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DEFINING THE FUTURE

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

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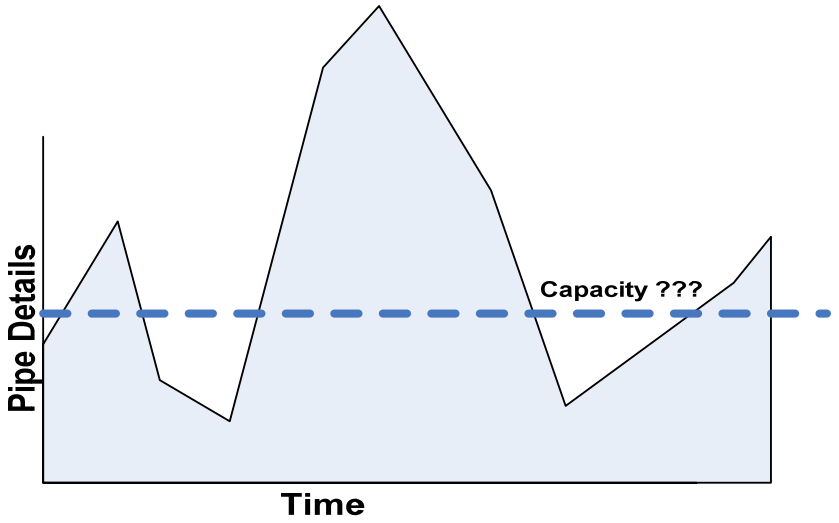
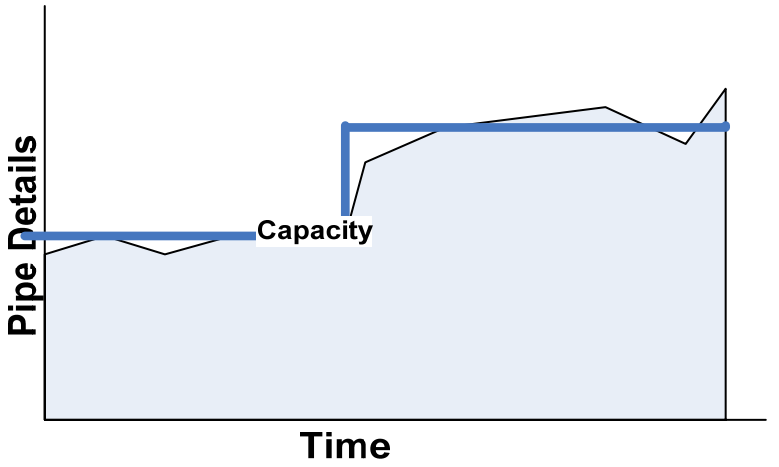
Motivation

- **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



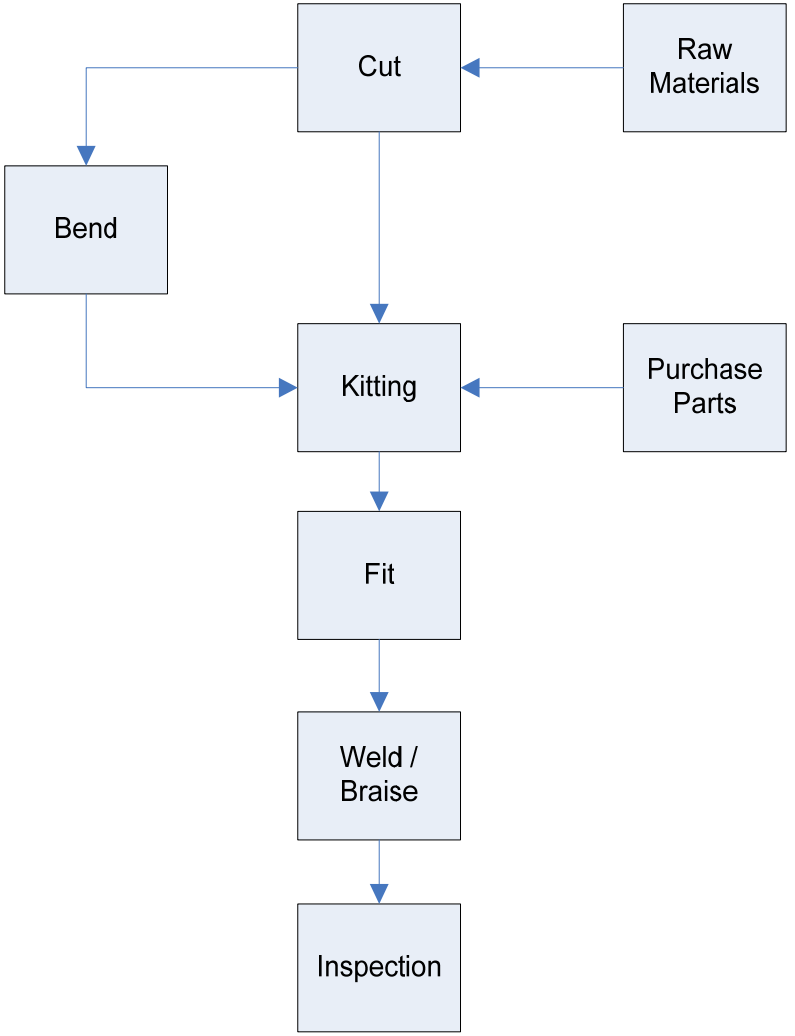


Background

- **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, …

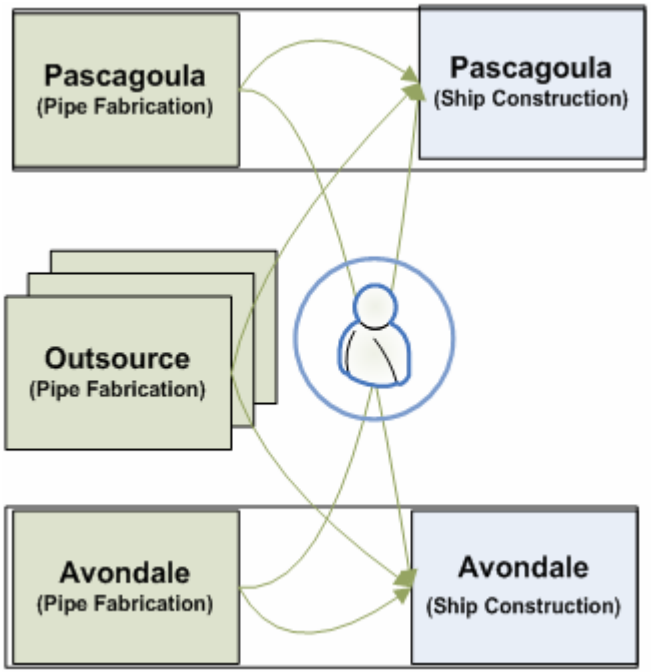
Background

- **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?

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Key Strategies

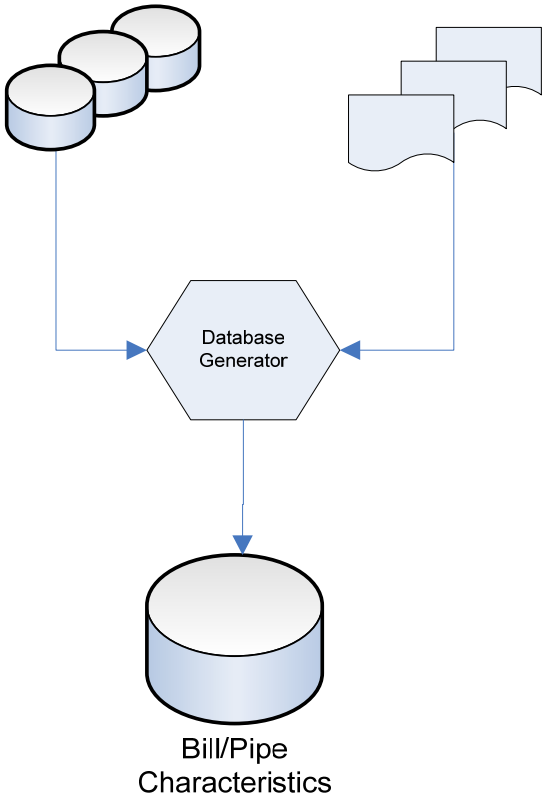
- **Focus on the bottleneck (fit & weld operations)**
  - Generate a Fit & Weld Production Plan based on resource availability, estimated work content, due date
  - Use project management approach: each PD is a resource-constrained project
- **Test the Fit & Weld Plan**
  - Consider other pipe shop operations (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

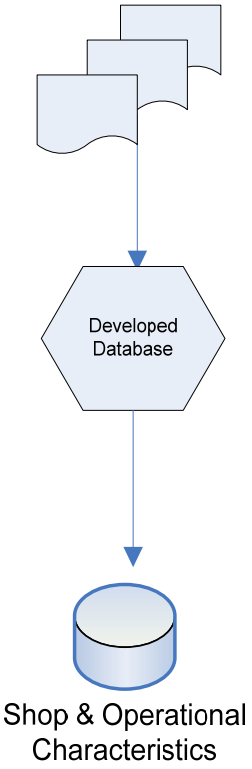
- **Database driven**
  - Pipe characteristics
  - Shop characteristics
- **Model driven**
  - Processing times
  - Shop processing behavior
  - High-level fit & weld model (bottleneck)
- **Decision support system**
  - Integrate data, models, and users
  - Effective user interface

