facilitating mutual understanding between the public agencies and private companies, which often have different perspectives on the integration process.

In the initial stages of a deployment project the broad strokes of the model "spiral" are useful as an overview of the integration process to help project managers, and other decision makers within a public

agency, set the course of the project and negotiate with potential partners. Once the project is underway, the descriptions within each cell of the model can be used by less senior members of the project team as a mechanism to identify potential problems and their solutions and so keep the project on track and on time. Moreover, the model can be used as a graphic checklist to track progress toward a successful systems integration project.

A world wide web-enabled version of the Systems Integration Model has also been developed. The first goal in creating the web version was to further clarify and promote the systems integration process outlined here. The second goal of the web-based version of the model is to enable a broader audience of transportation practitioners to have access to these guidance materials. The third goal is to invite feedback from practitioners as to lessons learned during the systems integration process, whether the model was followed or not, and feedback as to how the model could be improved. Attachment A presents a set of key graphics from this version of the model.

ACKNOWLEDGMENT

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Attachment A: Web-Version of the Systems Integration Model

To provide more convenient access to the Systems Integration Model, an interactive web-based version of the model was developed using Macromedia Flash. This attachment displays a number of screenshots from this version of the model. A floppy disk containing the software version of the model is also included with this report. Since the figures presented here duplicate the information covered in the body of this report, and since the figure titles should be self-explanatory, no further description is included in this attachment.

