NEXT GENERATION PROCESS MODELING & UTILIZING DIGITAL TWINS

GPCA R&I Summit 2019
The Connected Enterprise

CONNECTED AIRCRAFT
130K TOTAL AIRCRAFT

CONNECTED BUILDINGS
10M GLOBAL INSTALLED BASE

CONNECTED PLANT
10K+ GLOBAL INSTALLED BASE

CONNECTED WORKERS
550M GLOBAL PPE USERS

Accelerating Digital Transformation
AGENDA

Digital Twin Background

Powering the Digital Twin
• UniSim™ EvOlution Platform
• UniSim™ EO use cases

Digital Twin Examples
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Digital Twin Examples
Digital Twin | What is it?

• Concept
  - Means different things to different people
  - Basically, it’s a software (digital) replica of a physical plant
  - As complex as a full plant lifecycle model

• Possible Uses
  - Virtual plant walk throughs
  - Operator training – Virtual Reality
  - Remote monitoring and control
  - Feedstock Selection
  - Plant Optimization
Digital Twin | History

- Digital twin terminology first originated in the early 2000’s, and has been used across many different industries.

- Although digital twins are not new, their capabilities are expanding as new IIoT technologies increase both the data available to digital twins and the utilization of insights digital twins provide.

- Honeywell has been part of this digital twin journey:
  - Data gathering technology
  - Cloud based models and statistical analysis with expert guidance
  - Workflow and visualization tools
Digital Twin | Current Reality

• Full potential of digital twins has yet to be realized

• The market for digital twins is growing rapidly
  - Demand is increasing for their enhanced capabilities
    ▪ Including real-time operational guidance and asset monitoring

• What do we need for a real-time digital twin?
  - Accurate simulations validated & updated with actual plant data
  - Fast computational speeds for modeling in real time
    ▪ Next Generation modeling via EO
      - because sequential modeling has limitations in it’s solution methods to exploit high performance computing architectures
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Digital Twin Examples
Powering the Digital Twin | Equation Oriented Modeling

• What is Equation Oriented (EO) Modeling?
  - Opposed to Sequential-Modular (SM), which solves in series
  - EO architecture separates modeling from the solution procedure
  - EO solves all model equations simultaneously

• How is it used?
  - Utilized in complex flowsheets with an optimization aspect
  - Parameter estimation, Economic optimization

• Advantages:
  - Fast: Can solve large, complex models faster
  - Robust: Solves multiple recycle loops easily
  - Powerful: Handles real-time high fidelity dynamic processes
Powering the Digital Twin | UniSim EvOlation Platform
Equations Oriented (EO) Modeling Breakthrough

- UniSim EvOlation Platform Basics
  - Sequential and simultaneous modeling within same environment
  - Integrated Design and GUI Ecosystem
  - Powerful NOVA solver

- Fast Solving of Large, Complex Problems
  - Delivers analysis and decision making results unachievable with other tools/techniques
  - **New platform improves robustness, speed and power**
    - Up to 10x faster for optimization of large flowsheets

- Potential to realize “lifecycle modeling” goals
  - Same model for multiple applications/uses (Design, Training, Optimization)
  - Create flowsheet models suitable for external applications
    - Model deployment architecture
    - Performance monitoring, model based optimal control
UniSim EvOlation Platform | Motivation for Development

• An Equation Oriented (EO) modeling capability is a great complement to a Sequential Modular (SM) capability
  - The strengths of EO are the weaknesses of SM and vice-versa
  - Combined approach broadens the potential for future applications

• EO Strengths (SM Weaknesses)
  - Specification flexibility, supports lifecycle modeling, calculation parallelization potential, higher accuracy solutions, faster for complex flowsheets, independent of solver technology, online applications

• EO Weaknesses (SM Strengths)
  - Rigorous thermodynamics
  - Diagnostics for solver failures
  - Limited use of logic in model code
UniSim EO | View
UniSim EO | Blowdown Utility