General Approach

- **Design and develop pipe characteristics database**

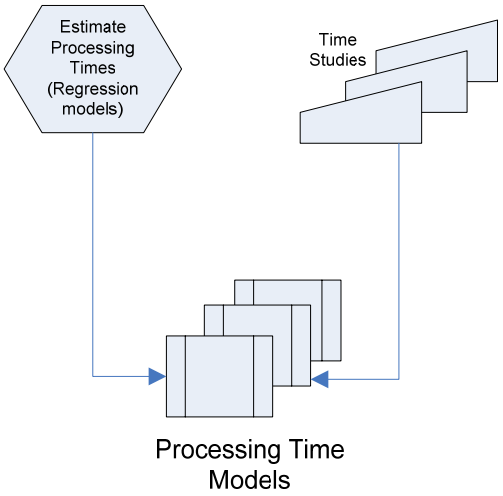


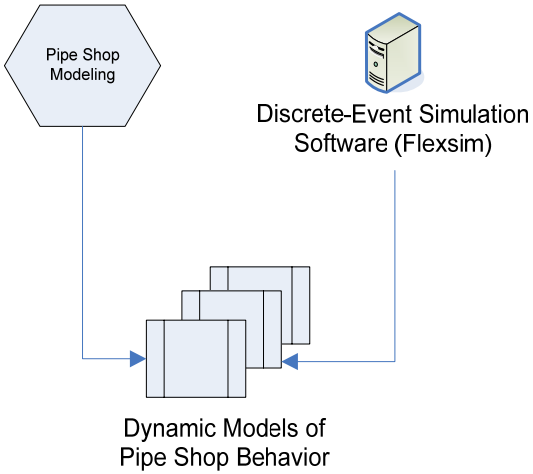
- **Develop shop characteristics database**

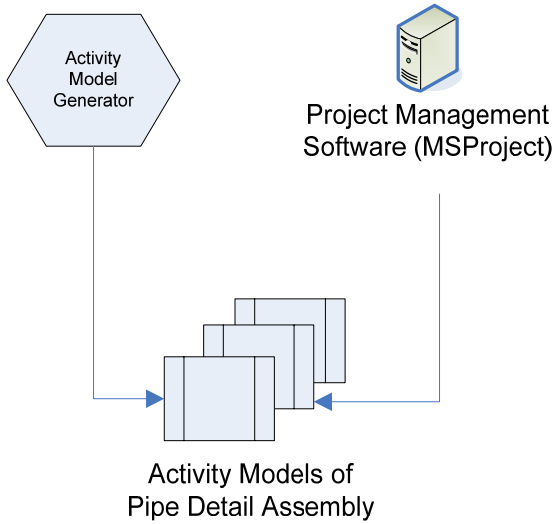


General Approach

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

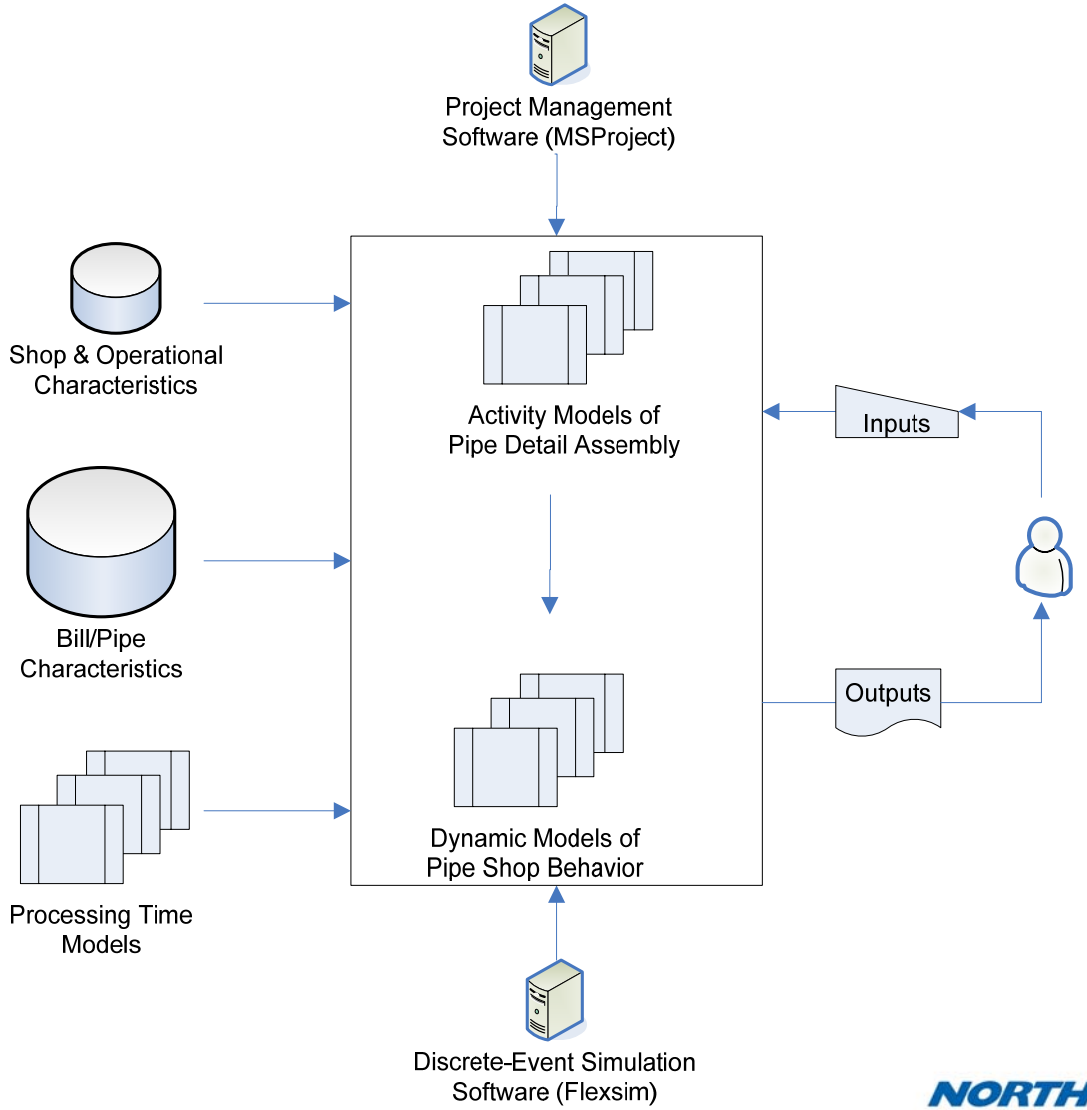






General Approach (DSS)

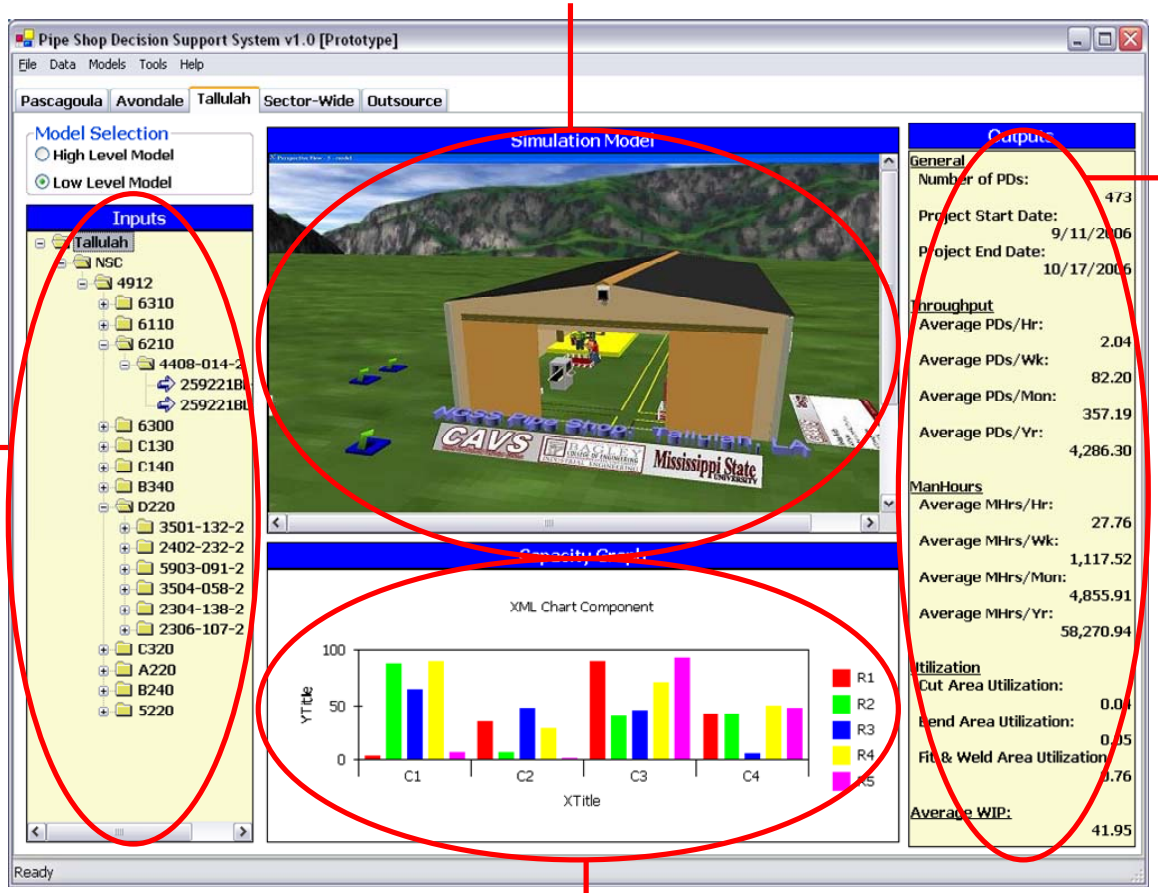
- **Integrate data, models, and users**



General Approach (DSS)