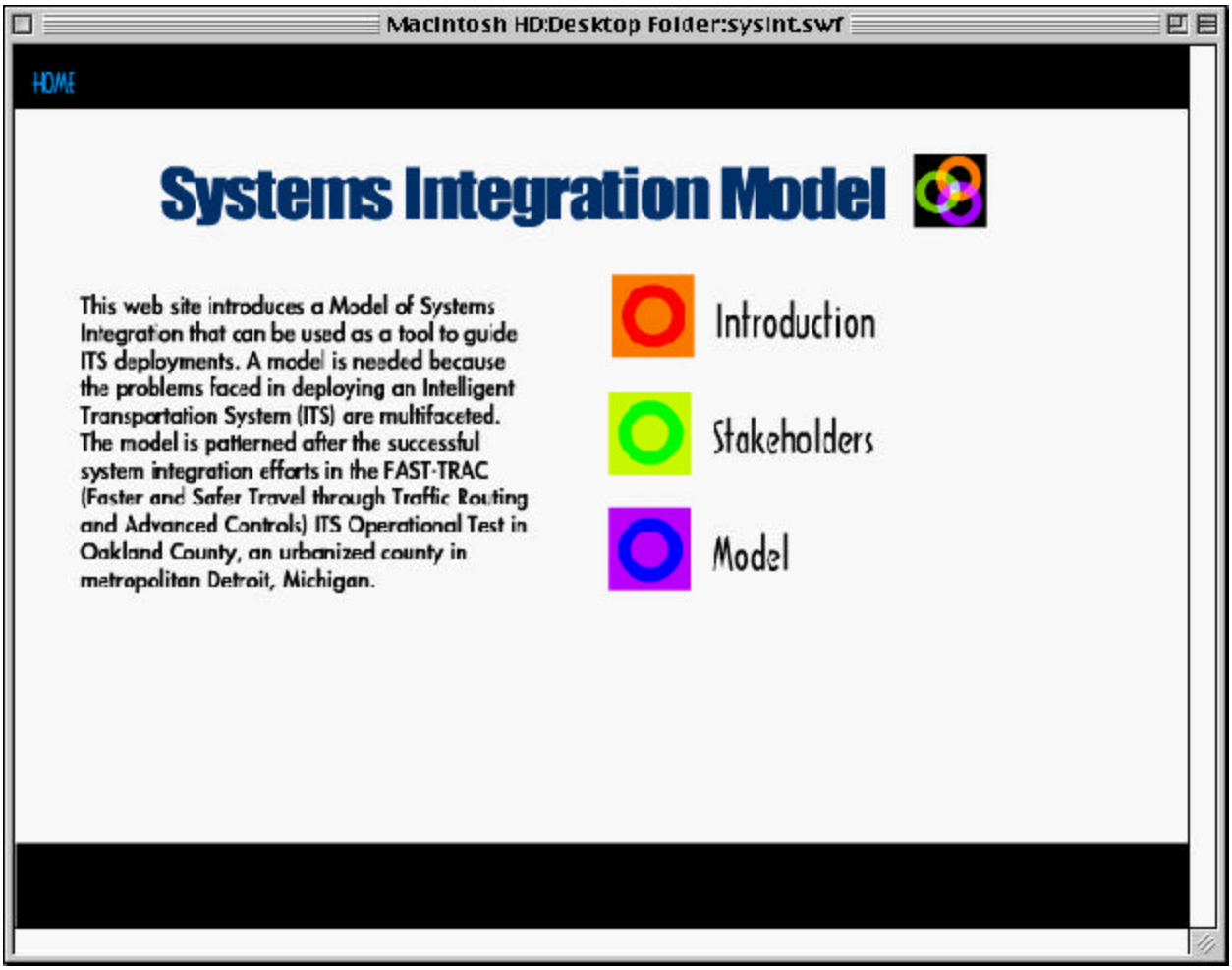

Figure A1: Home Page of the Software Version of the Systems Integration Model

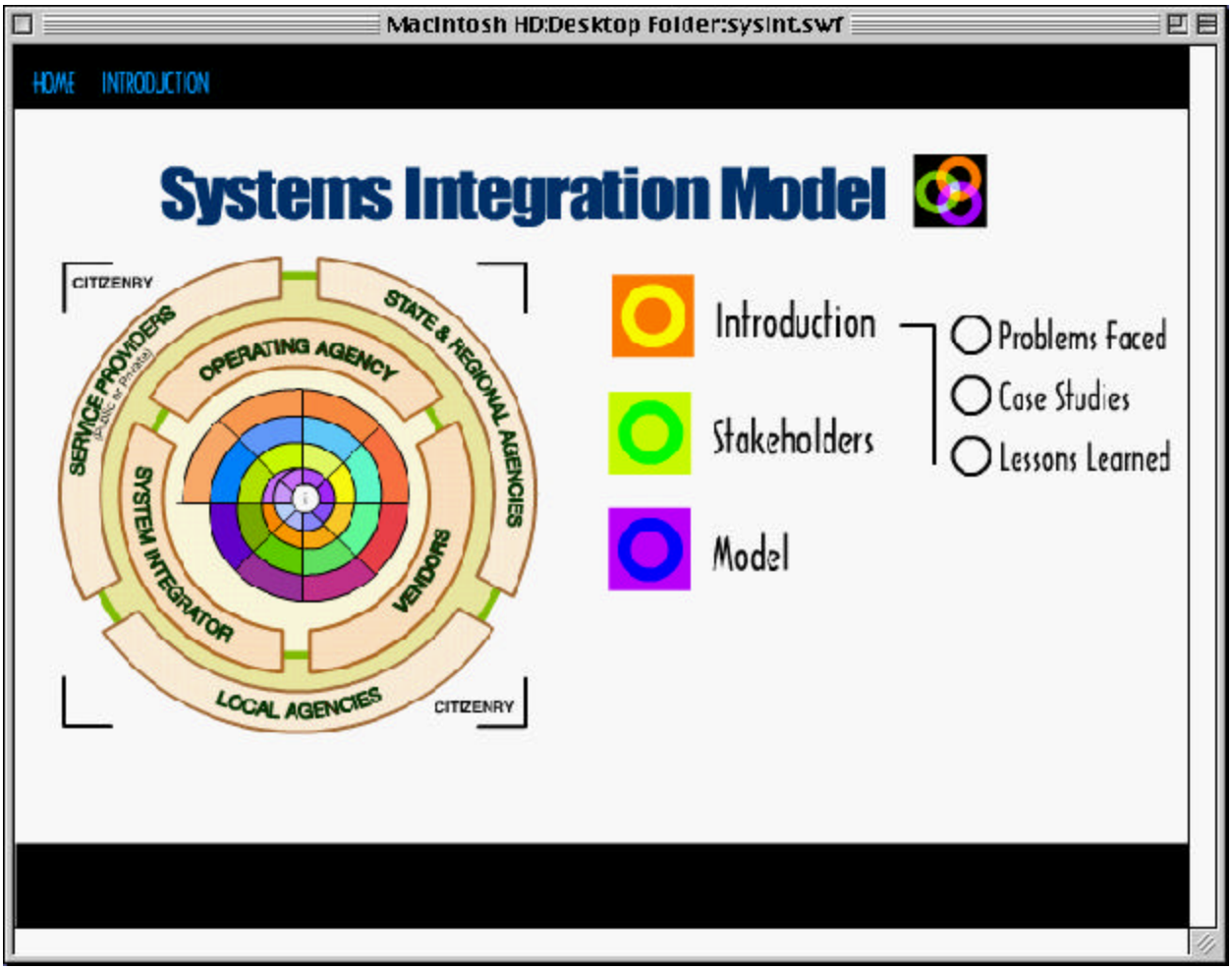

Figure A2: Home Page: Introduction Icon Selected

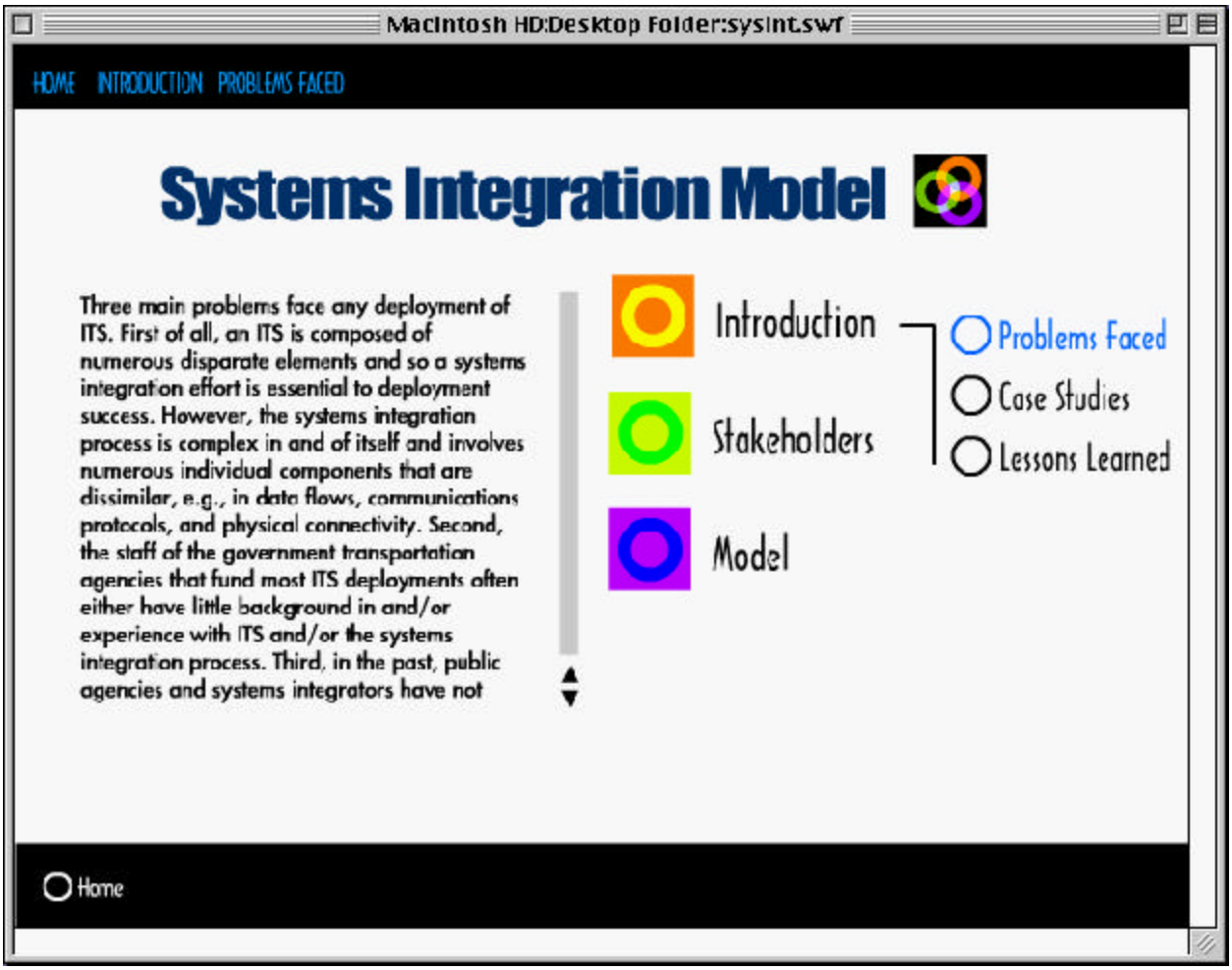

Figure A2-1: Home Page: Introduction Icon Selected: Problems Faced Selected

