

Decision Support System (DSS) for Sector-Wide Pipe Shop Capacity Planning

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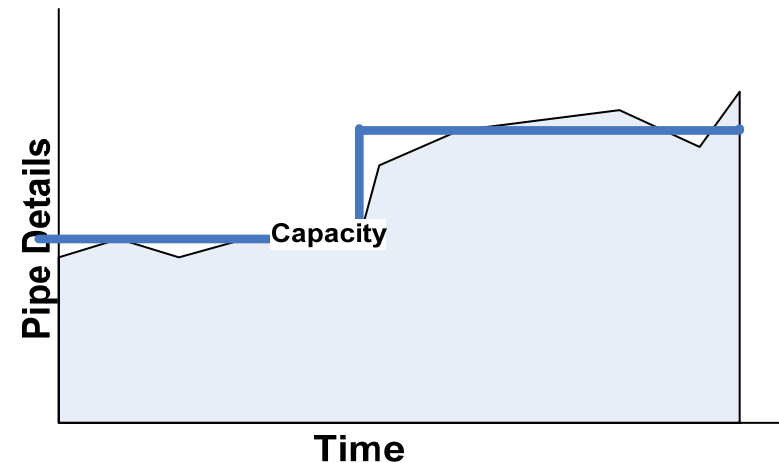
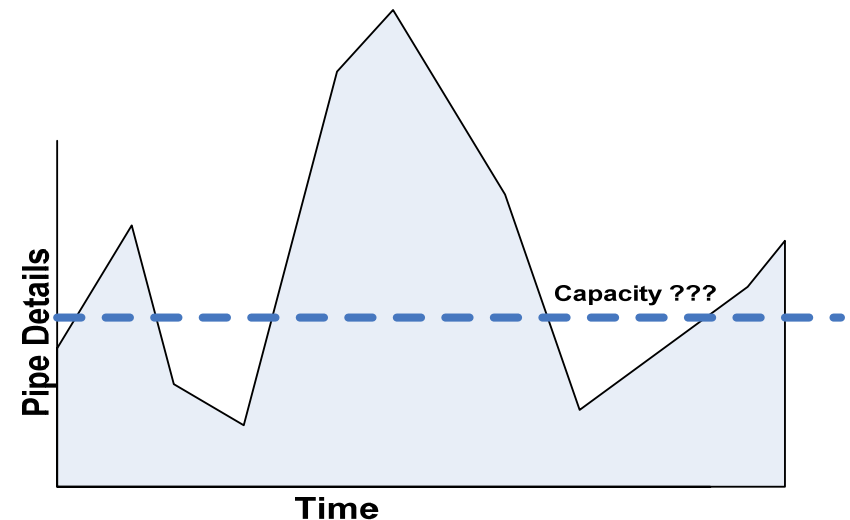
Motivation

■ Motivation

- Extreme variability in demand for pipes
- Reduced capacity due to Hurricane Katrina
- Test case for developing larger-scale DSS

■ Needs

- Smooth production while meeting demand
- Define and manage capacity effectively
 - Long-term planning
 - Short-term scheduling



Background

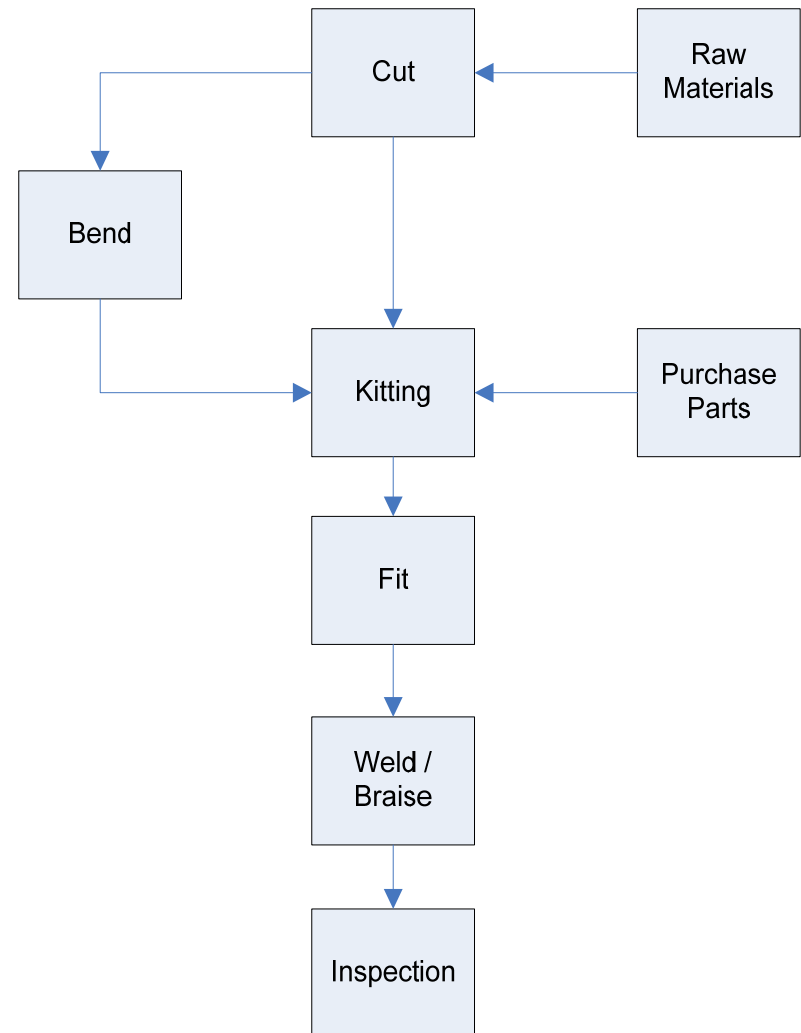
■ Terminology

- **Bill (Pipe Shop) = final product**
 - Set of Pipe Details (PDs)
 - Attributes: hull, unit, scheduled start, due date, priority, ...
- **Pipe Detail (PD) = sub-assembly of final product**
 - Set of pipes and purchase parts to be assembled (fit, weld/braise)
 - Attributes: number of pipes, number of purchased parts, weld type, quality indicator, ...
- **Pipe = Piece part (not directly considered in High-Level Model)**
 - Attributes: diameter, material, number of bends, ...

Background

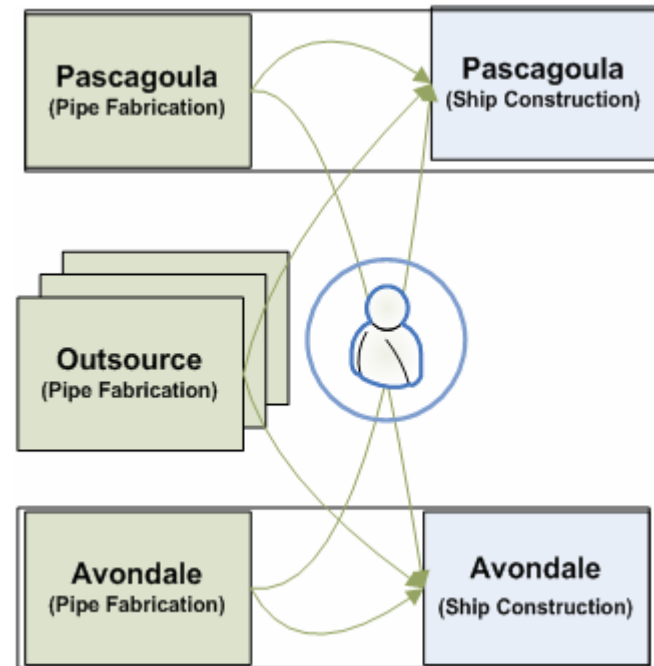
■ Pipe Shop Operations

- Cut – responsible for cutting raw pipe to length
- Bend – responsible for adding required bends to pipe
- Fit – responsible for assembling and tack welding of the pipe detail
- Braise or Weld – responsible for final weld operation
- Other
 - Kitting
 - Inspection



