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Nic Castelijns

Advanced Control, Optimization, and Monitoring
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Operations Excellence
Honeywell is the Market Leader in APC and RTO*

150+ Higher Level Optimization Applications
3200+ Multivariable Controller Applications
1000+ Major Unit Implementations (MPC-Based Optimization)
550+ Industrial Sites
300+ Customers Worldwide

Estimated $5 Billion in Benefits since 1996

“To make the most efficient use of each and every molecule by bringing Advanced Control & Optimization to every process”.

- We will accomplish this vision through a scalable, unified control and optimization solution that is easy to deploy across many vertical markets, and by delivering sustained business optimization results over the long term.
  - We will simplify where we can safely simplify
  - We will continue to provide world class consulting
  - We will continue to provide the lowest lifecycle cost
Unified Technology Platform

- Technology based on a common workflow
- Control to user specified constraints (limits)
- Optimize operations (economics)
- Standard infrastructure and common features
- Extensible and customizable

Flexible, scalable solution to cover a wide range of applications
What is Profit Suite?

- Embedded Regulatory Control
- Soft Sensing and Multivariate Statistical Analysis
  - General case
  - Process Specific
- Linear Multivariable Control
  - Dynamic ‘model-less’
  - Model-Based Predictive Control
- Nonlinear Model-based Control
  - Rigorous Steady-State
  - Rigorous Dynamic
  - Empirical Dynamic
- Real-Time Optimization
  - Dynamic Unit-based Optimization
  - Dynamic Multi-Unit Optimization
- Benefit Sustainment
  - Operator Engagement
  - Monitoring
  - Visualization

- Steady State and Dynamic Flow Sheet Simulation
- Operator Training and Simulation
Possible analogies …

• Thermostat in your house

• Cruise control

• Management of people processes
Get to the finish line first…
Design a light, fast, dependable car...

Understand the track, and conditions...

Controller Design, Modeling…
Pushing the limits, managing consumption

Controller Engine, On-board Optimization...
Driver visibility, awareness

Operator displays, alarms…
Where the rubber meets the road

Sensors, Valves, Actuators…
Race Strategy

Fuel Consumption
How much slower our lap time is for every kg of fuel on board (also called the “weight effect”)
Time to complete a lap with 1 lap of fuel on board

\[
C = 3 \text{ kg/lap} \\
E = 0.03 \text{ sec/(lap kg)} \\
t_1 = 100.045 \text{ sec}
\]
**APC Lifecycle Basis**

- **Deploy**
  - *Design* – Evaluate process and operating objectives
  - *Implement* – Create and install controller
  - *Operate* – Gather operations input and train the operators, test

- **Sustain**
  - *Operate* – Use the controller to generate benefits
  - *Maintain* – Ensure ongoing and improved generation of benefits
  - *Repair* – Fix controller if no longer meeting operating objectives
Deploy ➔ Design

- Best-in-class Engineering Environment
  - Workflow Driven Environment
  - Knowledge capture and “up-skilling” tools

- “One Model” Lifecycle Modeling
  - Linear and Nonlinear Model Predictive Control (& model-less)
  - Dynamic optimization built on controller models

- Embedded UOP Techniques and Know-How

- Market-Specific Enhancements (e.g. Industrial Energy Management)
Deploy ➔ Design: Market-Specific Solutions

- **Industrial Power Management**
  - Fluidized Bed support
    - CFBC, AFBC, PFBC
  - Biomass (type) fuel support

- **Oil & Gas Specific Solutions**
  - Gas-lift optimization
  - Slug Mitigation
  - Pressure Minimization

- **Ethanol**
  - Slurry and Water Balance
  - Fermentation
  - Distillation and Sieves
  - Stillage Module
Pushing the limits, managing consumption

Controller Engine, On-board Optimization...
Deploy ➔ Design: Engine Enhancements

- **Controller and Optimizer**
  - Sub-model controller capability for improved flexibility
  - Enhanced MV windup capability
  - Updated conditioning and non-linear transform blocks
  - Safety interlock parameter (Controller only)