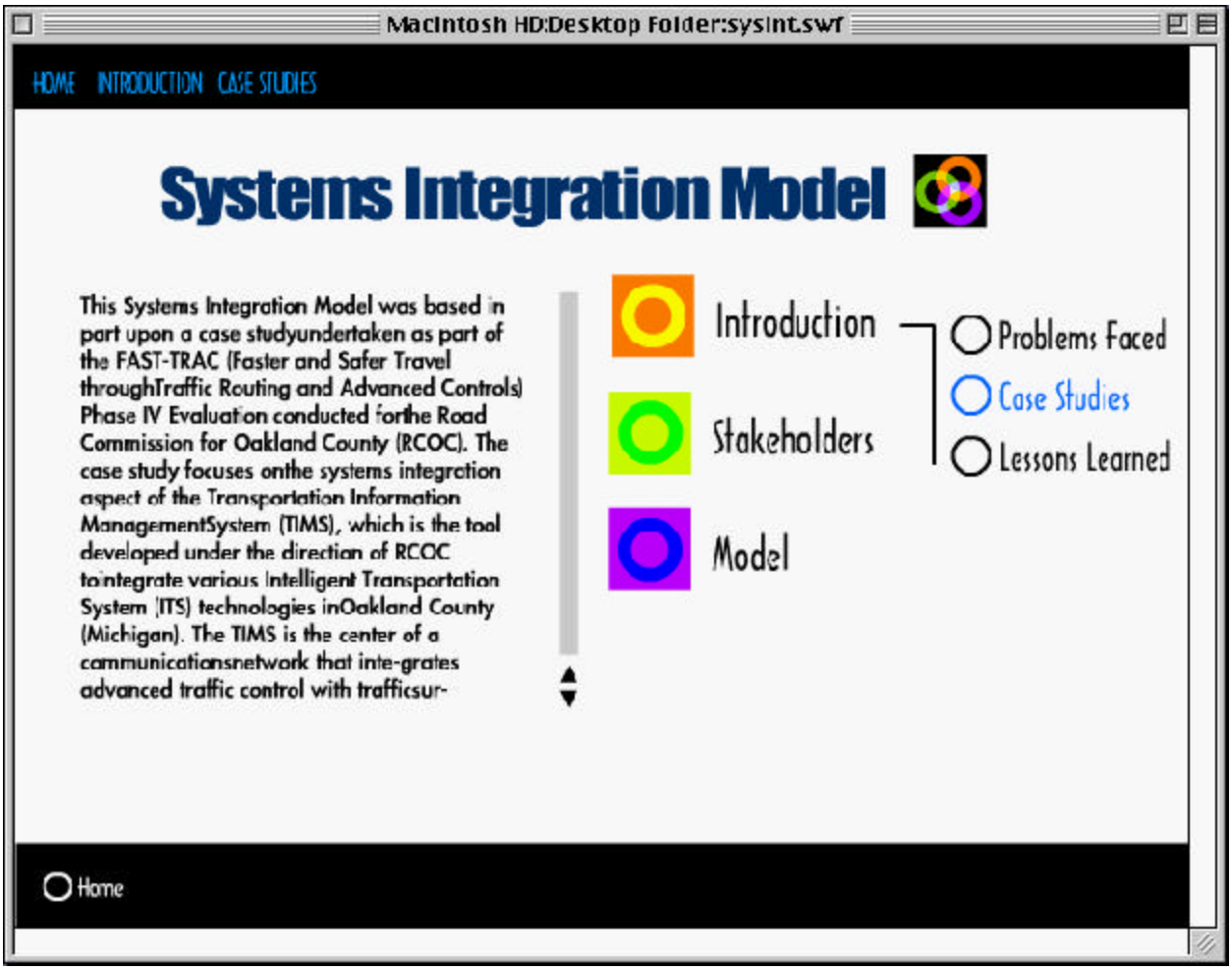

Figure A2-2: Home Page: Introduction Icon Selected: Case Studies Selected

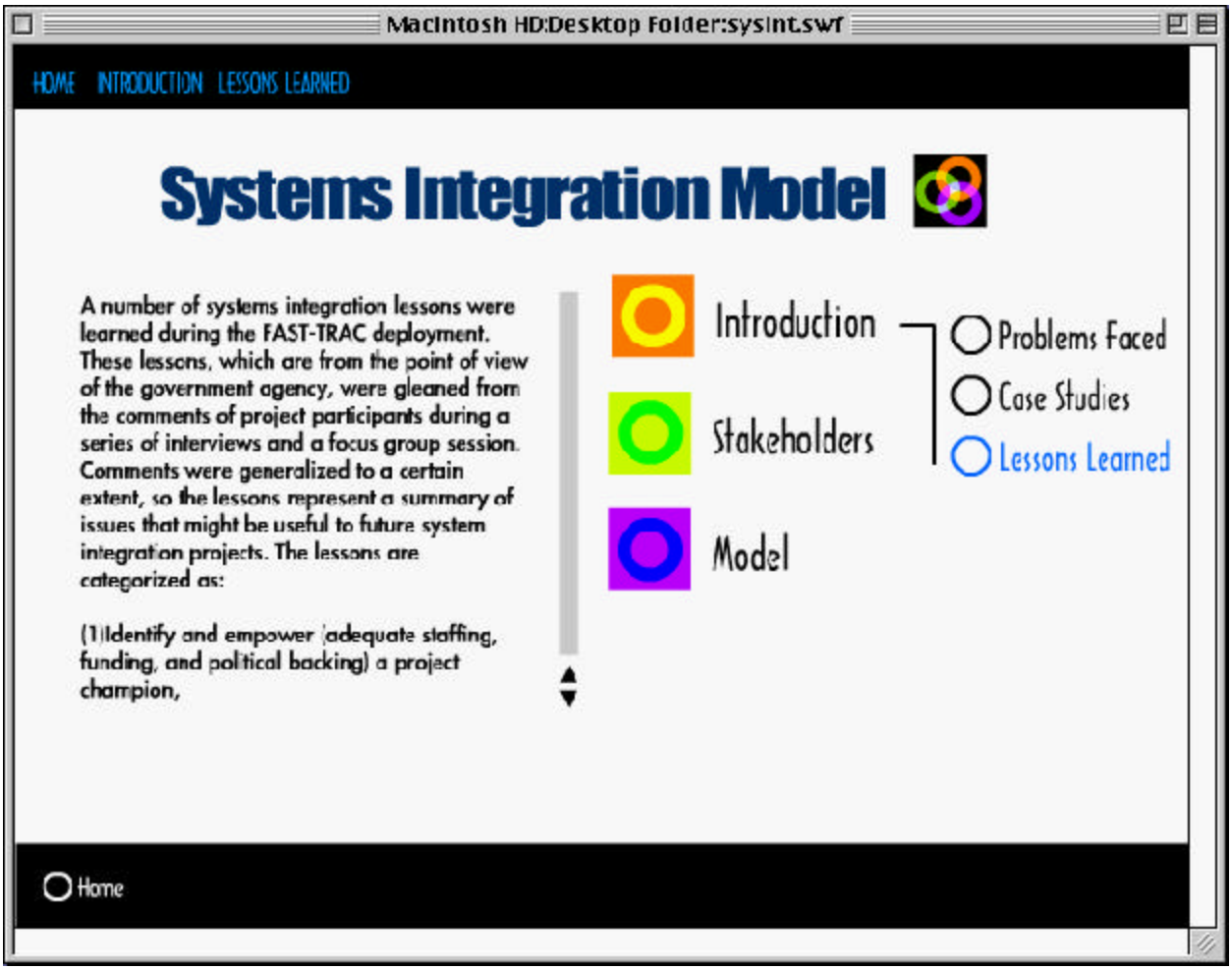

Figure A2-3: Home Page: Introduction Icon Selected: Lessons Learned Selected

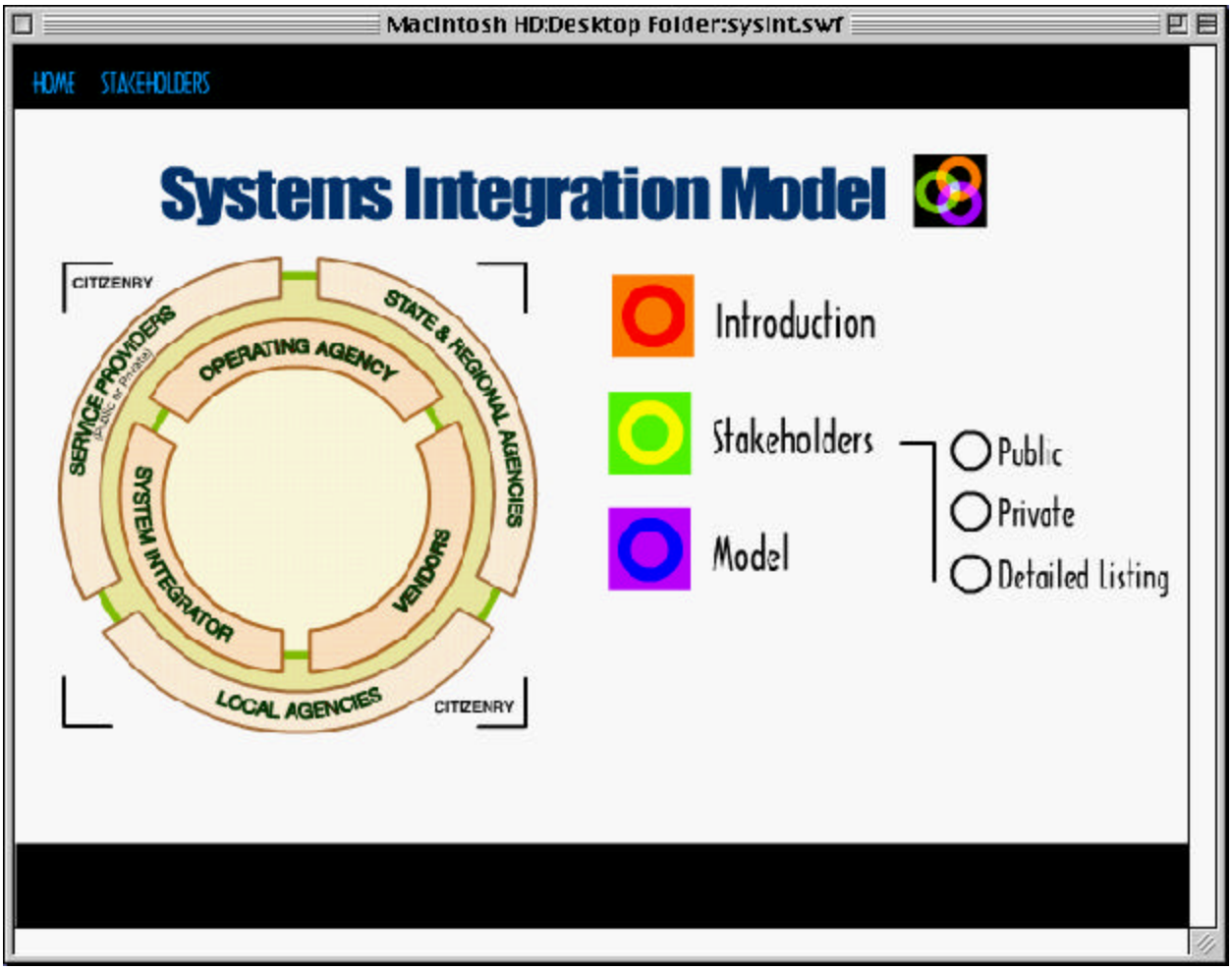

