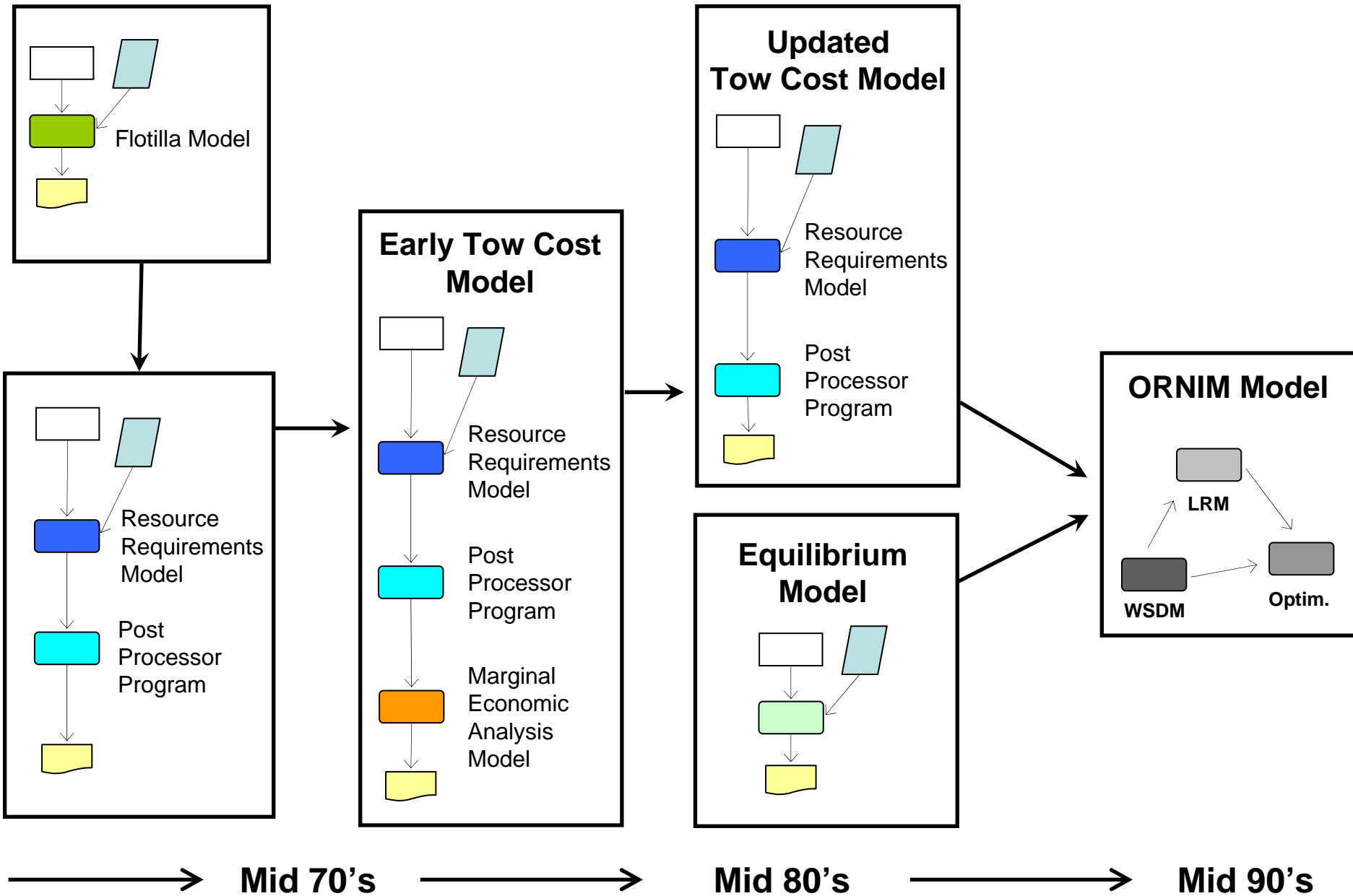


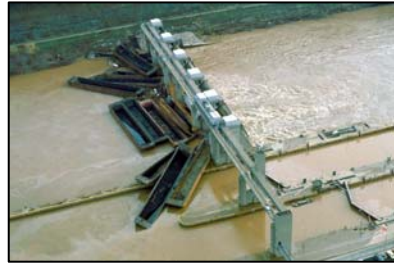
Ohio River Navigation Investment Model (ORNIM)