Challenges

- Demand for pipes from multiple programs and shipyards
- Pipes can be supplied from multiple shops
- Production location depends on pipe detail characteristics
- Processing times are not based on product characteristics
- Data resides in multiple disparate sources
- To be effective, must become an integral part of the way the planner works
- Large scale problem



**What should be produced,
where, and when?**

Key Strategies

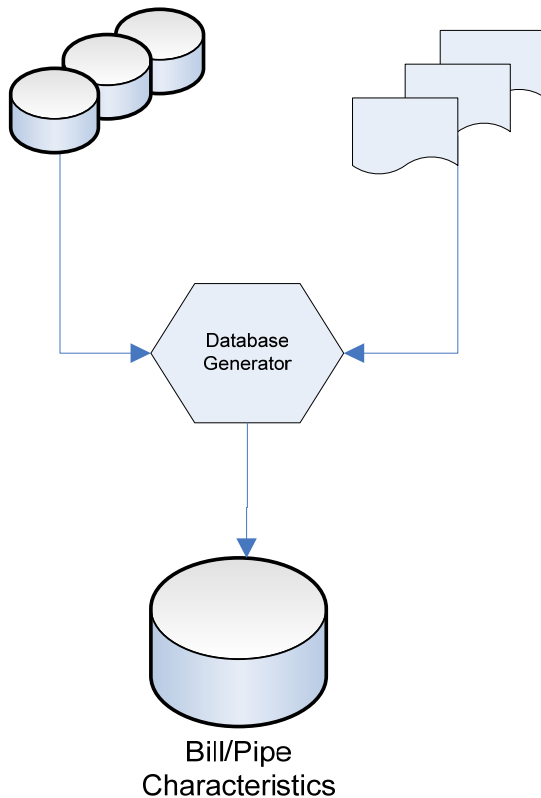
- **Focus on the bottleneck (fit & weld operations)**
 - Generate a Fit & Weld Production Plan based on resource availability, estimated work content, due date
 - Use project management approach: each PD is a resource-constrained project
- **Test the Fit & Weld Plan**
 - Consider other pipe shop operations (cut, bend, material handling, etc.) and their interactions
 - Consider variability and dynamics: simulate the operational environment
- **Estimate pipe shop capacity**
 - Use “representative” pipe demand
 - Load simulation models of shop

General Approach

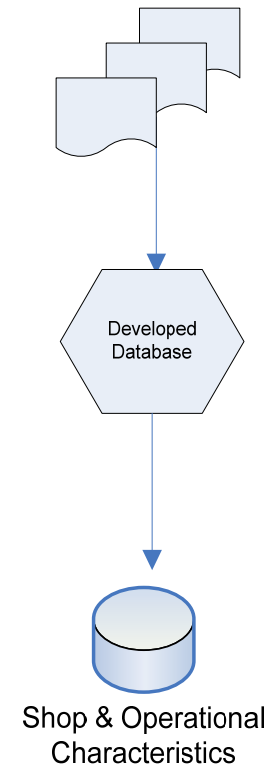
- **Database driven**
 - Pipe characteristics
 - Shop characteristics
- **Model driven**
 - Processing times
 - Shop processing behavior
 - High-level fit & weld model (bottleneck)
- **Decision support system**
 - Integrate data, models, and users
 - Effective user interface

