Enabling model based decision making by sharing consistent equation oriented dynamic models between multiple simulation and optimization environments

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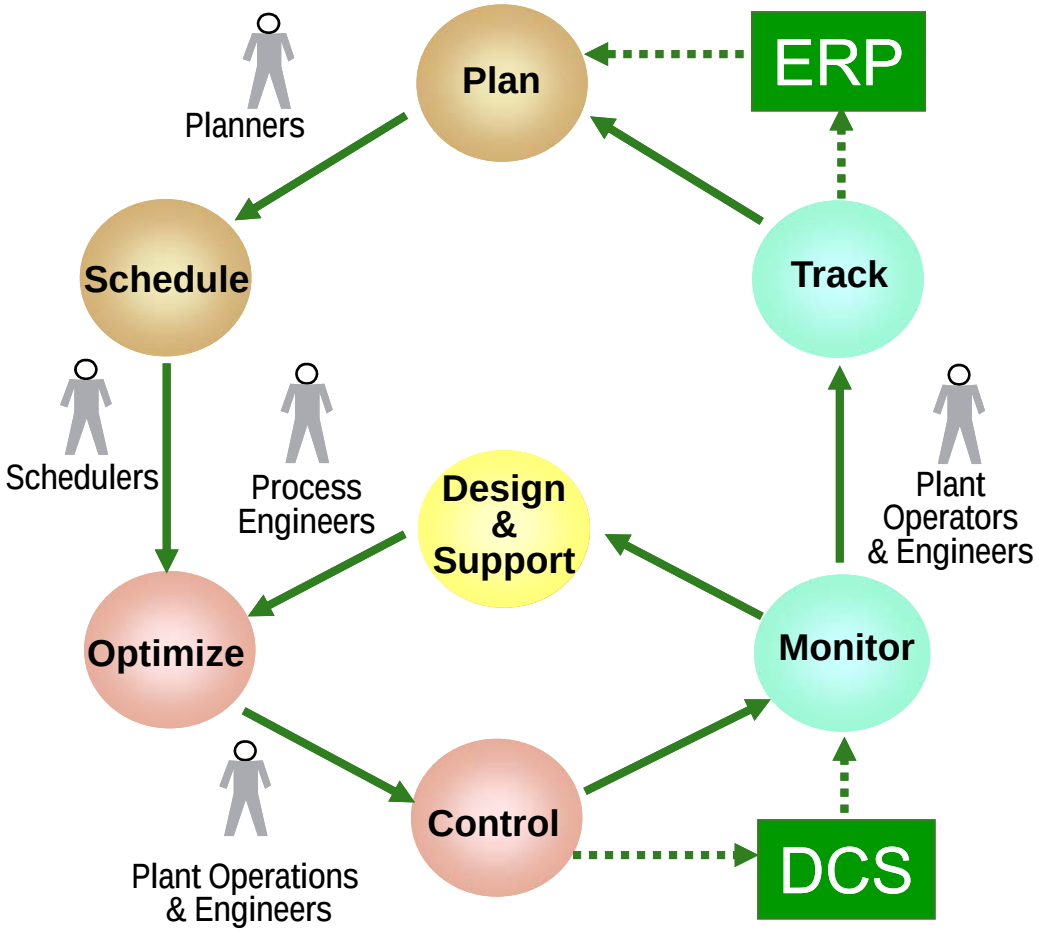
Consistent Model-Based Decision Making

Overview

- Why do we need to use consistent models?
- How do we enable use of consistent models?
  - Common computational engine
- How do we enable consistent dynamic models?
  - Enhance common computational engine
- Sample results of the implementation
  - Dynamic batch distillation model in Aspen Plus
  - Custom dynamic tank model in Aspen HYSYS and Aspen HYSYS Dynamics

Model-Based Decision Making



Why Do We Need To Share Models?