Figure A3: Home Page: Stakeholders Icon Selected

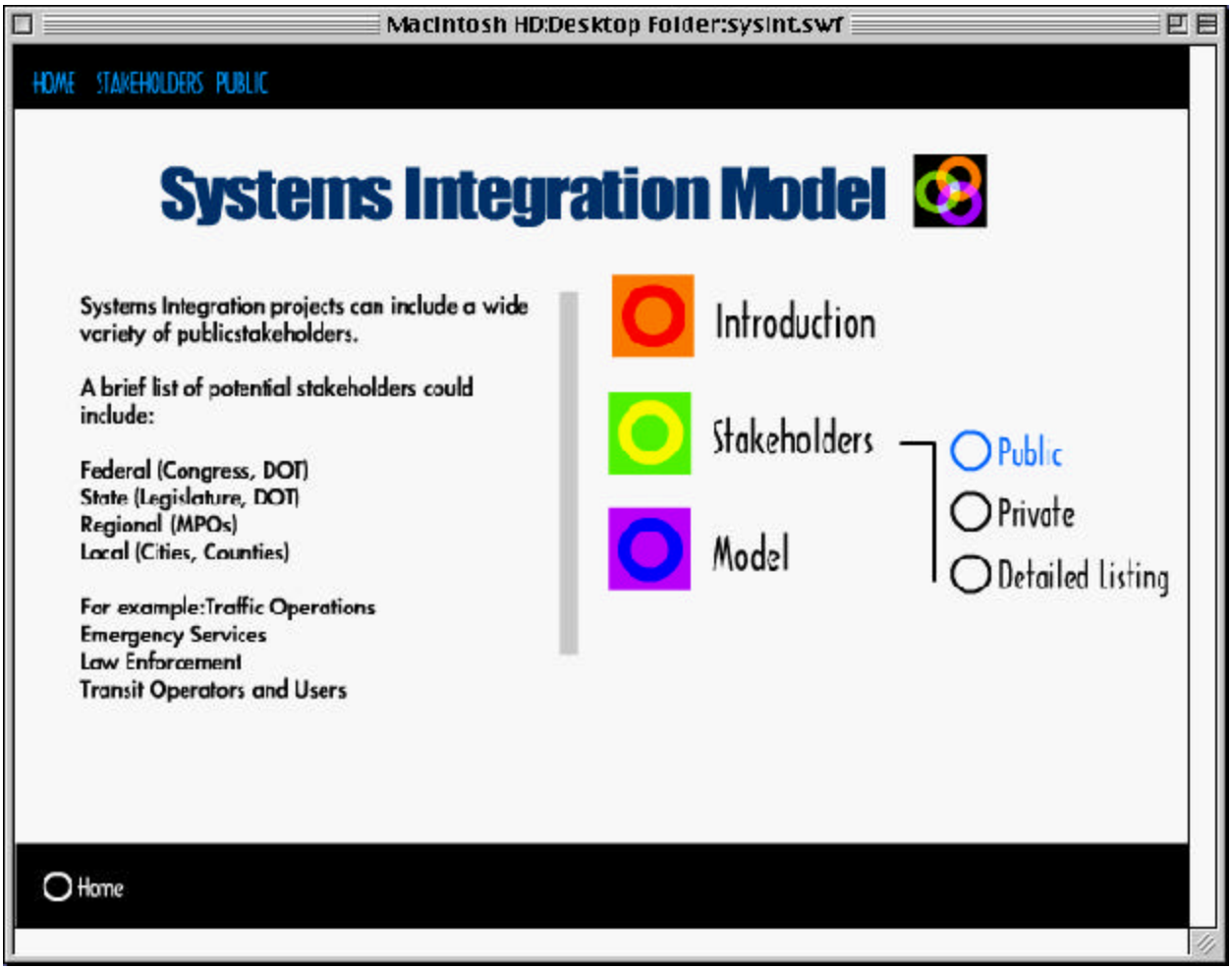

Figure A3-1: Home Page: Stakeholders Icon Selected: Public Selected

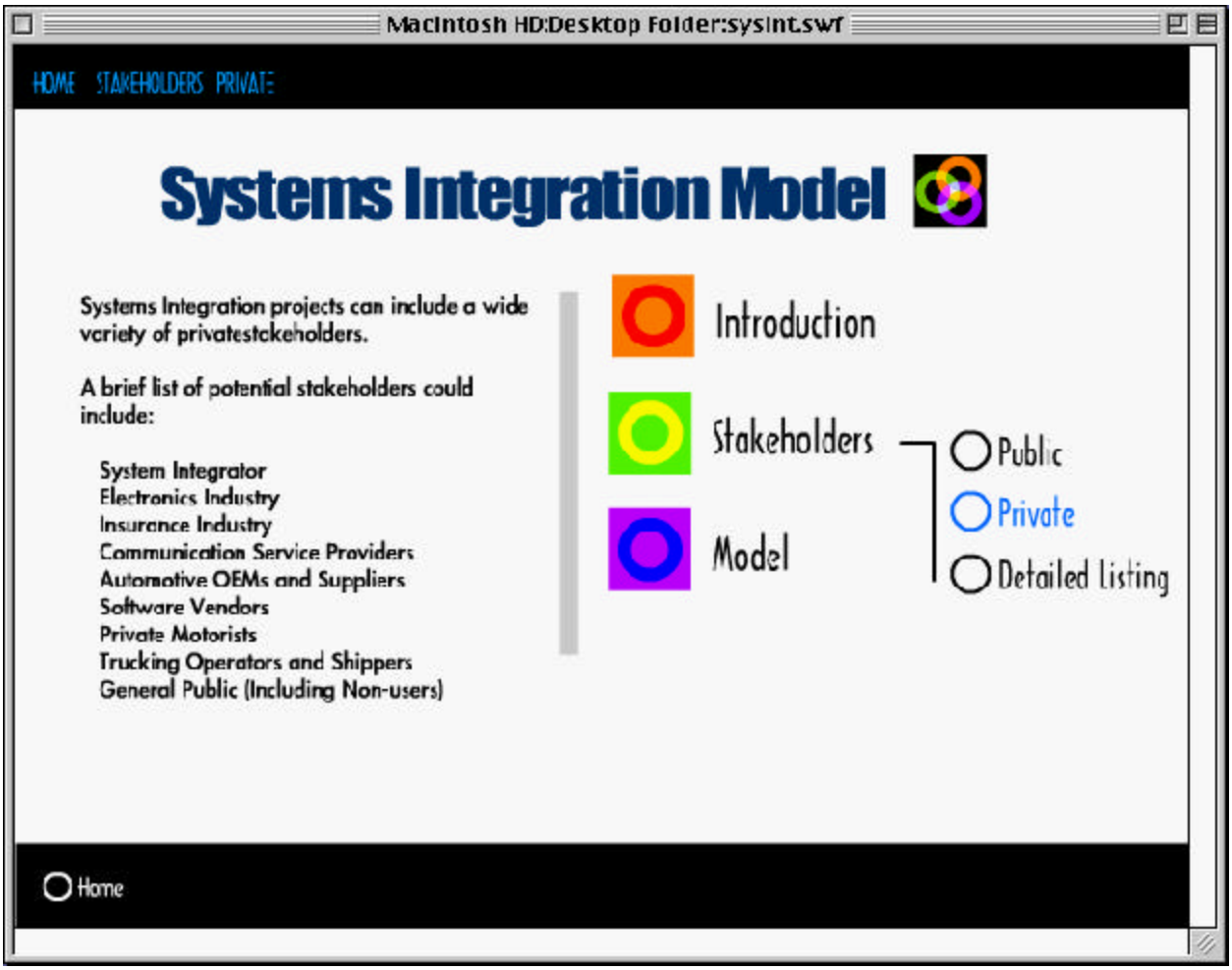

Figure A3-2: Home Page: Stakeholders Icon Selected: Private Selected

