



Pilot Tool for Linking Ship Design to Shipyard Simulation

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Agenda

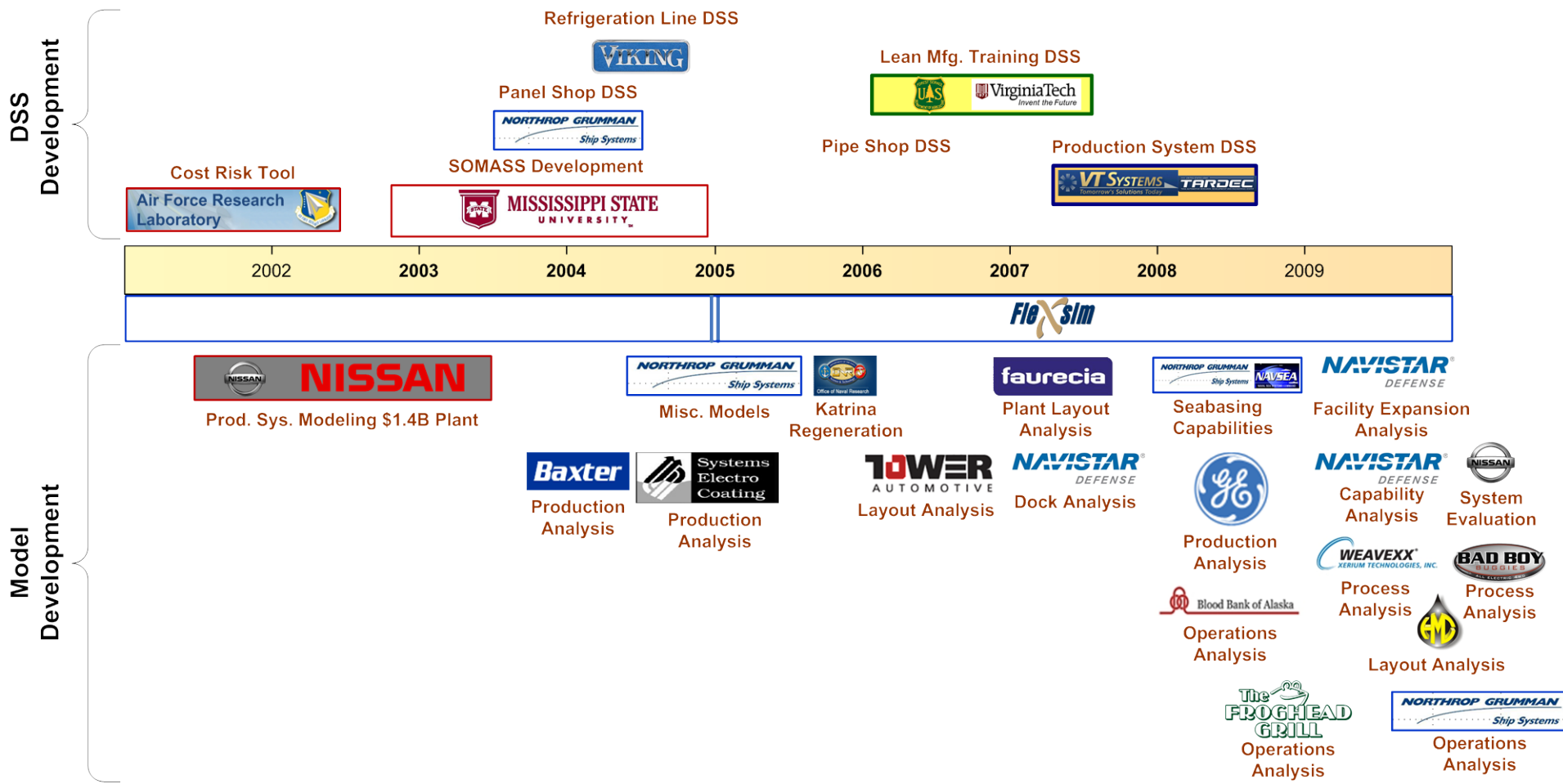
- Modeling and Simulation
- Background
- Production Design Simulation Tool
- Outfitting Prototype Simulation
 - Outfitting Operations
 - Unit Erection
- Next Steps

Modeling and simulation are important to industry

- National Research Council¹:
... one of the **breakthrough technologies** required to improve manufacturing performance in the 21st century.
- Oak Ridge Center for Manufacturing Technologies²:
... **no other technology offers more than a fraction of the potential** for improving products, perfecting processes, reducing design-to-manufacturing cycle time, and reducing product realization costs.

