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Collaboration in Regional Civilian and Military Transportation Planning

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Abstract

The Strategic Mobility 21 (SM 21) Program[1] is investigating new concepts for improving the utilization of the strategic ports in Southern California for military and civilian purposes. Among project goals are justifying the building of new regional transportation infrastructure to both double the present throughput of container shipments through the ports as well as efficiently support the surge deployment and sustainment of US military combat assets through the ports. This paper describes how the SM 21 program is using web-based collaboration technologies including wikis, blogs; and Modeling, Simulation and Analysis connectivity to address two key program areas: a regional planning interface that makes data, models, and analyses available to all stakeholders in an interactive and configurable manner and a specific interface that enables collaboration between military land transportation planners and military ship load planners. A goal of both efforts is to make significant improvements in both how information is shared and how the consequences of different courses of action are explored.

[**Note to reviewers of this initial draft:** This paper reports on on-going work. By the end of April 2007 this year's work will be finished and there will be much more to report on. By the end of March 2007, the development of software will have been completed - in time better describe the results in the final draft due on 2 April 2007. There are notes in this initial draft describing expected enhancements to be added in the final draft.]

[1] This research was supported by the Office of Naval Research under contract number xxxxxx[to be supplied in final draft]

1 Introduction

The Strategic Mobility 21 (SM 21) Program is investigating new concepts for improving the utilization of the ports in Southern California for military and civilian purposes. Project goals include:

1. conducting experiments and demonstrations of advanced logistics and transportation concepts, such as net enabled logistics;
2. assuring access to the ports of Los Angeles and Long Beach by the US military for surge deployment and sustainment distribution; and
3. developing a planning infrastructure to study alternative regional transportation concepts that can significantly increase the present throughput of container shipments through Southern California.

Among the concepts being investigated by SM21 is a new type of dual-use (military and civilian) facility called a Joint Power Projection Support Platform (JPPSP). If the concept proves feasible, the first JPPSP would be located at the Global Access facility that includes the Southern California Logistics Airport (SCLA) being built on the site of the former George Air Force Base near Victorville, California (http://www.logisticsairport.com/). This JPPSP would function as an "inland port", playing an important role in both commercial goods movement in the region as well as in staging and moving military equipment and supplies to the ports.

The SM21 program believes that significant changes in both business processes and in functional capabilities will be required to achieve project goals and justify the creation of the first JPPSP. Specifically:

1. The ability of all stakeholders to better understand and evaluate alternative transportation and logistics concepts should be enabled by the creation of an effective collaborative environment for regional planning.

2. The impact of military usage at the ports on simultaneous civilian use must be significantly reduced by implementing new processes for loading military equipment onto strategic sealift ships as well as the transportation of that equipment to the ports.

This paper describes a "web portal" developed by the SM21 program to achieve the above objectives.

2 The opportunity

2.1 Regional planning

Today, collaborative regional planning takes place over long periods and is based upon stakeholders reviewing "paper" reports produced by contractors. Each report typically takes 12 to 18 months to produce. The underlying data and assumptions in these reports are almost never made public, hindering the ability of others to understand the results and how these results were derived. There is an urgent need to change the situation by establishing a collaborative environment where all data, models, simulations, and analyses are publicly available for scrutiny along with the results derived by them.

Interested parties who read the research as well as the collaborators participating in the research require the ability to modify input data and model assumptions and to rerun any underlying simulations or analyses and compare the results with previous runs. Publishing research as a static report makes such a capability unavailable.

The SM21 program has realized that today's technology presents an opportunity to change completely the nature of the regional planning process. Planning products can now be living documents, created and published on collaborative web portals. The publications can be "live" in the sense that important information needed to create them as well all the modeling, simulation, and analysis tools used in their creation can be made available to stakeholders. In particular, far-reaching exploration of alternative future concepts for goods movement from the ports of Los Angeles and Long Beach into and through the Southern California region can be investigated and understood, hopefully leading to an understanding of the role that a JPPSP in Victorville would play in the region.