- Consistent basis for making decisions
  - Reuse rigorous models.
- Reliability of the predictions
- Speed of deployment
- Better knowledge management
  - Standardized work process: Models created and maintained by a group; Distributed to all users
  - Lower cost. Reduces need to have experts at every site

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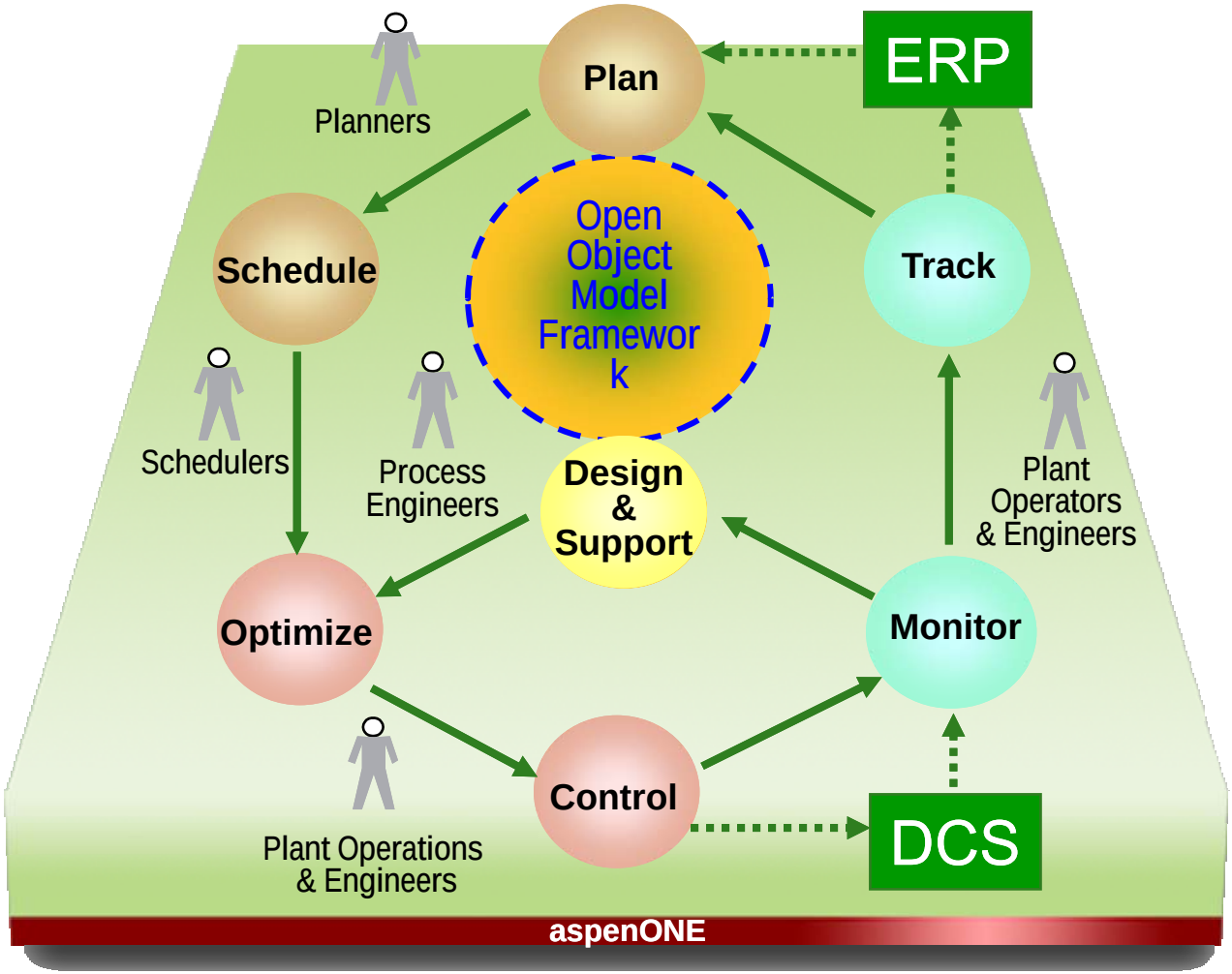
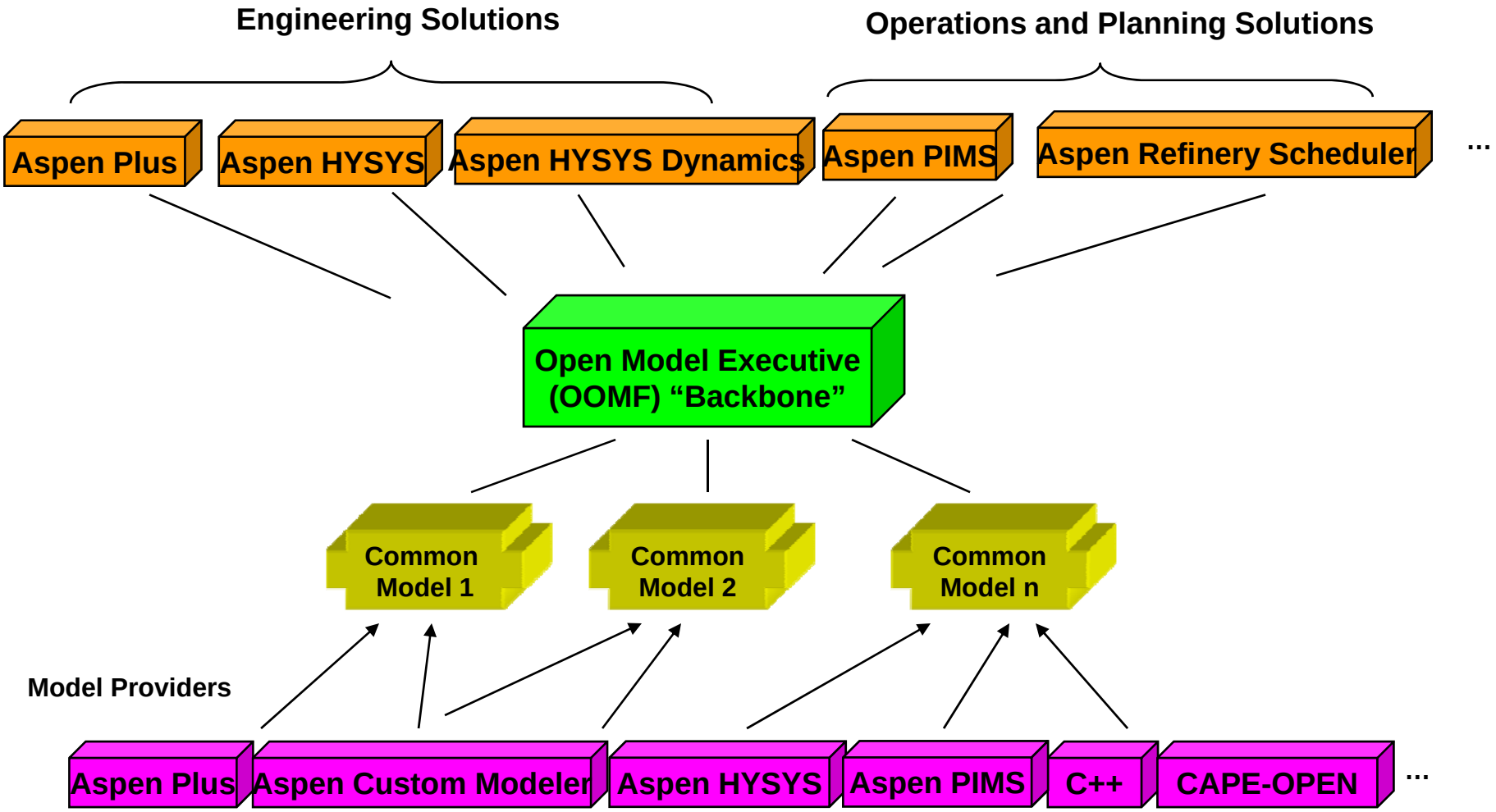
Consistent Model-Based Decision Making Common Computational Engine