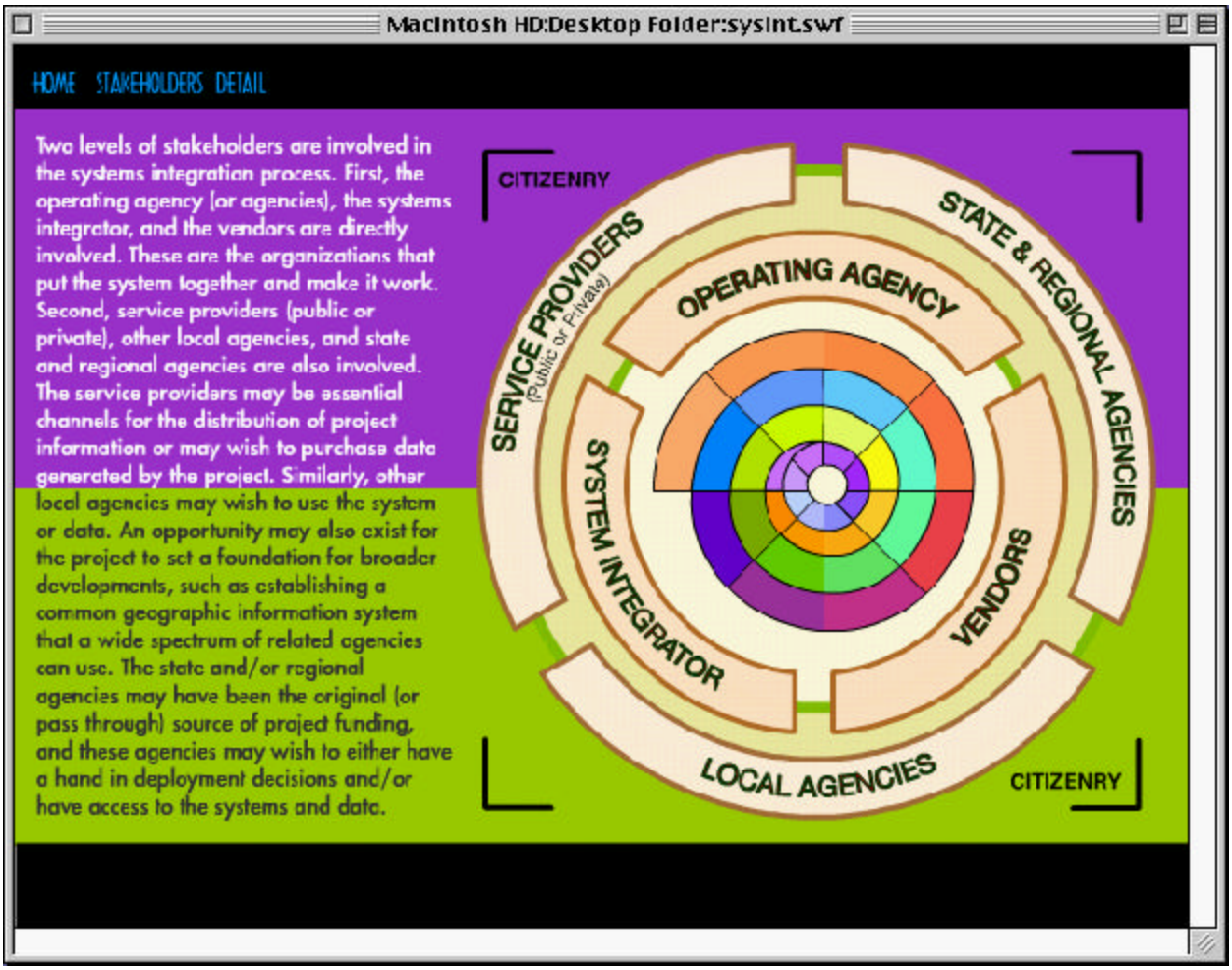

Figure A3-3: Home Page: Stakeholders Icon Selected: Detailed Listing Selected

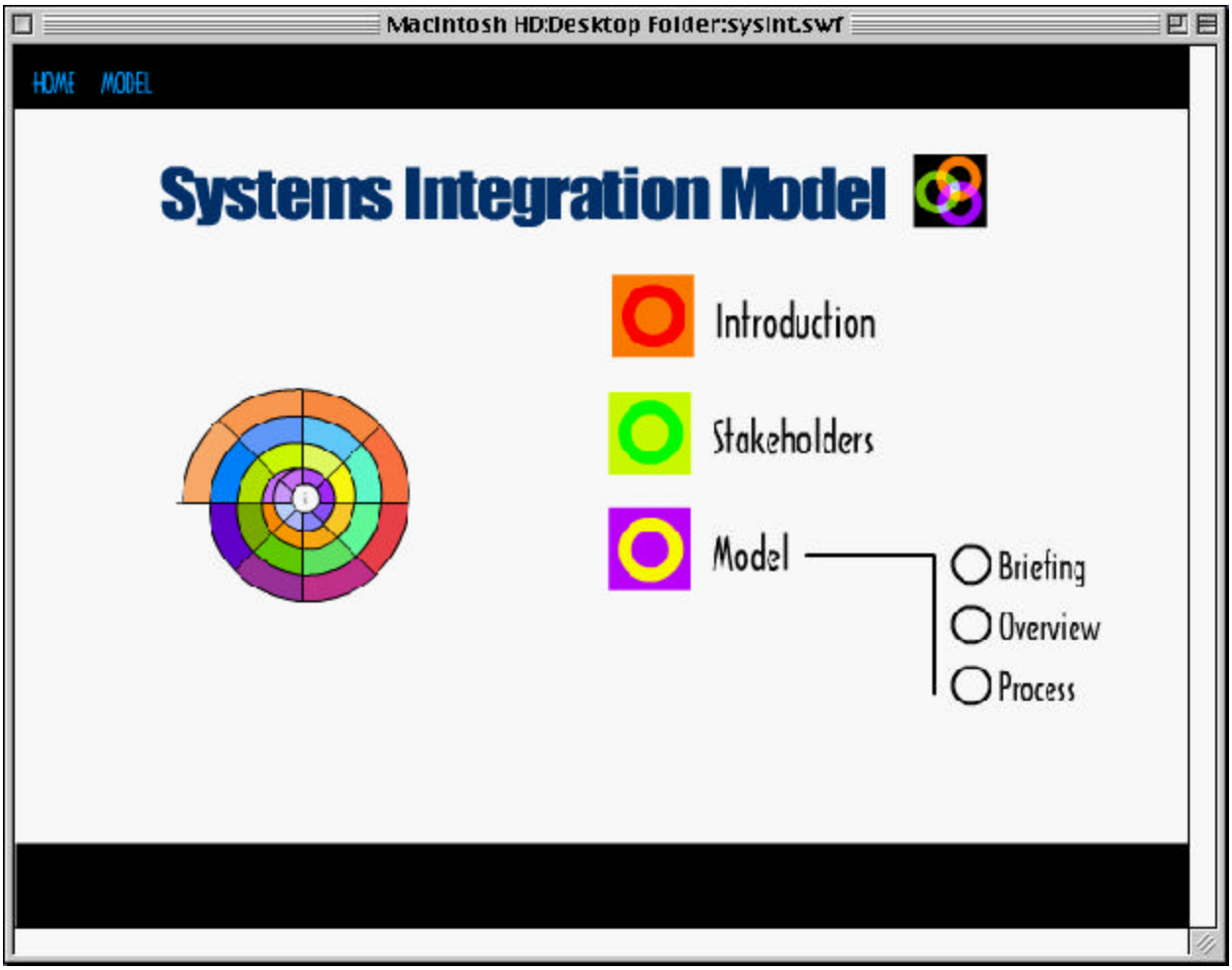

Figure A4: Home Page: Model Icon Selected

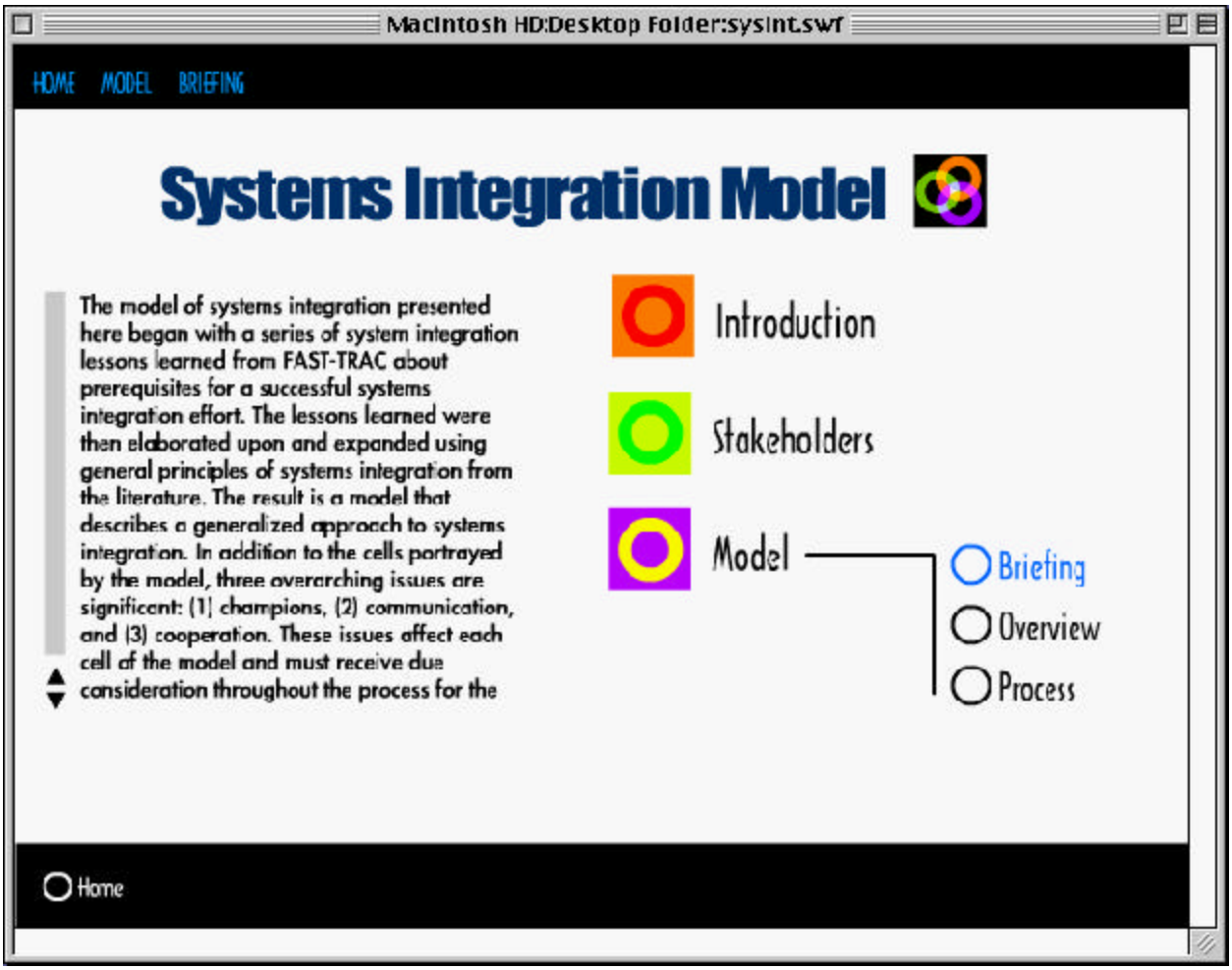

Figure A4-1: Home Page: Model Icon Selected: Briefing Selected