By Tim Smith
Sept. 2007

Evolution of Models



Typical ORNIM layout



Random Closure Probabilities



Reliability Estimates



Repair Plans and Costs

Lock Risk Module (LRM)



Cargo Forecasts



Towboat/Barge Operations

Waterway Supply and Demand Module (WSDM)



Lock Operations



River Network

Optimal Investment Module (Optimization)

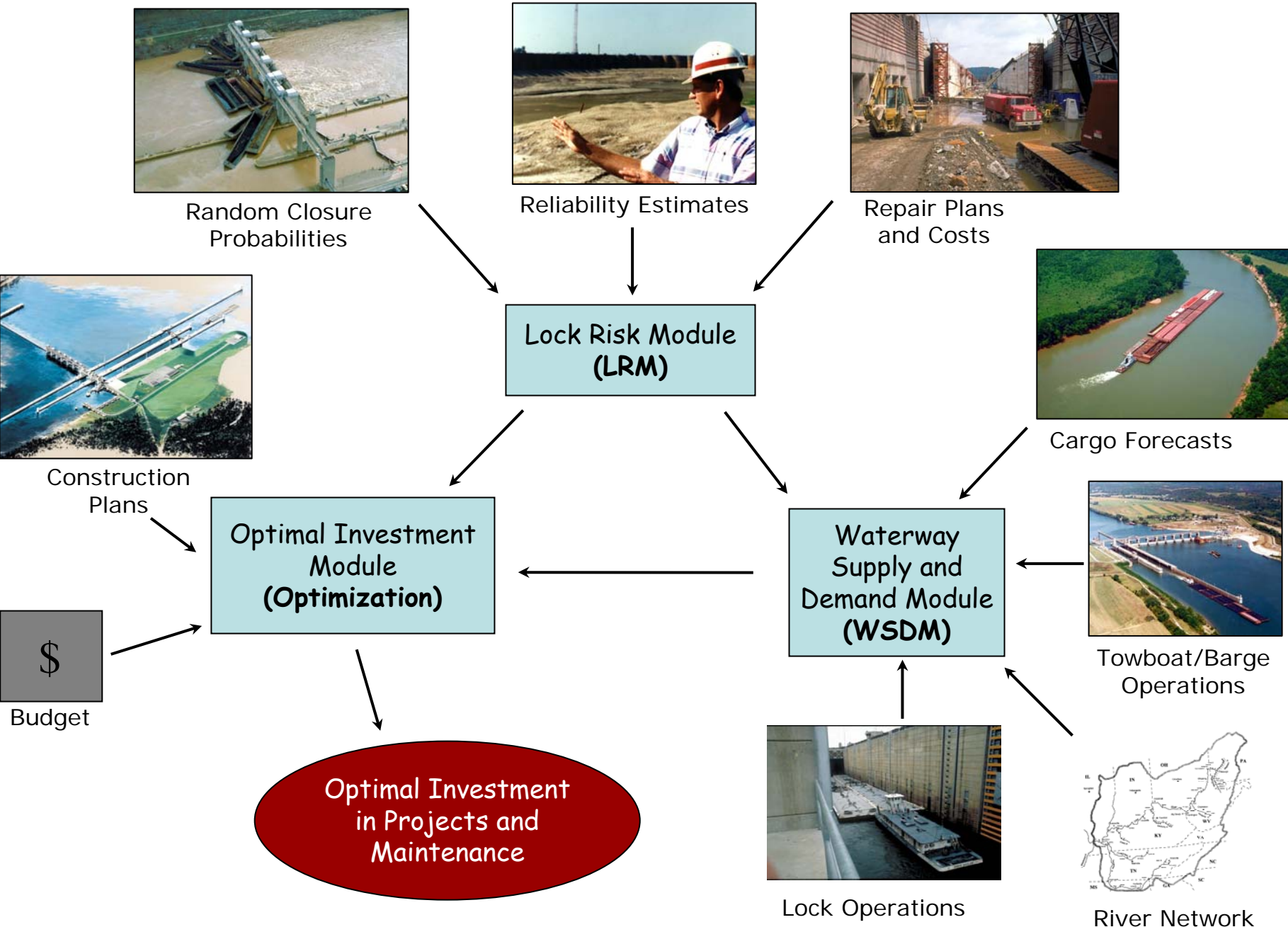
Optimal Investment in Projects and Maintenance