1. Visionary Manufacturing Challenges for 2020, Committee on Visionary Manufacturing Challenges, Board on Manufacturing and Engineering Design, Commission on Engineering and Technical Systems, National Research Council, National Academy Press, Washington, DC, 1998, pp. 5.
2. Integrated Manufacturing Technology (IMTR) Roadmapping Modeling and Simulation Workshop Group and IMTR Roadmapping Project Team, "IMTR Roadmap for Modeling and Simulation," IMTR Project Office, Oak Ridge Centers for Manufacturing Technologies, Oak Ridge, TN, 1998; in McLean, Charles, R. "Manufacturing Simulation and Visualization" program status report, NIST, <http://www.mel.nist.gov/proj/msv.htm>

Simulation-based projects



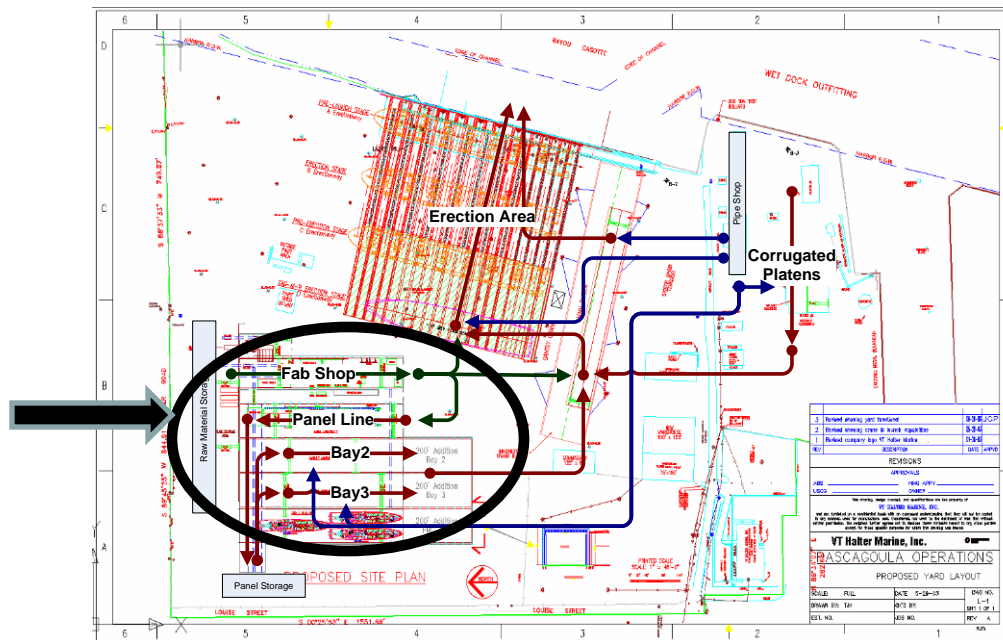
Background - System Objective

- Develop a planning tool that can be used for **rapidly** estimating the impact of **proposed ships** given work already in progress. This enables the following ...
 - Estimation of requirements for proposed ships through unit level based on varying levels of knowledge concerning ship details.
 - Early identification of “bottlenecks” and areas of available capacity so that these opportunities are exploited early in the planning/proposal cycle.
 - Forecast ship completion dates (in terms of completing the “shop”) with specific confidence levels.

Consideration is given to ...

- **Yard Operations:** simulation model includes material prep, panel line, and unit assembly.
- **Ship Structure:** Sections-Modules-Blocks-Units.
- **Requirements Development:** estimating requirements given the level of knowledge known at the time of analysis.

“Shop” area of focus



Approach

- **Develop** a simulation model of operations [material prep, panel line, and unit assembly]. Using parameters from the estimating algorithm (# of plates, # of stiffeners, ...) and the estimated processing times [min, max, most likely] based on shop experience. Also the simulation model incorporates such occurrences as downtimes, shift schedules, ...
- **Develop** a rapid approach for estimating ship requirements in support of proposed ships making use of a library of ship templates (e.g., Cargo, Tug, ...) which can be used at varying levels of known detail.
 - “copy and paste” of a previous ship (e.g., updated barge).
 - Only know total ship weight and that the overall weights should be distributed “like” a previous ship template.
- **Develop** a means for performing constraint based analysis which considers ships already in process.
 - Identify some of the bottleneck operations in advance so that alternative plans can be made upfront.
 - Estimate **ship completion dates through the shop** considering uncertainties – projected completion dates varying by confidence level for all ships analyzed.
- **Develop** a user interface decision support system for the planner which allows the planner to interface with all of the above components without becoming an expert in the computer technologies.