General Approach

- Design and develop pipe characteristics database

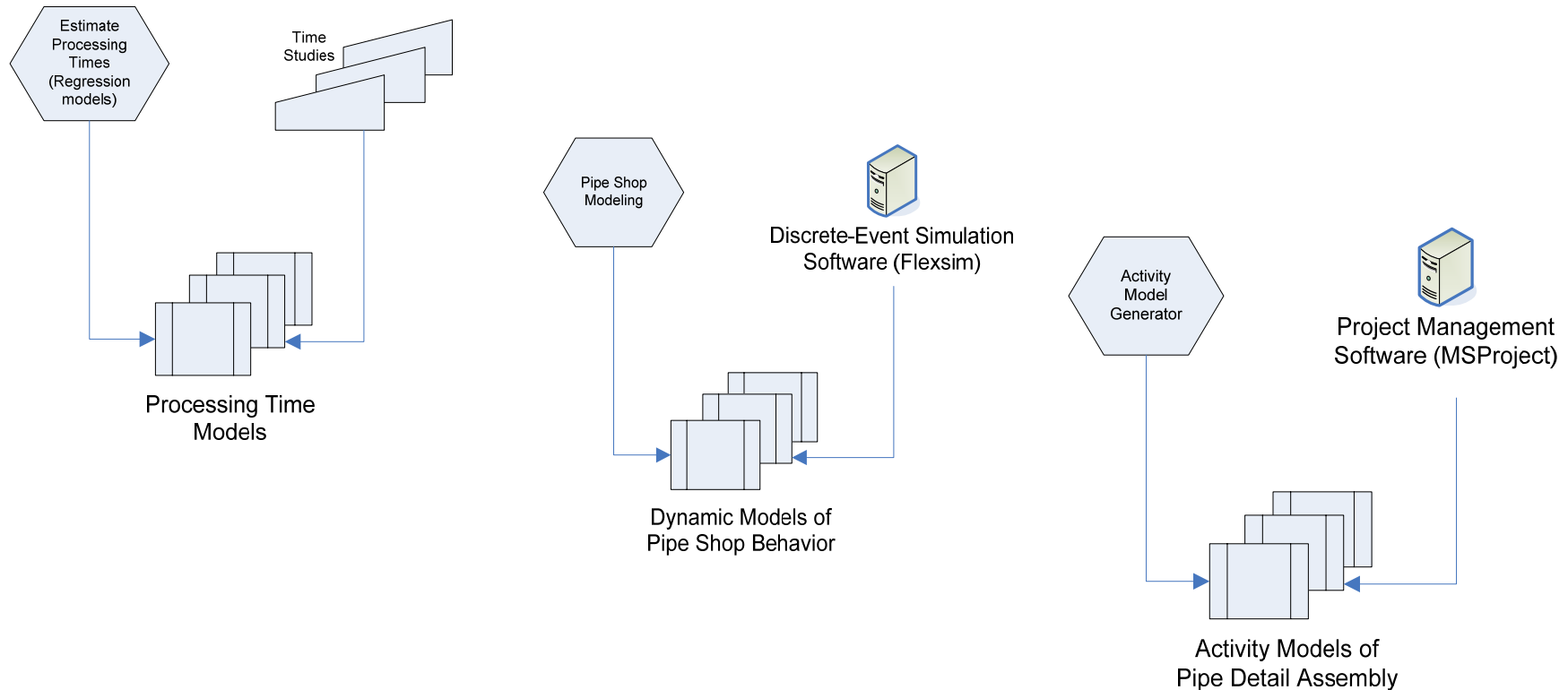


- Develop shop characteristics database



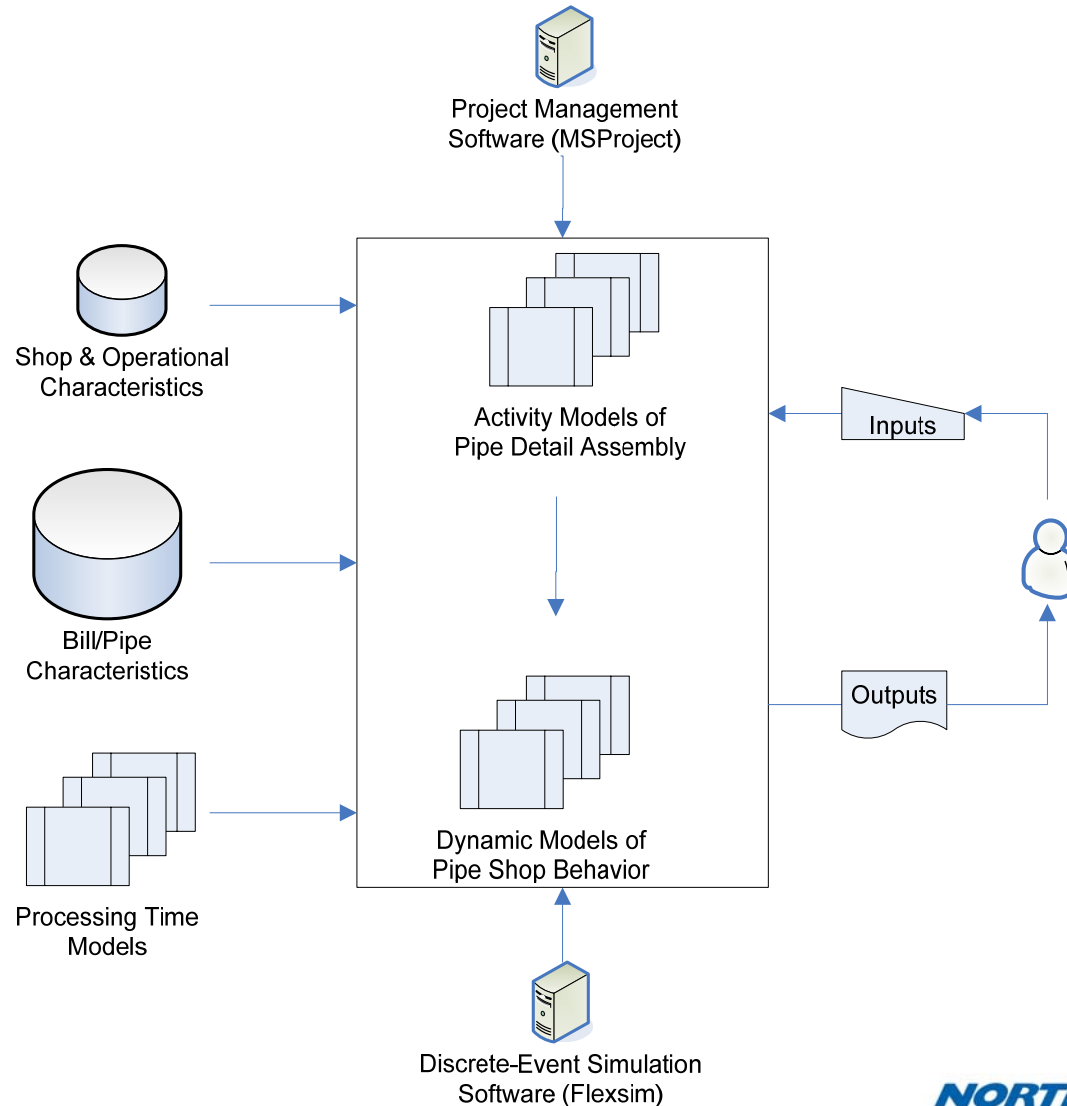
General Approach

- **Develop means to estimate processing times**
- **Model shop processing behavior**
- **Model fit & weld work as resource-constrained project**



General Approach (DSS)

- Integrate data, models, and users



General Approach (DSS)