2.2 Military transportation planning

Today, military deployments can have a major impact on the operations of a busy commercial port, such as the port of Long Beach. When a unit such as a Stryker Brigade Combat Team (SBCT) is deployed through such a port, all of the unit equipment is moved to the port and stored there before loading operations begin. The result is that between 20 and 30 acres of valuable on-dock space is occupied by military equipment. After all the deploying equipment is staged at the port, ship loading operations are initiated without employing the full loading capability of the ship, a situation that typically adds days or more to the total loading time.

The SM21 program has realized that by applying today's technology together with some process improvements, the development of a small amount of new software, the development of a few new interfaces, and the presence of a JPPSP that can serve as a "buffer", the current situation can be substantially improved, once again allowing the US military assured access to important strategic ports. This opportunity can be created by coordinating ship and rail/convoy planning in such a way that equipment arrives at the port "just in time" and in the correct order to be loaded onto a ship. As a result, the on-dock acreage required is reduced to 5 acres or less and the entire ship loading process can be accomplished less than two days.

2.3 Technology

In the past, tools to support collaboration have been scattered, special-purpose, and not well-integrated [FOUS]. For example, in our previous research [CARS], we used a single tool (a wiki) that we integrated ourselves with Instant Messaging and e-mail to conduct a study of collaboration in a joint forces planning environment. Today, well-integrated and highly functional suites such as Microsoft Office supported by SharePoint Server 2007 can connect people, process, and information together with a seamless set of integrated tools [MICR]. This makes it possible to deploy collaborative environments to support virtual organizations with minimal custom software development. We can now integrate collaboration, portals, search, content management, processes and forms, and intelligence with minimal effort and focus our research on providing value-added integration with legacy COTS and GOTS products.

3 Related research

Effective collaboration among disparate parties in a networked environment is viewed as a critical in the DoD's vision of network centric operations [ALBE1], [ALBE2]. Scott and others [SCOT] have evaluated the effectiveness of traditional commercial collaboration technologies such as email, instant messaging, video and desktop conferencing in a military command and control environment focusing on achieving activity awareness in on-going activities. Our present research differs in that we are looking at longer-term collaborations that take on the order of weeks or months to accomplish and that require access to substantial amounts of supporting data and information as well as to modeling, simulation and analysis tools.

Many papers, notably Fouss and Chang [FOUS] have developed taxonomies and classifications of collaborative tools. Among these tools, wiki technology has been widely evaluated by ourselves and others as a tool to support collaboration. Scott and his collaborators reported that "Wiki-style collaborative efforts work within communities of users because they establish systems of trust and reputation" [SCOT]. The well-known Wikipedia project started in 2001 and currently the English edition contains about 1.4 million articles, contributed by volunteers from all over the world [WIKI]. The GSA has developed the wiki-based COLAB [GSA], an open collaborative work environment (CWE) to support networking among communities of practice and demonstrated its effectiveness in several complex collaborative developments. Our own past research [CARS] developed linguistic techniques for evaluating the effectiveness of ongoing collaborations. The present research is distinguished because it incorporates wikis, blogs, discussion lists, and similar types of web-based collaboration and information tools as one element of an integrated approach to support collaborative work.

The UrbanSim work of Alan Borning and others at the University of Washington (http://www.urbansim.org/) uses a custom code base that emphasizes behavioral theory, using an explicit treatment of individual agents such as households, jobs, and locations, and to a micro-simulation of the choices that these agents make over time [BORN]. It consists of a set of interacting component models that simulate different actors or processes within the urban environment. This approach is complementary to ours. Our Modeling, Simulation, and Analysis approach concentrates on integrating widely used tools and approaches in time-domain simulation (such as Arena [AREN]), cost based optimization of transportation systems (such as MATLOG used with MATLAB [MATL]), and traditional economic cost modeling using business intelligence tools such as Microsoft Excel [EXCE]. Also, the approach taken by UrbanSim "requires exogenous input information derived from: population and employment estimates , regional economic forecasts, transportation system plans, land use plans, and land development policies such as density constraints, environmental constraints, and development impact fees" while our approach focuses on developing information such as this input data by collaborative work.