Decision Support and Simulation

Ship Data

CROWLEY BARGE BX11							
	Mod	Unit	No. of Plates	No of Struct.	No. of Panels	No. of Seams	No. of Struct. On Panels
Mid-Body	2300A						
	BTM	2311/12	39	175	8	15	106
	WANG	2321/22	17	256	8	22	88
	LONG BND	2331	21	32	0	0	0
	TRANSV BND	2321/23	12	13	0	0	0
DECK	2341/42	10	55	4	4	8	
	Total Weight		109	530	20	45	283
	% of Total WT						

Bow							
	Mod	Unit	No. of Plates	No of Struct.	No. of Panels	No. of Seams	No. of Struct. On Panels
Bow	1100						
	LOWER	1101	28	110	13	16	84
	MID	1102	30	84	5	7	66
	UPPER	1103	30	62	2	4	4
		Total Weight		88	256	20	27
	% of Total WT						

Decision Support System (UI)

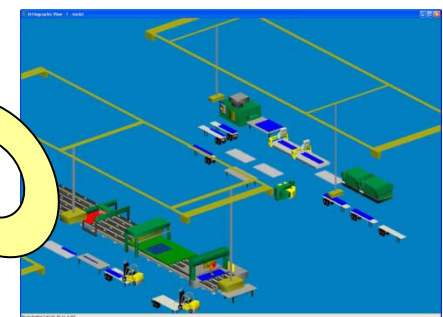
Assembly Information:
Ship: Crowley Barge
Name: 1101
Type: Bow
Description:

Schedule:

Type	Start Date	Complete Date
Scheduled	4/24/2009	5/1/2009
Simulated	1/1/1900	1/1/1900
Actual	1/1/1900	1/1/1900

Operations:
 Include Material Prep
 Include Panel Line
 Include Unit Assembly

Simulation Model



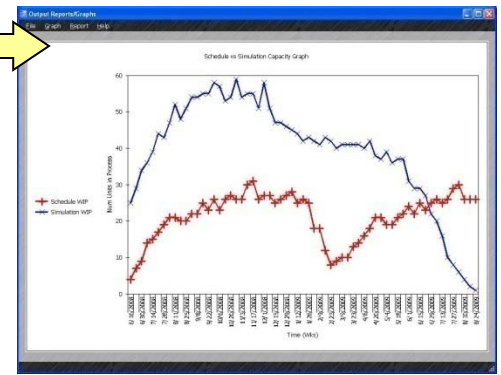
Process Data

Name	Shift	Min_Proce	Max_Proce	Avg_Proce	Routing_Percentage
Wheelabrator	10	50	200	100	100
NC Plasmaburr	10	50	200	100	100
NC Plasmaburr	10	50	200	100	100
Bevel Table	10	50	200	100	100
Break Press 1	10	50	200	100	50
Stiffener Shape	10	50	200	100	100
Edge Prep	10	50	200	100	100
Seamer	10	50	200	100	100
Stiffener Prep	10	50	200	100	100
Stiffener Fit	10	50	200	100	100
Stiffener Tack	10	50	200	100	100
Fillet Welder	10	50	200	100	100