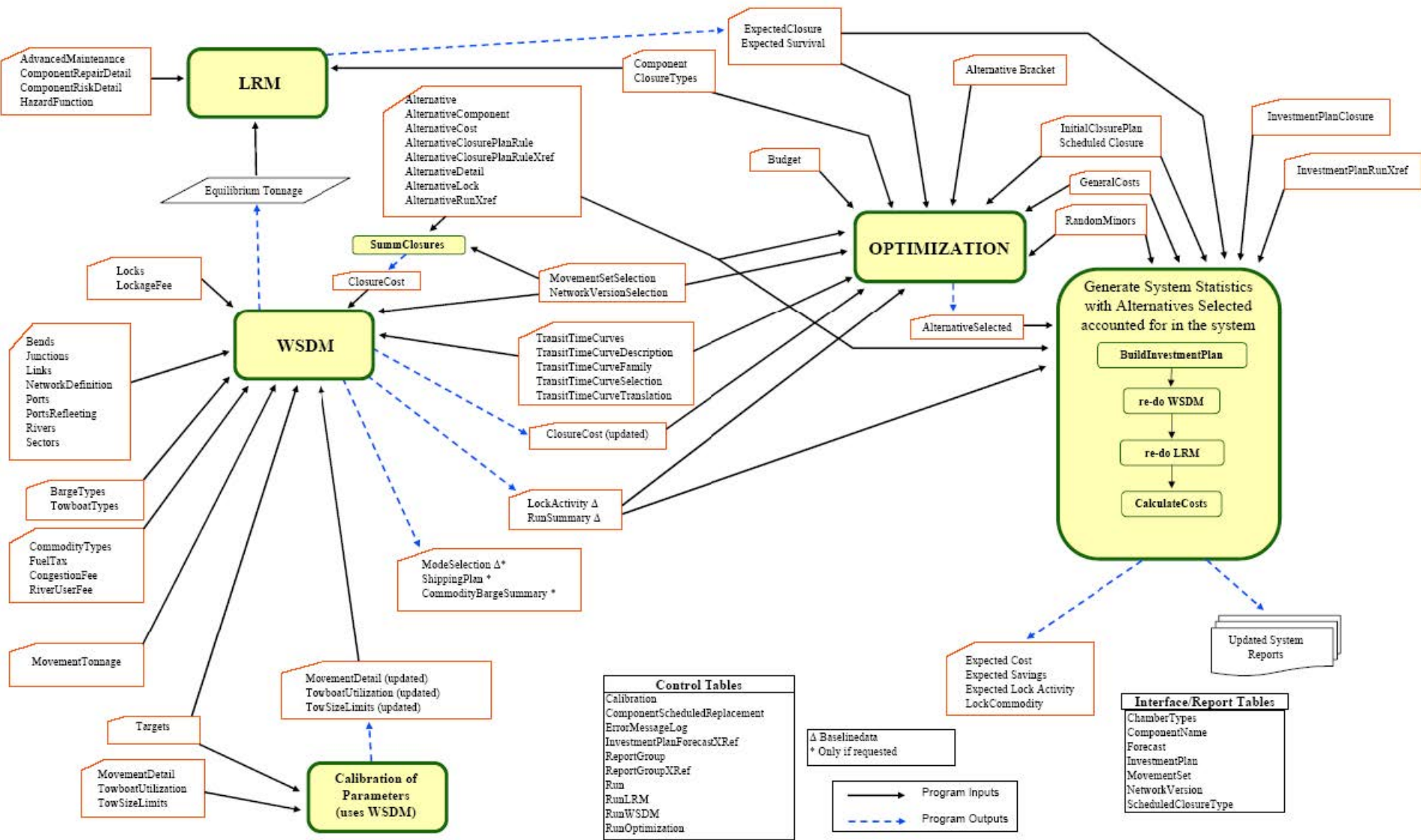
Construction Plans



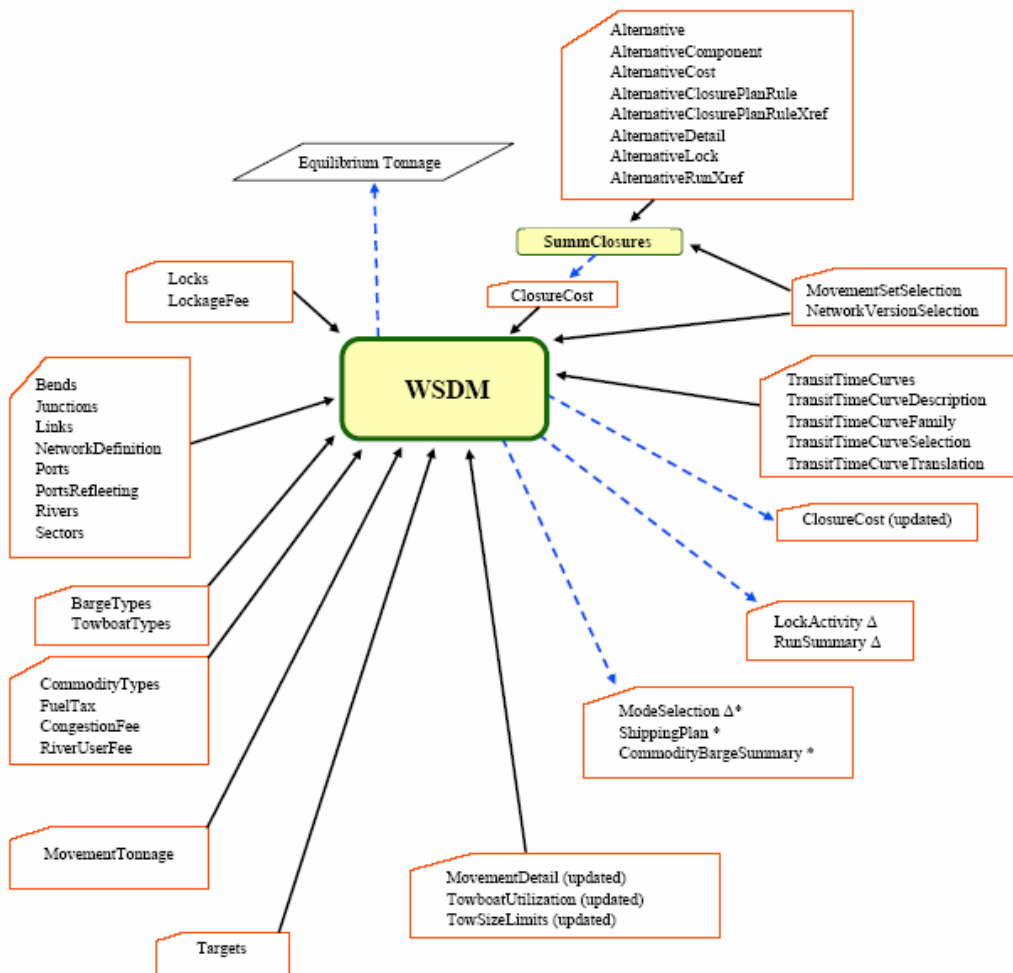
Budget



Inside ORNIM



Waterway Supply and Demand Module (WSDM)



...determines equilibrium waterway traffic levels under a given system configuration and forecast scenario for each year in the analysis