The Southern California Association of Governments has begun the development of the SCAG Regional Goods Movement Knowledge Base [SCAG]. This knowledge base provides a search engine that currently references about 195 papers and reports, however full text is not available for most of these at the time of this writing. Our research differs because our collaborative environments include not only reports and papers but also the underlying data and tools required to understand information in the reports. We are working with SCAG to insure that our tools will be complementary to theirs. Ambite and others have studied how data from heterogeneous sources related to the Southern California region might be combined for better freight flow analysis and planning [AMBI], however they have not implemented tools to enable any of their recommendations. Our research considers their approach and aims to realize selected portions of it in practice.

4 The SM 21 approach

4.1 Introduction

Figure 1 is a top-level use case diagram describing key elements of a JPPSP. Of importance to the present paper are these aspects of a JPPSP:

1. Unit movements including deployments through strategic ports, are planned using the Transportation Coordinators' Automated Information for Movement System II (TC-AIMS-II) system.
2. Ship stow plans are created using the Integrated Computerized Deployment System (ICODES), a knowledge-based ship stow planning software application that utilizes artificial-intelligence principles and techniques to assist embarkation specialists in the rapid development of cargo stow plans (http://www.cdmtech.com/web/guest/pages/products/ICODES).
3. Main elements of the JPPSP itself are operated by a COTS Terminal Operating System that can manage the arrival of goods and equipment by air, truck or rail, transfers between modes of transportation, short-term storage within the multi-modal and intermodal yards, and the onward movement of goods and equipment.
4. Important JPPSP models and data support the regional planning process.
5. Efficient port operations are based on concepts investigated and proven by SM21 efforts.

The next two subsections describe JPPSP facilities that support regional planning and surge deployments in more detail.