Planner



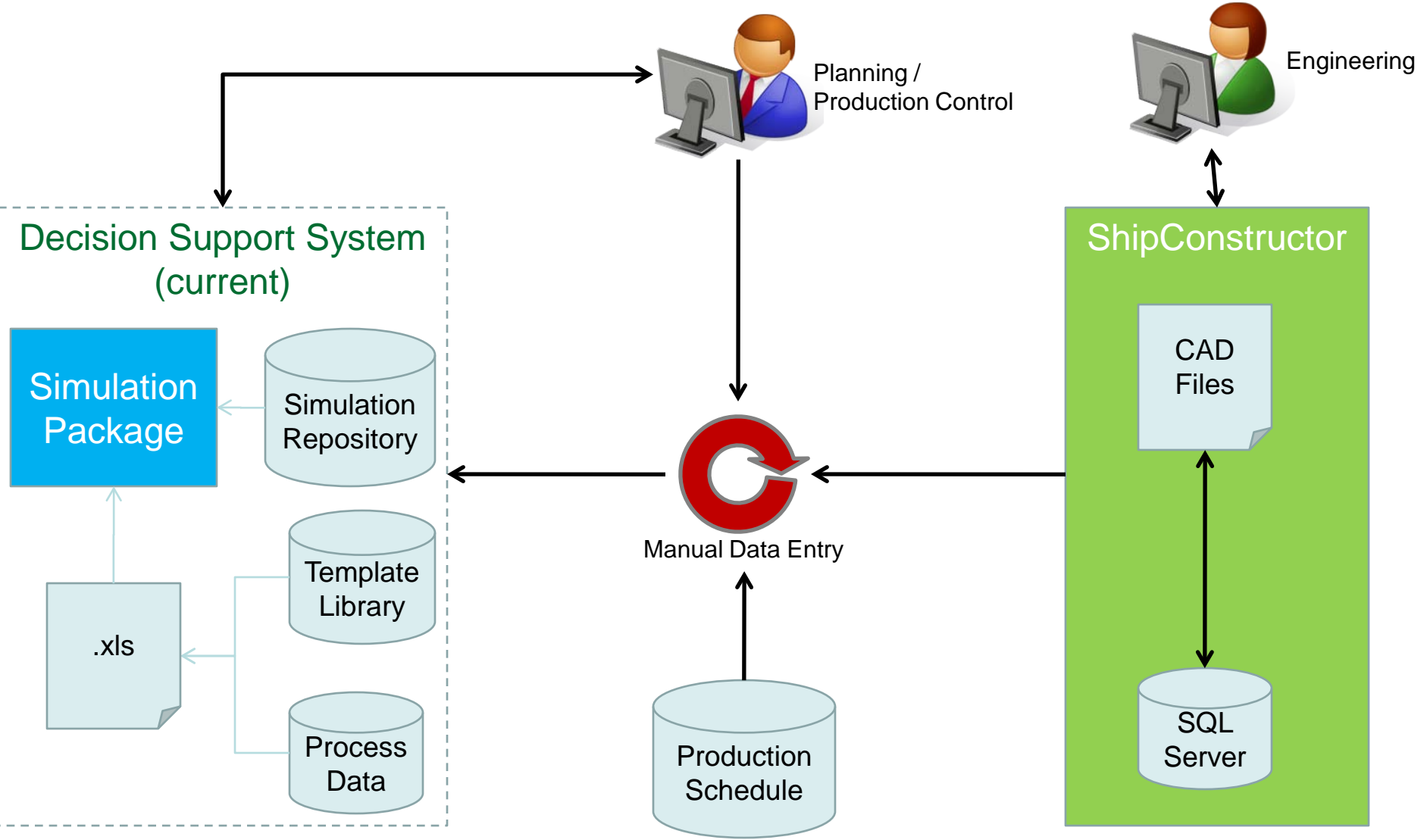
Reports

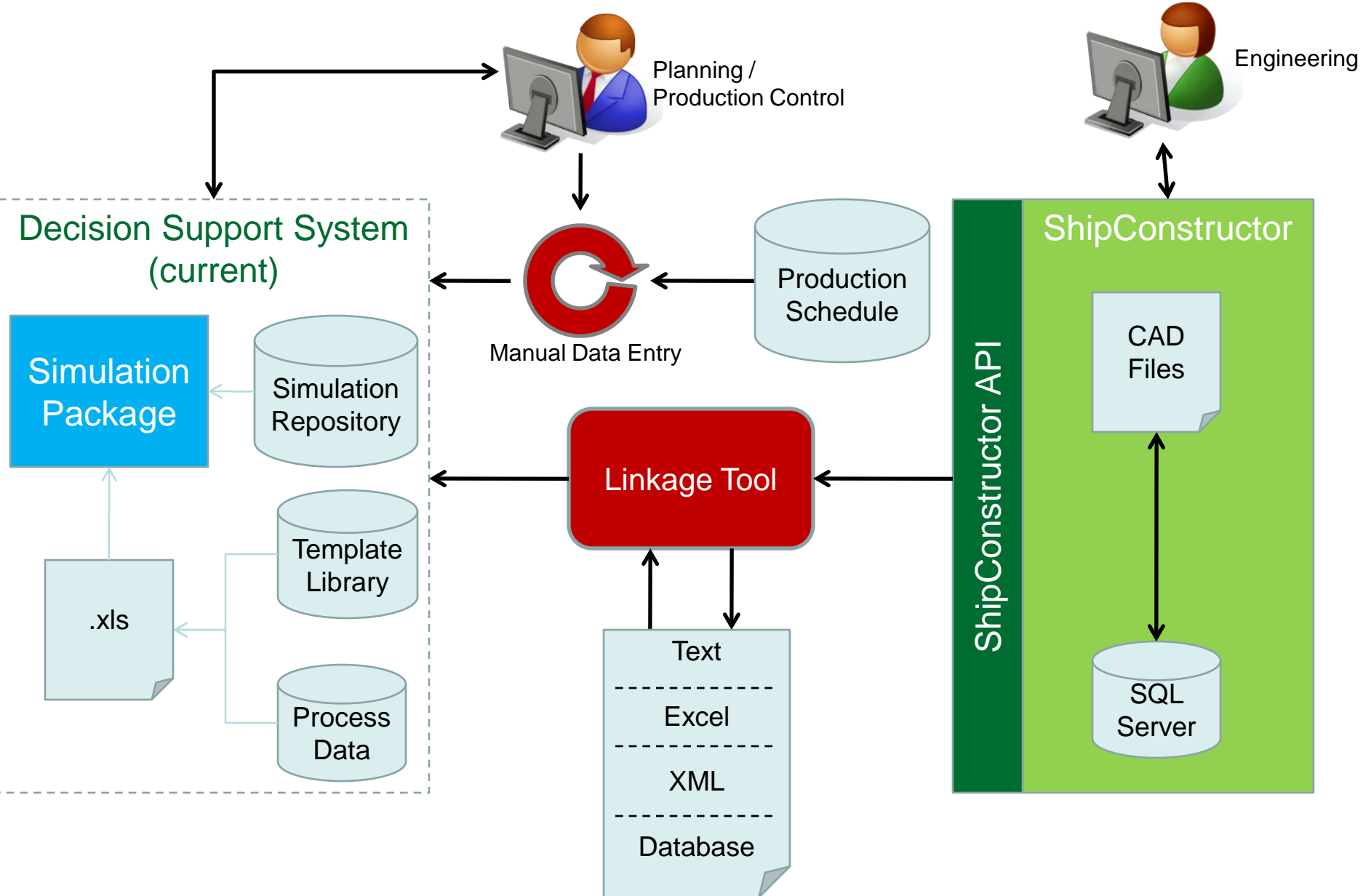


Panel Project Overview

- **Production Design Simulation Tool**
 - Develop enhancements to existing software tools that enable the linkage of key elements of a ship's design to simulation models. It is proposed that this tool will enhance the value of and extend the life of future and existing simulation models. By incorporating up-to-date design data, with little or no manual data manipulation or entry by users, into the simulation models it makes performing analysis and making decisions more rapid and efficient.
