USING LINEAR PROGRAMMING TO MANAGE BI CLAIMS

Linear programming, more commonly known as LP modelling, is commonly used as a supply chain management tool to solve the problem of how to get material to the right place, at the right time and at the lowest cost. Its use as a Business Interruption claims quantification tool is perhaps less understood.

The first LP model was developed by the Russian economist, Leonid Kantorovich, in 1939 to optimise the allocation of resources for the army. The maths required for LP modelling is highly complex and its only since computing power has become more affordable that we've seen its use spread. It is now used across many different industries, from Manufacturing and Transportation, through to Airlines for pricing ticket sales and even to help quantify Business Interruption Insurance claims, for example in relation to Oil Refineries.

Refinery LP modelling

Input into the LP model requires details of the variable parameters and costs, for example distilling to blending, crude availability, temperatures and pressures, yields from the process units for each set of conditions and storage constraints. In simple Oil Refineries, such as Topping and Cracking Refineries, there can be more than 500 linear equations and over 2,000 constraints, with the output often in the form of large data specific spreadsheets.

The LP model uses linear equations for each parameter to: optimise profit, or in some cases costs (if say a refinery receives a government subsidy); determine operational schedules for the coming weeks and months; and plan optimal times for refinery turnarounds.

The configuration of a refinery is modelled for each unit along with the operational details of plant and the refinery processes. These constraints include temperature and pressure; capacities of reactors; distillation, heating and cooling systems; catalyst yields versus life; and product yields, specifications and prices. Each Refinery and Petrochemical Plant has its own unique LP model, although one is not required where there is only one feedstock (e.g. methane gas) used to manufacture a single product (e.g. ammonia) for a common market.

Using the LP model

At each process step a yield of product is achieved. Changes in feedstock blend, temperatures or pressures etc. will affect the intermediate and end product yields. Raw material and product prices vary, so they are benchmarked when entered into the LP model, and this also requires regular and timely updating of the model.

The objective of a refinery is usually to buy the cheapest crude and to process it for the maximum profit, i.e. to obtain the best "Crack Spread".

Whilst artificial intelligence developments are now allowing some refineries to adapt their LP models to run in real time, most LP models are updated at least monthly to optimise crude purchases with orders placed up to 60 or 90 days in advance. Some refineries use a LP model to reflect product prices in order to optimise the use of the Crude Distillation Unit or to input intermediate streams to some units to improve product quality and volumes.

Use of LP models for Insurance Claims

The box on page 19 explains how LP models can support Business Interruption claims. The challenge Loss Adjusters face is that LP models are not always accurate. They rely on expressing complex hydrocarbon reactions, distillation curves, product specifications, etc. as simple mathematical equations.

With the LP model usually being based on a steady state crude slate input, refinery operation "post loss" may be outside the calibration range of the LP model. Coupled with this, Insurers' loss measurements are based on the delta between the actual Gross Profit from the loss affected operation and the hypothetical "had no loss occurred" profit position. An error in each calculation using an LP model can accumulate and result in the overstatement or understatement of the loss - typically this could range up to ±30%.

Recalibrating the LP model can be time intensive but we believe is a necessary exercise to give Insurers and Reinsurers confidence in the model presented by the Insured. It must also be noted that LP models optimise a margin, which is often presented as a sale and corresponding cost value, and is therefore not necessarily a complete measure of the insured

Gross Profit. Insurers often need an LP Consultant to confirm that the loss mitigation efforts have been exhaustive and the LP model calibration checked. A Forensic Accountant helps bridge the gap between the engineer's LP margin and the insured Gross Profit defined by the insurance Policy, as the LP model by itself cannot be used to determine the indemnifiable value of the Business Interruption loss.

Angus Bradley, Chartered Loss Adjuster, Integra Technical Services advises "having used LP models on a number of occasions over many years, we would suggest there are three key success factors"

- 1 -

The LP model needs to be properly validated to ensure it properly reflects the production capabilities of the facility.

- 2 -

Understanding the LP model allows modelling of mitigation options, including altering the crude slate – for instance, to overcome the loss of a desulphurisation unit.

- 3 -

The LP model can be used as a predictive tool for the Insured to select "but for" operating criteria, in the event of a loss (see article on page 14).

THE ROLE OF LP MODELS IN BI CLAIMS

LP Models are not the sole answer to Oil Refinery Business Interruption Insurance claims but they can help in five key ways.

1. Validating the Insured's predicted crude slate and feedstock purchasing and sales forecasts;
2. Determining whether the refinery plant can operate at the forecasted levels;
3. Predicting the refinery outputs from a reconfigured facility during a partial interruption to production;
4. Confirming how the refinery would have operated, had no loss occurred, i.e. the base line model for establishing what should have happened, but for the loss.
5. Determining the economics of various loss mitigation scenarios to enable an optimal course of action to minimise a refinery's Business Interruption loss.

EXAMPLES OF INTEGRA TECHNICAL SERVICES' CLAIMS EXPERIENCE INVOLVING LP MODELS

Texas, USA Complex PE and PPE interdependencies.	USD **200m**
Texas, USA Petrochemical complex outage.	USD **120m**
Texas, USA Fire, aromatics and olefins plant outage.	USD **320m**
Texas, USA Fire and explosion, PDA unit outage.	USD **380m**
Oman Fire wet gas scrubber, subrogation.	PRESENTLY ONGOING