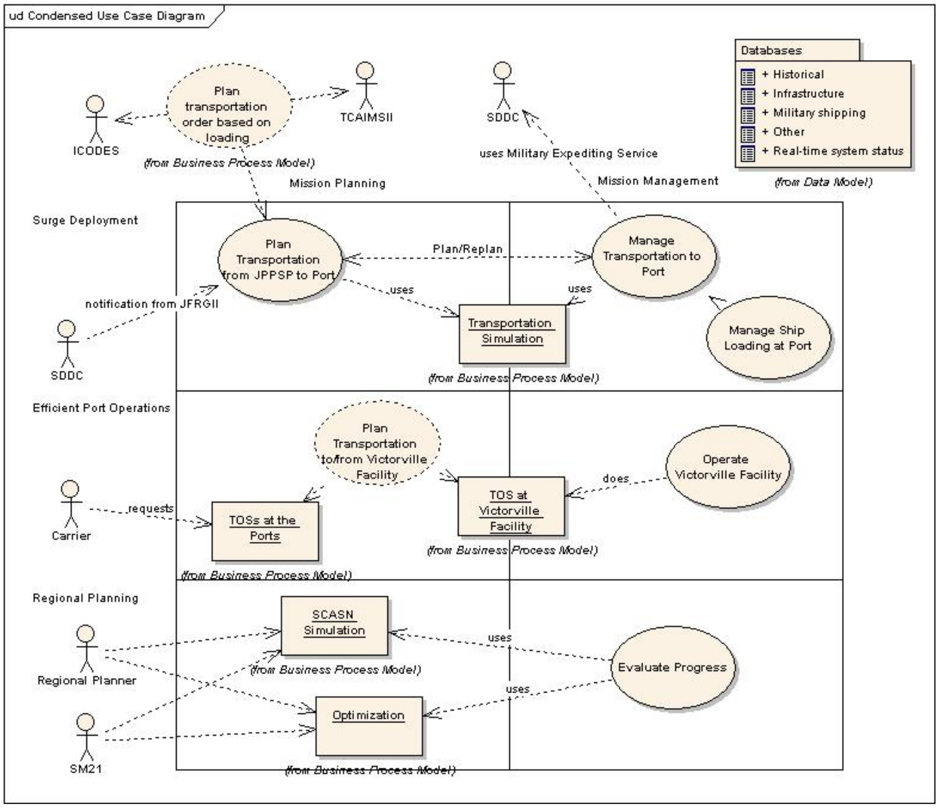

Figure 1. Summary use case diagram

4.2 Regional planning

In its early stages, the SM 21 Program realized that the program itself needed to make the case for the use of the ports of Los Angeles and Long Beach for surge deployment and sustainment, as well as the case for a build-out of additional transportation and logistics infrastructure within the Southern California area, notably in Victorville. The single largest justification for building new infrastructure is achieving higher container throughput through the ports. Secondary justifications include the reduction of the impact of container shipments on the region. Providing the US military assured access to the ports would not by itself justify the construction of a JPPSP in Victorville or any of the infrastructure needed to support commercial uses.

There are many potential solutions to regional problems. The effects of implementing individual aspects of a solution interact and thus are challenging to visualize and understand. This led us to conclude that better collaborative tools were needed to support such regional planning. In fact, within the SM21 project itself, many different integrated product teams were at work on various elements of the project. This led to a similar need to coordinate this work, enabling those on different teams to understand the work of others, to understand how information created by other tasks affects their tasks, and for displaying, visualizing, interacting with, and understanding the results of various simulation, modeling, and analysis efforts.

As we investigated alternatives, we realized that Metropolitan Planning Organization's such as the Southern California Association of Governments (SCAG) also need to coordinate activities in many different areas and enable interdisciplinary understanding of analysis, modeling, and simulation work. Today, most of such work is presented in a static manner in reports that take a long time to produce, have hidden input data and non-specified or ill-specified assumptions. These reports present only a limited number of the possibilities considered, not allowing the reader to interact with the models and analyses, for example, by changing certain assumptions, and looking at the resulting differences.

The approach that we developed called for replacing static analyses with living, collaborative web portals where input data as well as analyses, models, and simulations could be automatically configured into effective systems for understanding various aspects of transportation and logistics in the region. Our goal was to allow many alternative models and sets of input data to be organized, understood, and configured in different manners to create those models and simulations capable of answering specific regional planning questions.

The functional requirements developed for our Regional Planning Web Portal are:

1. Provide basic data sets to support regional planning. These include:
    a. schedules of ship arrivals
    b. rail schedules
    c. data on containers shipped through the ports (Port Import Export Reporting Service (PIERS) data, see http://www.piers.com)
2. Provide an ontology of concepts with definitions and relationships for use in describing key issues in regional planning including goods movement. This will be in the context of a wiki that readers can edit so that the content may evolve. UML diagrams will be included as appropriate. The "ontology" is basically the framework around which the wiki entries are organized. Users will be able to search for articles that define or explain concepts.
3. Provide a common user interface that supports developing networks (sets of nodes and arcs) as well as data associated with network elements (such as cost functions, delay characteristics, transit times, etc). This will be the common framework around which models and simulations are defined and optimization analyses organized. The intent is to provide a vendor-independent front end that can be used over technologies that are too arcane for direct use by non-experts.
4. Provide a common user interface for presenting and comparing the results of analysis, simulation, and model "runs". This will use Excel as its basis but with 2D and 3D graphics to be added later. Again, the intent is to provide a vendor-independent back end that can be used over technologies that are too arcane for direct use by non-experts.
5. Provides blogs where project personnel can share information.
6. Provide wiki's where project personnel and stakeholders can carry out discussions of key issues. Functionality will be added later to help form groups, locate experts, and advise leaders on how to guide discussion, achieve consensus, and publish results.

7. Provide a place for sharing documents with individual security control at the document level for restricting access.
8. Provide search over the whole web portal, including to tag-based search over data set contents.
9. Provide tools that extrapolate historical data to create input data to drive simulations and analyses.