- **Optimizer only**
  - Improved bumpless model update for Profit Optimizer

**Profit Controller delivers lower-cost delivery; higher lifecycle benefits**
Deploy ➔ Design: Profit NL Controller

- Dynamic nonlinear model-based control
  - Incorporates dynamic Linear model-based control
- Control-type decision on control type per-application

- R412:
  - Additional optimization capabilities
  - Support for combinations of both linear and non-linear models in the same controller
  - Enhanced basic operator interaction
    - e.g. dropping variables

*High-fidelity nonlinear control in a unified platform*
Deploy ➔ Design: Simulation Integration

UniSim Optimize

• Use UniSim models for gain updating of controller models or soft sensor applications

• Take full advantage of engineering design investments

Unique integration with UniSim provides lifecycle benefits
Deploy ➔ Design: Profit Suite Engineering Studio

- Replaces Profit Design Studio
  - R400: Profit NL Controller
  - R410: Profit Controller
  - R413: Profit SensorPro
  - R430+: Continuous improvement
- Workflow-oriented design
- Role-driven options
- Embedded Knowledge Management
- Project Lifecycle Support
  - Data collection & import
  - Data manipulation & exclusion
  - Empirical modeling (linear and nonlinear)
  - Simulation
  - Deployment
- Common Environment for all Modeling tasks

Planned for R430:
- Profit SensorPro
- Standard calculations
- Data rectification
- Auto Documentation
Deploy ➔ Design: Profit SensorPro

- Workflow improvements
- Integration with Profit Stepper
  - Automated soft-sensor test/ID
- Automate re-identification
- Lab + analyzer bias for all types
- Bias analyzer with Lab
- Automate lab entry
- Dynamic Subspace (DSS) enhancements

Planned for R430:
Profit Suite Engineering Studio
Templates and common calculations
Lab update improvements
Workflow enhancements
Deploy ➔ Implement

• Best-in-class Engineering Environment
  – Workflow Driven Environment
  – Knowledge capture and “up-skilling” tools
• “One Model” Lifecycle Modeling
  – Linear and Nonlinear Model Predictive Control (& model-less)
  – Dynamic optimization built on controller models

• Unmatched Experion Integration

• Universal Connectivity
  – Leverage MatrikonOPC

• Virtualization Support
Deploy ➔ Implement: Profit Stepper

- **Workflow**
  - Seed ID information
  - On-the-fly Variable Addition
  - Collect only variable type
  - Variable sequencing and queuing

- **Execution**
  - Transformed variable support
  - Annotation improvements
  - Non-Honeywell MPC testing (CLID)
  - Constrained OL Testing
  - Soft Sensor Testing (SensorPro)
  - Ramped input signals
  - Application Virtualization
  - High / Low limits to open loop testing
  - Mixed-Mode testing (i.e. two or more MV’s unrelated simultaneously)
  - High-purity/Weak-direction testing

Planned for R430:
- Transformed variable support
- Seed ID information
- Collect only variable type
- Improved data selection/exclusion
- Annotation improvements
Deploy ➔ Implement: Platform Virtualization

• Customer-deployed Virtualized Platforms
  – Reduce hardware costs (fewer servers)
  – Increase availability (may require additional capability)
  – Simplify disaster recovery

• Support deployment and execution of Profit Suite applications in virtualized environment
  – Qualification, testing, and benchmarking

• Support *only* HPS qualified virtualization platforms
  – Currently *only* VMWare Vsphere
Deploy ➔ Implement: Operator Station

- Establish web server for use at L3/L3.5
  - Server would be primary gateway for L4→L3 access to Profit Suite
- Security
  - Fully comply with Honeywell Network Security specifications
  - Certificate-based security for Read or Read/Write access

- Use Click-Once technology
  - Automated delivery of PSOS client to L4 desktop via web server
  - Simplify delivery to L3 desktop
    - Enable automated delivery of themes
  - Enable easy updates of software