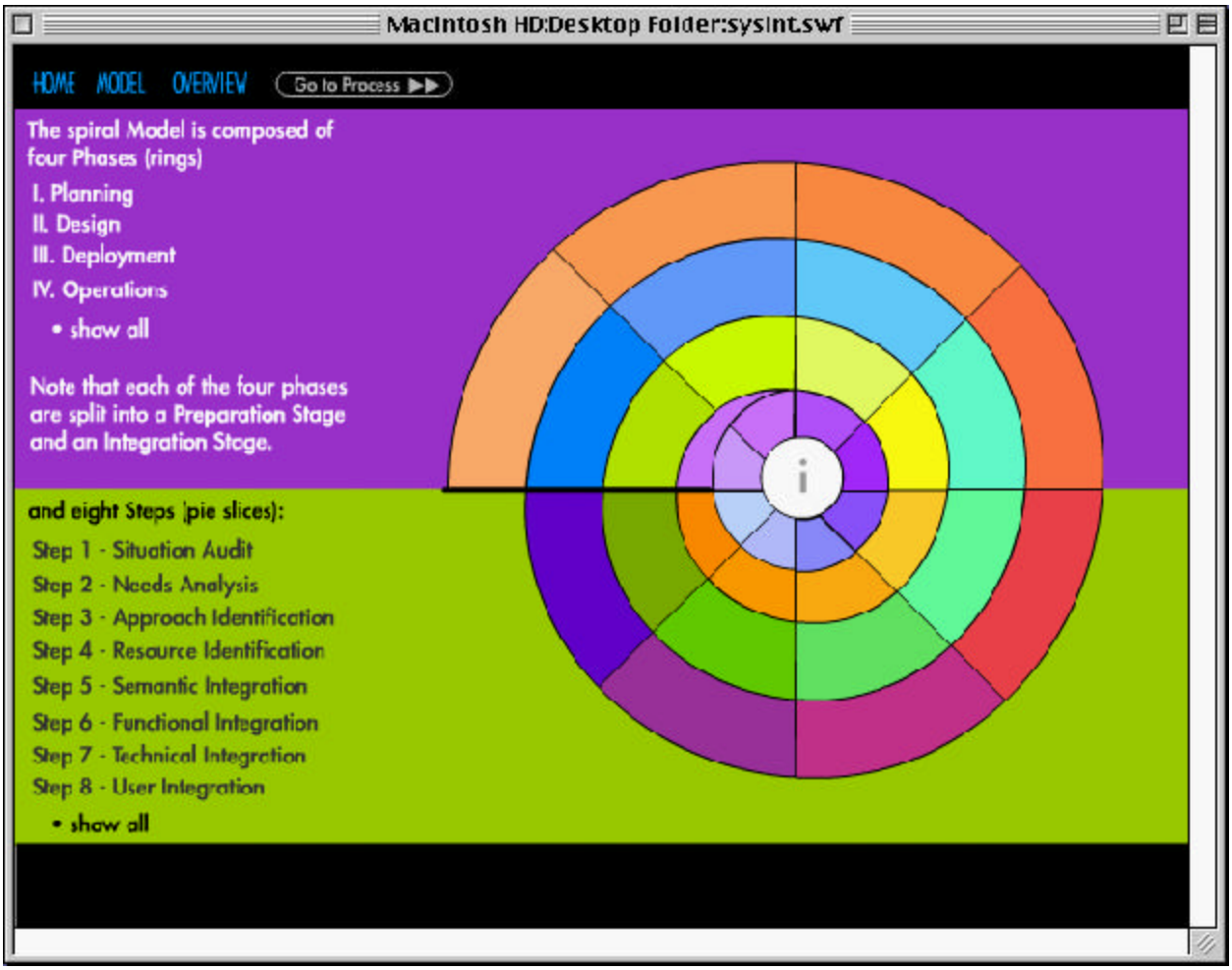

Figure A4-2: Home Page: Model Icon Selected: Overview Selected

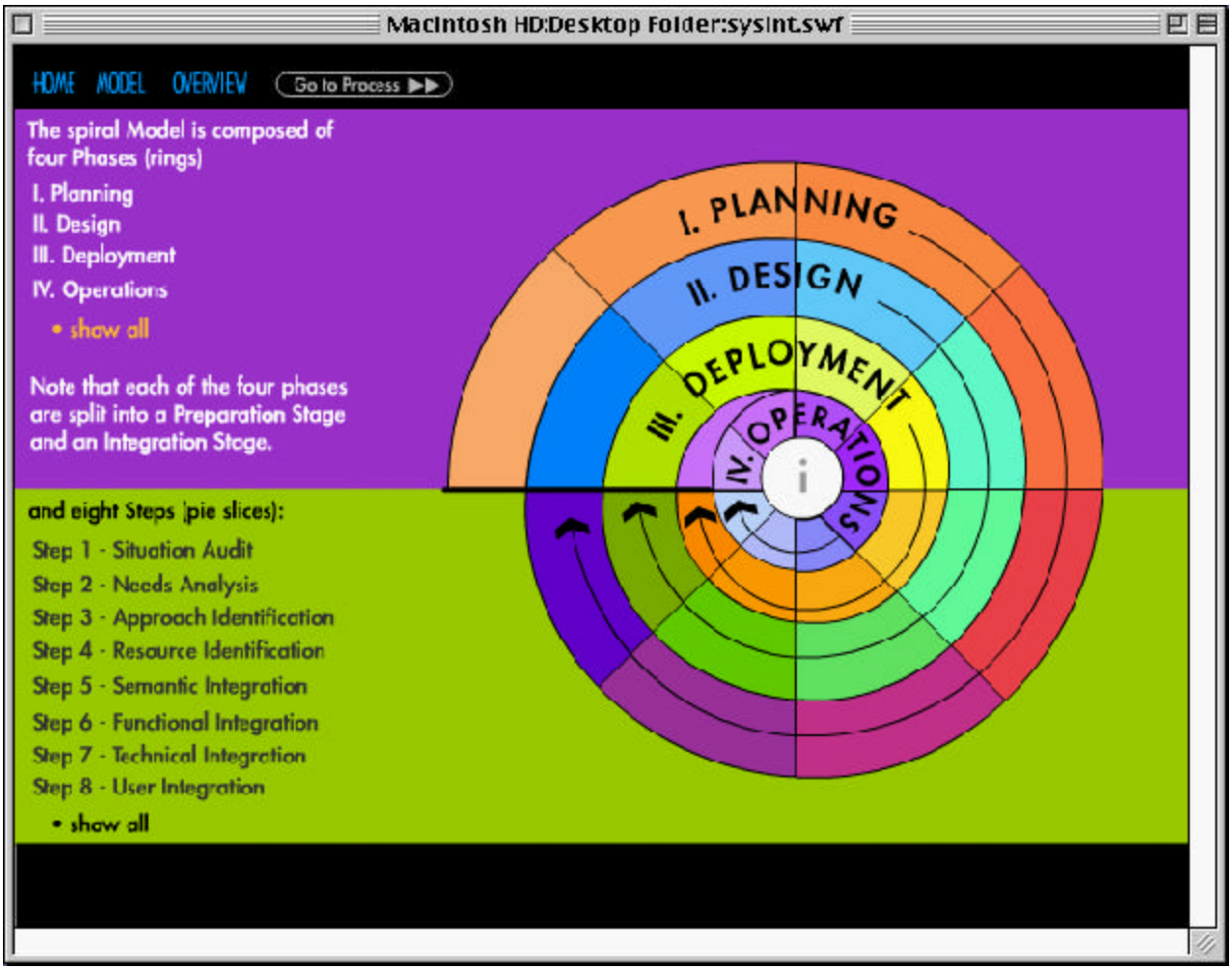

Figure A4-2-1: Home Page: Model Icon Selected: Overview Selected: Show All Model Phases Selected

(Note that the items on the left can be selected