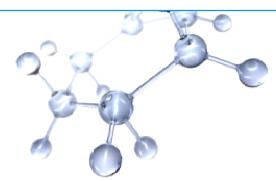


Advanced Process Control in ExxonMobil Chemical Company: Successes and Challenges



Tyler A. Soderstrom PhD.

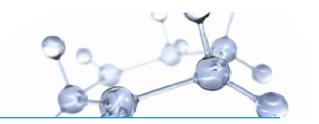
Yang Zhang PhD.

John Hedengren PhD.

Session 10B01: In Honor of Tom Edgar's 65 Birthday II

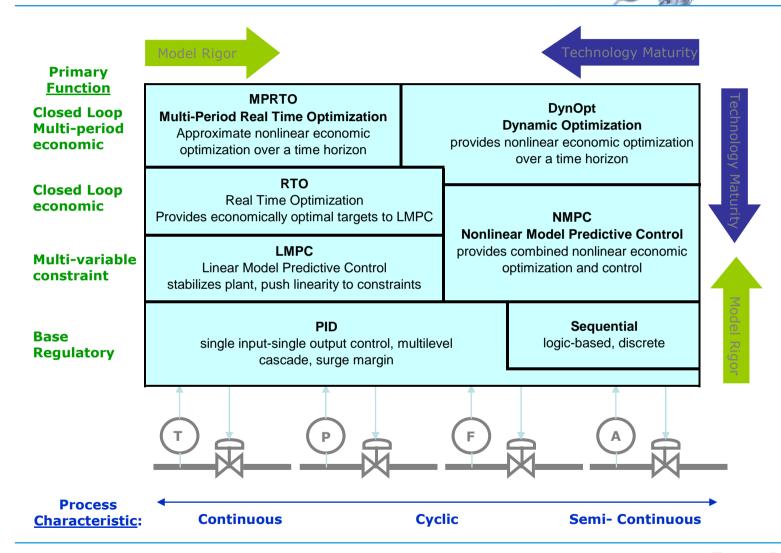
2010 AIChE Annual Meeting Salt Lake City, UT November 7-12, 2010

Outline



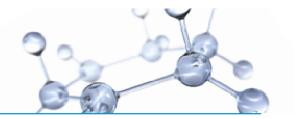
- Process Industries Advanced Control Toolbox
- ExxonMobil Chemical's Advanced Control Experience
- Engineering Specialists: Process Control
- Advanced Control Improvement Needs
- Tom Edgar's Impact
- Summary & Conclusions

Process Industries Advanced Control Toolbox

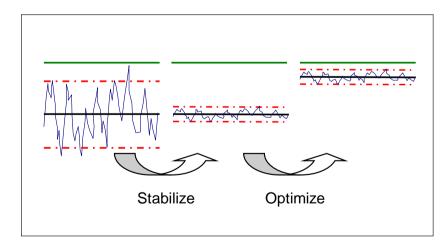




Linear Model Predictive Control (LMPC)



- LMPC is the most widely used advanced control technology
 - Medium Size application routinely delivers significant energy savings as well as additional production
 - Example: Butadiene Recovery Unit, Baton Rouge Chemical Plant
 - 40 Manipulated Inputs, 50 Controlled Variables
 - Reduced steam consumption 12MBTU/hr (\$800k/yr)
 - Example: "Typical" Ethylene Plant
 - 77 Manipulated Inputs,
 189 Controlled Variables
 - 109 Additional Feed Forward Inputs
 - Energy Reduction / Feed Increase on similar scale

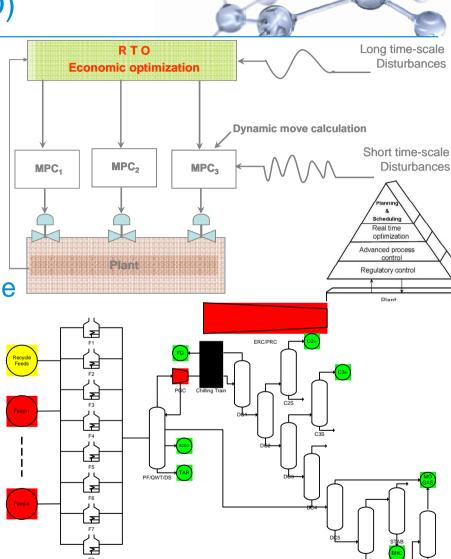


Real Time Optimization (RTO)