Our technical approach to meeting the above requirements is based on:

1. using blogs to express points of view and share information;
2. using wikis to build consensus in various areas by providing persistence that can evolve over time;
3. accept and incorporate data natural formats such as text files, spreadsheets, etc., and tag it according to various ontologies/schemas to allow it to be mined; and
4. integrate modeling, simulation, and analyses along with visualization as part of the wikis

Additional elements of our approach are:

1. centralized databases and the systems built on them are not a suitable basis for our work;
2. all models/schemas/ontologies are local, have limited scope, and will evolve; competing models/schemas/ontologies are good, not bad;
3. centralized and/or standardized data dictionaries are not appropriate; and
4. achieving shared knowledge by human participants over some limited “universe of discourse” at a point in time is a goal - and this process is repeated many times as the dialog evolves; collaboration enables the communication that allows shared visions to be developed.

Figure 2 shows the top-level user interface of the Regional Planning Web portal we have developed. Key aspects of the operation of the portal are:

1. The SM21 Stakeholder wiki library contains data about project stakeholders. Each library page contains contact data, links to web sites, and other important information. Examples of stakeholders are: SCAG, terminal at the ports, the Class I railroads, and the City of Victorville. These pages will evolve over time as stakeholders supplement and correct them.

2. The SM21 Wikipedia is an encyclopedia that contains the "ontology" used throughout all SM21 wikis. All concepts are defined in the wiki and related concepts are cross-linked. UML is used as the descriptive language where appropriate. Links to important sources of external information are included. These pages will evolve over time as stakeholders supplement and correct them. The initial page links directly to two indices, one alphabetical and the other topical. Access to the wikipedia is typically by using the search box on any page.

3. Shared Document Library: This is a place to upload and share documents. It is expected that documents will be converted and merged with other content

elsewhere in the wiki. Documents are organized in folders based on common topics.

4. Wiki discussions: This is the place where discussions can be held.

5. Modeling, Simulation, and Analysis (MS&A): This is a wiki library page that introduces how the site organizes MS&A data, how programs may be executed, and how data may be viewed. There is a hidden document library that stores web parts pages. Most MS&A data is organized in Excel spreadsheets, although some of it can be visualized in other ways also (such as Visio diagrams.) There is one web parts page per "document type" used in MS&A. Each web parts page will include a definition of the fields, an explanation of how fields work together to achieve a given function, and a list window listing the files of that type currently on the site. These lists can be sorted and filtered in various ways by a user. One example type of MS&A data is:

6. Locations and Objects: This is the page that defines and gives access to the Nodes and Locations Document Library. It describes the format of each file in the library and gives a list of the files currently in the library. There will be a similar page for each library type. One example file is: Nodes at POLB (the Port of Long Beach) that lists the terminal at the port along with their characteristics.

7. All pages contain a search box with a link to "Advanced search" also. The site uses "Sharepoint Server for Search 2007" which has very advanced search capabilities, including customizable search engines and search based on metadata.