- Develop effective user interface

Current model representation

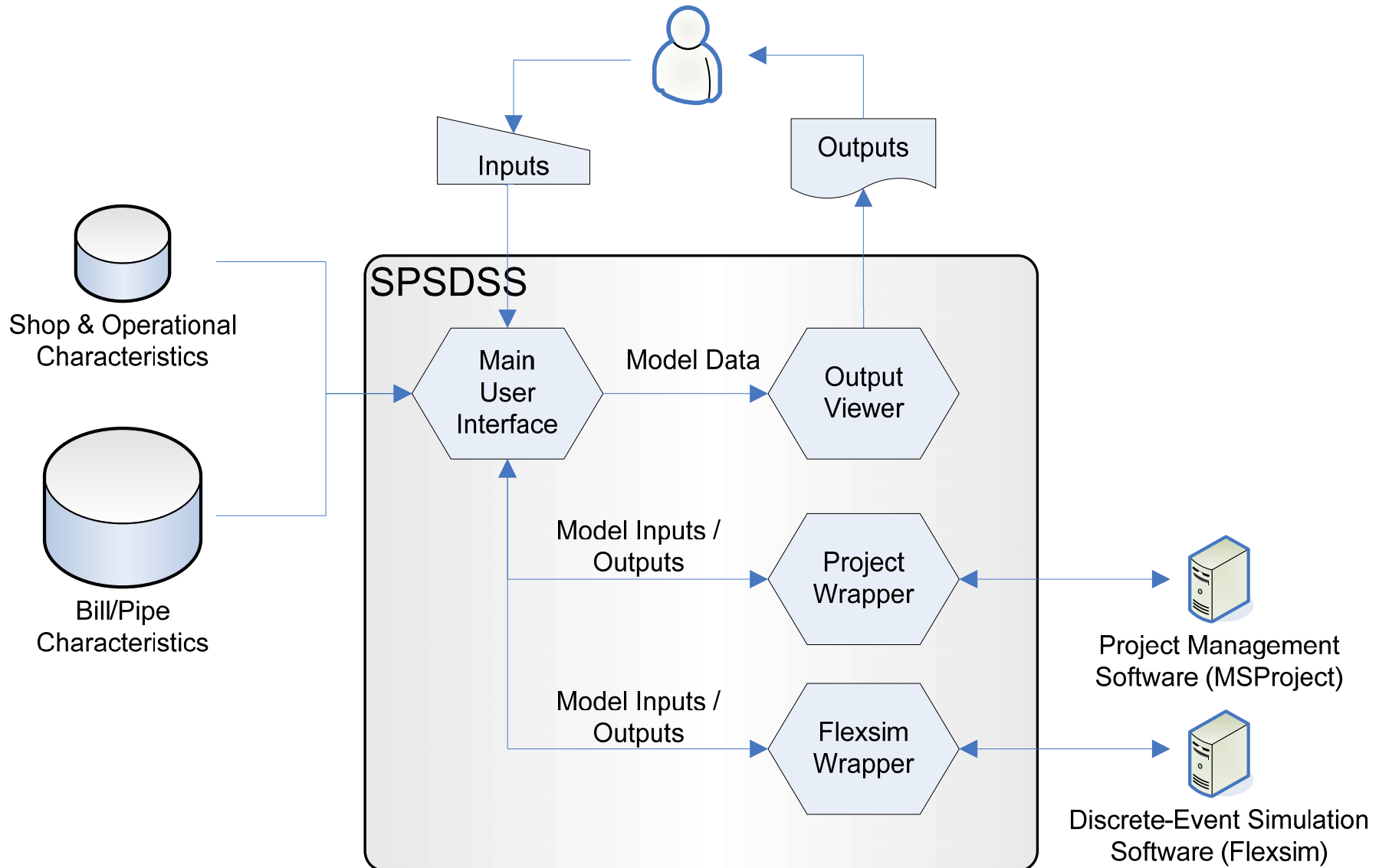
Model chart or graph output

Basic Information Flow

*Dummy Data shown



Architecture



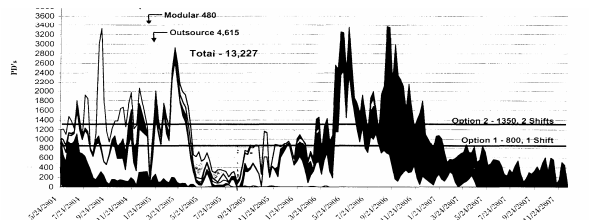
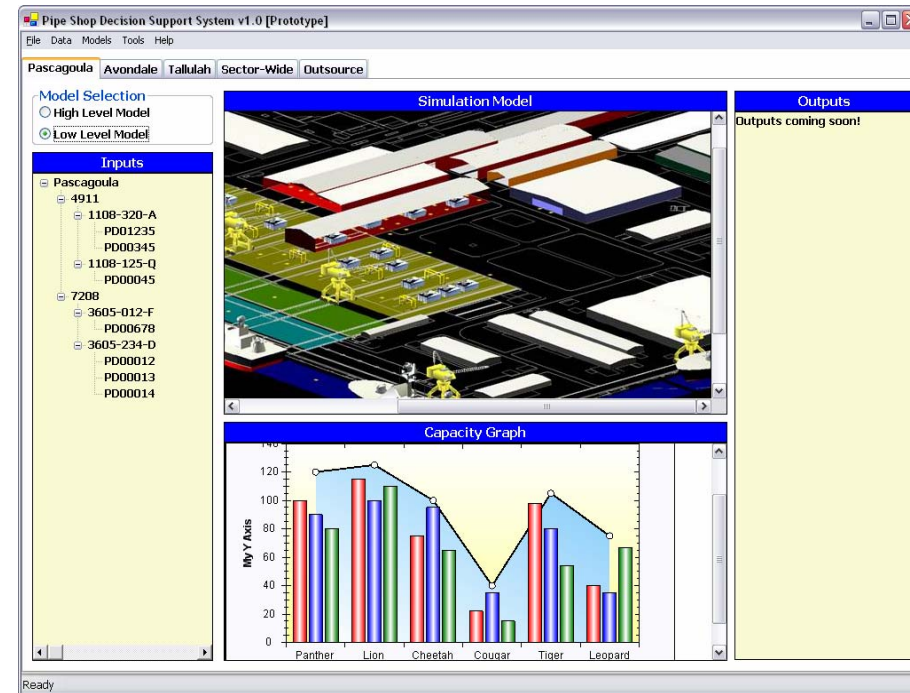
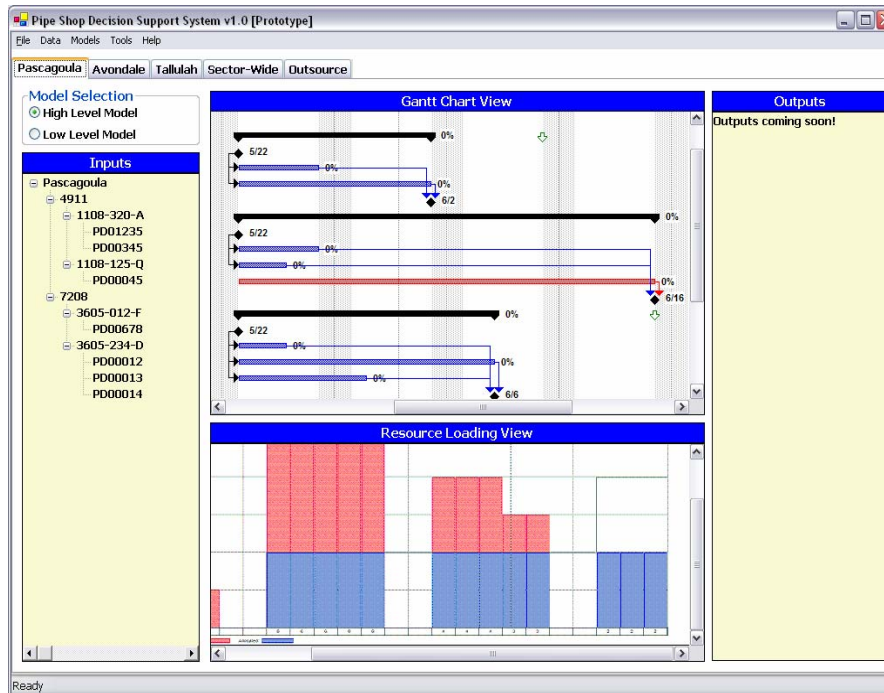
Pipe Shop DSS (prototype)

- **Planning (high-level) Model**

- for bottleneck capacity planning and analysis
- high-level operational trade-offs and production decisions

- **Operations (low-level) Model**

- assess plan at shop level, including all operations
- establish capacity for high-level model



Planning (High-Level) Model

- **Built In:**

- Microsoft Project 2003

- **Purpose:**

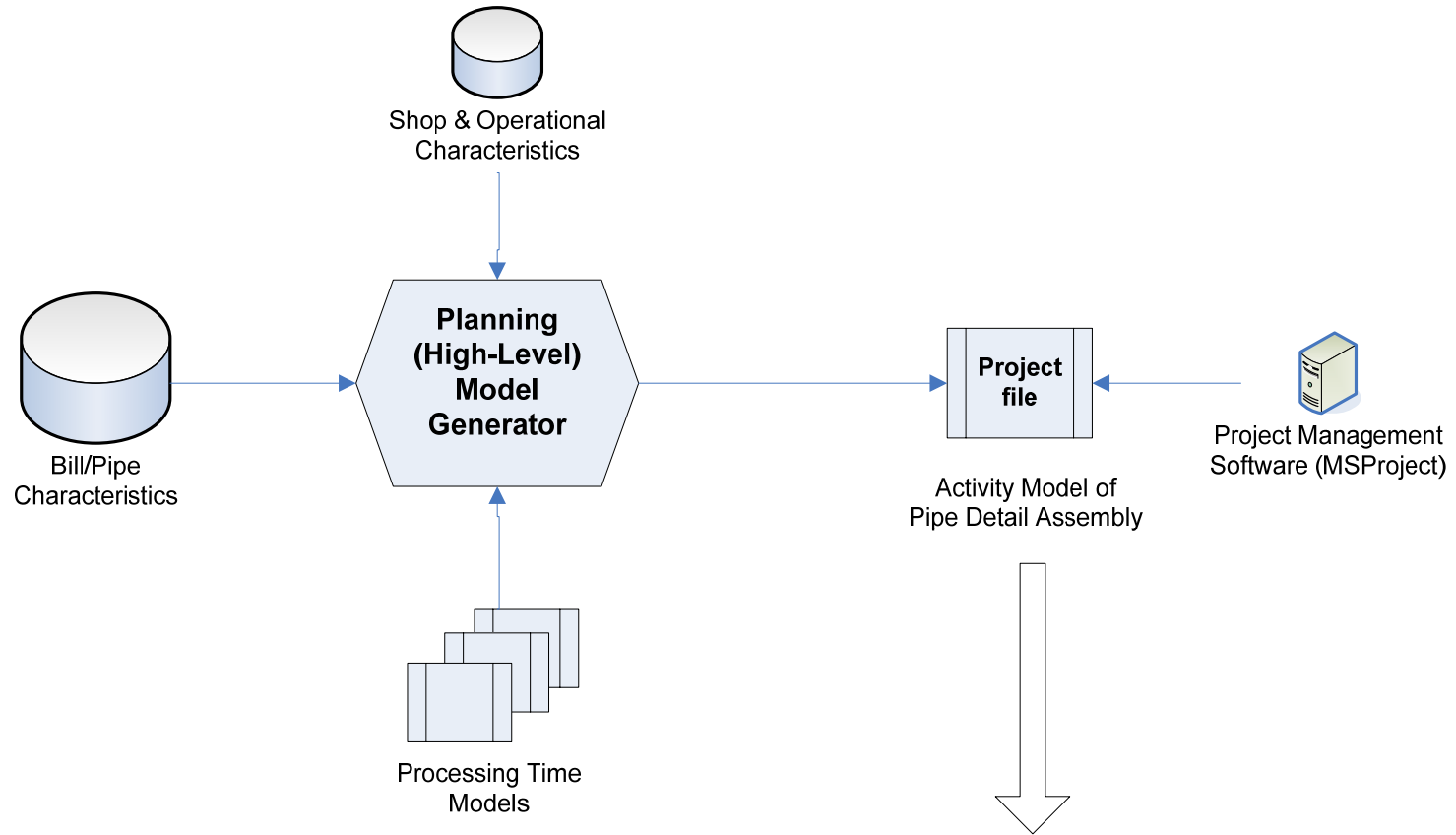
- Convert PD characteristics and Bill information into resource-loaded plan based on work content
- Display plan for producing PDs (in Gantt chart view)
- Display resource utilization over time
- Assess impact of changes in Bill production location, resource level (bottleneck), priorities, due date, ...
- “Level” resources considering resource availability and due dates