- **Develop effective user interface**

Current model representation



System input

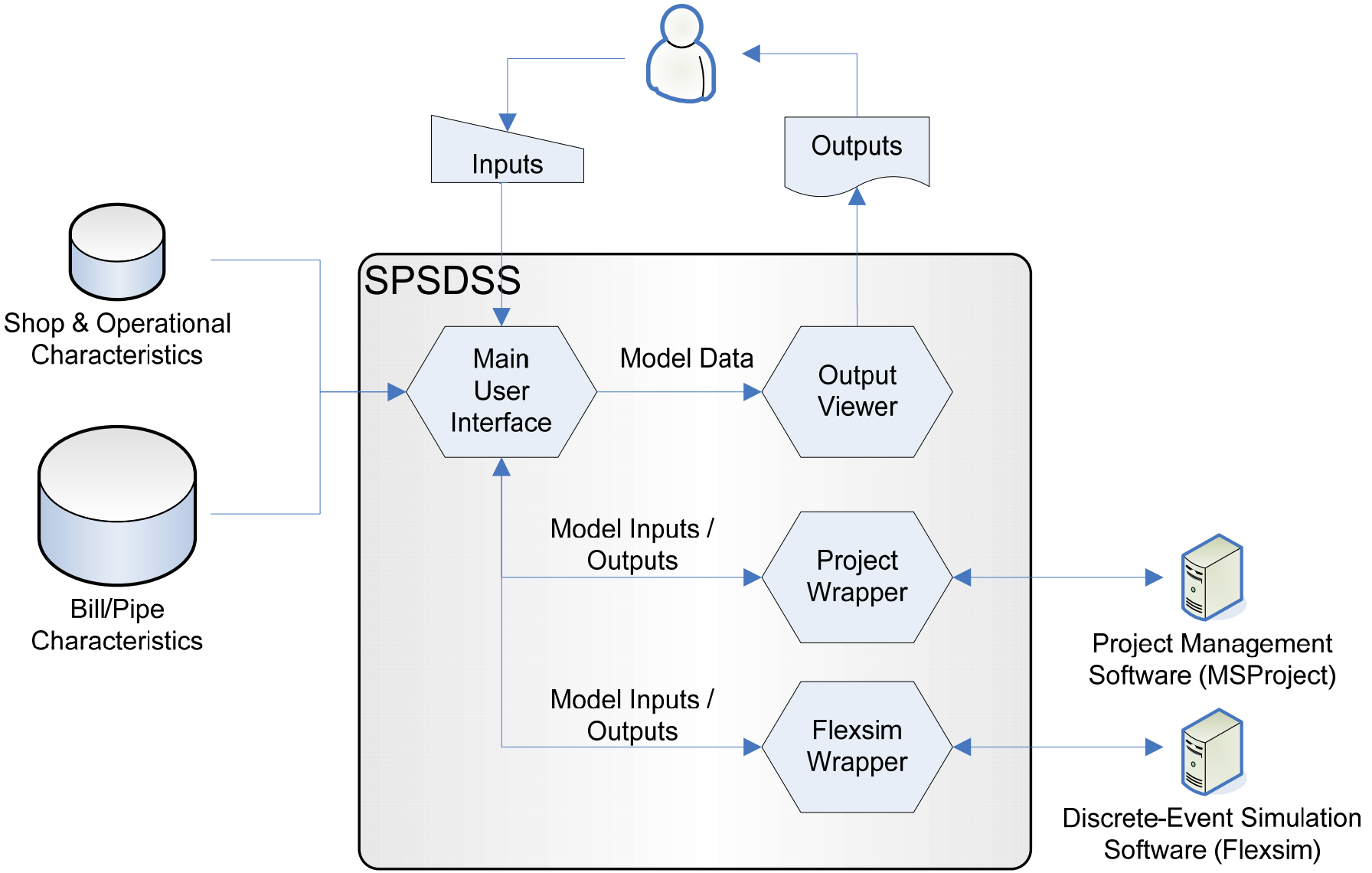
Basic system output; more detail can be accessed via the Output Viewer.

Model chart or graph output

*Dummy Data shown

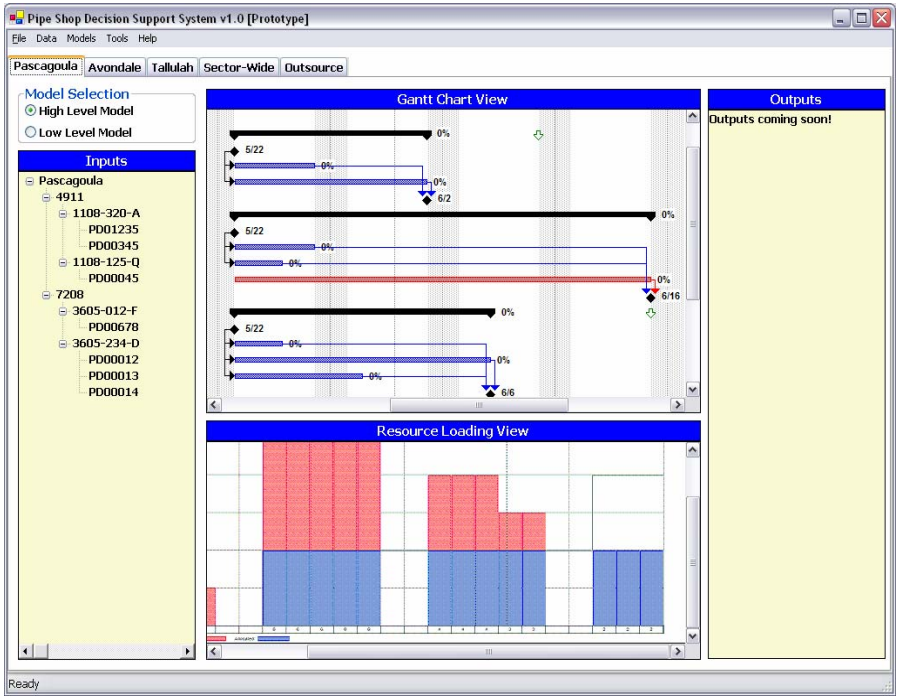
Basic Information Flow

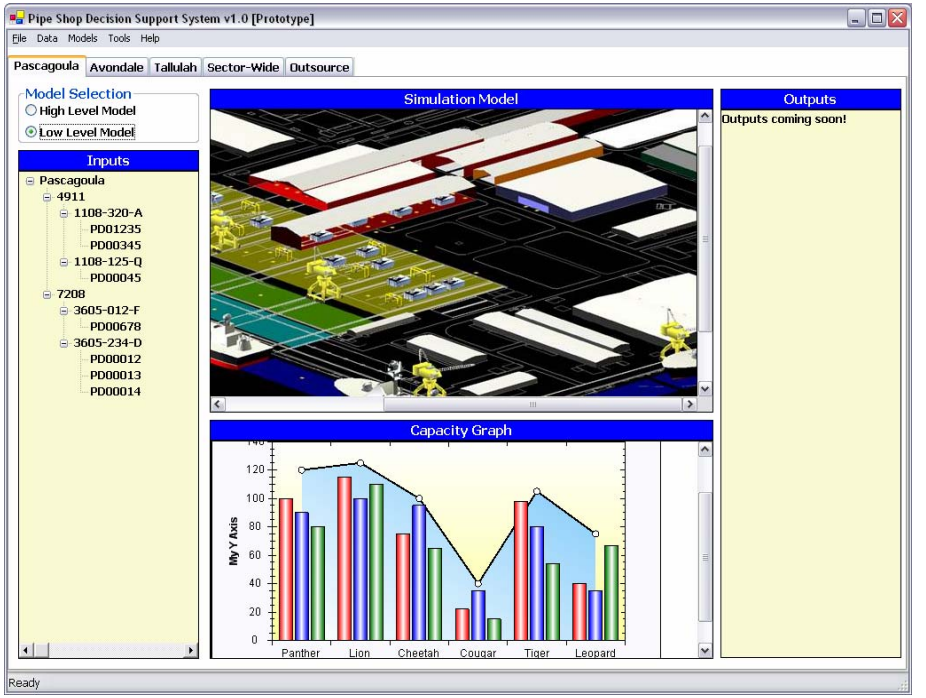
Architecture

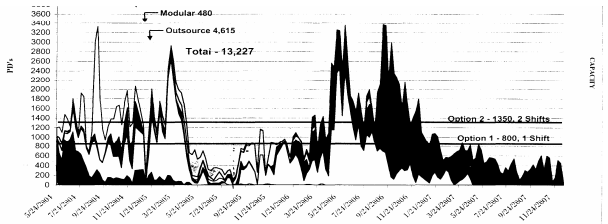


Pipe Shop DSS (prototype)