Consistent Model-Based Decision Making
Common Computational Engine



Consistent Model-Based Decision Making

Custom Steady State models can already be shared

- Since 2002 steady state models developed using Aspen Custom Modeler can be seamlessly integrated into process plant models in Aspen Plus, Aspen HYSYS etc.
  - Solve in Sequential Modular and Equation Oriented solution modes
  - Icons, tables, custom forms, Visual Basic scripts are exported and available in Aspen Plus, Aspen HYSYS
  - Model variables are accessible in design specifications, sensitivity calculations, calculator blocks

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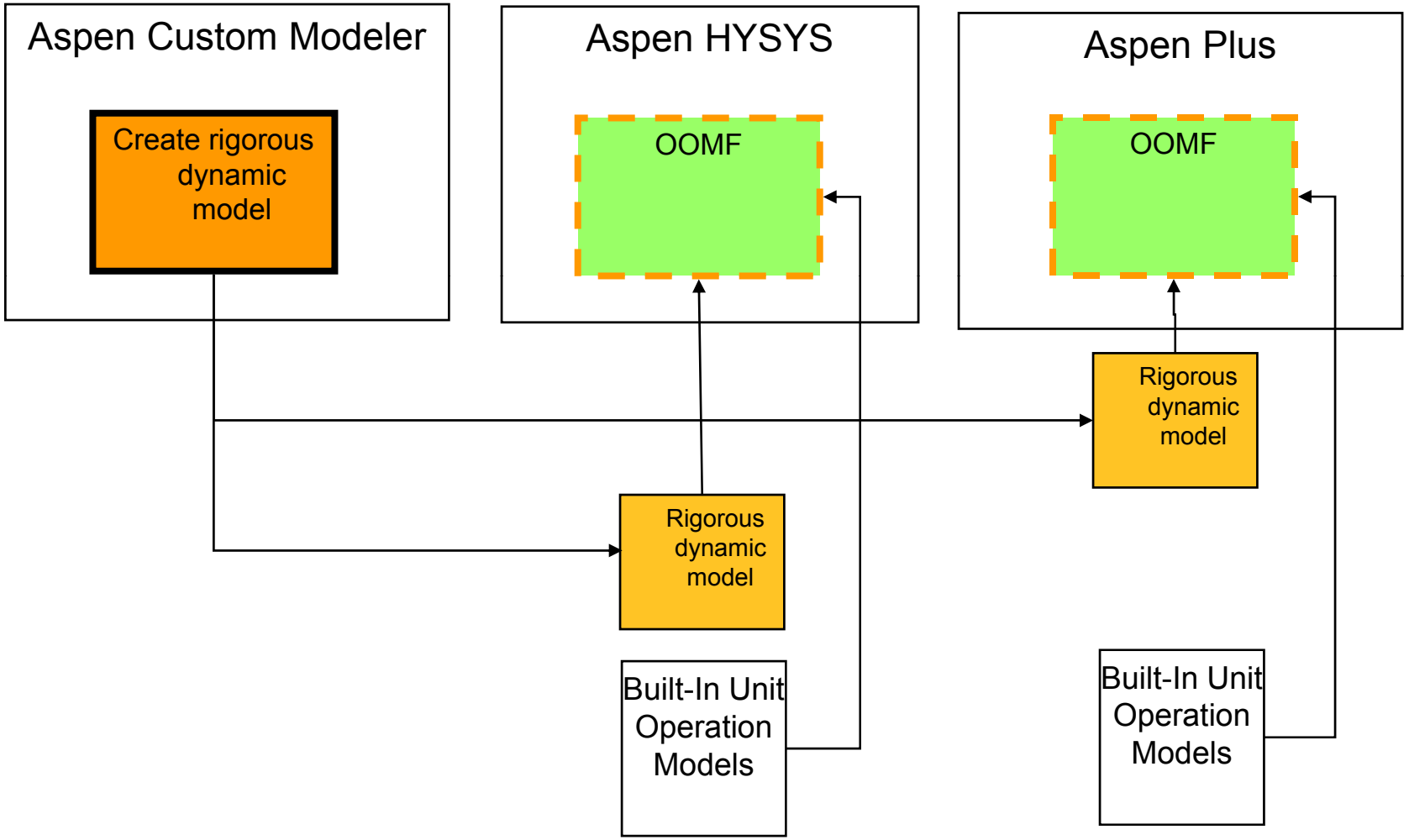
Consistent Model-Based Decision Making

