SS OPTMIZ-01 Part 1
SimSci Optimization Opening Session

Optimization Update and Integrated Yield Accounting

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ROMeo 6.1 Guiding Objectives

Strengthen customer partnerships by developing features that meet their needs with online optimization software by:

• Meeting Customer Commitments
• Expanding into Utilities Optimization Market
• Enhancing Usability, Improve Configuration Efficiency and Maintainability
• Solution Extensions
What’s New in ROMeo 6.1

• First wave of KBC Reactors, NHTR
• Utilities Optimization (ERTO)
• Information Stream
• LP Update Manager
• Off-sites Integration
• MBM Enhancements
SimSci Refinery Reactor Model Portfolio

FCC
- Can model typical FCC unit with up to 20wt% of 1050F+ in feed
- Kinetic model with rigorous material, heat and pressure balance
- Feed characterization included

Reformer
- Can model Semi-Regen, Cyclic, or CCR
- Can be used for both fuel and aromatics producing units
- Coke prediction included

HDP
- Structure oriented lumping (SOL) approach
- Can model hydrotreating and hydrocracking of typical feed type with a single reactor
- Feed characterization included

HF Alky
- Can model both UOP and Phillips processes
- Can predict alkylate and ASO rates, RON and MON numbers

SF Alky
- Can model both DuPont Stratco and ExxonMobil Auto refrigeration processes
- Model predicts alkylate yields, RON, MON, acid consumption and spent acid composition

ISOM
- Model light naphtha isomerization processes
- Model based on UOP catalysts for Butamer and Penex processes

DCU
- Model delayed coker unit including coke drums and fractionator
- Can process resid, FCC slurry and tar sand feeds
- Three products, gas, liquid and coke

VOM
- Model visbreaking unit including furnace, fractionator and blending
- Take resid, VGO, and cutter stock feeds
- Three products, gas, naphtha and fuel

Most Comprehensive list of Refinery Reactor Models based on ExxonMobil operating experience
SimSci Reactor Model Implementation

- Petrobras FCC RTO Project
- PetroChina RFCC ARPM
- TONEN General (Japan) Migration
- SK (S. Korea) RTO
  - Reformer
  - FCC
  - HDP
Excel Offline Simulation Interface

• Excel OPSAddin to ROMeo Environment
• User-friendly interface to ROMeo and refinery reactor models
• Targeting process engineers (PRO/II users) too busy to learn ROMeo and want to use reactor models
• Templates available for build cases and do case study and comparison
• Invensys services: building models and training users
Excel Interface – Case Comparison Interface