- *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







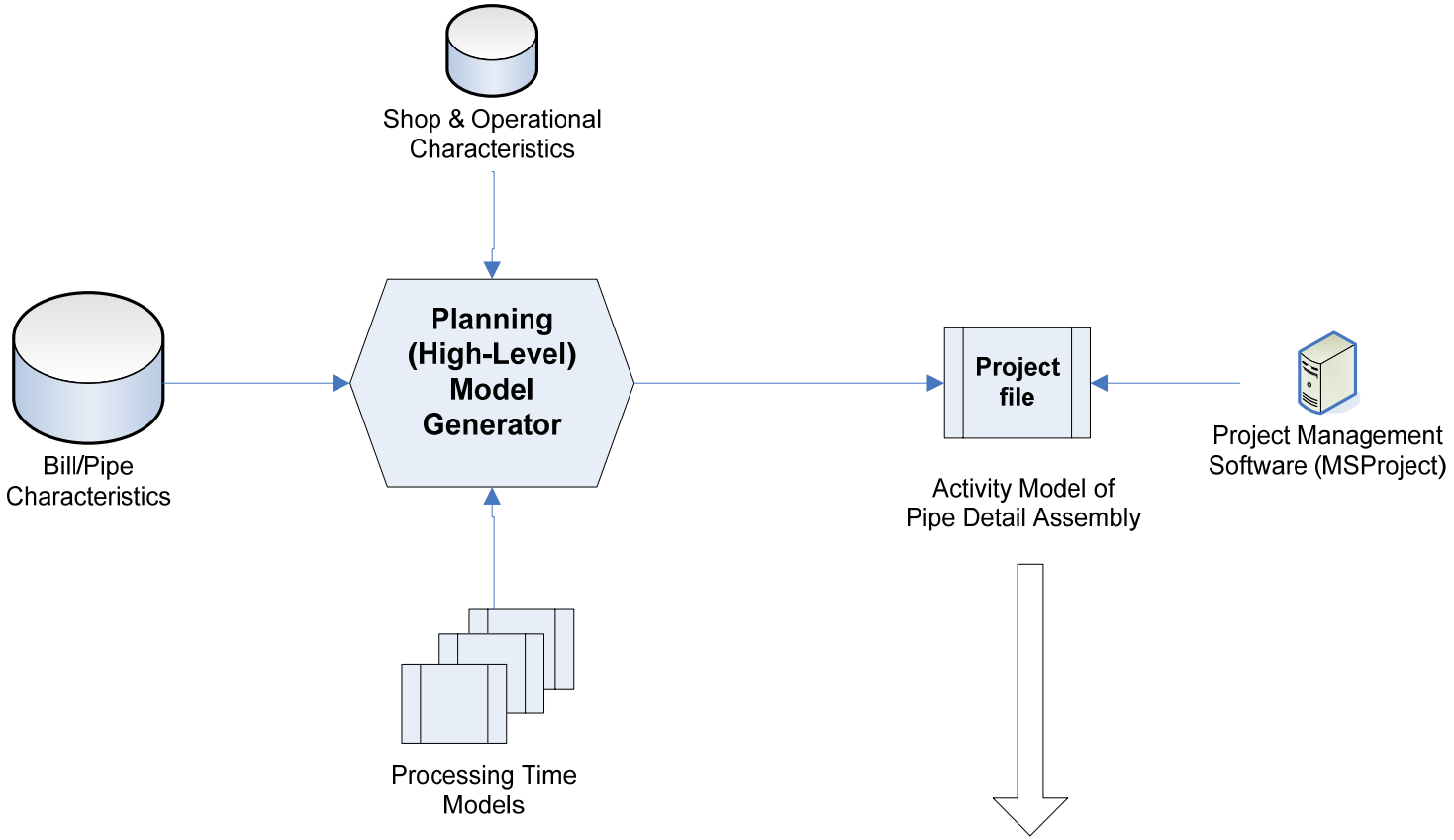
Planning (High-Level) Model

- **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

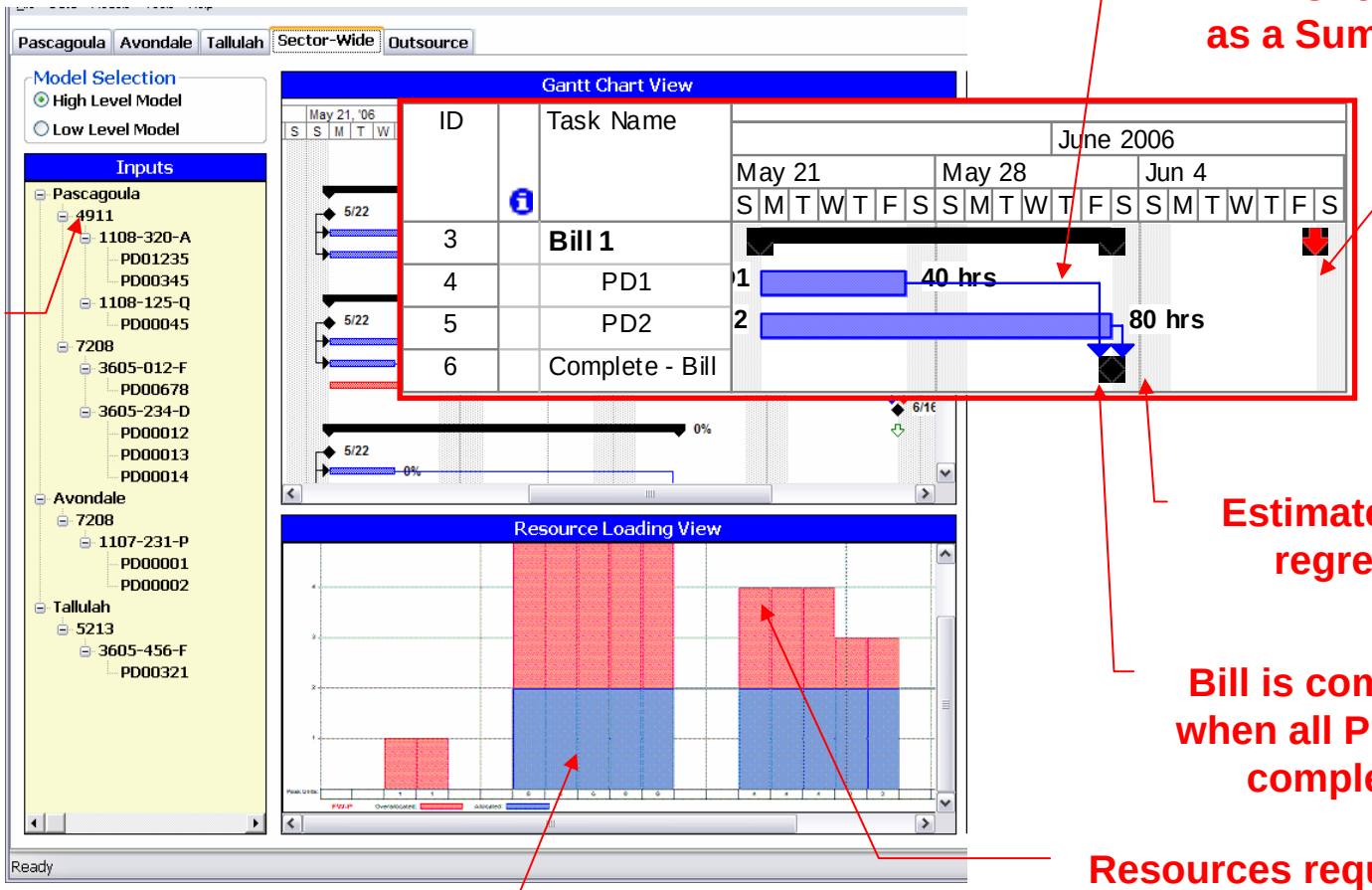
- **Key Aspects:**
  - Only models bottleneck operations in pipe shop – fit & weld
  - Includes shift schedules
  - Executes at individual shop or sector levels
  - Executes at PD or Bill level
  - Estimates system performance, e.g. shop utilization, resource utilization, system throughput, manhour measurements, 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 S M T W T F S
3		**Bill 1**	
4		PD1	1 40 hrs
5		PD2	2 80 hrs
6		Complete - Bill	

