CLOCKWORK SOLUTIONS

PRODUCT APPLICATION

# SPAR™ Project Briefs: Hydrocarbon and Chemical Industries

*This listing of completed projects is partial and representative only. In some projects, Clockwork's role was major (modeling, running, and reporting). In others, it was at the level of consulting on client questions relating to how the SPAR model should be built by the client's personnel. In several cases, the SPAR work was entirely done by Clockwork's licensees. Note that client-confidential information cannot be disclosed.*

## Grassroots Petrochemical Site Supply Chain

The site, a $10B investment, consists of several interconnected processing plants, including a cracker and several chemical plants. The cracker produces ethylene and propylene which serve as feedstocks to the chemical plants. Naphtha, the primary feedstock to the cracker is delivered by tankers. Other feedstocks arrive by trains and pipelines.

The cracker delivers the ethylene and propylene to the consumer chemical plants and to storage caverns via pipelines. The caverns serve to smooth out the effects of changes in production and demand flows of the ethylene and propylene.

The purpose of the project was to analyze the feedstock and intermediate product supply chains in order to assess the size and operating procedures of intermediate storage.

Clockwork Solutions developed a SPAR™ model that considered the following elements:

- Planned and unplanned outages at the individual train level in each of 10 or so chemical plants
- Storage units volumes and flow rates
- Planned and unplanned pipeline outages
- Feedstock arrival rate and volume

The model computed the expected number of chemical plant outages induced by insufficient storage. Initial model output showed a surprisingly high sensitivity in downstream operations to small variations in the Naphtha tanker delivery rates. The model's findings led the client's management to revise contractual delivery terms and to resize storage at the delivery terminal. At the present time, the model is used to optimize storage volumes of several of the supply chains.

## Plastics Plant Turnaround

A US-based plant implementing a corrosive plastics process undergoes a turnaround every two years. Turnaround activities address piping, reactors, rotating equipment, and heat exchangers. Corporate management has set higher production goals and a lower maintenance budget. Plant management recognized the need to change the way maintenance is done.


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The purpose of the SPAR™ modeling assignment was threefold:

- Demonstrate the analysis approach to plant and corporate management
- Identify opportunities to reduce maintenance cost and increase production throughput
- Quantify the potential payoff

The plant maintained failure, repair, and maintenance records for the equipment for several years. This data was incomplete and of variable quality. Life data distributions were created from the data to reflect aging effects, and the distributions were then validated by using them in a SPAR™ model of the plant to predict its past behavior.

We analyzed several alternative maintenance scenarios by means of the SPAR™ model we developed. The end result showed that most of the activities performed during the turnaround were superfluous; eliminating them would not materially affect the forced outage rate. Other maintenance activities could be performed on a less frequent basis.

The primary benefit shown was elimination of nearly three weeks of scheduled down-time over a four-year period. A secondary benefit was reduced maintenance cost due to the elimination of unnecessary turnaround activities.

## Petrochemical Plant Equipment Inspection

A large petrochemical manufacturing site has more than 2,500 operating heat exchangers of various types, materials, sizes, and configurations. Pitting, thinning, fatigue, and biologically-induced deformities all can lead to tube leaks. Production must be stopped to replace the leaking tubes.

Currently, the plant uses a periodic eddy-current test to inspect the exchanger tubes for pits or excessive thinning. High risk tubes are replaced. The test, which requires removal of the exchanger, is expensive in lost production and required manpower.

SPAR™ models were created to answer the following questions:

- How frequently should the test be performed?
- What constitutes a high-risk tube?

The first step of the project characterized the frequency of pitting and biologically induced deformities and the rate of tube thinning. This phase relied on some historical data as well as interviews with field personnel. The second phase consisted of optimizing the test frequency and identifying a tube thinning threshold for tube replacement.

## Integrated Gas Production

A US consortium is developing a major, new $2.5B hydrocarbons project which will include a gathering-field in the Amazon rainforest, an adjacent gas plant, pipelines through rough mountainous terrain that transport the gas and extracted liquids, a fractionation plant, and coastal export facilities.

SPAR™ models of the project were created during the conceptual design phase to identify and quantify major project risks and to assist the design team with major project investment trade-off decisions. For example, assessing the value of investing in additional gas compression capacity at the beginning of the pipeline, *versus* more redundancy in the pipeline booster stations, *versus* additional storage capacity at the end of the pipeline.

In the detailed design phase, the SPAR™ models were used to assist the design team with equipment selection to determine the optimal storage tank volume, to assess the operability of the design, to determine the performance and support terms required of the various OEMs, and to begin planning the logistics and maintenance resources needed.

The project operator plans to use the SPAR™ models as an operations improvement tool. Specific planned uses include: plan spare parts purchases and allocations, assess the benefits of proposed engineering improvements, and explore alternative maintenance policies and logistics resources.

## Petrochemical Plant Spare Parts

The plant consists of more than a dozen similar production trains, all producing the same product. To reduce overall operations and maintenance costs, plant management embarked on an evaluation of its spare parts stocking policy. Current annual expenditures on spare parts account for several million dollars.

The SPAR™ model of the plant focused on equipment whose subassemblies had the highest cost. The model established a link between the spare part stocking, repair and reordering policies, and plant production. The model also explored the benefits of changing these policies to accommodate changes in the business cycle.

The results of the model showed that approximately 15% of the value of currently stocked inventory could be eliminated without any adverse effects on production output.

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