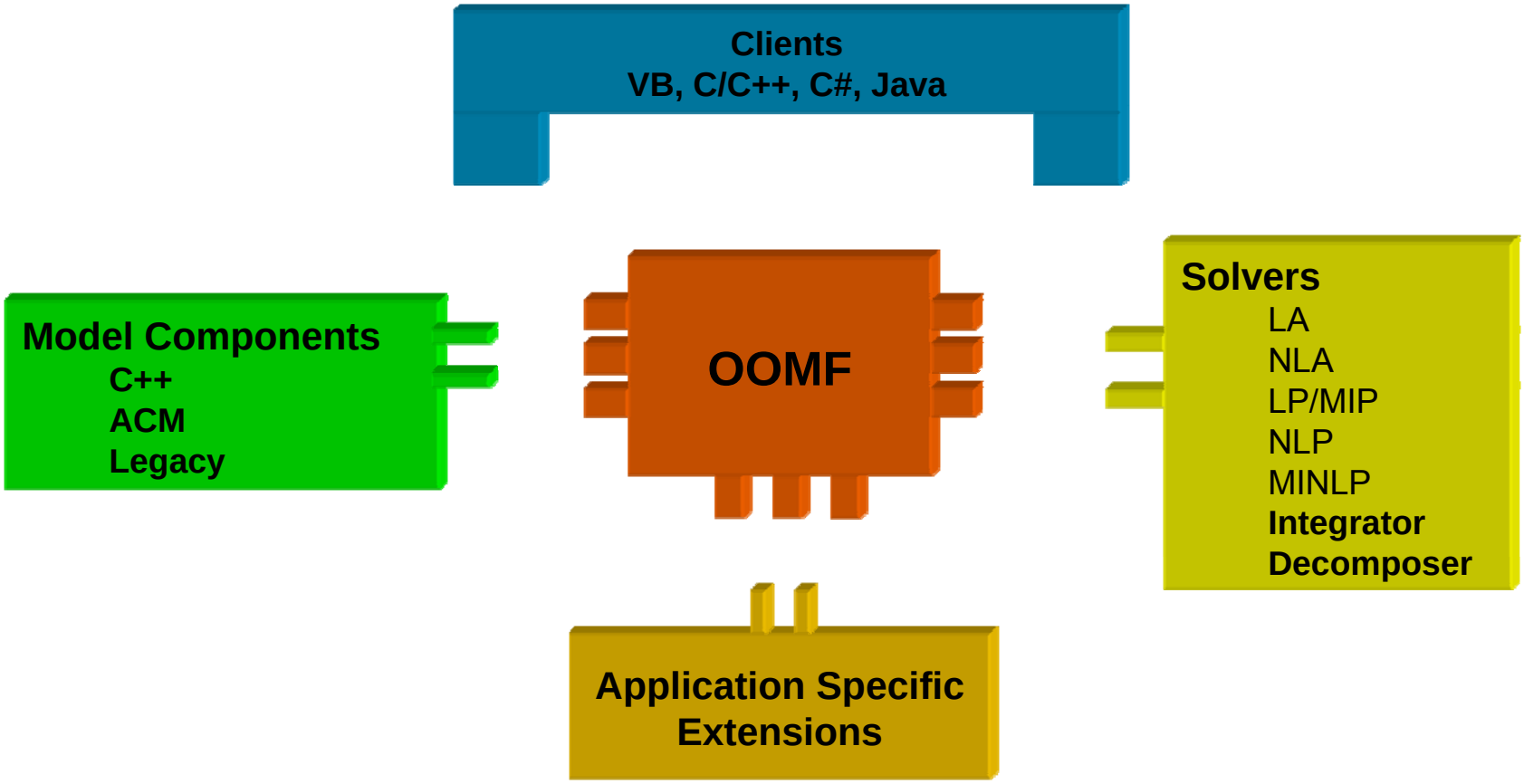
Rigorous Dynamic models can now be shared

- Author dynamic model in high level modeling environment
  - Aspen Custom Modeler
- Integrate the dynamic model with overall process model in
  - Aspen Plus and Aspen Plus Dynamics
  - Aspen HYSYS and Aspen HYSYS Dynamics
- Workflow enabled by common computational engine
  - Open Object Model Framework (OOMF)
  - Aspen Open Solvers (AOS)