period, taking into account scheduled lock closures.

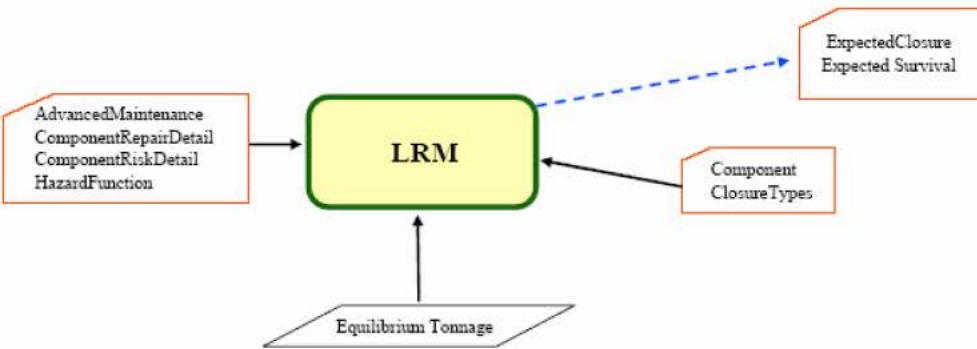
Step 1 – Determine Shipping Plans

WSDM calculates the towing costs and determines the cost-effective tow configurations to move the port-to-port tonnage on the waterway network honoring tow and operating characteristics.

