Optimizing Chevron’s Refineries

How Applied Operations Research Enables Chevron to Optimize the Crude-to-Customer Supply Chain and Fuel the World Efficiently

INFORMS
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San Antonio, Texas
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Optimizing Chevron’s Refineries

Robert Creek
Process Planning Manager
Technology Solutions
Chevron
Background
On the Energy Business
Background on the Energy Business
“Energy Is Fueling Future Growth”
Background on the Energy Business
Chevron Downstream

Mike Wirth
Executive Vice President
Downstream and Chemicals
Optimizing Chevron's Refineries

Mark Davis
Refinery Integration Team Lead
Americas Products
Chevron
Opportunities
Opportunities
Breadth of the Challenge
Opportunities
Worldwide Crude Oil Production

- 0.5 MMbpd
- 1.0 MMbpd
- 3.0 MMbpd
- 10 MMbpd
Opportunities
Crude Optimization

Various Crude Qualities
Yield, Percent Volume

Sulfur, Percent Weight

0.0 1.0 2.0 3.0 4.0 5.0
0 10 20 30 40 50

Gasoline Jet Diesel Gas Oil Resid Sulfur

Bakken (USA) Brent (UK) Arab Light (Saudi Arabia) Maya (Mexico) Bonny Light (Nigeria) ESPO (Russia) Bitumen (Canada)
Opportunities
Refinery Product Capability

Gasoline
Jet
Diesel
Lubricants, Chemicals, and Fuel Oil
Opportunities
Refinery Capability
Opportunities

Refinery Capability
Opportunities

Product Optimization
Opportunities
Putting It All Together: Supply Chain Optimization
Opportunities

Business Challenge: Gasoline Sulfur

Challenge
Too much sulfur in gasoline streams

Crude Oil Solution

Product Mix Solution

Operational Solutions

Capital Solution
Optimizing Chevron’s Refineries

Ted Kutz
Senior Consulting Engineer – Planning Technology Solutions
Chevron
Approach and Methods
Approach and Methods

Selecting Refinery Optimization Method

Criteria for Success

- Solve time
- Solution convergence
- Global optimization (for refining)
- Models process unit complexity
- Represents refinery flow
- Updates easily
# Approach and Methods

## Selecting Refinery Optimization Method

<table>
<thead>
<tr>
<th>Criteria for Success</th>
<th>Pure LP</th>
<th>Distributive Recursion LP</th>
<th>Other Non-Linear Methods</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solve time</td>
<td>Excellent</td>
<td>Excellent</td>
<td>Fair</td>
</tr>
<tr>
<td>Solution convergence</td>
<td>Excellent</td>
<td>Very good</td>
<td>Good</td>
</tr>
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<td>Global optimization (for refining)</td>
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<td>Poor</td>
<td>Very good</td>
<td>Poor</td>
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</tbody>
</table>

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Two segregated feeds to two destinations

Objective Function = 50(80 – 68) + 50(72-68) = $800
Distributive recursion blends the qualities of the red and yellow feeds

Objective Function = 100(75 – 68) = $700
Approach and Methods

Distributive Recursion LP Model

Distributive recursion tracks the value of each feed via quality cascade.
Stream Value = a + bx + cy + dz + …

Where:

x, y and z are the stream qualities.
a, b, c and d are value factors determined by the destination.
Approach and Methods
Linking Opportunity to Value
Approach and Methods
Modeling the Cracking Unit
## Petro Model Sizes and Solve Times

<table>
<thead>
<tr>
<th>Model Type</th>
<th>Equations</th>
<th>Coefficients</th>
<th>Solve Time (Seconds)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single-Period Models</td>
<td>5,000-10,000</td>
<td>100,000-200,000</td>
<td>5</td>
</tr>
<tr>
<td>Multi-Refinery Models</td>
<td>10,000-20,000</td>
<td>200,000-400,000</td>
<td>10</td>
</tr>
<tr>
<td>Multi-Period Single Refinery Models</td>
<td>25,000-100,000</td>
<td>500,000-1,000,000</td>
<td>60</td>
</tr>
</tbody>
</table>
Approach and Methods

Reporting
Approach and Methods
Inputs to Petro

Underlying Model
- Crude Oil Data
- Refinery Data
- Processing Unit Models

Petro Models

Dynamic Updates
- Price Forecasts
- Feedstock Availability
- Demand Forecasts
Approach and Methods
Petro Development

Mike Wirth
Executive Vice President
Downstream and Chemicals
People and Processes
People and Processes
Who Does the Work?
People and Processes
Leadership Development

Mike Wirth
Executive Vice President
Downstream and Chemicals
People and Processes
Decision-Making Tool

Stephanie Roveda
Product Trading Manager
People and Processes
Focus Areas

- Refinery Analyst
- Crude Analyst
- Product Analyst
- Regional Analyst
People and Processes
Petro Integration

Plan Implementation
- Refinery Scheduling Tools
- Product Blending Tools
- Refinery Control and Optimization Tools

Linking Organizations
- Supply Chain Management Tools
- Capital Management
- Decision Analysis Tools

Petro Models and Outputs
People and Processes

Petro Integration With Decision Analysis Models

Petro Analysis

Refinery Feed and Product Balances

Decision Analysis (DA) Models

Project Earnings (k$/day) for 4 Projects vs. 8 Planning Scenarios
Scenarios are created by changing product prices and refinery constraints

Expected Value “S-Curve”

Capital Project Tornado Diagram

Factor 1
Factor 2
Factor 3
Factor 4
Factor 5
Factor 6
Factor 7

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People and Processes
Capital Decisions

Mike Coyle
Vice President of Downstream Strategy
People and Processes
Continuous Improvement

Opportunity
- Distributive Recursion
- Reporting
- System Improvements

Value
- Work Processes
- Management Support
- Modeling Methods
- Data Quality
- Capable Analysts
- Leadership Training
Benefits
Benefits
Informing Fuel Regulators

Bob Anderson
Senior Fuels Policy Advisor
$1 Billion Annually for Chevron

- Continuous earnings from operating the business: $600 million/year
- Capital management and response to legislation: $400 million/year

Additional Benefits Ongoing

- Develops leaders
- Improves communication of goals and results
- Converts data into useful information

Plus additional value to licensees
$10 Billion over the last 30 years

... and growing!
Benefits

Value to Our Business

Mike Wirth
Executive Vice President
Downstream and Chemicals
Questions + Answers
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