Common Visualization for Manager, Engineer, and Operator
Deploy ➔ Implement: Profit XL Bridge

• Establishes runtime link between Microsoft Excel and Profit Suite (URT Infrastructure)

• Returns specified results to URT platform for use in Profit Suite runtime applications

Simplified, flexible environment reduces effort and increases information availability
Deploy ➔ Implement: Additional Enhancements

- URT Software Development Kit
  - Configuration templates
  - Simplified calculation deployment
  - Functional test faculties

- Runtime Scripting
  - Updated environment (Microsoft support)

- Documentation
  - Workflow driven
  - Embedded data dictionaries
Deploy ➔ Operate

- **Best-in-class Engineering Environment**
  - Workflow Driven Environment
  - Knowledge capture and “up-skilling” tools
  - Internal simulation

- **“One Model” Lifecycle Modeling**
  - Linear and Nonlinear Model Predictive Control (& model-less)
  - Dynamic optimization built on controller models

- **Integration with Simulation**
  - Leverage UniSim
Deploy ➔ Operate: Simulation Integration

- Leverage Profit Suite applications in conjunction with Operator Training Simulation
  - Support Freeze, snapshot, and hyper real-time execution of Profit Controller in simulated environments
  - *No incremental license fees for use of Profit Suite with UniSim Operations*
  - Train on the virtual plant
    - Establish APC as *normal* plant control
    - Validate performance and improve application acceptance

*Unique integration with UniSim provides lifecycle benefits*
APC Lifecycle Basis

- **Deploy**
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- **Sustain**
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  - *Repair* – Fix controller if no longer meeting operating objectives
Driver visibility, awareness

Operator displays, alarms…
Sustain ➔ Operate: Operator Effectiveness

- HMI Web integration
- LCN Native Window Support for Profit Optimizer

- Innovative analysis and informational tools/visualizations
  - History playback through user interfaces
  - MV movement analysis

- Extended Workflow Integration
  - PSOS Quick Trends
  - User Entered Comments
  - Page reordering
  - Allow Print from PSOS
  - Improved change log sorting
  - Simplified input for same timestamp for batch of lab results
  - Configurable significant digits

*Improved operator engagement and troubleshooting/maintenance capability*
Sustain ➔ Operate: Visualization

- Multiple Controller View
- Operator Dashboard Extensions
  - Profit Assistant concepts
- Decision Support/Analysis Tools
  - What-if Analysis
  - Dynamic Bullseye Plot
  - Operator Confidence Plot
- Improved Trend Functionality
- Enhanced localization capabilities
  - Additional language support
Sustain ➔ Operate: Asset awareness

- Operator indicators
  - MV performance
  - Bringing technology from CPM
    - Tuning issues
    - Mechanical issues
Where the rubber meets the road

Sensors, Valves, Actuators…
Sustain ➔ Maintain

• Design for Maintainability and Migration

• State of the art Performance Monitoring
  • Regulatory layer
  • Multivariable control layer
  • Optimization

• “One Model” Lifecycle Modeling
  – Linear and Nonlinear Model Predictive Control (& model-less)
  – Dynamic optimization built on controller models

• Enable the Operator as first line of support
Sustain ➔ Maintain: Monitoring

- CPM (check engine light)
  - MV monitoring (future onboard)
  - Mechanical vs. Tuning
  - Vendor independent metrics
  - Improved automation for setup and configuration of performance monitoring trends and displays

- CPM Lite
  - PID only (suitable for MVs)

- CPM Enterprise
  - PID and MPC
Control assets are the foundation of plant performance

Financial Performance

- Decreased revenue, increased costs

Plant Performance

- Quality, throughput, raw materials & utilities usage

Process Unit Performance

- Yields, conversions, separations, etc

Physical Equipment

- Poor equipment performance

Process Control Assets

- POOR CONTROL

- Valves, sensors, regulatory control, advanced control, analyzers, Inferentials

75% of your physical assets are under process control:
Differentiators

- DCS and APC vendor independent
- Universal data connectivity
- Integrated all-in-one package
  - Regulatory loop performance monitoring
  - Advanced control performance monitoring
  - PID loop tuning
- Configurable out-of-the-box solution
- Largest market share
- Longest product history
- Developed over 15 years of collaborative research programs
- Honeywell’s intimate knowledge and deployment capabilities
- Global Support Network
Sustain ➔ Maintain: CPM Lite