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| Input Summary    |         |         |         |         |         |         |
| Feed Mass Fraction |       |         |         |         |         |         |
| 1 2 | CH4 | CH2 | CH3 | CH2H6 | CH3H8 | i-butene | n-butene | 2-methylpentane | 2,3- dimethylpentane | 2,4- dimethylpentane | 2,5- dimethylpentane | 3-methylpentane | 4-methylpentane | n-pentane | 2-methylhexane | cyclopentane | isopentane | isopentane | neopentane | di-ethyl benzene | n-hexane | 2,6- dimethylhexane | cyclohexane | toluene | toluene | xylene | xylene | 1,1- disopropyl benzene | n-heptane | 2,3-dimethyl heptane | 2,4- dimethyl heptane | 2,5- dimethyl heptane | 3-methyl heptane | 4-methyl heptane | n-octane | 2,6- dimethyl octane | 2,7- dimethyl octane | 2,3,4- tri methyl octane | 2,3,5- tri methyl octane | 2,3,6- tri methyl octane | 2,4,5- tri methyl octane | 2,4,6- tri methyl octane | 4,4- dimethyl octane | n-nonane | 2,6- dimethyl nonane | 2,7- dimethyl nonane | 2,3,4- tri methyl nonane | 2,3,5- tri methyl nonane | 2,3,6- tri methyl nonane | 2,4,5- tri methyl nonane | 2,4,6- tri methyl nonane | 4,4- dimethyl nonane | n-decane | 2,6- dimethyl decane | 2,7- dimethyl decane | 2,3,4- tri methyl decane | 2,3,5- tri methyl decane | 2,3,6- tri methyl decane | 2,4,5- tri methyl decane | 2,4,6- tri methyl decane | 4,4- dimethyl decane | n-undecane | 2,6- dimethyl undecane | 2,7- dimethyl undecane | 2,3,4- tri methyl undecane | 2,3,5- tri methyl undecane | 2,3,6- tri methyl undecane | 2,4,5- tri methyl undecane | 2,4,6- tri methyl undecane | 4,4- dimethyl undecane | n-dodecane | 2,6- dimethyl dodecane | 2,7- dimethyl dodecane | 2,3,4- tri methyl dodecane | 2,3,5- tri methyl dodecane | 2,3,6- tri methyl dodecane | 2,4,5- tri methyl dodecane | 2,4,6- tri methyl dodecane | 4,4- dimethyl dodecane | n-tridecane | 2,6- dimethyl tridecane | 2,7- dimethyl tridecane | 2,3,4- tri methyl tridecane | 2,3,5- tri methyl tridecane | 2,3,6- tri methyl tridecane | 2,4,5- tri methyl tridecane | 2,4,6- tri methyl tridecane | 4,4- dimethyl tridecane | n-tetradecane | 2,6- dimethyl tetradecane | 2,7- dimethyl tetradecane | 2,3,4- tri methyl tetradecane | 2,3,5- tri methyl tetradecane | 2,3,6- tri methyl tetradecane | 2,4,5- tri methyl tetradecane | 2,4,6- tri methyl tetradecane | 4,4- dimethyl tetradecane | n-pentadecane | 2,6- dimethyl pentadecane | 2,7- dimethyl pentadecane | 2,3,4- tri methyl pentadecane | 2,3,5- tri methyl pentadecane | 2,3,6- tri methyl pentadecane | 2,4,5- tri methyl pentadecane | 2,4,6- tri methyl pentadecane | 4,4- dimethyl pentadecane | n-hexadecane | 2,6- dimethyl hexadecane | 2,7- dimethyl hexadecane | 2,3,4- tri methyl hexadecane | 2,3,5- tri methyl hexadecane | 2,3,6- tri methyl hexadecane | 2,4,5- tri methyl hexadecane | 2,4,6- tri methyl hexadecane | 4,4- dimethyl hexadecane | n-heptadecane | 2,6- dimethyl heptadecane | 2,7- dimethyl heptadecane | 2,3,4- tri methyl heptadecane | 2,3,5- tri methyl heptadecane | 2,3,6- tri methyl heptadecane | 2,4,5- tri methyl heptadecane | 2,4,6- tri methyl heptadecane | 4,4- dimethyl heptadecane | n-octadecane | 2,6- dimethyl octadecane | 2,7- dimethyl octadecane | 2,3,4- tri methyl octadecane | 2,3,5- tri methyl octadecane | 2,3,6- tri methyl octadecane | 2,4,5- tri methyl octadecane | 2,4,6- tri methyl octadecane | 4,4- dimethyl octadecane | n-nonadecane | 2,6- dimethyl nonadecane | 2,7- dimethyl nonadecane | 2,3,4- tri methyl nonadecane | 2,3,5- tri methyl nonadecane | 2,3,6- tri methyl nonadecane | 2,4,5- tri methyl nonadecane | 2,4,6- tri methyl nonadecane | 4,4- dimethyl nonadecane | n-undecatriacontane | 2,6- dimethyl undecatriacontane | 2,7- dimethyl undecatriacontane | 2,3,4- tri methyl undecatriacontane | 2,3,5- tri methyl undecatriacontane | 2,3,6- tri methyl undecatriacontane | 2,4,5- tri methyl undecatriacontane | 2,4,6- tri methyl undecatriacontane | 4,4- dimethyl undecatriacontane |

| Output Summary |         |         |         |         |         |         |
| Vapor Source | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| Liquid Source | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| Mass Balance | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| Mol. Balance | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| Energy Balance | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| Power | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| Flow Rate | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| Pressure | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| Temperature | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |

| Operation Summary |         |         |         |         |         |         |
| Time | 500.00 | 500.00 | 500.00 | 500.00 | 500.00 | 500.00 |
| Temp | 900.86 | 900.86 | 900.86 | 900.86 | 900.86 | 900.86 |
| H2/HC Ratio | 1.48 | 2.07 | 1.56 | 1.62 | 1.48 | 1.48 |
| CH4 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 |
| C2H6 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| C3H8 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| C4H9 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| C5H11 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
User-defined Worksheet
Reactor Model Summary

- SimSci Refinery Reactor Model Portfolio completed with ROMeo 6.0.2
- Extending reactor models to offsites and planning