Step 2 – Equilibrate Traffic Levels

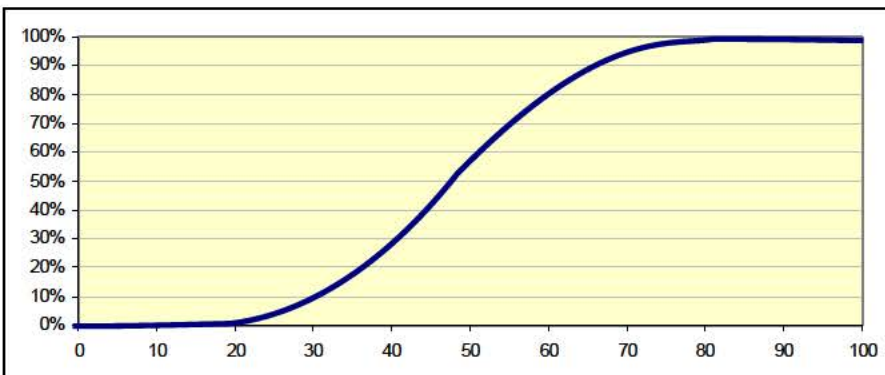
Ranks mvts by base rate savings...adds mvts and iterates until savings are stable with no negatives.

Lock Risk Module (LRM)



...estimates the probability of each potential closure in each year of a component's life given equilibrium traffic levels, hazard functions and event trees.

A **hazard function** identifies the probability of failure of a component in a specified time period, given that it has survived up to the selected time period.

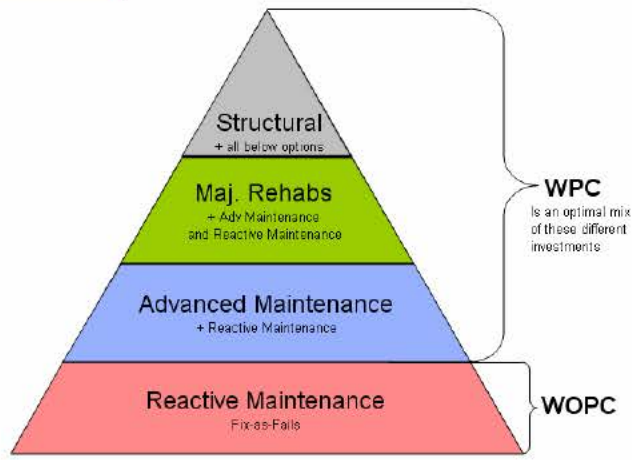
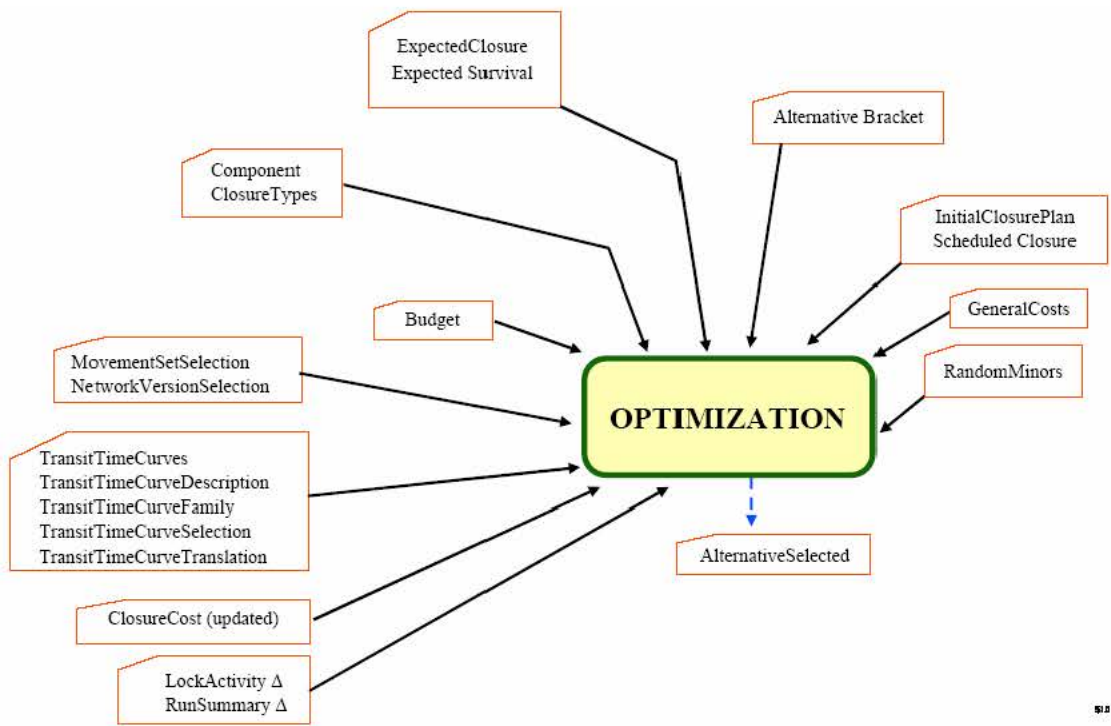