Representing the Bottleneck Operations as a Project



Yard
Hull
Bill
PD

Bill is represented as a Summary Task

Bill due date

Estimated duration from regression models

Bill is complete when all PDs are complete

Resources required

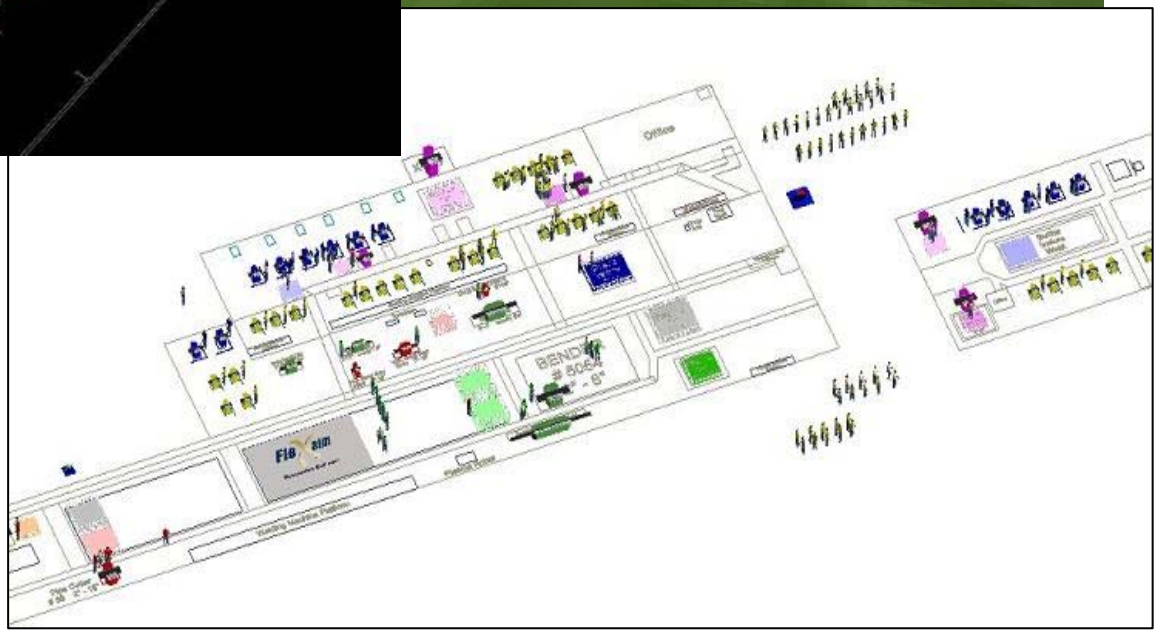
Available resources

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

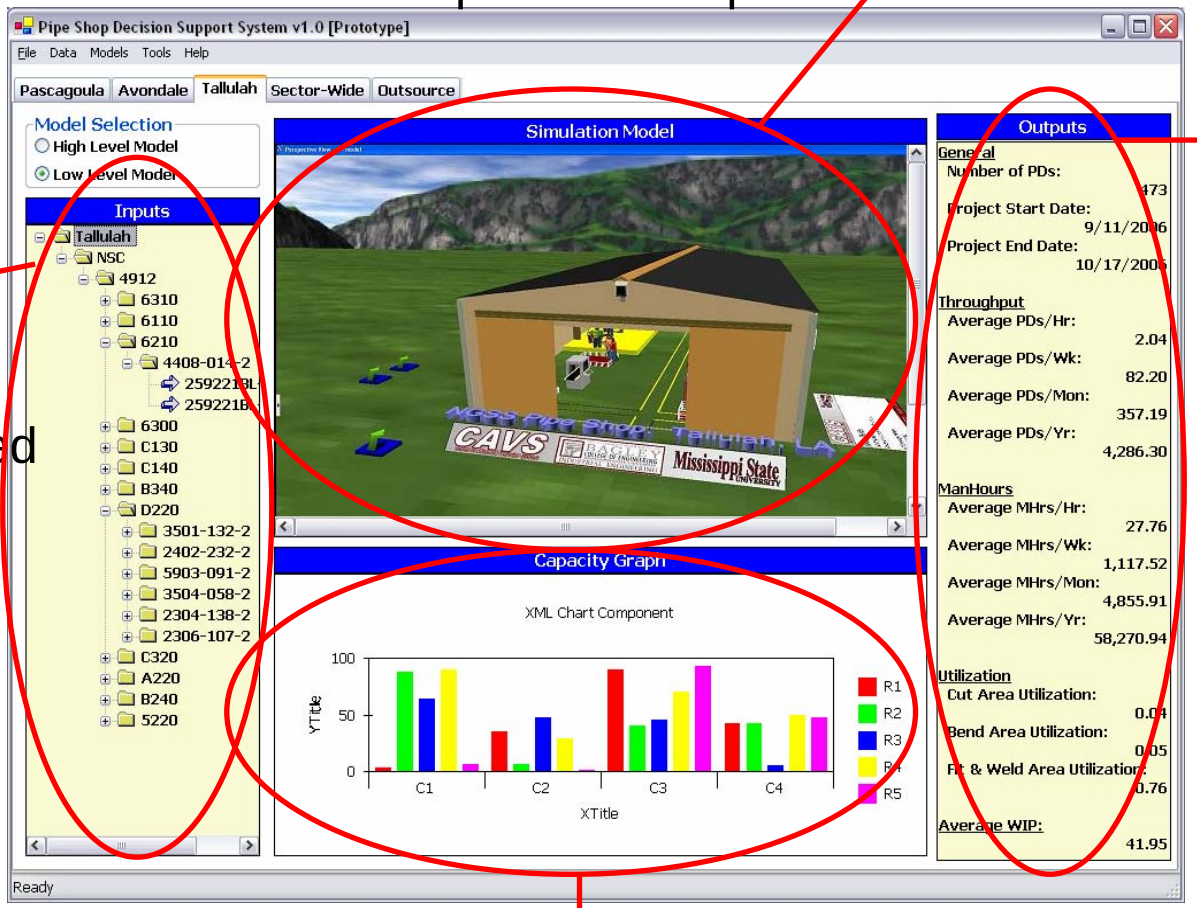


Sector-wide Pipe Shop Decision Support System – Walkthrough

Walkthrough

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

System inputs are represented on the left side.



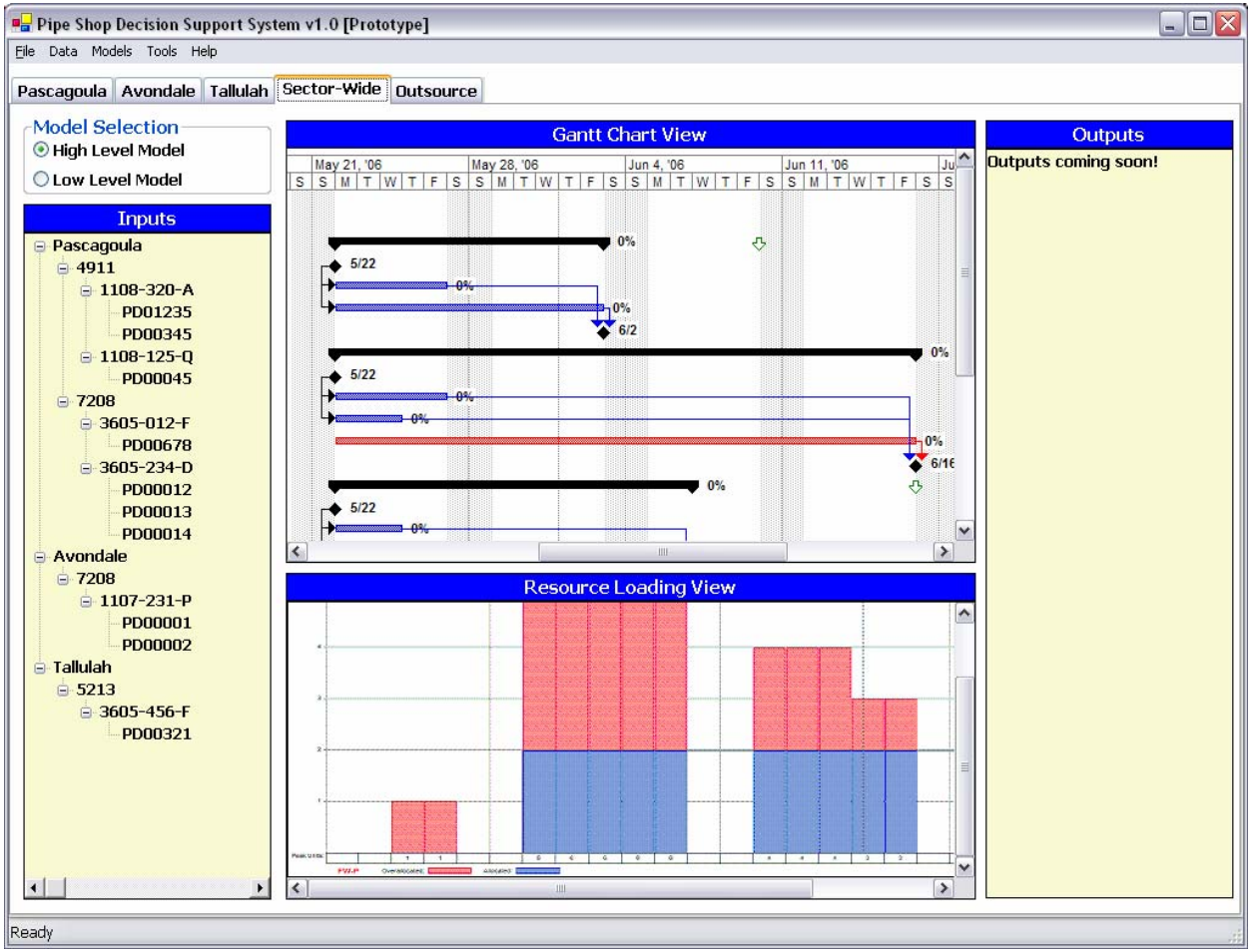
Basic system outputs such as PDs or Bills completed per week are displayed right side. More detailed outputs can be accessed via the Output viewer.