Our Modeling Strengths

- Full suite of reactor modeling technology for Refinery-wide Optimization
- Benefit from years of operating experience by ExxonMobil
- Rigorous kinetics: accurate modeling over wider operating range
- Open equations: robust & broader scope modeling & optimization
- User-friendly GUI, Excel Offline Interface
Utilities Enhancements with 6.1

• Single platform: Process RTO and Utilities Optimization
  => flexibility of training on a single tool

• Enhance usability
  => utility models fit for Utilities/Energy optimization

• New Energy Real-Time Optimization (ERTO) Models:
  • Boiler Model
  • Steam Turbine Model
  • Heat Recovery Steam Generator Model (HRSG)
  • Gas Turbine Generator Model (GTG)
ERTO Boiler

• Simple (Steam Side) Model
  – Option to Free Boiler Feed Water Within Model
• Detailed (Exhaust Side) model
• Internal or External Fuel & Air Streams
• Fixed or Calculated Efficiency
ERTO Boiler

• Boiler2 icon – lay down
ERTO Boiler – Simple Model

- Simple Flowsheet
  - Feed Water, Steam and Blowdown
  - Fixed Efficiency
ERTO Boiler – Simple Model

- Simple Model
- Calculated Efficiency
  - Feed Water, Steam and Blowdown
  - Fuels and Air
  - Choose 1 free fuel
ERTO Steam Turbine

- Same Model as Original Steam Turbine
- Ability to Free Feed Rate Through Model
ERTO HRSG

- Can be Paired with the GTG
- Fired or Unfired
- Simple and Detailed models
- Internal or External Fuel Side Streams
ERTO GTG

- Paired with the HRSG Model
- No Feed or Product Streams
- Curves for:
  - Max Power
  - IGV Position
  - Heat Rate
  - Unfired Efficiency
Usability Improvement with 6.1

Enhance Usability, Improve Building Efficiency and Maintainability

- Customers desire improved sustainability and maintainability of ROMeo applications
  - Update features to provide graphical features that make it easier to determine how the model is configured and related.
  - New Information Stream Model
  - Ergonomic Enhancements – 33 New keyboard shortcuts
  - RTS Macro Manager
    - Centralized management of scripts used in the Real-Time-System(RTS)
InfoStream

- Graphically Link or Equate variables
- Graphically Link Parameters
- Equations in the form of $a + b \ (\text{Var} - c)$
InfoStream
InfoVectors

- User Defined Sets of Variables and/or Parameters that can be Viewed in InfoStream
RTS Macro Manager

- Same as the Model Macro Manager
- Standard Macros
  - XML in Server\System\Config
  - Can be Updated and Shared
- Sequence Macros
  - Available to the Current Sequence Only
Solution Extensions with 6.1

Integration of ROMeo with other applications

- Component and heat balance capability to MBM
- Connect to Invensys Off-sites Suite
- Updates to planning applications
MBM Component and Heat Balance

- Options to Either Report or Balance Components
  - Not Linked to Thermo
  - Split Fractions
- Option to Report Heat Balance
  - Simplified User input of Duty per Node
MBM Component and Heat Balance

Report Component Balances
Reconcile Component Balances
Report Heat Balances
New 3rd Party Reactor Model with 6.1

Customer Commitments

• Customers desire the ability to use 3rd party reactor models in ROMeo, like the Naphtha Hydrotreater Model

• Build interfaces to SimSuite 4.1

• New SimSuite 4.1 N-HTR Model
NHTR (PetroSim 4.1) Reactor

- New Naphtha Hydrotreater Reactor
- KBC’s PetroSim 4.1
- Runs as part of PetroSim, not as a dll
- Options to Open the PetroSim GUI when Running the Model in ROMeo
- Requires KBC PetroSim Installation and *.ksc Data File
- Tip: Keep the PetroSim Model as Small as Possible
Leveraging ROMeo within the Invensys Portfolio

- Operations Planning
- Inventory Management
- Product Quality Tracking
- Blend Execution
Offsites Integration with ROMeo 6.1

- **Objectives**
  - Leverage Off-sites Crude composition data for ROMeo Optimization
  - Leverage ROMeo product properties with Offsites Product Blending

- **Value**
  - Improved Crude Feed composition improves ROMeo Optimization results
  - Optimized Product property data improves Off-sites product blending output

