Your Challenges & Objectives

As manufactures what objectives and challenges do you have today, for the rest of 2011 and beyond?

Increase production, reduce costs, improve quality etc

So digging a little deeper – what about…

- Producing the same forecast tonnes but do it faster (reduced variable costs)
- Significant improvement in transition from one product to the next
- Getting the product on spec quicker (reaching steady state)
- Reduce or eliminate off-spec and hence product re-work
- Reduce Raw material consumption
RA Pavilion Company Snapshot

- **Mission**
  Providing the world’s leading model-based software to improve our customers’ profitability

- **Founded in 1991**
  Combined intellectual property of DuPont and Eastman Chemical Company

- **Global Presence**
  Offices in North America, Europe, China, and Pacific Rim

- **Financials**
  A division of Rockwell Automation, Inc., a $5 billion industrial automation company headquartered in Milwaukee, WI and serving over 80 countries

- **Commitment to Innovation**
  Team of researchers, computer scientists and industry experts leveraging more than 190+ patents in the field of modeling, control and optimization + environmental compliance
Enhance Profitability through:

- **Increase Production**
  - Unlock capacity
  - Maximize throughput

- **Reduce Manufacturing Costs**
  - Use less energy per unit of output
  - Maximize alternative fuels use

- **Improve Product Quality**
  - Minimize variability
  - Reduce deviation from specifications

- **Reduce Environmental Risk**
  - Achieve active emissions compliance
  - Support emissions trading
1. 
2. Manufacturing Industries we Serve 
3. 
4. 
5. 
6.
Rockwell’s MPC Process Technology provides Operational & Business Value to Process Industries

<table>
<thead>
<tr>
<th>CPG Dairy</th>
<th>CMM</th>
<th>Polymer/Chemical</th>
<th>Bio-fuels</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dryers</td>
<td>Crushing/Grinding</td>
<td>Reactors/Extruders</td>
<td>DDGS Evap/Dryer</td>
</tr>
<tr>
<td>Evaporators</td>
<td>Kilns &amp; Drying</td>
<td>Distillation Towers</td>
<td>Water Balance</td>
</tr>
<tr>
<td>Energy Centers</td>
<td>Stockpile Blending</td>
<td>Furnaces</td>
<td>Fermentation</td>
</tr>
<tr>
<td>Process Types</td>
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<td>Distillation</td>
</tr>
<tr>
<td>Milk Powder</td>
<td>Cement</td>
<td>PE, PP, PS, PC</td>
<td>Process Types</td>
</tr>
<tr>
<td>Coffee</td>
<td>Minerals</td>
<td>Ethylene Plants</td>
<td>Corn Ethanol</td>
</tr>
<tr>
<td>Laundry Detergent</td>
<td>Fertilizer</td>
<td>Styrene Plants</td>
<td>Cane Ethanol</td>
</tr>
<tr>
<td>Conc. juice</td>
<td>Ammonia</td>
<td>Crude Refining</td>
<td>Bio-diesel</td>
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Rockwell’s Multiple Portfolio’s achieves accelerated cross solution Industry transfer
Rockwell’s MPC Process Technology provides Operational & Business Value to Process Industries

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<td>– 5 to 15% production increase</td>
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<td>– 4 to 8% prime product yield increase</td>
<td>– 4 to 12% ethanol production capacity increase</td>
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<td>– 30 to 60 % moisture variability reduction &amp; Yield Uplift to 1%</td>
<td>– 2 to 5% energy consumption reduction</td>
<td>– 35 to 75% product variability reduction</td>
<td>– 2 to 5% ethanol yield increase</td>
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<td>– 75% off-spec product reduction</td>
<td>– 20 to 40% product variability reduction</td>
<td>– 20-40% transition time reduction</td>
<td>– 3 to 6% energy use/gallon reduction</td>
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<td>– 5 to 10% energy consumption reduction per tonne of product</td>
<td>– 10 to 30% off-spec product reduction</td>
<td>– 3 to 7% feed stock wastage reduction</td>
<td>– 1 to 2% DDGS yield increase</td>
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Typical Benefits include:

- 5 to 15% production increase
- 30 to 60 % moisture variability reduction & Yield Uplift to 1%
- 75% off-spec product reduction
- 5 to 10% energy consumption reduction per tonne of product
- Improve Product Quality & Consistency

Typical Benefits include:

- 2 to 5% production increase
- 2 to 5% energy consumption reduction
- 20 to 40% product variability reduction
- 10 to 30% off-spec product reduction

Typical Benefits include:

- 4 to 8% prime product yield increase
- 35 to 75% product variability reduction
- 20-40% transition time reduction
- 3 to 7% feed stock wastage reduction

Typical Benefits include:

- 4 to 12% ethanol production capacity increase
- 2 to 5% ethanol yield increase
- 3 to 6% energy use/gallon reduction
- 1 to 2% DDGS yield increase

Rockwell’s Multiple Portfolio’s achieves accelerated cross solution Industry transfer
What process units have we experience in?

Best Available Technology in the field of model based prediction, control and optimization in industries worldwide

- Evaporators (MVR/TVR) /Finishers, Flash Coolers and Crystallization
- Industrial Dryers: Rotary/Drum, FilterMat & Spray Towers (various configurations)
- Vibro Fluid Beds (VFBs)
- Rotary & PFR kilns, Ball mills, Roller mills, Crusher Circuits
- Rotary Vacuum Filters (RVFs)
- Digesters & Calciners
- Cupola Furnaces (Mineral Wool)
- Polymer reactors, extruders
How Rockwell Delivers Customer Value

The ValueFirst Customer Engagement Methodology
Delivering Value to Market Leaders

Cement
- CA
- HeidelbergCement Group
- Blue Circle Southern
- Buzzi Unicem

Minerals & Metals
- Alcoa
- Rio Tinto
- De Beers
- Imerys
- Vale

CPG
- Fonterra
- Dairy for Life
- FrieslandCampina
- Unilever
- Nestle
- Arla

Chemicals / Polymers
- Braskem
- Samsung
- Total
- Ineos
- GE Plastics
- BP
- Chevron Phillips
- Nova Chemicals
- Total
- Glacial Lakes Energy, LLC
- Front Range Energy LLC
Consumer Packaged Goods (CPG) - Dairy

Rockwell continues to develop & enhance Solutions that meet Industry demand.
Evaporator & Spray Dryer - Products

Dryer and Evaporator Processes

- **Milk Powders**
  - Whole milk
  - Skim
  - Nutritional
- **Protein & Whey products**
  - Whey powders
    - standard, demineralized etc
  - Caseinates
    - sodium, calcium
  - Protein concentrates & isolates
- **Laundry/Detergent Powders**
- **Soluble Coffee Powders (spray)**

Rockwell continues to enhance the Dryer & Evap Solution to meet Industry challenges
Pavilion’s Cement Industry Solution
Plant-wide Profit Optimization for Bioethanol Leaders

Production Performance Management

Cook / Fermentation Application

Evap. Stillage

Distillation Application

Real-time Environmental Management
The Challenge: Dynamic Constraints

Lots of factors to consider when optimizing asset utilization. 45-65 hours from grind to 200-proof ethanol product.

** Equipment load constraints
The Solution: Ethanol Plant Scope

MPC Objectives:
- Optimize plant throughput
- Maximize ethanol and DDGS yield
- Minimize energy/galloon Ethanol

Fermentation MPC

Distillation/Sieves MPC

Waterbalance MPC

Dryers/Evaporators MPC
Bringing it All Together to Maximize Value
Environmental Applications

1. Real-time Environmental Management (REM)

2. Wastewater Management

3. Predictive Emissions Monitoring System (PEMS)
   - SoftwareCEM®
REM Air Applications - Industry Independent

**Sources**
- Boilers
- Turbines
- Duct Burners
- Dryers
- Regenerative Thermal Oxidizers
- Flares
- Storage Tanks
- Thermal Oxidizers
- IC Engines
- Process Heaters
- Furnaces

**Fuel Types**
- Natural Gas
- No. 2 Fuel Oil
- Other Fuel Oils
- Combined Fuels
- Process Off Gas
- Refinery Gas
Software CEM Applications - Industry Independent

**Process**
- Boilers
- Turbines
- Duct Burners
- Dryers
- Thermal Oxidizers
- Reciprocating Engines
- Process Heaters
- Olefin Furnaces
- Crude Heaters

**Fuels**
- Natural Gas
- No. 2 Fuel Oil
- Other Fuel Oils
- Refinery Gas
- Process Gas
- Combined Fuels
Agenda

1.