to display more information relevant to that topic.)

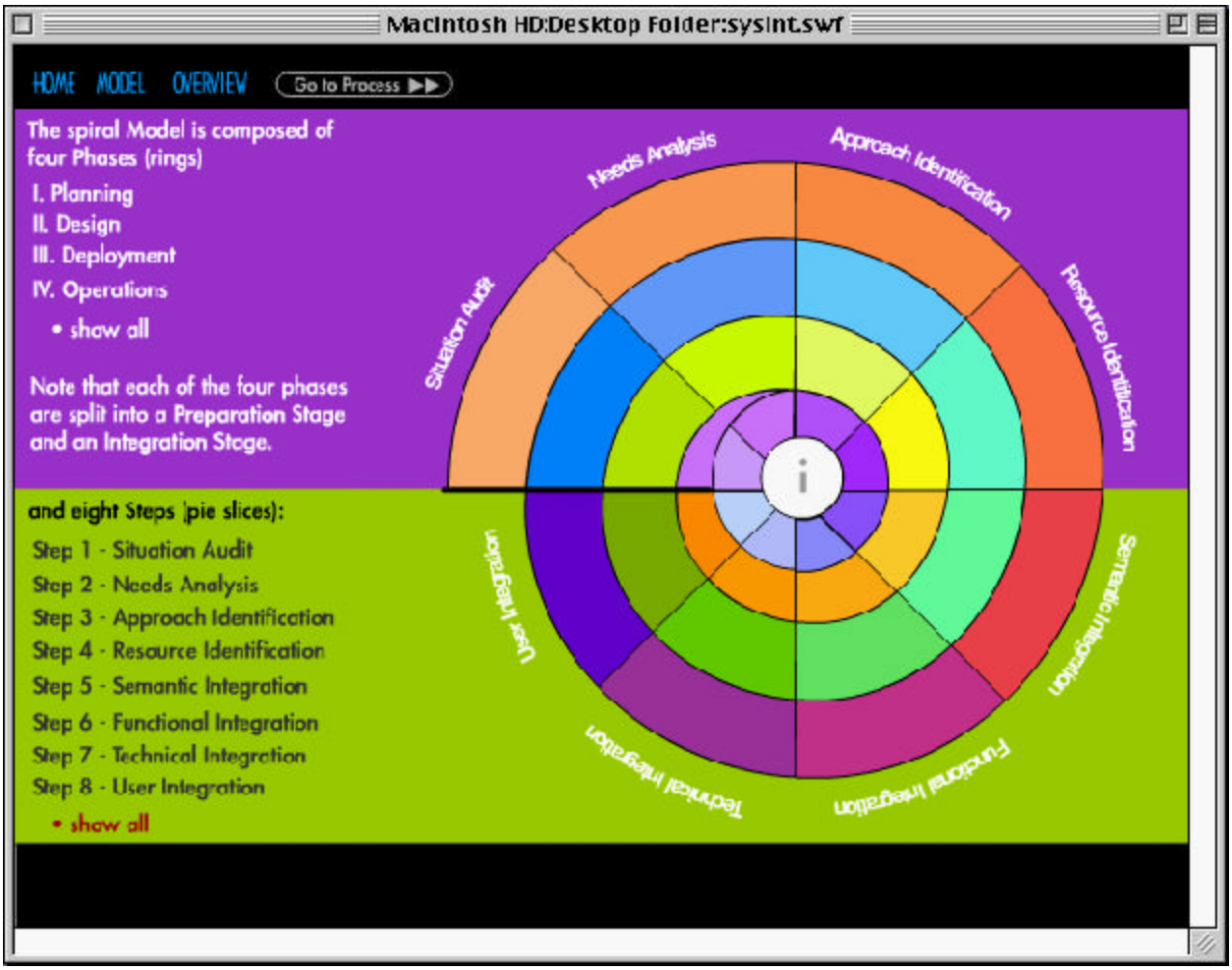

Figure A4-2-2: Home Page: Model Icon Selected: Overview Selected: Show All Pie Slices Selected

(Note that the items on the left can be selected to display more information relevant to that topic.)