• Tune it
  – Run tuning software to improve

• Fix it
  – Something mechanical

• Investigate further
  – Common oscillations
  – Controllers not in normal mode
  ➔ Expert Guidance
Sustain ➔ Maintain: CPM MPC Metrics

❖ Utilization
  ❖ Is it turned on and in use?

❖ Performance
  ❖ Is it performing as expected?

❖ Model mismatch
  ❖ Is the model a cause for deterioration in performance?

❖ Constraints violation
  ❖ Which MV constraints are limiting the performance?
\[
\frac{K_M}{\tau_M s + 1} e^{-\theta_M s}
\]

Controller \rightarrow Model \rightarrow \hat{y}

\[
\frac{K_P}{\tau_P s + 1} e^{-\theta_P s}
\]

Plant \rightarrow y

Gain Mismatch

Phase Mismatch
Sustain ➔ Maintain: Constraints metrics

• MV
  – High Limit Activation
    • % of time when MV steady state target is at its high limit.
  – Low Limit Activation
    • % of time when MV steady state target is at its low limit.
  – Limit Tracking
    • High Limit Activation + Low Limit Activation

• It is the percentage of time when MV Steady state is at its limits, which means time of MV optimization is doing what it is supposed to do. However, a degree of freedom is lost.
Sustain ➔ Maintain: Sustaining the Benefits

Typical Results

- Restore lost benefits of 25-100% of mal-performing applications
- Improve delivered benefits 5-25% in first year
- Improve delivered benefits 3-10% in second year
- Improve delivered benefits 1-5% each successive year

The bottom line grows with safety, reliability and efficiency
Sustain ➔ Repair: Profit Expert

- **Expert Diagnosis**
  - On-demand MQA
    - Low level analysis of Profit Controller performance
    - Patented approach to sub-model quality assessment
  - Tuning Recommendations
  - Remote Serviceability enhancements
  - Improved automation for setup and configuration of performance monitoring trends and displays
**Sustain ➔ Repair: Profit Stepper**

**Workflow**
- Seed ID information
- On-the-fly Variable Addition
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**Execution**
- Transformed variable support
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**Planned for R430:**
- Transformed variable support
- Seed ID information
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- Improved data selection/exclusion
- Annotation improvements
Sustaining Benefits: Technology Matters

Traditional Process Control

- Modeling is an art
- Off-line matrix conditioning
- Requires steady state
- Process change difficulty
  - Complicated tools

Profit Suite

- Easy modeling tools
  - linear and non-linear
- Online matrix conditioning
- More benefits  More uptime
- Maintain benefits over time
  - No PhD required
Less effort to stay running…
Race Strategy

Overall Optimization...

Fuel Consumption

How much slower our lap time is for every kg of fuel on board (also called the “weight effect”)

Time to complete a lap with 1 lap of fuel on board

\[ C = 3 \text{ kg/lap} \]

\[ E = 0.03 \text{ sec/(lap kg)} \]

\[ t_1 = 100.045 \text{ sec} \]
Business Level Optimization

- **Mega-scale Optimization Support**
  - Site-wide and/or Multi-site
  - Planning & Schedule Integration
  - Dynamic QP Solver Engine (SpdQP)
  - Tiered Optimization
    - Discrete Optimization
    - Planning Integration & Schedule Management

- **MES Integration**
  - CPM Evolution
  - Supply Chain Management Solutions
    - “Real-time” Business Optimization
  - Boundary Management/OLI
    - What is the real operating space available
  - Operations Management & Operating Instructions
    - How does the operating space get properly managed and communicated
  - MES Framework
    - Leverage SOA, OPC-UA infrastructures;
    - “Intuition” platform
Design for Migration/Maintainability