2.

3. Our Process Technology – Pavilion8 Model Predictive Control (MPC)

4.

5.

6.
Levels of Plant Optimization

- Real-time Optimization
- Model Predictive Control
  - Nonlinear Multivariable Control
  - Linear Multivariable Control
- Inferential Sensors
- Basic Supervisory Control
- Advanced Regulatory Control
- Regulatory Control

Increasing Effort & Increasing Value
Predictive Modeling for Continuous Processes

• **Predictive Modeling Engine Incorporates:**
  – Empirical and neural network models
  – Fundamental and first principle models, if available
  – Rule logic and process flow
  – Basic calculations
  – Fundamental knowledge

• **The Result of 20 Years of Research Represented by 190+ Patents:**
  – Modeling
  – Prediction
  – Control
  – Optimization
Model Predictive Control Advantages

- Finding the most limiting constraints is the key for a successful control scheme.
- Reject process disturbances quickly (ambient disturbances, interaction between process units).
- Reduce process variability and enhance stability of process – hence provide consistent repeatable process operation.
- This level of optimal control enables the process to be moved closer to a constraint, and handling multiple process constraints.
- The end RESULT is improved operation, reduced costs and enhanced profitability.
Pavilion8 Dynamic Model Predictive Control

• Advanced Process Control for the most difficult applications
  – **Multivariable**: Multi-input, multi-output processes with complex interactions are easily handled without introducing variability
  – **Linear & Nonlinear**: Highly nonlinear input/output relationships are accurately incorporated across the operating range
  – **Predictive**: Future trajectories for MV’s and CV’s are precisely computed based on process model for the most accurate control
  – **Adaptive**: control is dynamic utilizing process feedback for continuous performance improvement

• Parametric Hybrid Nonlinear Modeling
  – Combines empirical models with first principles knowledge
  – Most accurate models possible, better than either one alone
  – Explicit incorporation of variable dynamic responses
  – Provides the most precise control during transitions
How MPC Enables Operational Objectives

Reduced Variability = “Plant Obedience”
Reduce Variability up to – 60%
(For Business Case analysis – 45%)

Achieves Uplift - closer to spec or performance limit whilst managing the process within constraints and safety margins

Model Predictive Control & Optimization techniques

- The “intelligence” applied is based on real-time process data
- All significant parameters are considered in a Multivariable model.
- MPC systems predicts variability caused by changing conditions and applies corrections to the process before quality and process objectives are compromised.

The Business Value is Achieved by “raising the bar”
Model Predictive Control - Precise Transition

Use first step of horizon

MV measured value

MV set point

MV prediction

MV desired value

MV desired level specified manually or by steady-state optimizer

Controller optimizes future trajectories using an internal simulation

CV measured value

Current time indicator

CV prediction

CV desired value
Rockwell Improves Manufacturing Processes

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Virtual Online Analyzers
What is a Soft Sensor?

- In-line sensors expensive or unavailable
- Lab Analysis too slow for real-time control

Process Samples

One to 24 hour time delay!

Process Adjustments

Analysis

Lab Results

143.0
What is a Soft Sensor?

- Software model that predicts process values based on real-time process data

Real-time Process Data → Soft Sensor Prediction

Process Adjustments

Process Samples

Analysis

Lab Results

Less than 1 minute!
Where can Predictive SoftSensors be used?

- Almost any continuous process

- Examples:
  - Powder Moisture
  - Powder Bulk Density
  - Polymer melt index & density
  - Cement fineness and Blaine
  - Ethanol concentration
  - Crude oil distillation cut points
  - Chemical distillation impurities
  - Stack NO\textsubscript{X} emissions
  - Paper strength properties
Thank you!
Any Questions?