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

*Dummy Data shown

Basic Information Flow

Walkthrough

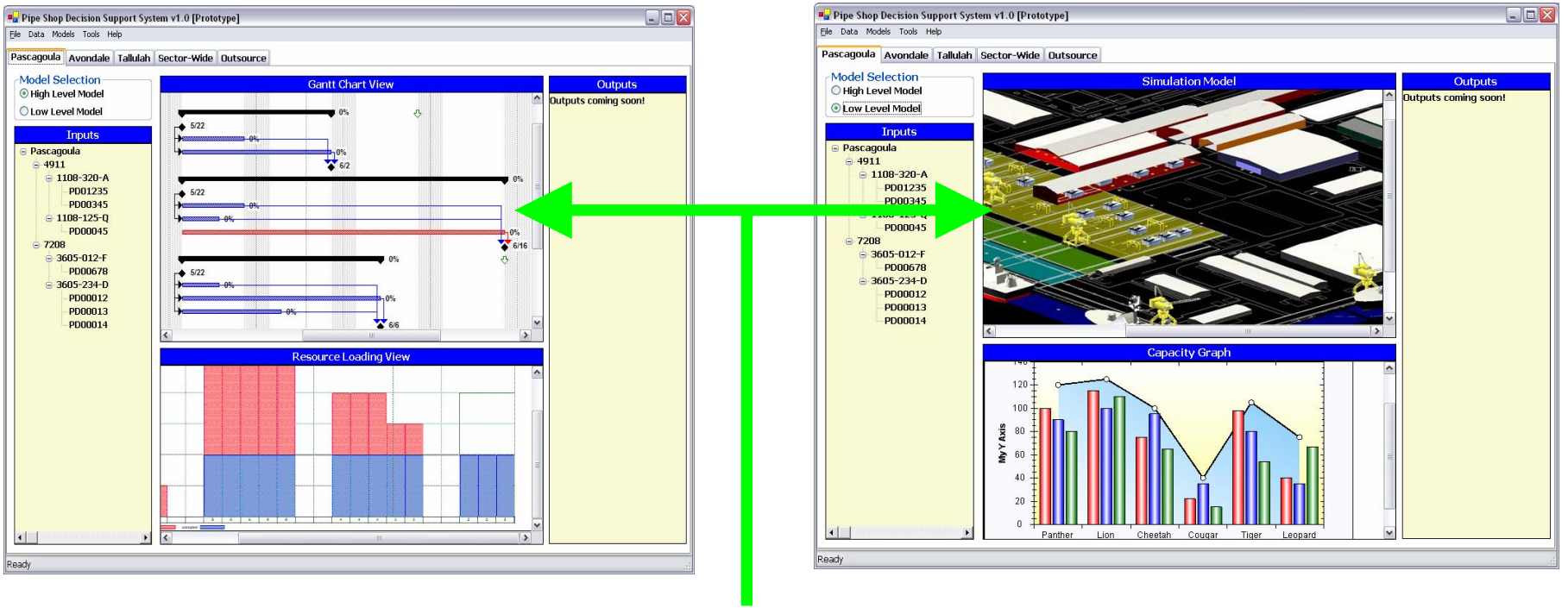


Each tab of the interface corresponds to a shop – Pascagoula, Avondale, and Tallulah.

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

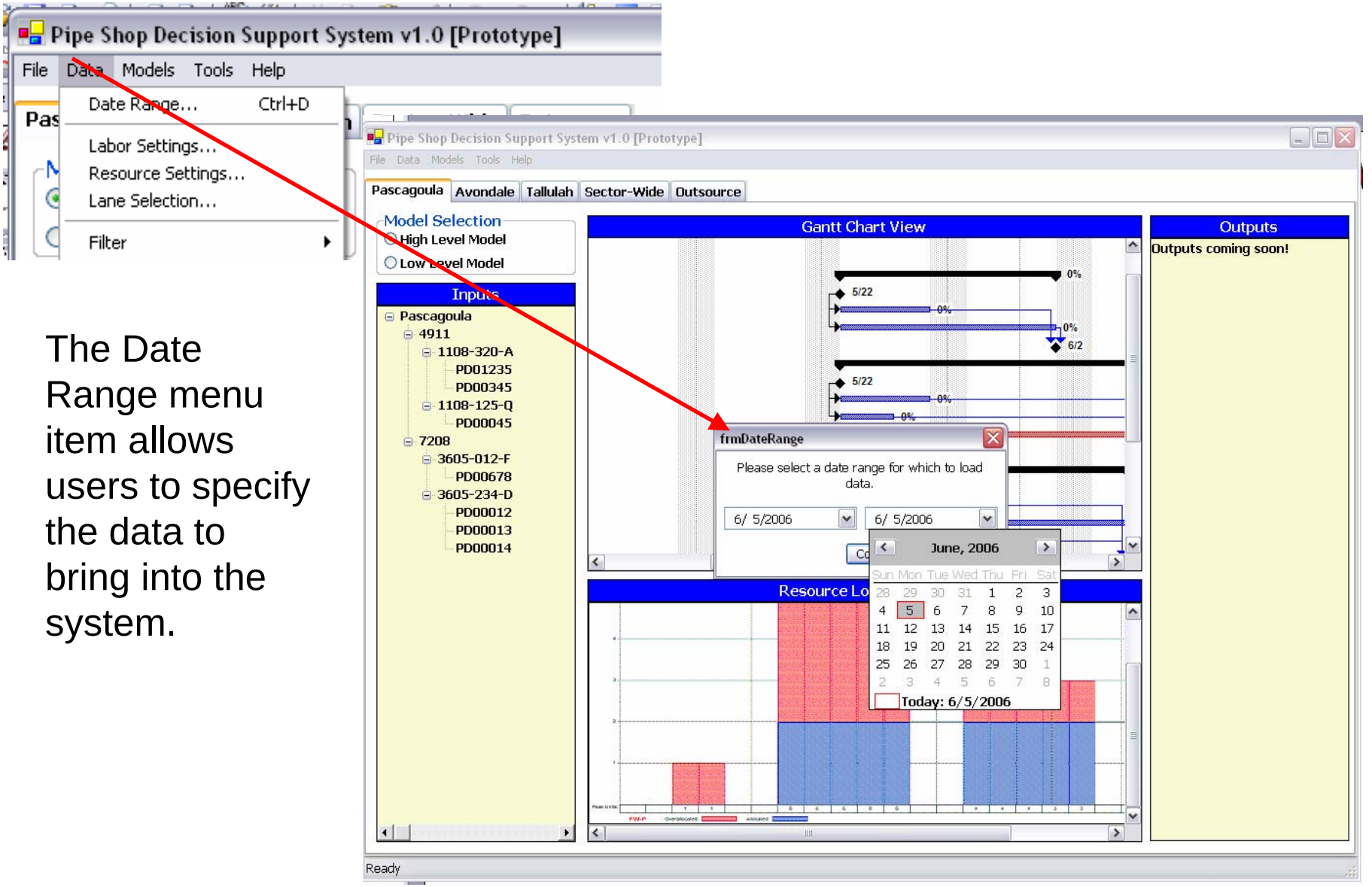
The “Outsourcing” tab keeps a list of bills that have been marked for potential outsourcing.

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.