• Deliver high-value functionality faster
  – Functional enhancements delivered as incremental release*
  – Cumulative over release cycle

• Reduce Migration Effort/Risk
  – Final update provides all new release functionality
  – No uninstall/reinstall
Profit Suite Roadmap

### 2012

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<tr>
<td><strong>R410</strong></td>
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<td>Simpler Install</td>
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<td>UOP Isomar and Tatoray Performance Module Toolkits</td>
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<td>Advanced Energy Solutions</td>
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<td>Profit Suite Engineering Studio</td>
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### 2013

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<td><strong>R412</strong></td>
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<td></td>
<td>Easier to connect</td>
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<td>Matrikon OPC</td>
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<td>Easier to install</td>
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<td>Patch type install</td>
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### 2014

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<td><strong>R430</strong></td>
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<td>Focus on ease of use</td>
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<td>Easy APC</td>
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<td>Industrial Adaptive workflow</td>
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<td>Improved documentation</td>
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<td>Improved User interfaces</td>
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### 2015

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<td><strong>R440</strong></td>
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<td>Next Gen Layered Optimization</td>
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<td>RTO migration tools</td>
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- **R411** 64 bit support
  - PHD/UPS upgrade
  - SQL upgrade
  - DMC conversion tool
- **R413** Easier to configure
  - Profit SensorPro templates
  - Profit SensorPro connections
# Performance Monitoring Roadmap

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**CPM R563**
- CPM backlog of PARs/issues
- Compatibility with OI and AM
- Integrated TaiJi PID release
- Consolidated OI & AM Release

**CPM R570**
- CPM /Loop Scout integration
- Next Gen PID Perf. Monitor
- Faster configuration with Automated templates
- Cloud or local

**CPM R600**
- CPM/Profit Expert integration
- Next Gen MPC Perf. Monitor
- New MPC metrics
- Cloud or local

**Control Performance Monitor**
- CPM Lite
  - CPM /Loop Scout integration
  - Next Gen PID Algorithms
  - Max 500 loops
  - Simple setup
  - Simple solutions

- CPM R571
  - TaiJi PID and OperTune integration
  - Honeywell ID and Tuning rules
Questions?

www.honeywell.com/ps
Profit Suite R430 – Incremental Releases

• Profit Suite R411
  – Full 64 bit support
  – DMC+ conversion support

• Profit Suite R412
  – Auto documentation in PSES and PDS – provide as built documentation in Word document
  – PSOS client side installation/upgrade from server
  – Improve Excel integration in PSES and PDS
  – Custom calculations in PSES
  – Matrikon OPC products integration with Profit Suite

• Profit Suite R413
  – PSES support for Profit SensorPro
  – User requested improvements to Profit SensorPro
  – Use Profit SensorPro in PSES to do benefits analysis
  – Templates in Profit SensorPro for common inferentials
Profit Suite R410 – Delivered Scope

- **Incremental** release of Profit Suite building on Profit Suite R400
- Introducing:
  - Advanced Energy Solutions (AES) R410 (New!)
  - UOP Isomar and Tatoray Performance Module Toolkits (New!)
  - Profit Suite Engineering Studio for Profit Controller (New!)
- Enhancing
  - Controller Engine
  - Optimizer Engine
  - Maintenance Solutions (Profit Stepper, Expert, etc.)
  - Visualization
  - UniSim Optimize
- Providing
  - Simplified Installation and deployment
  - Updated System and Microsoft Compatibility
Valid Migration Paths

- <500 loop CPM
- Large CPM install
- Loop Scout Local Server
- Loop Scout as a service

CPM Lite

CPM Enterprise R570

CPM in the Cloud (R570)

No APC monitoring
Valid Migration Paths

- <500 loop CPM
- Large CPM install
- Loop Scout Local Server
- Loop Scout as a service

CPM Lite

CPM Enterprise R570

CPM in the Cloud (R570)

2014