Planning (High-Level) Model

- **Key Aspects:**

- Only models bottleneck operations in pipe shop – fit & weld
- Includes shift schedules
- Executes at individual shop or sector levels
- Executes at PD or Bill level
- Estimates system performance, e.g. shop utilization, resource utilization, system throughput, manhour measurements, PD time in system, breakdown of time spent in process, ...

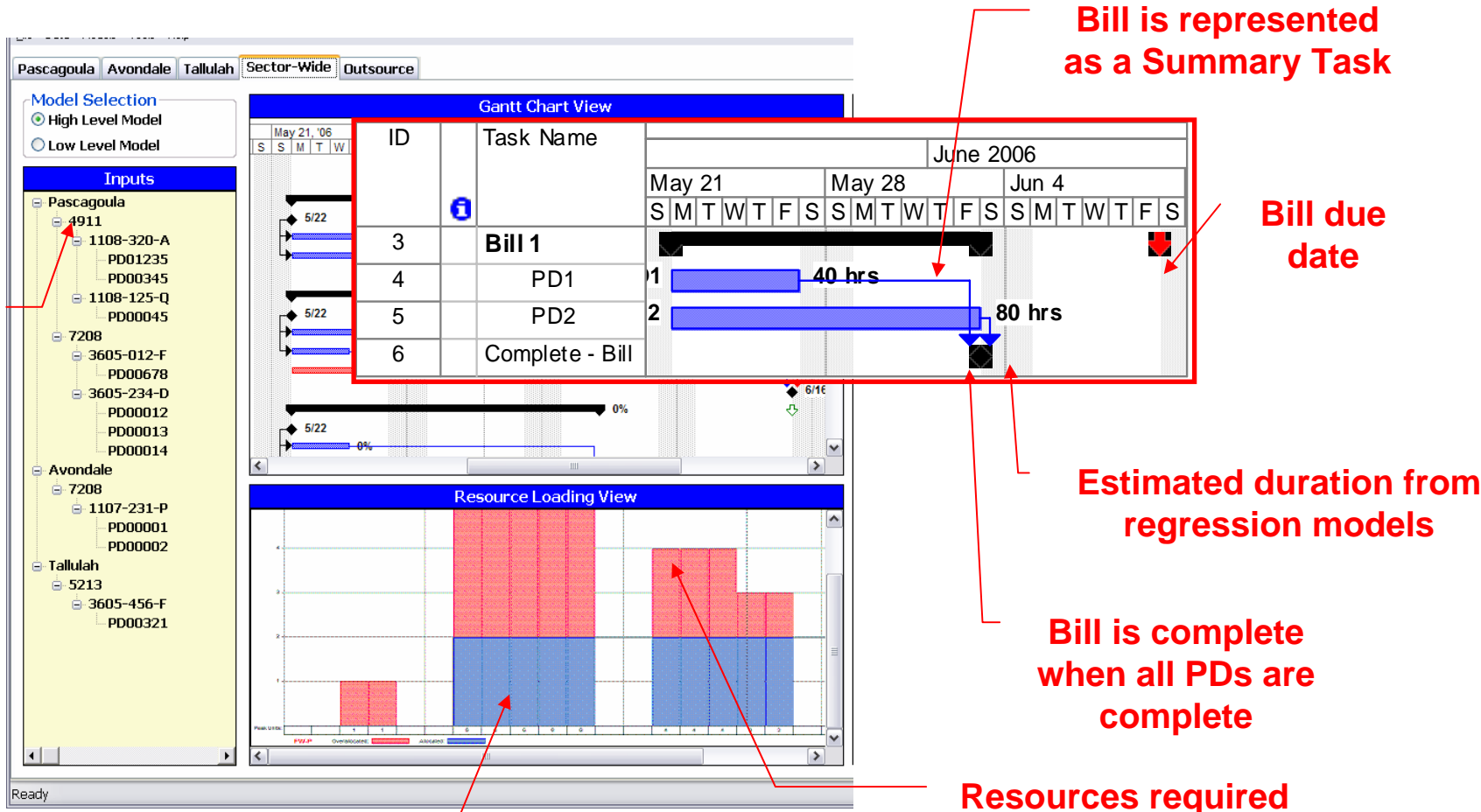
Generating the Planning (High-level) Model



ID	Task Name	June 2006													
		May 21					May 28					Jun 4			
		S	M	T	W	T	F	S	S	M	T	W	T	F	S
3	Bill 1	[Gantt bar from May 21 to Jun 4]													
4	PD1	1	[Gantt bar from May 21 to May 28, 40 hrs]												
5	PD2	2	[Gantt bar from May 21 to Jun 4, 80 hrs]												
6	Complete - Bill	[Gantt bar from May 21 to Jun 4]													