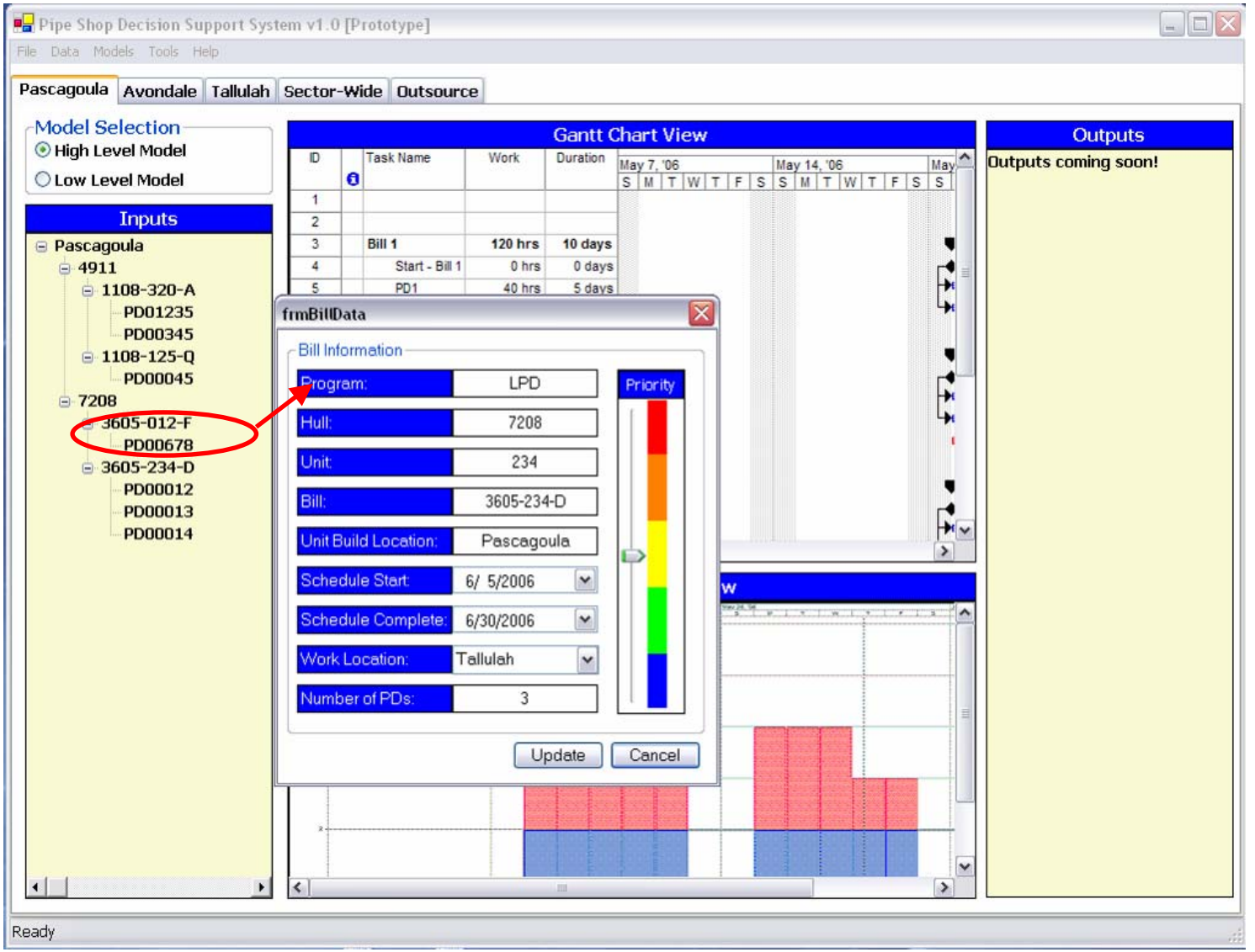
Walkthrough



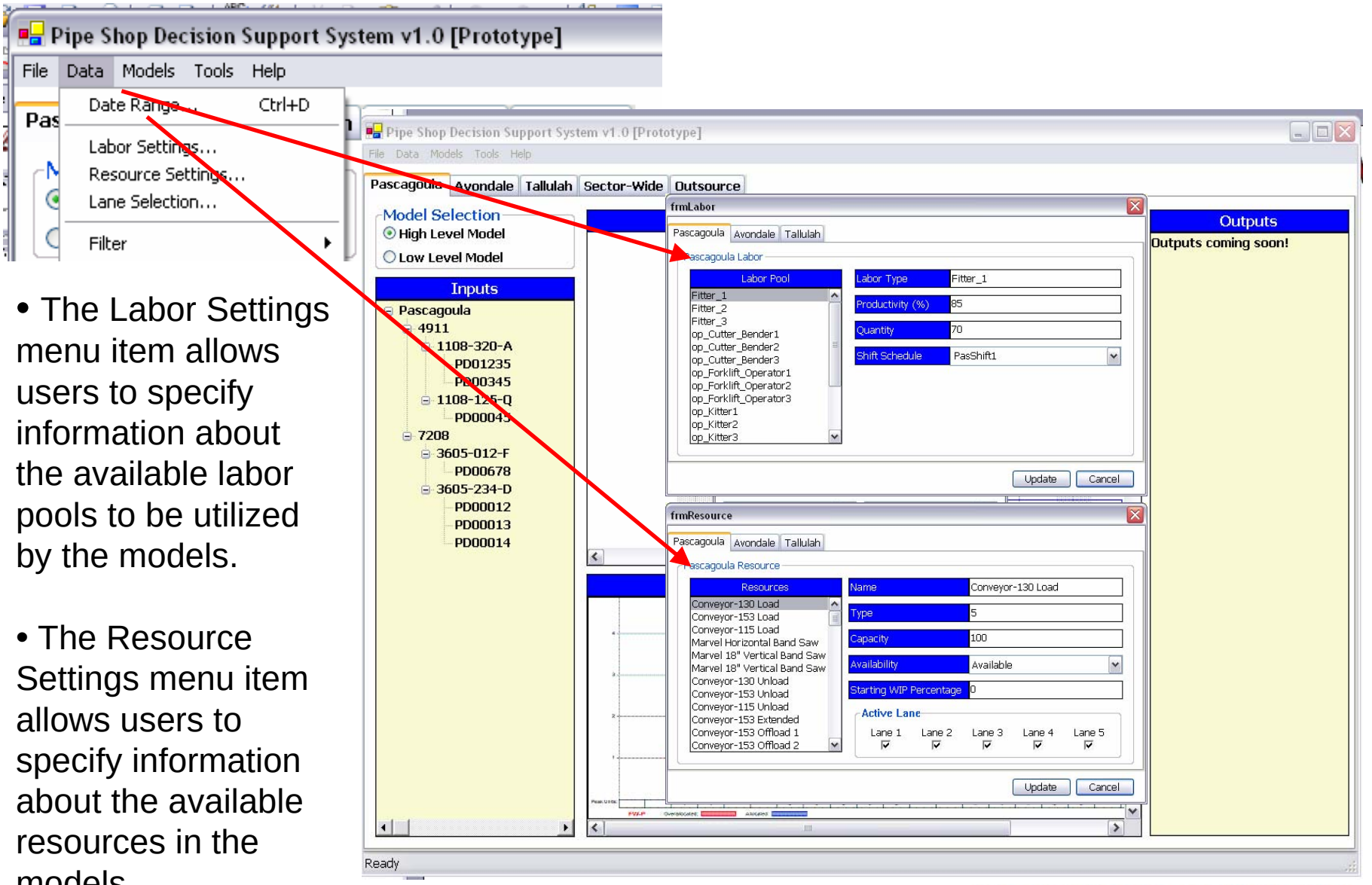
The Date Range menu item allows users to specify the data to bring into the system.