Off-sites Operations

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Crude/Feed Data

Product Properties

Engineering or RTO Model
Off-sites Integration with 6.1 via EDI

- SQLOLEDB Connection Designed to Work Specifically with Off-sites
- Option to Import All Tags when First Creating Port Group
  (This option goes away once the group has been created)
Updating LP Models with ROMeo 6.1

Capabilities
• Update any LP model with rigorous model results (vectors)
• Accommodate the variety in the LP model structures
• Reliable and easy

Process
• Import LP model coefficients from ROMeo rigorous model run(s)
• Planner retains control of the Mapping process
• Ability to make custom unit conversions if required
• Export results in spread sheet form, ready for use in LP
• Retains record of all model updates and ability to trend coefficient values over time
LP Update Manager

Crude/Feed Data → LP Update Manager → RTO Model → Plant RTDB → Plant Data → DCS

Refinery LP → LP Update Manager → LP Vectors
LP Update Manager Overview
LP Update Manager Environment

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**Please note:** The table contains values for various chemical properties, such as sulfur and nitrogen percentages, and their respective indices and indices.
All updated coefficients are "blocked"
What’s Coming Up in 6.1.1

ROMeo 6.1.1

• Spiral Integration
• Information Stream Improvements
• REFSim 4.1 Integration
ROMeo 6.1.1 and Beyond

**Spiral Integration**
- On track for ROMeo 6.1.1 release

**MINLP**
- Mixed Integer non-linear optimization
- Planned for ROMeo 7 release

**64-Bit Operation**
- ROMeo servers to be native 64-bit
- KBC v3.3 models currently 32-bit, v4.1 will be 64-bit compatible (not a barrier, separate processor)
- Spyro 64-bit release uncertain pending commitment from Technip
- Release will be with ROMeo 7
ROMeo Intelligence 🔗 ROMeo iMonitor

ROMeo 6.0 release with Intelligence:
- Integration component to push data from ROMeo to WWIntelligence environment
- Uni-directional data flow: ROMeo ⇒ WWIntelligence

Addressed need to:
- Monitor ROMeo RTO applications and Key Performance Indicators
- Provide user-accessibility via the browser

Invensys is moving to incorporate iMonitor into the ROMeo Suite
- Extends the features that are offered by the WWIntelligence integration
- Users can interact with ROMeo via the web browser (data entry capability)

Invensys will maintain and support iMonitor moving forward
ROMeo iMonitor

Orientation between Shell and Invensys initiated

Code and documentation supplied to Invensys

Next steps:

- Analyze code and documentation
- Conduct additional orientation and instruction webinars
- Design architecture for system in Invensys offices
- Define features, if any to add
- Lodge code and platform development into Invensys development workflow structure
- Compile and test code on Invensys system

Planned release with ROMeo 6.2
High-level Roadmap

2013
- Efficiency Enhancements
- ERTO 1st release
- LP Bridge-Rxtrs
- Offsites Integration
- MBM Component Balance

2014
- Improved FCC Model
- Integration with Spiral
- 64-Bit Support
- MINLP
- iMonitor

2015
- Line Up Manager
- Aromatics Rxtr

2016
- Enhanced APC Integration
- NH3 Rxtr Models

2017
- Improved Integration with Spiral

Focused Development
- Customer Satisfaction
- Leverage via Integration
- Ease of Use
- Partnering with our customers

Patches
- Released as required
- Customer driven
Integrated Yield Accounting
ErrorSolver User Environment
Integration to Off-sites
Integrated Mass Balance & Reconciliation

1. Tank and movement data
2. Purchase and sales
3. Process Data Lab. Data
4. DR results

- ERP
- RTDB
- LIMS

Automatic DR
- DR Models
- Material Balance
- Composition Tracking

Yield Accounting Reporting System
Tank Inventory & Movement System
Modeling Capability for Mass, Volume and Energy

H2 - Energy
Fuel Gas/LNG - Energy
Fuel Oil - Energy

H2 Supply → H2 Consumption → Fuel Gas Supply → Fuel Oil Supply

Process Yield DR Models

Heater & Boiler etc.

Rundown → OFF-SITES

Charge
Conclusion
ROMeo 6.1
- Reactor Models
- Utilities
- New features
- Planning and Offsites Integration

ROMeo 6.1.1 and beyond
- Spiral Integration
- Information Stream Improvements
- REFSim 4.1 Integration
- 64-bit, MINLP, iMonitor

Yield Accounting Offering
- Complex-wide process & utility system material balance reconciliation
Questions & Answers