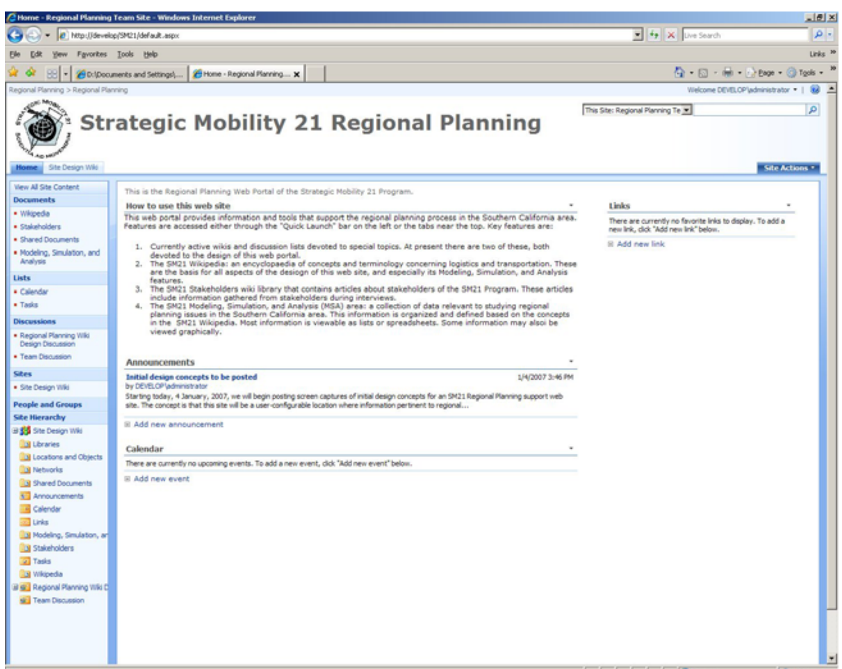

Figure 2. Top level regional planning interface

[**Note to reviewers about the initial draft:** By the time that the final draft is written on 2 April, the functionality of this portion of the web portal will be more fully developed. We will expand this initial draft material to include:

- a more detailed description of how the various document libraries are used to drive simulations;
- more detail of how input data is converted into the formats that simulations require;
- some screen shots of these tools in use, including graphical displays of both input and output
- results from initial experiments, including the use of the web portal in regional planning collaboration by stakeholders]

4.3 Military transportation planning

To reduce the impact that military deployments can have a major impact on the operations of a busy commercial port, such as the port of Long Beach, the SM21 program developed an approach based on:

1. applying today's collaboration, planning, and algorithm technologies;
2. implementing some process improvements in the manner in which ships are loaded at the port;
3. continuing to use the functionality of legacy systems such as ICOCES and TC-AIMS-II by adapting key elements of those systems into a Service-Oriented Architecture usable by a web portal;
4. development of a small amount of new algorithms and software to fill key gaps;
5. using the functionality of a JPPSP in Victorville to serve as a "buffer" for incoming equipment as well as a location where equipment can be re-ordered on rail cars or in convoys to respond to unexpected circumstances.

We identified key gaps that our JPPSP needed to fill:

1. ICODES develops effective ship stow plans, yet it provides no functionality to create a ship-loading plan from such a ship stow plan. Such a plan would specify the hatches from which a ship is to be loaded as well as the time-sequenced order in which equipment is to be loaded onto the ship.

2. TC-AIMS II can produce an initial rail-loading plan for a unit movement that can be used to order transportation for the move. TC-AIMS II can also produce unit equipment lists for such a movement, although such lists often require refinement by the other systems that use them, such as ICODES. However, TC-AIMS II has no capability to produce a detailed, final rail car loading plan nor can it track that actual equipment that is loaded onto a rail car.

3. There is no system that can translate a ship loading plan into a corresponding rail loading plan in such a manner that the loaded rail cars can be delivered to the port "just in time" for unloading and transfer onto a ship. Considering that a SBCT deployment requires 5-6 unit trains each about 5,000 feet long, and that there are many constraints the manner in which equipment must be loaded, delivered on dock, and unloaded, this is not a simple process.

4. There is no system that can monitor and manage rail transportation to the port to achieve efficient port operations with minimal disruption to commercial operations.

Two key individuals of who must collaborate to achieve the above are the military ship stow planner and the military rail load planner. Each is these users may be assumed to be an expert in his own discipline. The need for collaborative work comes about because the rail loads need to be planned in such a manner that they can be delivered to the port and military equipment removed from the rail cars “just-in-time” for stowing onto the ship. The Surge Deployment Web Portal provides a collaborative interface between a ship load planner (using ICODES) and a military rail load planner (using TC-AIMS II).

The functional requirements developed for our Surge Deployment Web Portal are:

1. Interface with ICODES through a web service interface to be provided by ICODES to receive visualizations (as SVG files) of ship load plans along with associated entity data.
2. Display ICODES stow plans.
3. Provide a link back to ICODES so that a user can use ICODES directly to modify ship stow plans.
4. Display unit equipment lists received from TC-AIMS II.
5. Display preliminary rail plans received from TC-AIMS II.
6. Allows a human user to compare a ship stow plans with rail loading plans to identify discrepancies.
7. Create a plan of ship loading order ("ship load plan") from an ICODES ship stow plan.
8. Create a rail load plan from a ship load plan. This will plan the rail loads so that the arrival order of unit equipment at the port can be "just in time" for loading onto the ship.
9. Re-plan in response to incremental and partial changes.
10. Re-plan in response to rail conditions, such as rail cars that are left behind due to mechanical problems or trains that arrive out of sequence.
11. Identify mis-matches in rail load and ship stow plans and to suggest rail operations at the JPPSP that will correct the problems.