Walkthrough

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



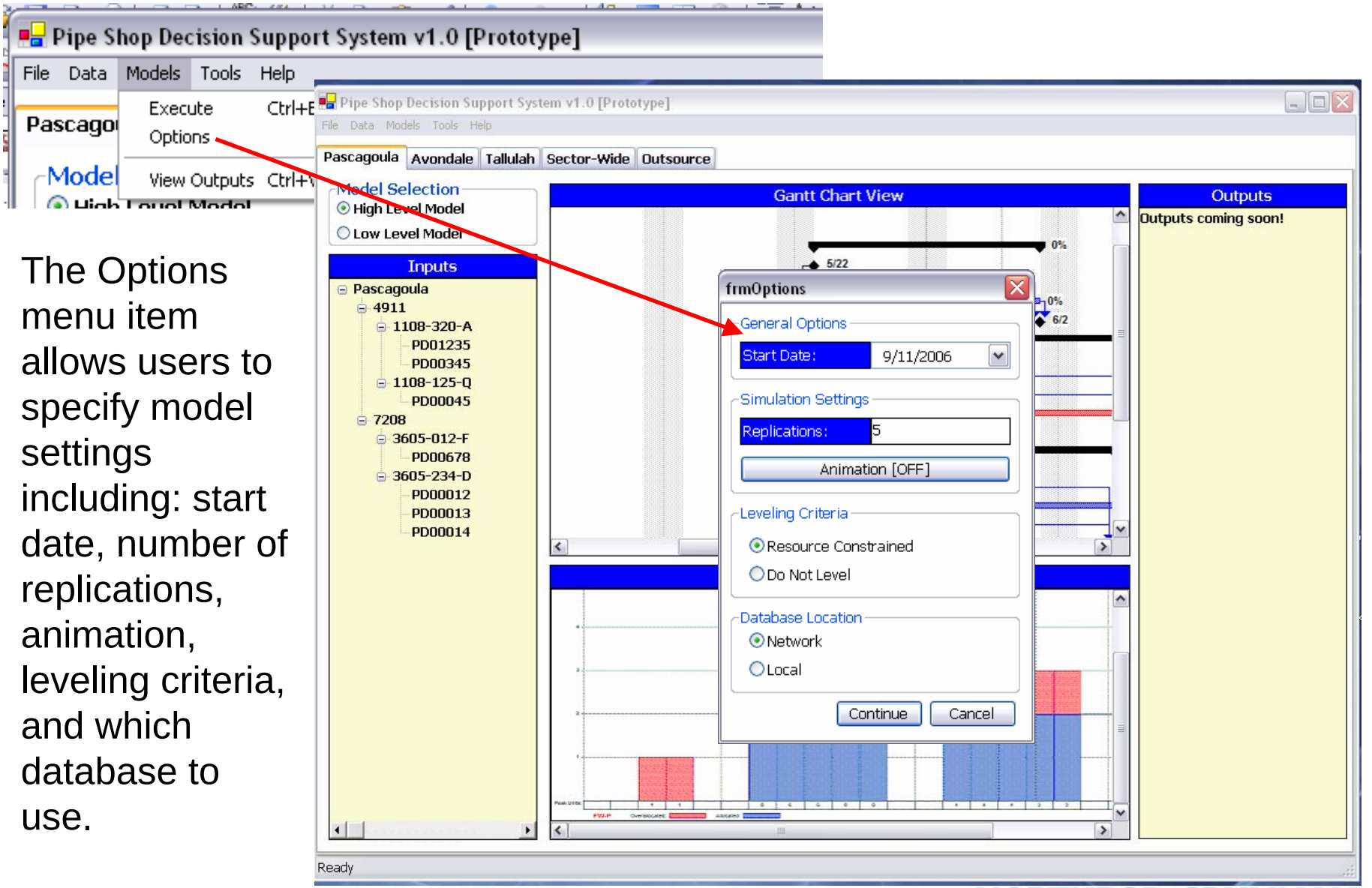
Walkthrough



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

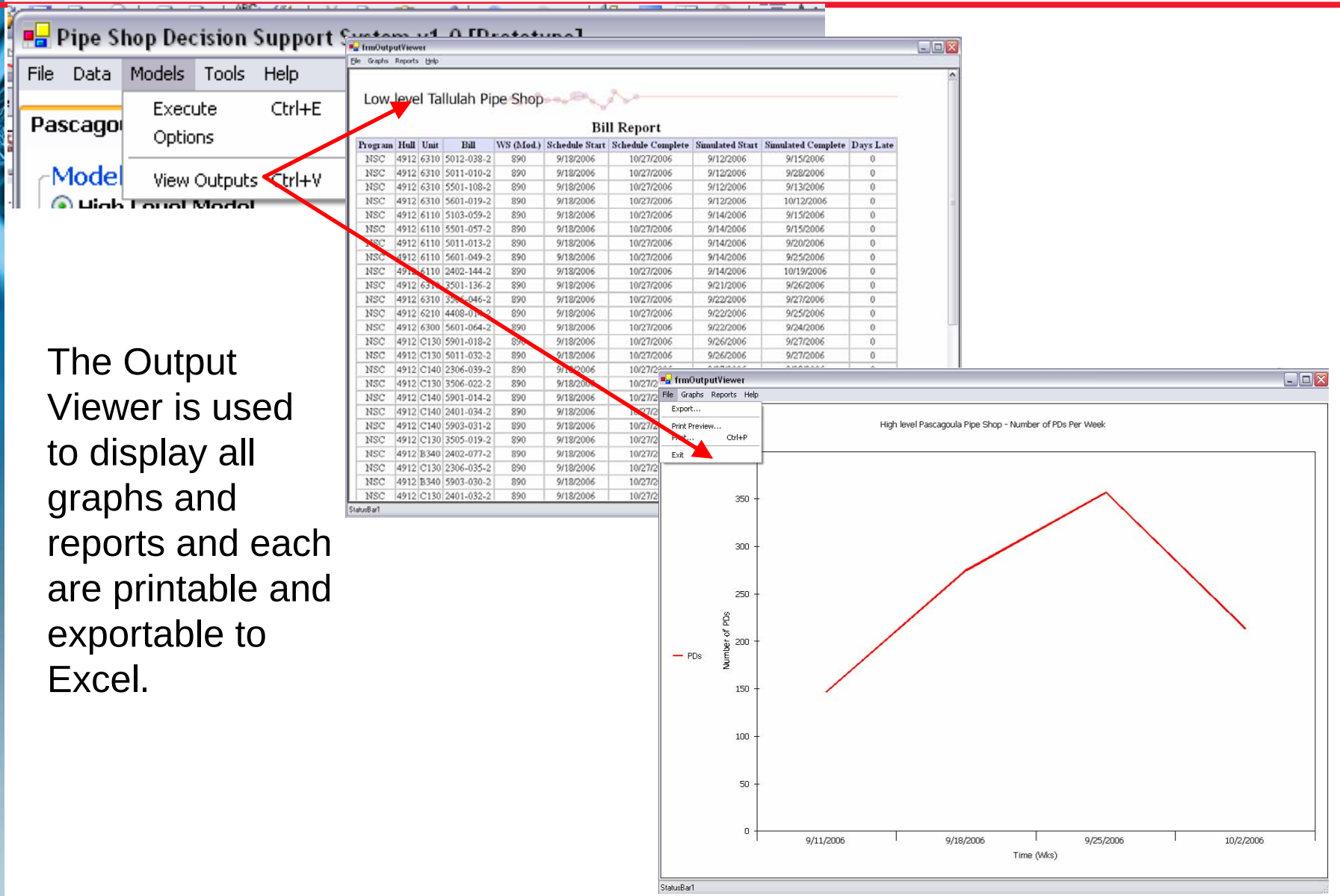
- The Resource Settings menu item allows users to specify information about the available resources in the models.

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.

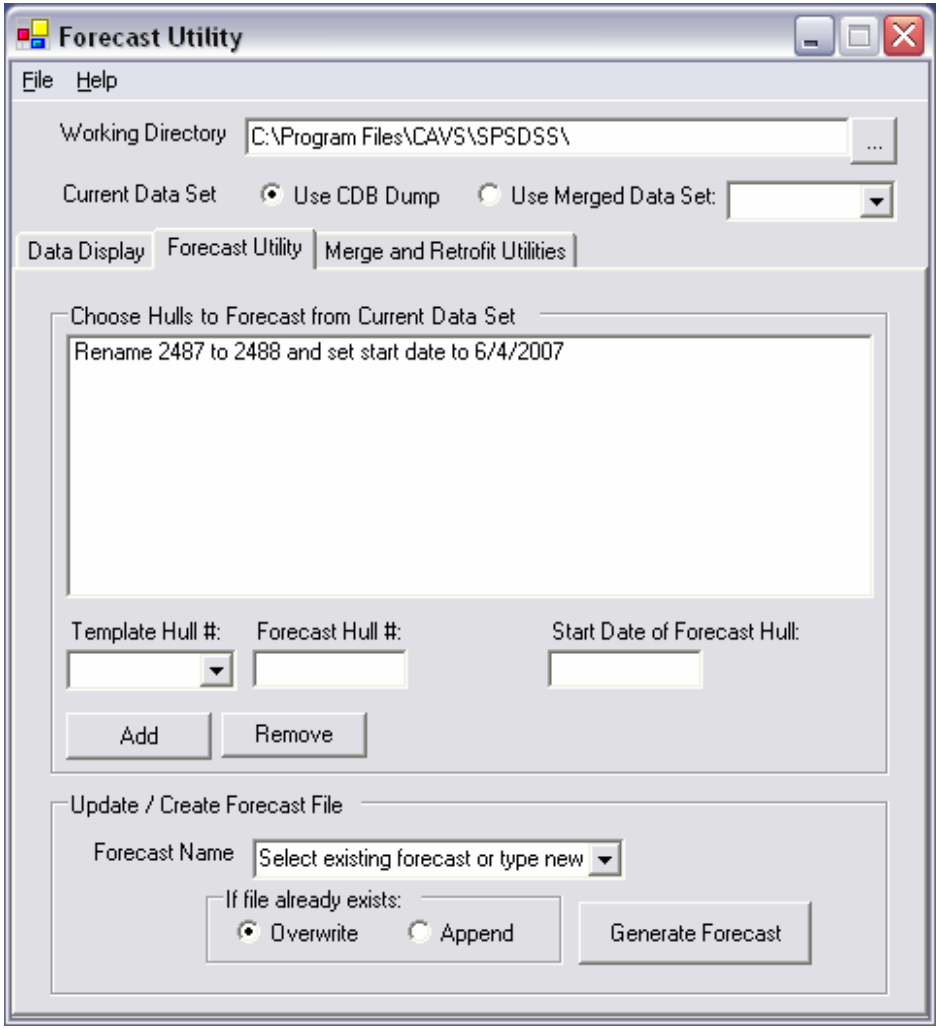
Walkthrough



The 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

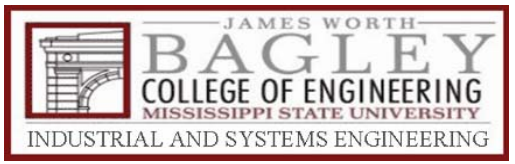


Expected Results / User Responses

- **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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