Representing the Bottleneck Operations as a Project

Yard
Hull
Bill
PD



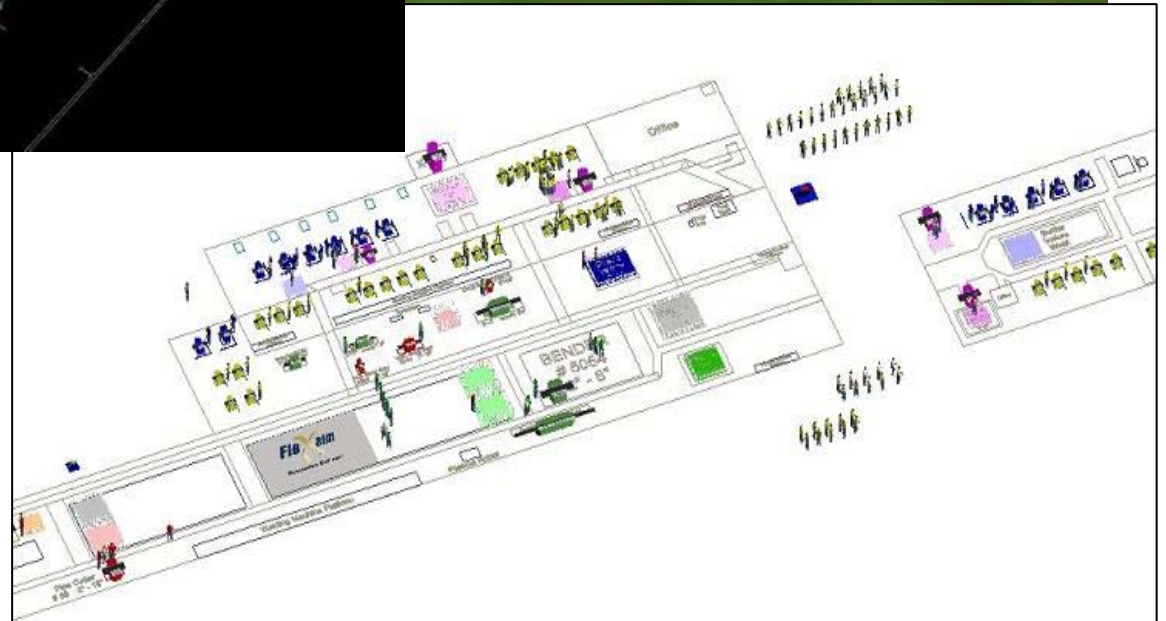
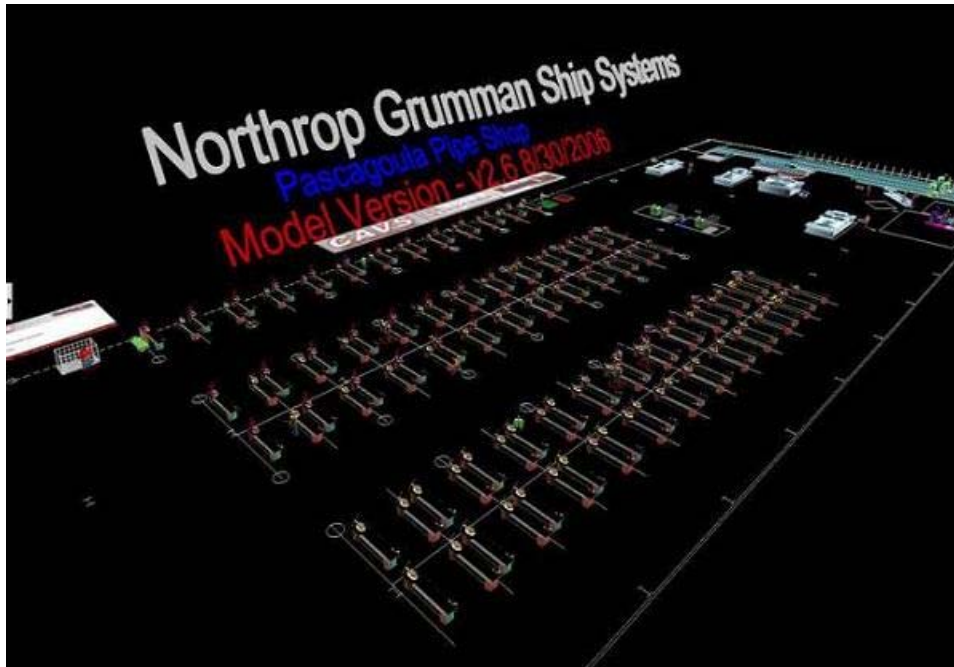
Available resources

May invoke "leveling" to smooth resource use or force resource constraint (due date slip is likely)

Operations (Low Level) Models

- **Built In:**
 - Flexsim Simulation Software
- **Purpose:**
 - Executes PDs allocated to the shop
 - Assess impact of changes in Bill production location, resource level, priorities, due date, ...
- **Key Aspects:**
 - 3 Models: Pascagoula, Avondale, and Tallulah
 - Includes logic for custom processes and routings
 - Incorporates downtimes and equipment repair
 - Includes shift schedules
 - Outputs system statistics such as area utilizations, resource utilizations, system throughput, manhour measurements and pipe detail information such as time in system, time in each area, and time spent in process.

Operations (Low Level) Models



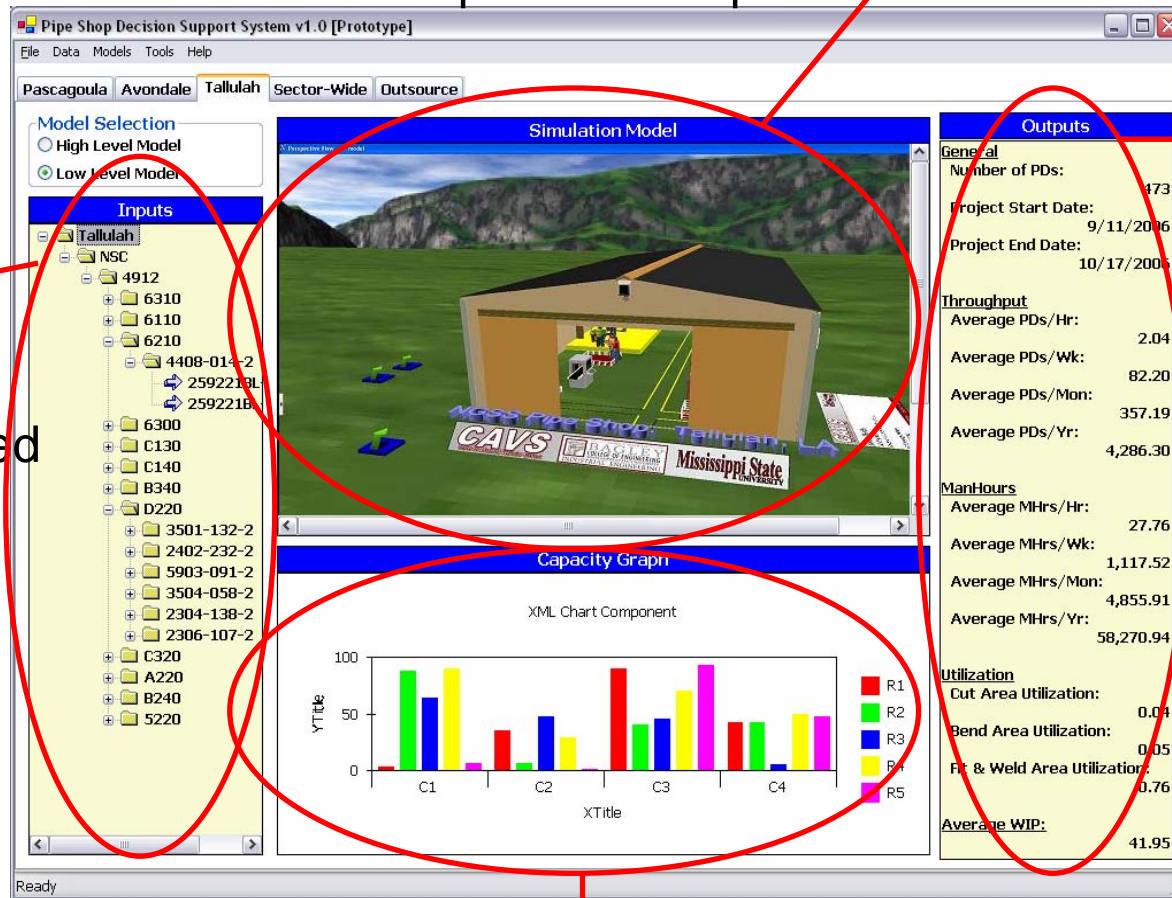
Sector-wide Pipe Shop Decision Support System – Walkthrough

Walkthrough

Current model representation will be display here and update as required.

Basic system outputs such as PDs or Bills completed per week are displayed right side. More detailed outputs can be accessed via the Output viewer.

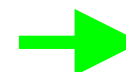
System inputs are represented on the left side.



Model chart or graph output will be displayed here when generated.