Figure 3 shows the second-level user interface of the Surge Deployment Web Portal we have developed, giving access to functions that support a given deployment (“Example 1” in this case). Key aspects of the operation of the portal are:

1. Active deployments appear as tabs on the top bar of the top-level page.
2. On the second level page there are tabs to access pages for the ship stow plan and the rail load plan. Each of these displays their respective plan in various formats including tabular and graphical.
3. The ship stow plan page includes access to the function that creates a ship load plan from a ship stow plan
4. The rail load plan includes access to the function that creates a rail load plan from a ship load plan.

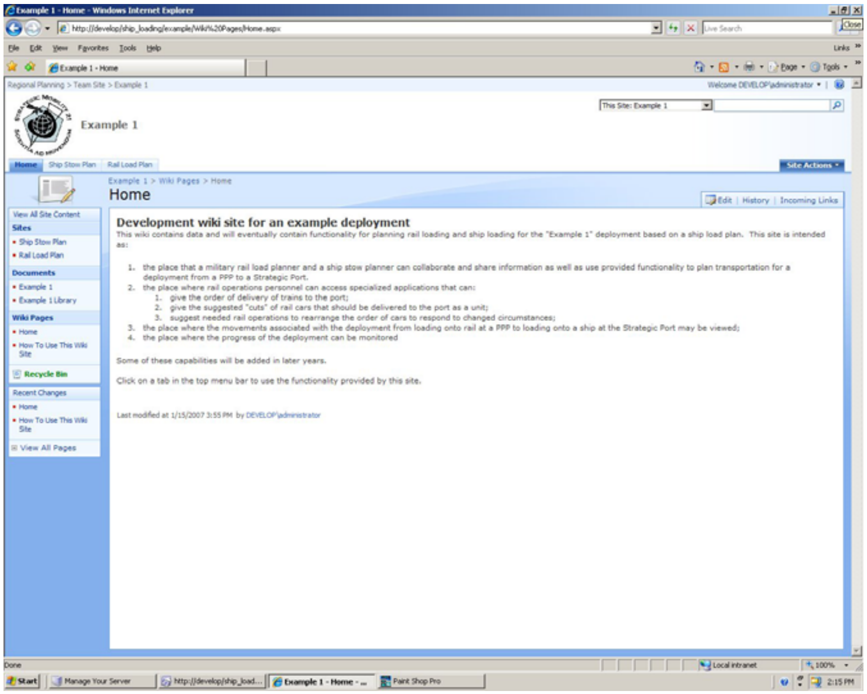

Figure 3. One page of the surge deployment web portal page

Separate pages not shown here:

1. interact with the Military Expediting Service to monitor the progress of rail movements to the JPPSP;
2. verify that all cars of each train involved in the movement are in the correct order based on the analysis of Car Location Messages; and
3. plan rail operations to reorder cars on trains as required as well as create cuts of cars for delivery to the dock

[**Note to reviewers about the initial draft:** By the time that the final draft is written on 2 April, the functionality of this portion of the web portal will be more fully developed. We will expand this initial draft material to include:
- a description of the algorithm that derives a ship loading plan from a ship stow plan;
- a description of the algorithm that derives a rail load plan from a ship load plan;
- some better screen shots of these tools in use.
- a description of the experiences of military personnel and contractors using the web portal.]

5 Conclusions and future work

This paper has described two collaborative interfaces that provide cost-effective solutions to key problems. The SM21 program is funded for two additional years. In these future years the base functionality developed in the first year will be expanded by:

1. adding additional data sets.
2. enhancing the knowledge base in the wikis,
3. incorporating models to support additional simulations and analyses,

4. conducting experiments in conjunction with unit deployments to demonstrate the functionality,
5. working real regional planning tasks collaboratively using the features of the web portal, and
6. expanding the portal's command and control capabilities to support a regional common operating picture for goods movement.

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