- **Outfitting Prototype Simulation**
 - One of the major elements of ship building is the outfitting; therefore, the modeling of outfitting is a required part of any overall shipyard simulation model. This project proposes to evaluate and develop approaches to address the outfitting modeling challenge. In addition, this project proposes to develop a prototype interface for extracting key data elements from *ShipConstructor* into a preliminary outfitting model.

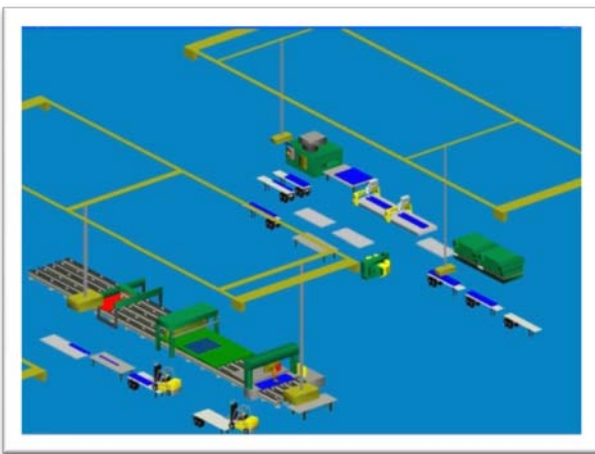
Production Design Simulation Tool



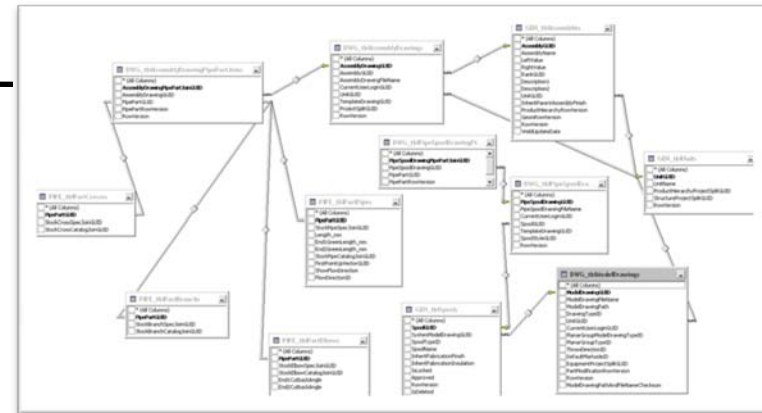
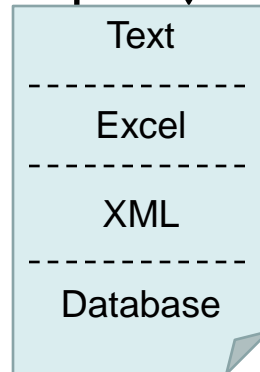