An **event tree** describes the levels of failure and the associated consequences and repairs.

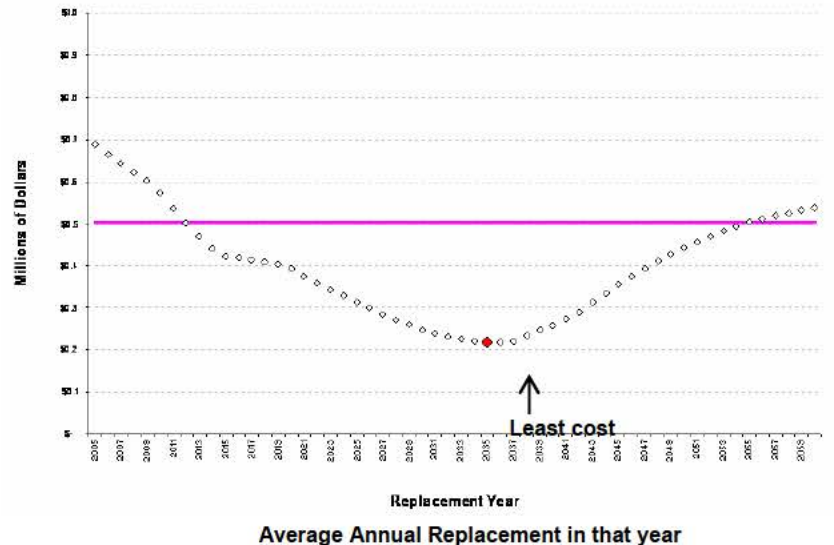
Component	Annual Time Dependant Probabilities	Prob. Degree of Failure	Repair Level	Prob. Repair Level	Year of Repair	Coet	Year of Failure Closure Days	Following Year 12 Spd Days	Effect on Reliability
Main - Gate Event Tree	Satisfactory Table Values	Major 100%	New Gate	5%	1	\$13,150,000	365	0	R 1 all future years
			Major Repair	35%	1	\$1,575,000	45	0	Back 5 years
	Annual Unsatisfactory Table Values	Minor 0%	Temporary Repair w th New Gates 60%	60%	1	\$3,575,000	45	0	R 1 all future years
					2	\$3,575,000	45	0	
					3	\$5,050,000	30	0	
Scheduled Replacement Year 1 - 30 closure days and coet \$5,050,000 Year 2 - 30 closure days and coet \$5,050,000 Future Reliability will be equal to 1.0 for all future years after replacement									