Consistent Model-Based Decision Making



Consistent Model-Based Decision Making
OOMF – Common Computational Engine

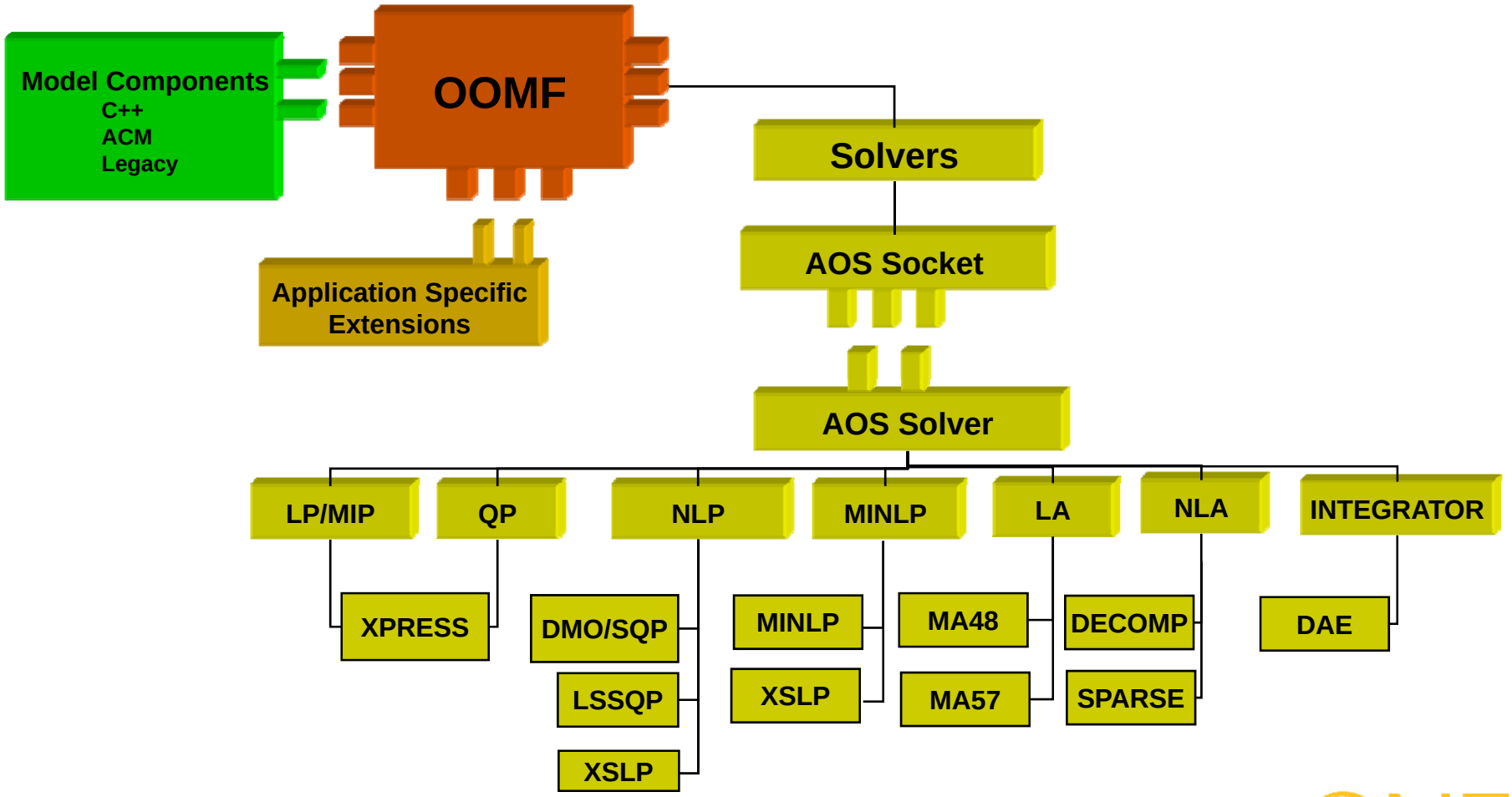


Consistent Model-Based Decision Making
OOMF – Dynamic Modeling Support

Drive the dynamic model through time

- Start, pause, re-start, and reset
- Finite State Machine
  - Manage and control the multiple states from start to end
- Task manager
  - Load, activate, parse and interpret configured tasks
- Event Manager
  - Explicit events - step the simulation through time
  - Implicit events - conditions, actions, monitors
- Data historian
  - Record, View variable time profiles; Save snapshots
- Open Solver driver
  - Differential Algebraic Equation System object

Consistent Model-Based Decision Making
Aspen Open Solvers



Consistent Model-Based Decision Making
Open Solver - Dynamic Modeling Support

Solve the dynamic model

- Aspen Open Solver Integrator
  - Explicit Euler, Implicit Euler, Runge-Kutta, Gear
- Interfaces and implementation for
  - Differential Algebraic Equation System Object
  - Group Decomposition
  - Tearing
  - Homotopy
- Event location
  - Discontinuities, Tasks
- Diagnostic Reports