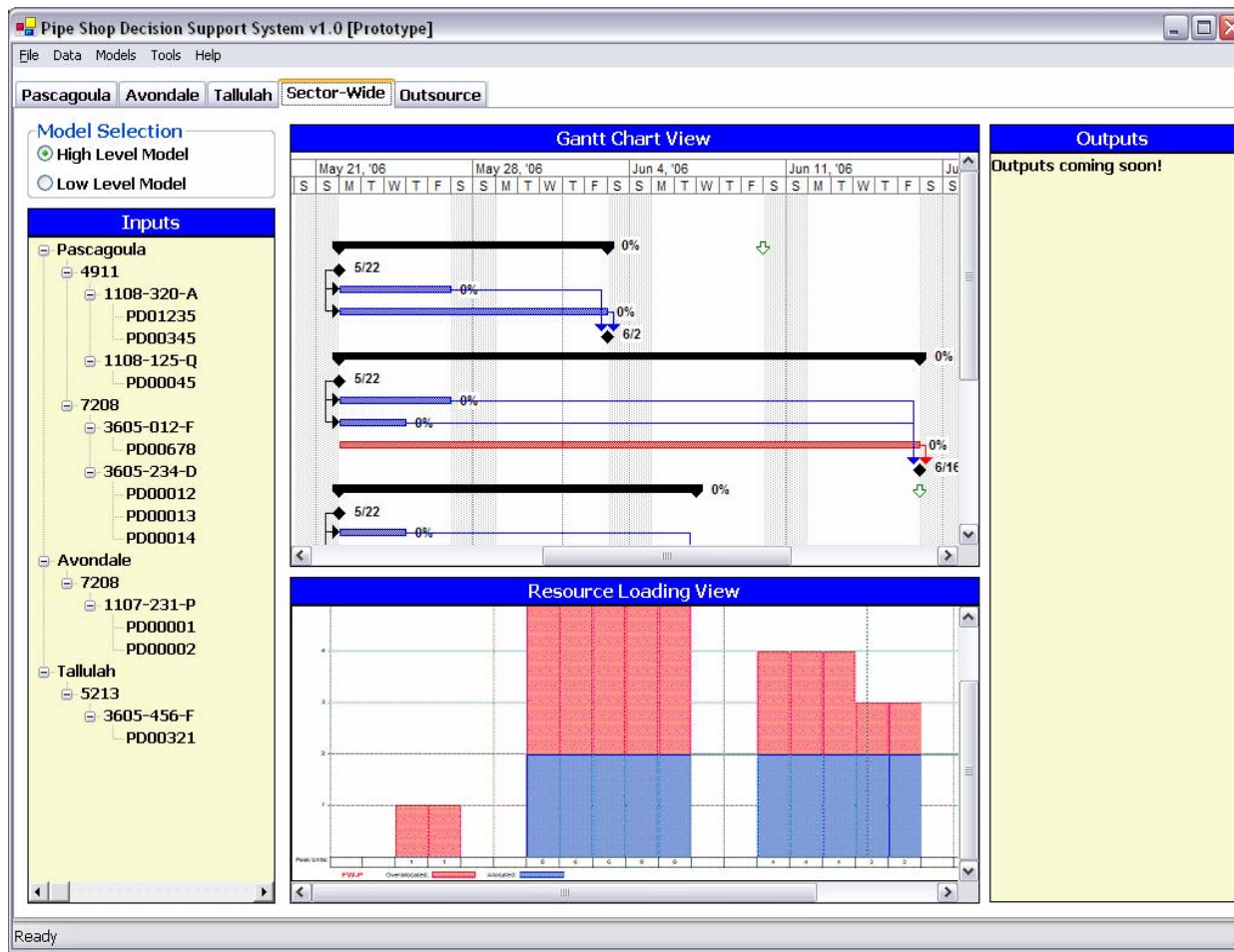
*Dummy Data shown

Basic Information Flow



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Walkthrough

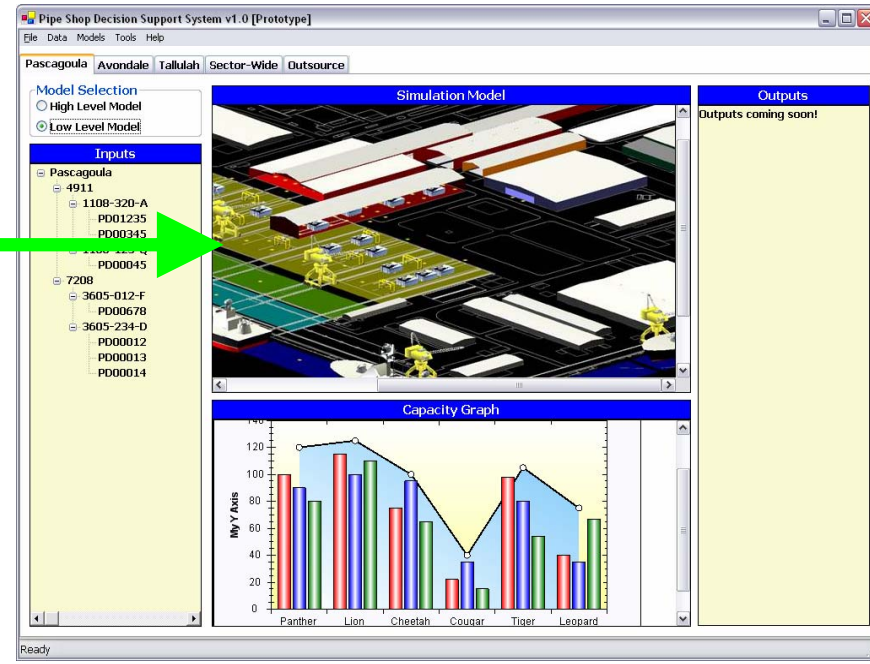
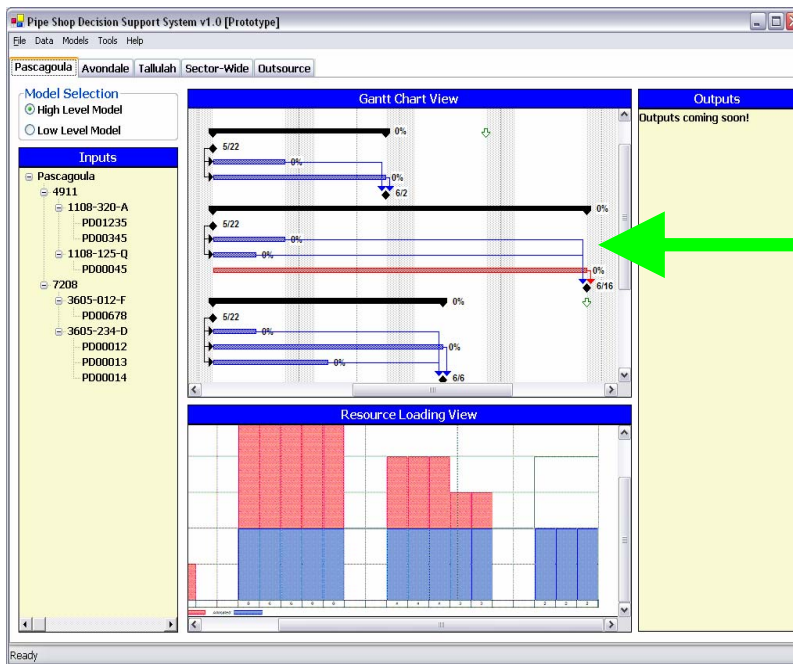


Each tab of the interface corresponds to a shop – Pascagoula, Avondale, and Tallulah.

The “Sector-Wide” tab combines the data represented on each of the individual shop tabs.

The “Outsourcing” tab keeps a list of bills that have been marked for potential outsourcing.

Walkthrough



On each shop tab, users will be able to transition from using the high level model to the low level simulation models and utilize the same data set in both models.

Walkthrough

The Date Range menu item allows users to specify the data to bring into the system.