- Optimize the plant automatically on hourly basis by setting the underlying MPC setpoint
- Utilize real time price / cost information and plant constraints

 Cover all key unit operations in the plant

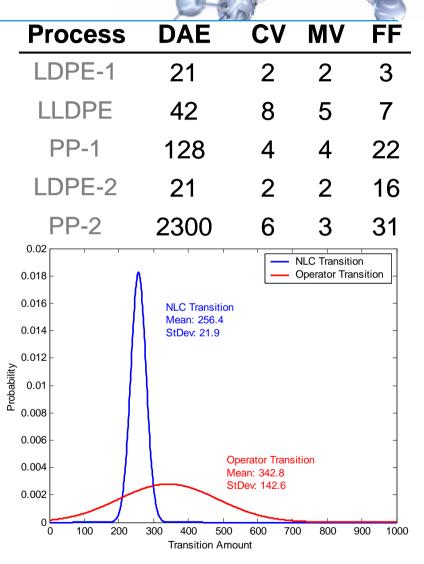
- Utilize rigorous thermodynamics and reaction kinetics to represent plant steady-state behavior
- Plant wide scope provides substantial benefits





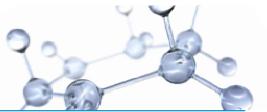


- Most ExxonMobil Chemical Company applications are firstprinciples based with some empirical elements
- Largest penetration of technology in polymers area
- Consistent control of properties through grade transitions is significant benefit of applications
- Modeling and parameter estimation require significant effort
- Little (if any) plant testing required









- Relatively small central group
- Maintain expertise in supported technologies
- Support site projects and initiatives
- Provide higher level support for applications worldwide
 - Sites maintain significant expertise in supported technologies
 - Central group facilitates application updates, troubleshoots modeling and technology issues
- Keep up to date with "State of the Art Technology"
 - Collaboration with academic researchers to deliver proof of concept applications
 - Work with vendors to drive technology improvements to address issues discovered at manufacturing sites







- Actively contribute to professional societies
- Actively participate in joint academic / industry consortia
- Maintain a fresh perspective
 - Seminars from visiting professors
 - Support graduate student internships
- Actively participate in vendor user groups
- Collaborate with colleagues internally

Advanced Control Improvement Needs



Linear MPC

- Better control infrastructure design
- Model consistency and closer integration to RTO
- Identification tools that systematically enforce relationships between variables

Real Time Optimization

- Better NLP & MINLP solvers and parallel computing to handle large scale, mixinteger, and complementarity problem
- Better understanding of distributed optimization & control

Nonlinear MPC

- Improved state / disturbance estimation methods
- Parameter estimation
- Improved integration of first principals and empirical models
- Evolution to dynamic optimization

Tom Edgar's Impact



Education

- Undergraduate embraced new technology for course organization, teaching concepts, and working problems
- Graduate direct research of and maintain funding for a substantial research group
- ExxonMobil has directly benefited from the quality of graduates produced

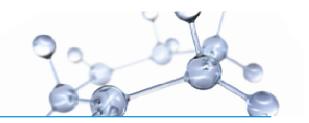
Research

 More than 250 refereed journal articles and significantly more conference publications

Industrial Collaboration

 Making students available for internships and to work directly on problems of interest to industry

Summary & Conclusions



- Advanced control has been extremely successful applied to industrial problems.
- Advanced control is not a "solved problem", many research challenges still exist.
- Ongoing academic and industrial collaboration is needed.
- Maintaining capability to sustain applications is an ever-present challenge.
- Educators such as Tom Edgar are key to supplying the next generation of engineers with understanding of the technology and its capability.



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