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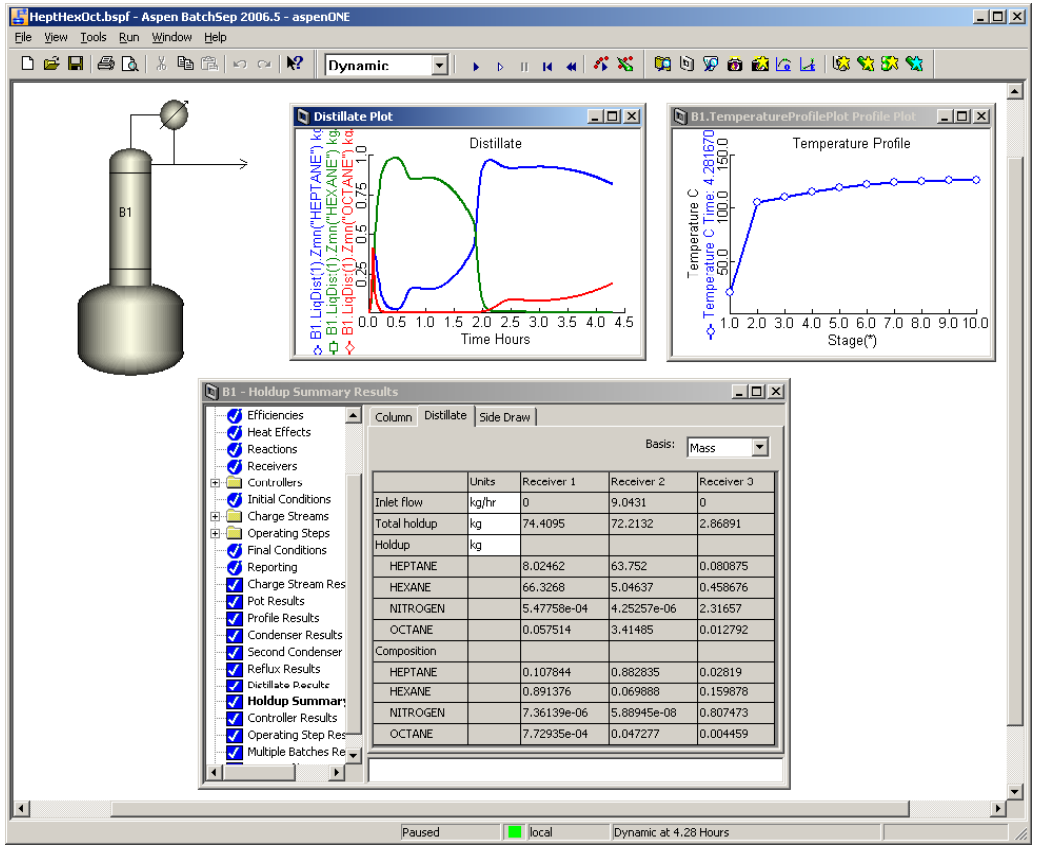
Consistent Model-Based Decision Making Results of the Implementation

Author the dynamic model in Aspen Custom Modeler.

- Create a dynamic model based on proprietary knowledge or chemical engineering literature
- Integrate dynamic model with overall process model in Aspen Plus and Aspen HYSYS.
- Two examples follow
  - Batch Distillation Model authored in Aspen Custom Modeler; integrated within an Aspen Plus process model
  - Custom tank model authored in Aspen Custom modeler; integrated within an Aspen HYSYS and Aspen HYSYS Dynamics model

Consistent Model-Based Decision Making
Aspen Batch Distillation

- Aspen Batch Distillation is a dynamic model developed using Aspen Custom Modeler
- Used for design, analysis and optimization of batch distillation processes