Key Components

- Data Extraction Interface
- Data Transfer Mechanism



Data Transfer
Mechanism



Data Extraction
Interface

Data Extraction

- Define data to be extracted from ShipConstructor files.
 - Data is driven by current fabrication simulation model and prototype outfitting model to be developed.
 - Fabrication (Fabrication Data Reqs_Pilot Linkage Tool.docx)
 - Outfitting (Outfitting Data Reqs_Pilot Linkage Tool.docx)
- Utilize ShipConstructor Application Programming Interface (API)

Data Transfer Approaches

- Direct connection to Flexsim
 - Reduced overhead may help any scalability issues
 - Locks the linkage tool to the simulation package
- Intermediary files
 - Text, Excel, XML, Database
 - Allows for flexibility (i.e. intermediary can be used directly by simulation package or another external software)
 - Allows for the opportunity for interaction of multiple types of data (e.g. CAD data and schedule data)
 - Greater overhead and storage space required

Production Design Simulation Tool

- Next Steps
 - Complete code to extract fabrication information from ShipConstructor.
 - Complete code to transfer data to simulation model (VT Halter combine shop model).
 - Perform scalability tests on possible data transfer mechanisms.
 - Extend code to extract outfitting data and transfer to simulation model (outfitting prototype model)

Outfitting Prototype Simulation

Overview

Outfitting is the process of integrating all non-steel components into the ship. These components include prefabricated pipe details and plumbing fixtures, HVAC ducts and equipment, electrical wires and systems, structural elements (i.e. ladders, rails, walkways, foundations, etc.), and the painting of internal surfaces and components. These processes are performed by skilled labor once the blocks have been assembled in the ship erection area.

Outfitting Concept Models

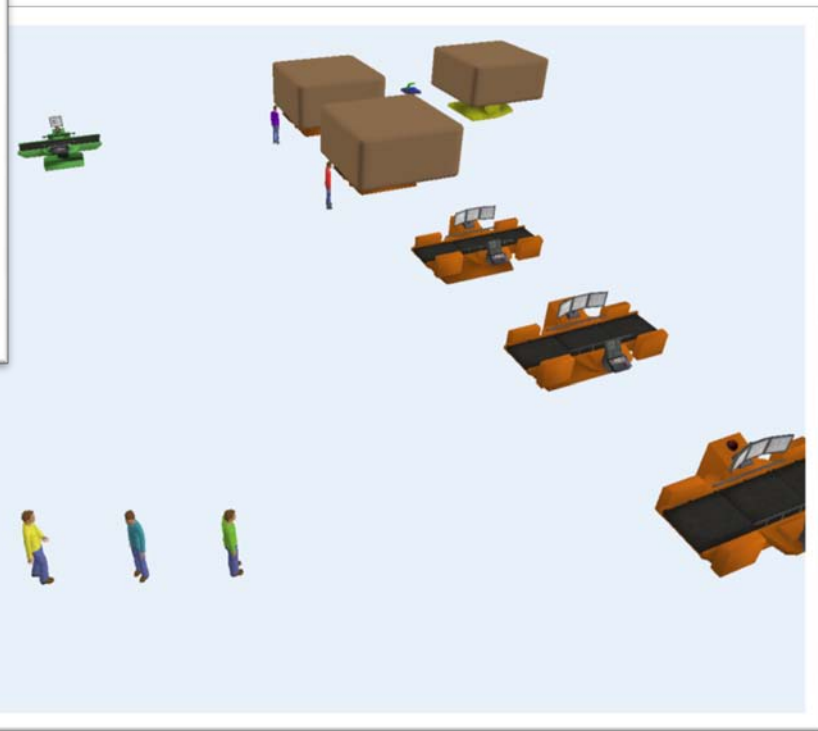
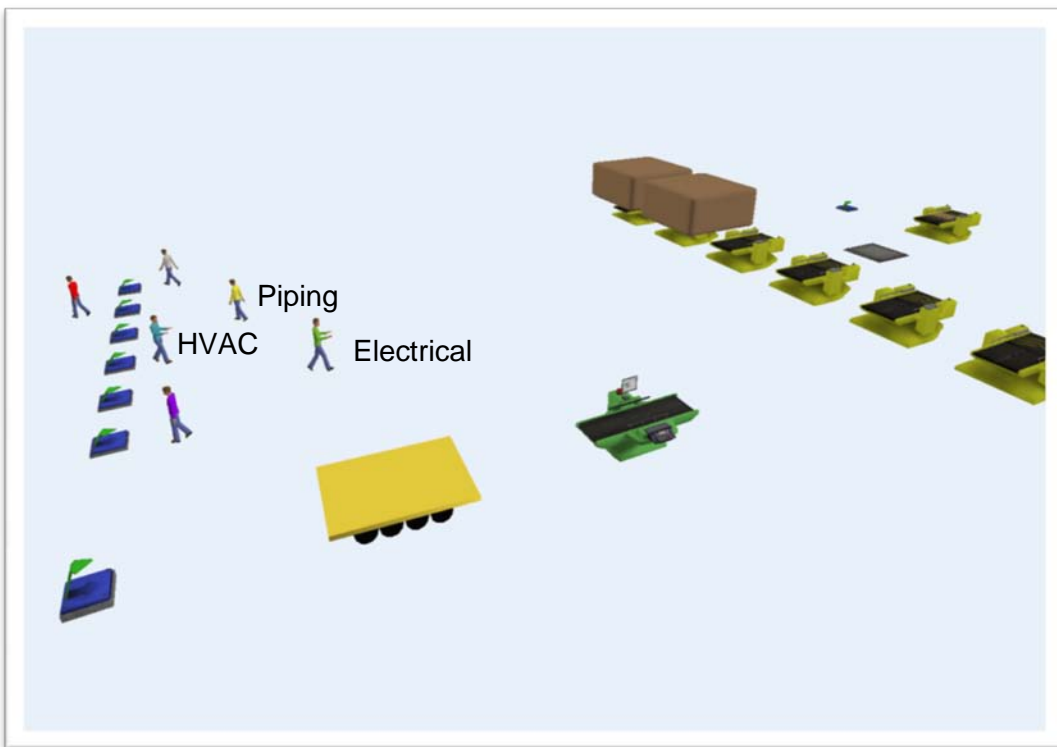
- Outfitting Processes
 - Models the use of skilled labor teams to perform work within blocks
 - Concept #1 – Assembly Analogy
 - Concept #2 – Process Sequence Analogy
- Unit Erection
 - Models the assembly of blocks into the ship hull
 - Restricts the ability of skill labor teams to perform required operations