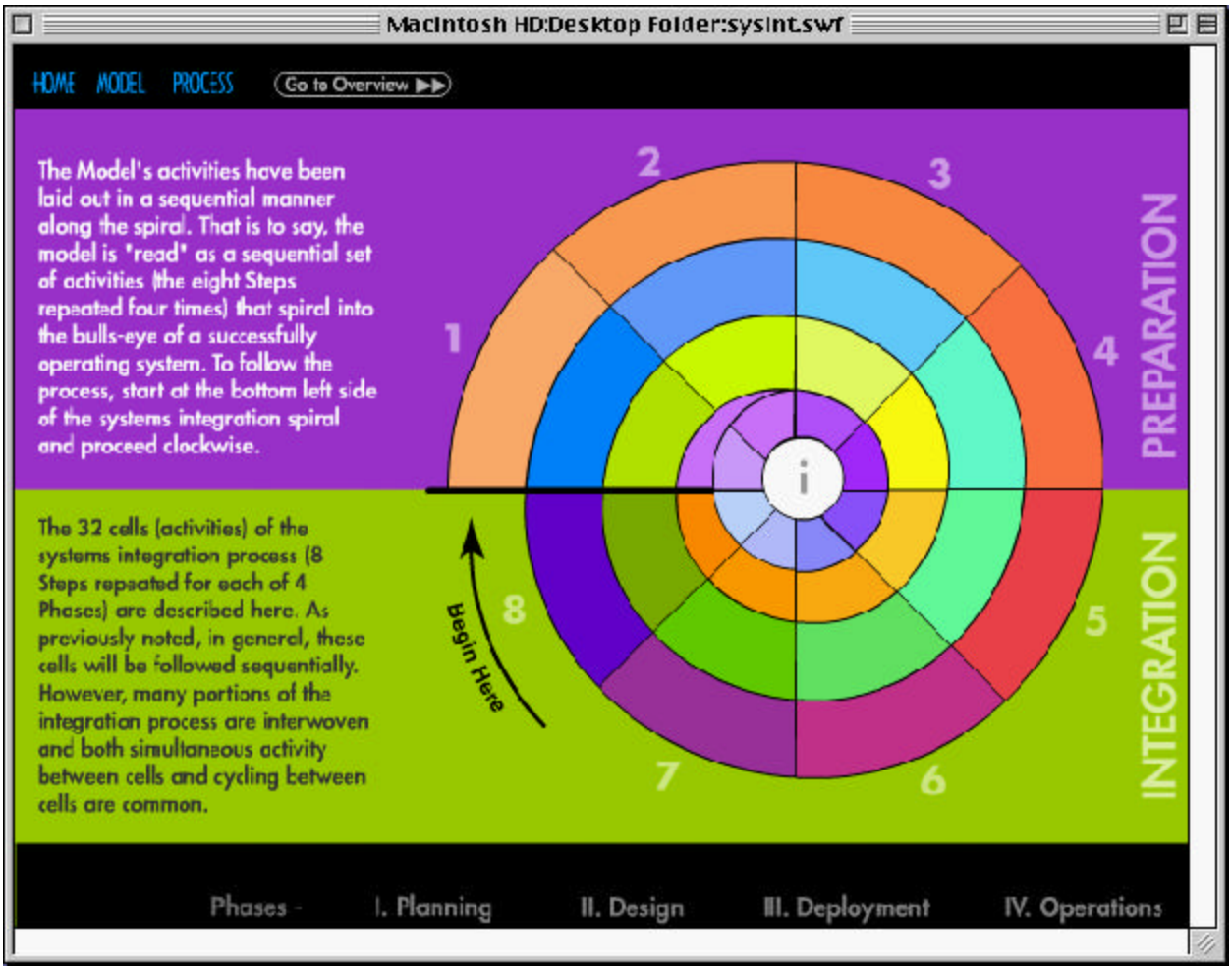

Figure A4-3: Home Page: Model Icon Selected: Process Selected

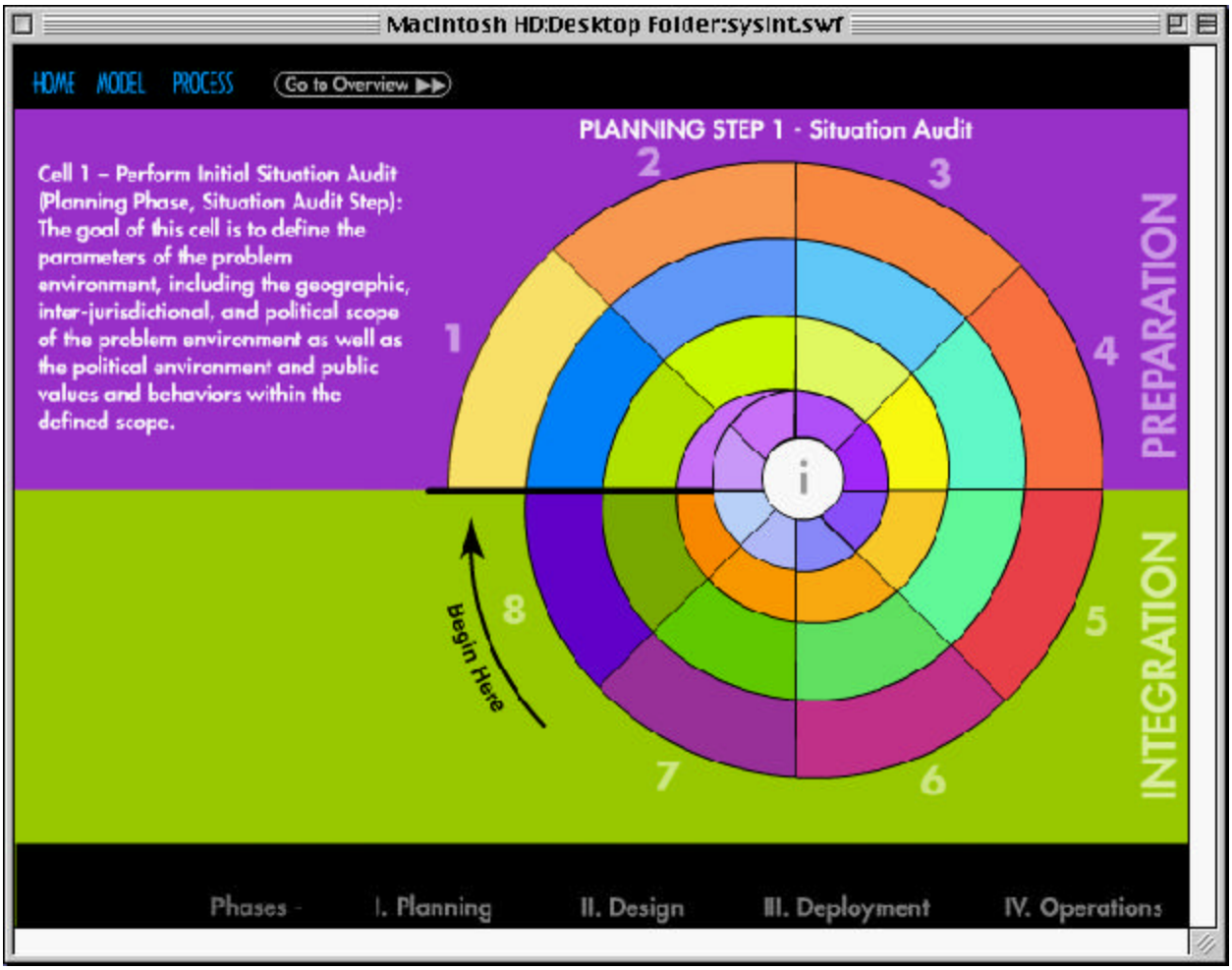

Figure A4-3-1: Home Page: Model Icon Selected: Process Selected: Cell One Selected
(Note that any cell of the spiral can be selected to
display more information relevant to that topic.
The same is true for many of the other blocks of text
on this page of the interactive model.)