Optimization Module

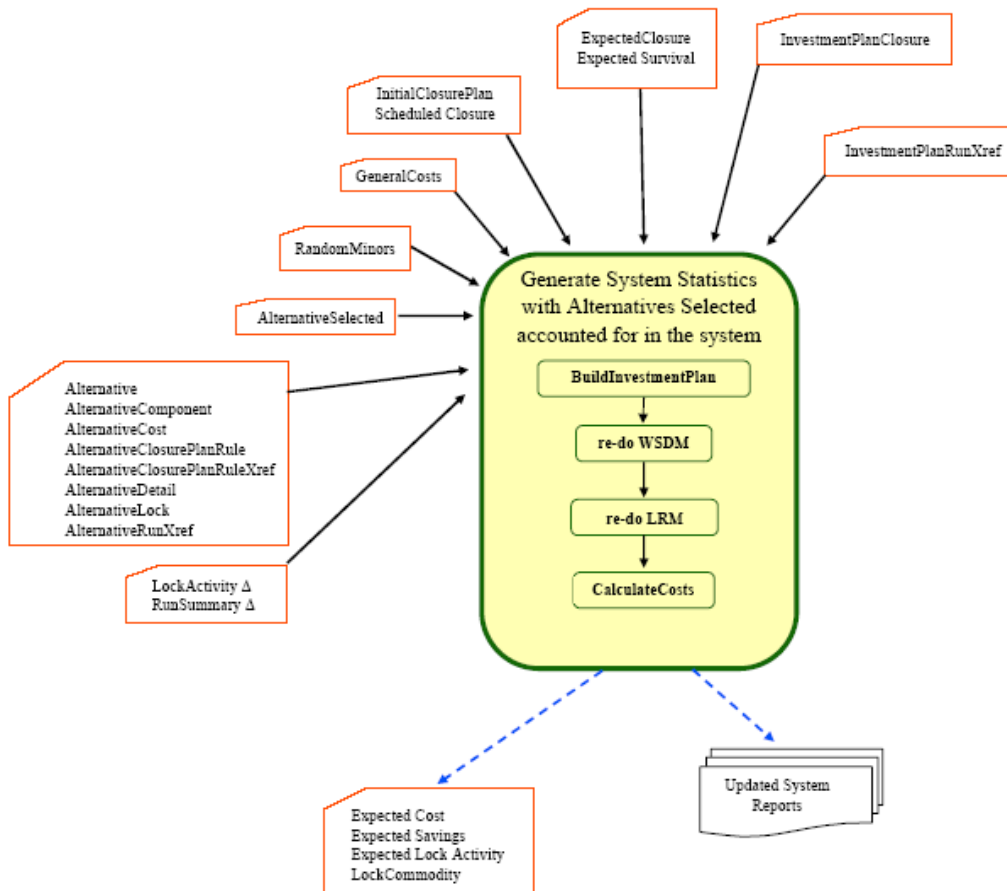
...systematically compares investments and selects the optimal investment strategy and summarizes the results.