The screenshot displays the 'Pipe Shop Decision Support System v1.0 [Prototype]' interface. The 'Data' menu is open, showing the 'Date Range...' option highlighted. A red arrow points from this menu item to a dialog box titled 'frmDateRange'. The dialog box contains the text 'Please select a date range for which to load data.' and two date pickers, both set to '6/ 5/2006'. A calendar for June 2006 is also visible, with the 5th of June selected. The main interface shows a 'Gantt Chart View' and an 'Outputs' panel with the message 'Outputs coming soon!'.

Walkthrough

Double-clicking on an input brings up related information about the selected object.

Pipe Shop Decision Support System v1.0 [Prototype]

File Data Models Tools Help

Pascagoula Avondale Tallulah Sector-Wide Outsource

Model Selection
 High Level Model
 Low Level Model

Inputs

- Pascagoula
 - 4911
 - 1108-320-A
 - PD01235
 - PD00345
 - 1108-125-Q
 - PD00045
 - 7208
 - 3605-012-F**
 - PD00678
 - 3605-234-D
 - PD00012
 - PD00013
 - PD00014

frmBillData

Bill Information

Program: LPD Priority

Hull: 7208

Unit: 234

Bill: 3605-234-D

Unit Build Location: Pascagoula

Schedule Start: 6/ 5/2006

Schedule Complete: 6/30/2006

Work Location: Tallahah

Number of PDs: 3

Update Cancel

Gantt Chart View

ID	Task Name	Work	Duration	May 7, '06	May 14, '06	May
				S	S	S
				M	M	M
				T	T	T
				W	W	W
				T	T	T
				F	F	F
				S	S	S
1						
2						
3	Bill 1	120 hrs	10 days			
4	Start - Bill 1	0 hrs	0 days			
5	PD1	40 hrs	5 days			

Outputs

Outputs coming soon!

Ready

Walkthrough

• The Labor Settings menu item allows users to specify information about the available labor pools to be utilized by the models.

• The Resource Settings menu item allows users to specify information about the available resources in the models.

Walkthrough

The Options menu item allows users to specify model settings including: start date, number of replications, animation, leveling criteria, and which database to use.

Walkthrough

The screenshot displays the 'Pipe Shop Decision Support' application. The 'View Outputs' menu is open, showing options like 'Execute' and 'Options'. A red arrow points from the 'View Outputs' menu to the 'Low level Tallulah Pipe Shop' graph. Another red arrow points from the 'View Outputs' menu to the 'High level Pascagoula Pipe Shop - Number of PDs Per Week' graph. The 'Bill Report' table is visible in the background.

Program	Hull	Unit	Bill	WS (Mod.)	Schedule Start	Schedule Complete	Simulated Start	Simulated Complete	Days Late
NSC	4912	6310	5012-038-2	890	9/18/2006	10/27/2006	9/12/2006	9/15/2006	0
NSC	4912	6310	5011-010-2	890	9/18/2006	10/27/2006	9/12/2006	9/28/2006	0
NSC	4912	6310	5501-108-2	890	9/18/2006	10/27/2006	9/12/2006	9/13/2006	0
NSC	4912	6310	5601-019-2	890	9/18/2006	10/27/2006	9/12/2006	10/12/2006	0
NSC	4912	6110	5103-059-2	890	9/18/2006	10/27/2006	9/14/2006	9/15/2006	0
NSC	4912	6110	5501-057-2	890	9/18/2006	10/27/2006	9/14/2006	9/15/2006	0
NSC	4912	6110	5011-013-2	890	9/18/2006	10/27/2006	9/14/2006	9/20/2006	0
NSC	4912	6110	5601-049-2	890	9/18/2006	10/27/2006	9/14/2006	9/25/2006	0
NSC	4912	6110	2402-144-2	890	9/18/2006	10/27/2006	9/14/2006	10/19/2006	0
NSC	4912	6310	3501-136-2	890	9/18/2006	10/27/2006	9/21/2006	9/26/2006	0
NSC	4912	6310	3200-046-2	890	9/18/2006	10/27/2006	9/22/2006	9/27/2006	0
NSC	4912	6210	4408-011-2	890	9/18/2006	10/27/2006	9/22/2006	9/25/2006	0
NSC	4912	6300	5601-064-2	890	9/18/2006	10/27/2006	9/22/2006	9/24/2006	0
NSC	4912	C130	5901-018-2	890	9/18/2006	10/27/2006	9/26/2006	9/27/2006	0
NSC	4912	C130	5011-032-2	890	9/18/2006	10/27/2006	9/26/2006	9/27/2006	0
NSC	4912	C140	2306-039-2	890	9/18/2006	10/27/2006	9/26/2006	9/27/2006	0
NSC	4912	C130	3506-022-2	890	9/18/2006	10/27/2006	9/26/2006	9/27/2006	0
NSC	4912	C140	5901-014-2	890	9/18/2006	10/27/2006	9/26/2006	9/27/2006	0
NSC	4912	C140	2401-034-2	890	9/18/2006	10/27/2006	9/26/2006	9/27/2006	0
NSC	4912	C140	5903-031-2	890	9/18/2006	10/27/2006	9/26/2006	9/27/2006	0
NSC	4912	C130	3505-019-2	890	9/18/2006	10/27/2006	9/26/2006	9/27/2006	0
NSC	4912	B340	2402-077-2	890	9/18/2006	10/27/2006	9/26/2006	9/27/2006	0
NSC	4912	C130	2306-035-2	890	9/18/2006	10/27/2006	9/26/2006	9/27/2006	0
NSC	4912	B340	5903-030-2	890	9/18/2006	10/27/2006	9/26/2006	9/27/2006	0
NSC	4912	C130	2401-032-2	890	9/18/2006	10/27/2006	9/26/2006	9/27/2006	0

The graph shows the 'Number of PDs' (Y-axis, 0 to 350) versus 'Time (Wks)' (X-axis, 9/11/2006 to 10/2/2006). The data points are approximately: (9/11/2006, 150), (9/18/2006, 280), (9/25/2006, 350), (10/2/2006, 220).

The Output Viewer is used to display all graphs and reports and each are printable and exportable to Excel.

Forecasting Utility

- Allows planners to:
 - add new and proposed hull data to the system based on existing hull data
 - merge proposed changes with existing data

The screenshot shows the 'Forecast Utility' application window. The title bar reads 'Forecast Utility'. The menu bar includes 'File' and 'Help'. The 'Working Directory' is set to 'C:\Program Files\CAVS\SPSDSS\'. The 'Current Data Set' is set to 'Use CDB Dump'. The 'Data Display' tab is active, showing a list of hulls to forecast with the text 'Rename 2487 to 2488 and set start date to 6/4/2007'. Below this, there are fields for 'Template Hull #', 'Forecast Hull #', and 'Start Date of Forecast Hull', along with 'Add' and 'Remove' buttons. At the bottom, there is a section for 'Update / Create Forecast File' with a 'Forecast Name' dropdown set to 'Select existing forecast or type new', radio buttons for 'Overwrite' (selected) and 'Append', and a 'Generate Forecast' button.

Expected Results / User Responses

- **Better understanding of current Shop capacity**
- **Optimal use of capacity**
 - Less outsourcing
 - Better planning
 - Smoothed work-flow

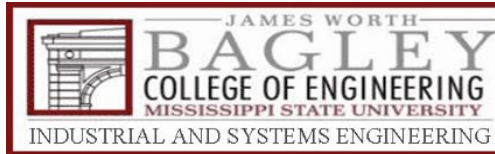
Future Development

- **Generalize *SPSDSS* framework for use in other shops and shipyards**
- **Expand *SPSDSS* framework for use as a shipyard decision support system**
- **Incorporate Optimization technologies to improve results**
- **Incorporate new models types such as math models and other simulation packages**

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Ship Systems

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EXTENSION



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