UniSim Design R430 Blowdown Utility
- Introduced non-equilibrium calculations
- Improved heat transfer between phases
- Improvements to the vessel geometry

UniSim Design R440 : EO Blowdown Utility
- Introduced blowdown scheduling
- Improved reporting

UniSim Design R442
EO Blowdown Utility
- Extended blowdown scheduling to the flowsheet environment
- Allowed for 2D heat conduction in the vessel walls and heads
UniSim EO | Next Generation Refining Capabilities

- Refinery Modelling Infrastructure
  - Refining Properties
  - Crude Environment - Assay Management
  - Supply Chain Integration - LP Vector Generation

- Refining Reactor Models
  - Equation Oriented Reactor Models
    - Refiner, Isomerization, Hydrocracker, Hydrotreater, etc.
  - Validated by Honeywell subject matter experts
  - Flexible and easy calibration

- Refining Workflows
  - Assay synthesis supporting crude selection and analysis
  - Heat exchanger monitoring and optimization

EO Simulation Platform
What’s Next?

- Digital twins continue to gain complexity
- Processor speeds are not growing fast enough to keep up with demands
- Need to upgrade software capabilities, utilizing multi-core architectures
- Some improvements for SM
- Significant improvements for EO.
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Digital Twin Examples
UniSim Design | Links with Performance Solutions

**UniSim® Competency Suite**
- Process Operator Training Simulator

**Predict® Suite**
- Real Time Corrosion Management

**Symphonite™ RPMS**
- Supply Chain Optimization

**Connected Performance Services**
Cloud-based service to monitor, predict, and improve plant performance

**Profit™ Controller**
- Embedded APC in UniSim
- Direct link to Profit Controller

**HCP Asset Performance Calculations**

**Profit™ Optimization**
- Real Time Closed Loop Optimization
Honeywell Connected Plant | Connected Performance Services

Connected Performance Services uses UniSim Design for the real-time simulation of operating units:

<table>
<thead>
<tr>
<th>Process Reliability Advisor</th>
<th>Process Optimization Advisor</th>
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<tbody>
<tr>
<td>• Level of use: One Unit or a combination of Units</td>
<td>• Level of use: Across a complex of Units</td>
</tr>
<tr>
<td>• UniSim Design houses the digital twin &amp; kinetic models</td>
<td>• UniSim Design houses the digital twin &amp; kinetic models with an optimization engine applied</td>
</tr>
<tr>
<td>• Provides actionable insights</td>
<td>• Provides an economic evaluation of the complex</td>
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Digital Twin
- Full unit, including feed, constraints, as-built conditions, current catalyst deactivation, current fouling levels, etc. (all received from commercial data)
- Demonstrates the theoretical potential of this unit
Deeper Dive | Digital Twin for Connected Performance Services

Access through UOP Portal with secure login with identified users

Ongoing capture of plant (process/lab) data

Customer Site

Secure Honeywell cloud

Customer Value (Incremental Operating Margin):

- Up to +$0.30-0.50/bbl. in Refining
- Up to +$10-20/MT in Petrochemicals
Honeywell Connected Plant is a versatile approach that turns data into actionable insight through the use of industrial applications that enable:

- Every day to be your best day of production, and
- Everyone in your organization to be leading experts
- Industry leading performance

**PROCESS PERFORMANCE**

Improve process & catalyst reliability through early event detection. Improve throughput & yield

**CONTROL PERFORMANCE**

Identify process / advanced control issues contributing to lost performance. Sustain throughput & yield for longer periods of time

**ASSET PERFORMANCE**

Proactively identify issues with critical assets that can lead to unplanned downtime or lesser production performance

- **Underlying intelligence**

  Improve plant performance & increase profitability by up to $0.30-0.50/bbl in Refining | Up to $10-20/MT in Petrochemicals
Thank you!