Component Replacement – Example



Generate System Statistics

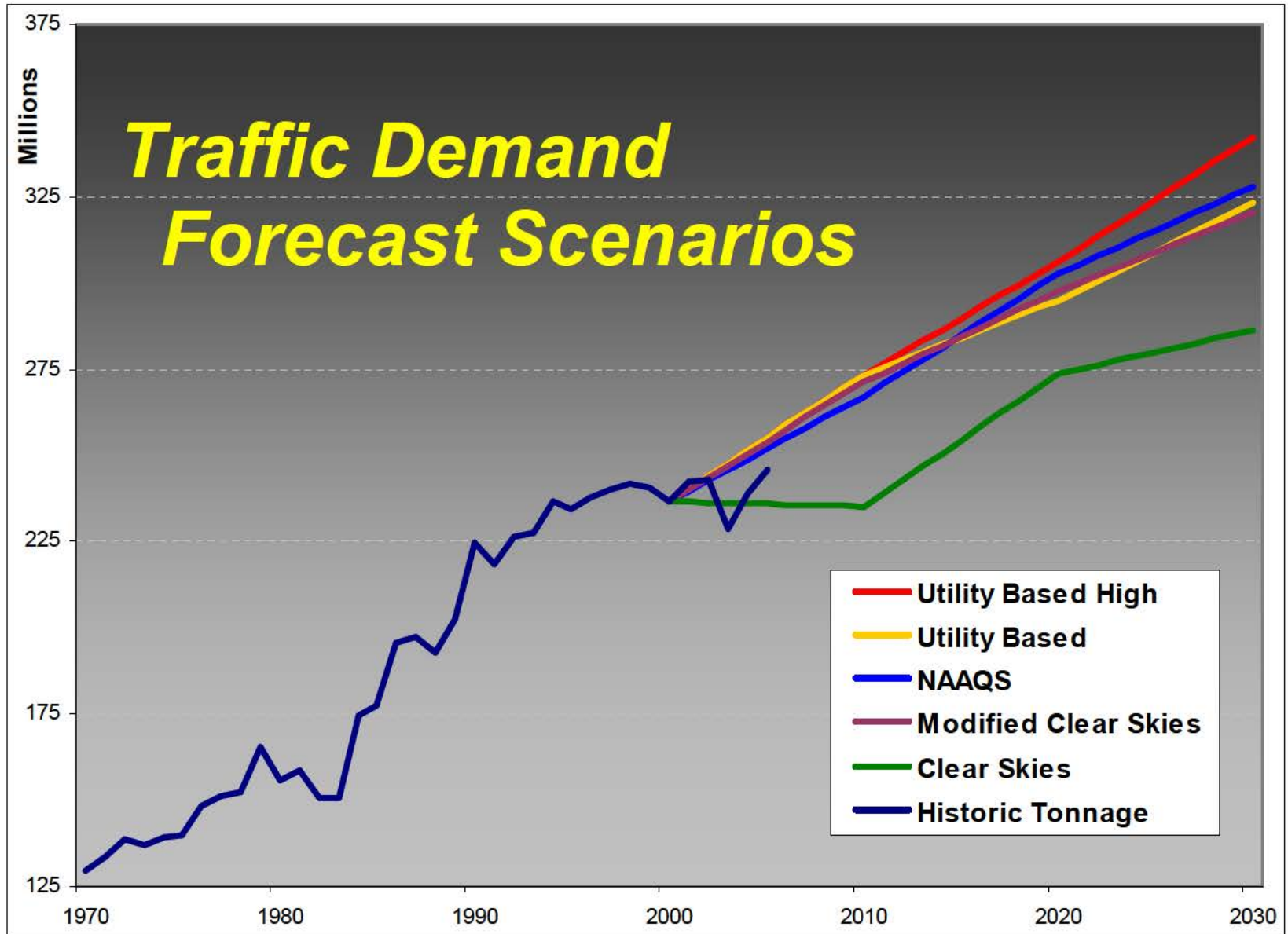


...optimized project alternatives are input into a system investment plan

...re-run WSDM and LRM to get the effects of the selected alternatives on the system

...calculate system costs for the investment plan and output system statistics

Uncertainty.....



Ohio River Main Stem System Investment Plan

Example Output:

Project	Clear Skies	Modified Clear Skies	NAAQS	Utility Based	Utility Based High
Belleville	CR	MR - 2017	MR - 2017	MR - 2017	MR - 2028
Cannelton	MR - 2017	MR - 2017	MR - 2016	MR - 2017	MR - 2017
Dashields	New 600' - 2011	New 600' - 2010	New 600' - 2010	New 600' - 2010	New 600' - 2010
Emsworth	New 600' - 2010	New 600' - 2010	New 600' - 2010	New 600' - 2010	New 600' - 2010
Hannibal	MR - 2012	MR - 2011	MR - 2011	MR - 2012	MR - 2011
Markland	CR	MR - 2010	MR - 2010	MR - 2010	MR - 2010
McAlpine	CR	CR	CR	CR	CR
Meldahl	MR - 2013	MR - 2010	MR - 2010	MR - 2010	MR - 2010
Montgomery	New 600' - 2010	New 600' - 2010	New 1200' - 2010	New 600' - 2010	New 600' - 2010
New Cumberland	CR	CR	CR	CR	CR
Newburgh	MR - 2025	MR - 2016	MR - 2016	MR - 2016	MR - 2016
Pike Island	MR - 2016	MR - 2015	MR - 2015	MR - 2016	MR - 2015
Racine	MR - 2020	MR - 2019	MR - 2020	MR - 2019	MR - 2019
RC Byrd	CR	MR - 2044	MR - 2020	MR - 2030	MR - 2033
Smithland	CR	CR	CR	CR	CR
Willow Island	MR - 2027	MR - 2027	MR - 2027	MR - 2027	MR - 2028

CR = Component Replacements

MR = Main Chamber Rehabilitation

New 600' or 1200' = New Single chamber built in place of the existing auxiliary. The old main is only used when the new chamber is down for maintenance.

Questions?