Outfitting Processes

- Concept #1: Assembly Analogy
 - Uses a combiner to represent the outfitting process
 - Block enters the combiner and determines the outfitting processes needed to be installed
 - The combiner calls for those specific pieces to be delivered
 - As soon as a crew is available they will bring the part and begin installing
 - As many crews as a available can install their parts in the block.
- Concept #2: Process Sequence Analogy
 - Uses a multi-processor to represent the outfitting process
 - The block enters the multi-processor and the first process checks which outfitting process is needed and then checks the matching crew to see if available
 - Depending on the availability of the specific skill labor, the process is performed or the next process needed to be performed is checked until an available crew is found
 - After the first process is completed the multi-processor checks for the next outfitting process needed to be completed and checks for the matching crew until all required processes are completed

Simulation Model Concepts

Concept #1:
“Assembly Analogy”



Concept #2:
“Process Sequence Analogy”

Current Model Challenges

- Concept #1 (Assembly Analogy):
 - Skilled labor groups begin work as soon as they become available.
- Concept #2 (Process Sequence Analogy):
 - Only allows one skilled labor to be working on one outfitting process at a time.
 - When a block only has processes left to complete that need labor that is currently unavailable the block will exit the outfitting process.

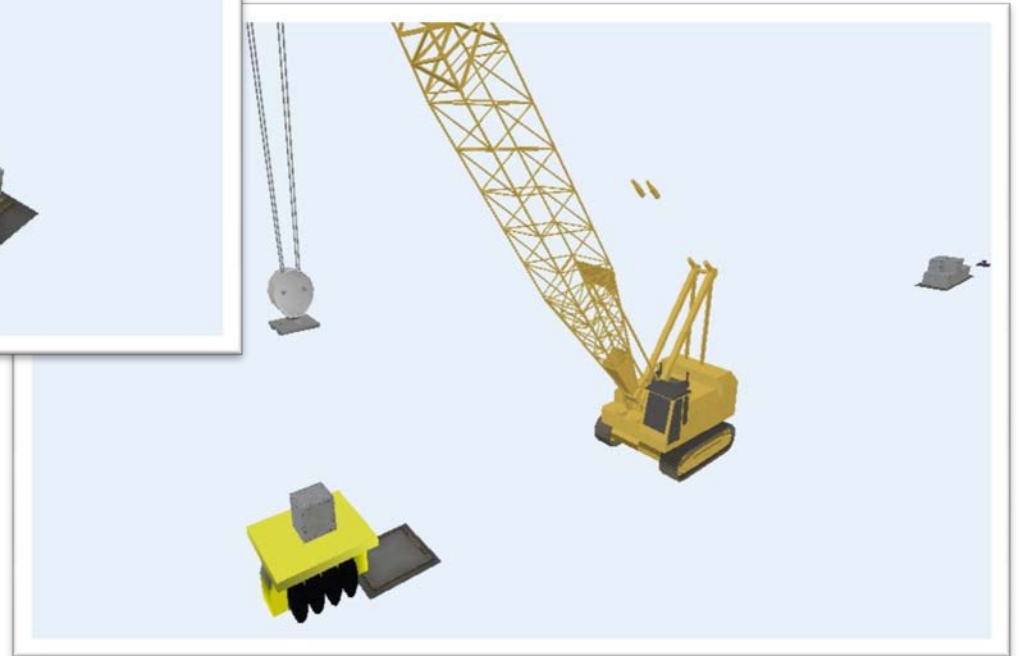
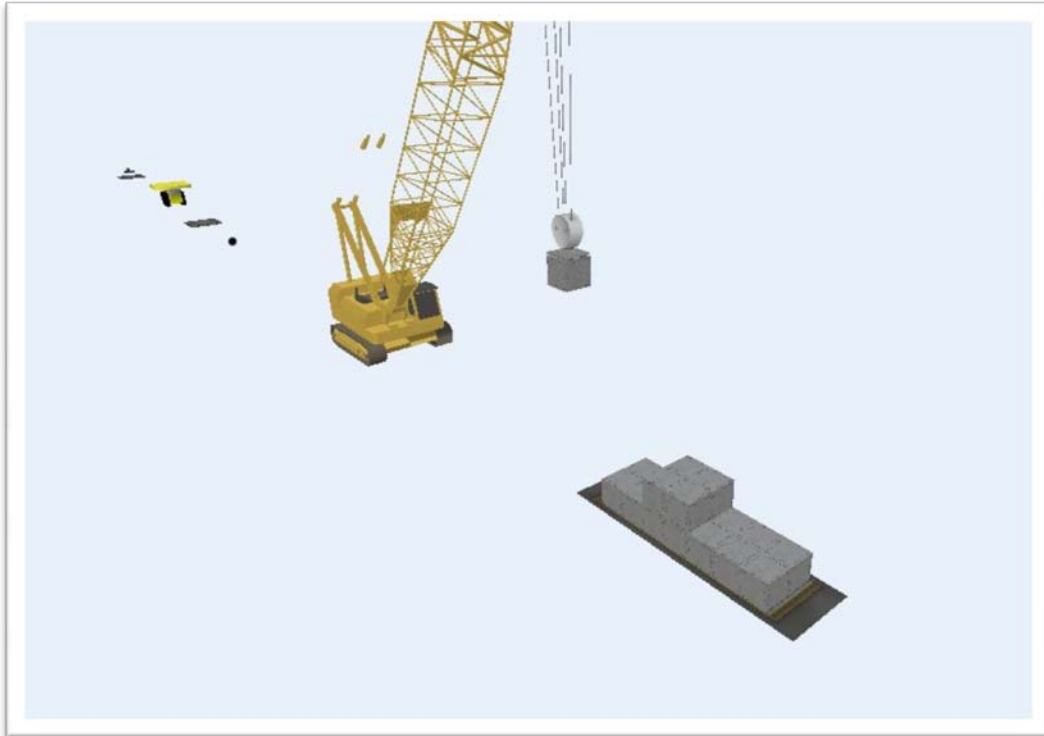
Additional Required Information

- How many laborers make up a crew.
- How many crews are available for each type of skilled labor.
- Which crew of skilled laborers can work simultaneously in a block.
- Which processes need to be completed in a specific order.
- The effect of number of laborers on process time.
- The other factors that contribute to the process time.

Unit Erection

- Transport receives an assembly block and transports it to a mobile crane
- Crane delivers the block to specific location in the stacking area to have next stages of work performed on it
- Once all blocks have been completed, the completed ship will exit the system

Concept Model



Unit Erection

- Next Steps
 - Logic needs to be implemented in order to determine which block the crawler should bring to the crane
 - Model needs to be scaled to real world environment
 - Multiple delivery stations and cranes need to be added
 - Code needs to be added to keep the crawler at destination until the crane has completely moved the block to the stacking area
 - Code needs to be added to get the crane to visually drop the block into its correct place

Project Issues

- Contractual Issues between MSU and ShipConstructor
 - Prevented access to ShipConstructor software
 - Resolved May 2010
 - ShipConstructor software obtained May 2010
 - ShipConstructor API training June 2010
- Communication issues between MSU and VT Halter Marine
 - Prevented acquisition of actual ship data
 - Issues resolved September 2010
 - Data transfer in process

Next Steps - Project

- Get ShipConstructor remaining data from VT Halter Marine.
- Trips to VT Halter Marine to obtain more outfitting information and answer production data questions.
- Obtain a no-cost extension to complete the project.
- Complete data extraction from ShipConstructor.
- Analyze data transfer mechanisms for most efficient method.
- Complete outfitting prototype model
- Analyze scalability of Linkage Tool and outfitting model.



Questions