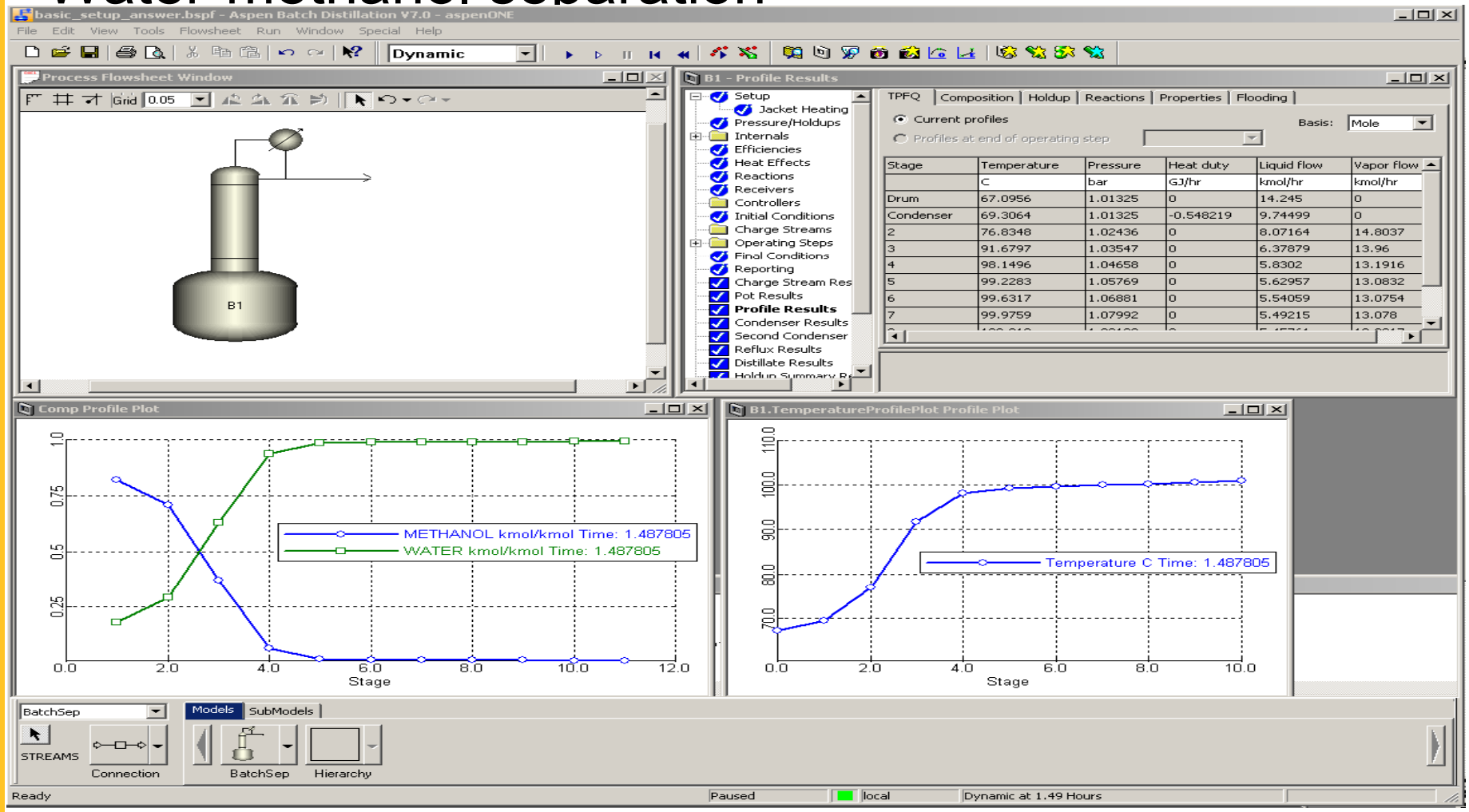


Consistent Model-Based Decision Making
Aspen Batch Distillation

- Developed using Aspen Custom Modeler
- Uses Aspen Properties
  - Rigorously model two-phase and three-phase columns
- Integrates a large DAE system
  - 1000 to100000+ equations
  - Implicit Euler or Gear solution methods
- Uses tasks to model a sequence of batch operations
- Rich user interface for configuring column and operating steps

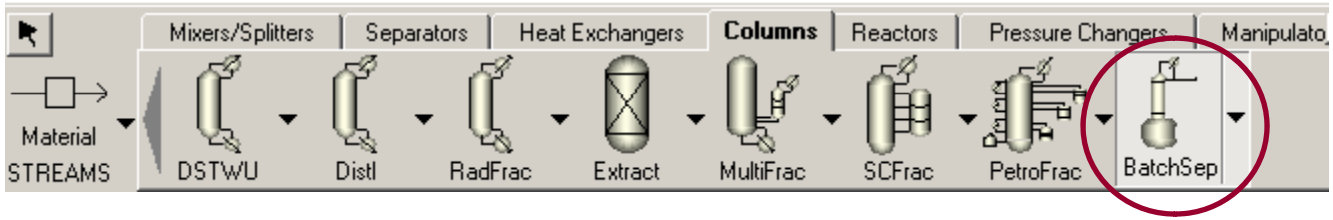
Consistent Model-Based Decision Making
Aspen Batch Distillation Sample Model

- Water-methanol separation



Consistent Model-Based Decision Making Integration into Aspen Plus Via OOMF

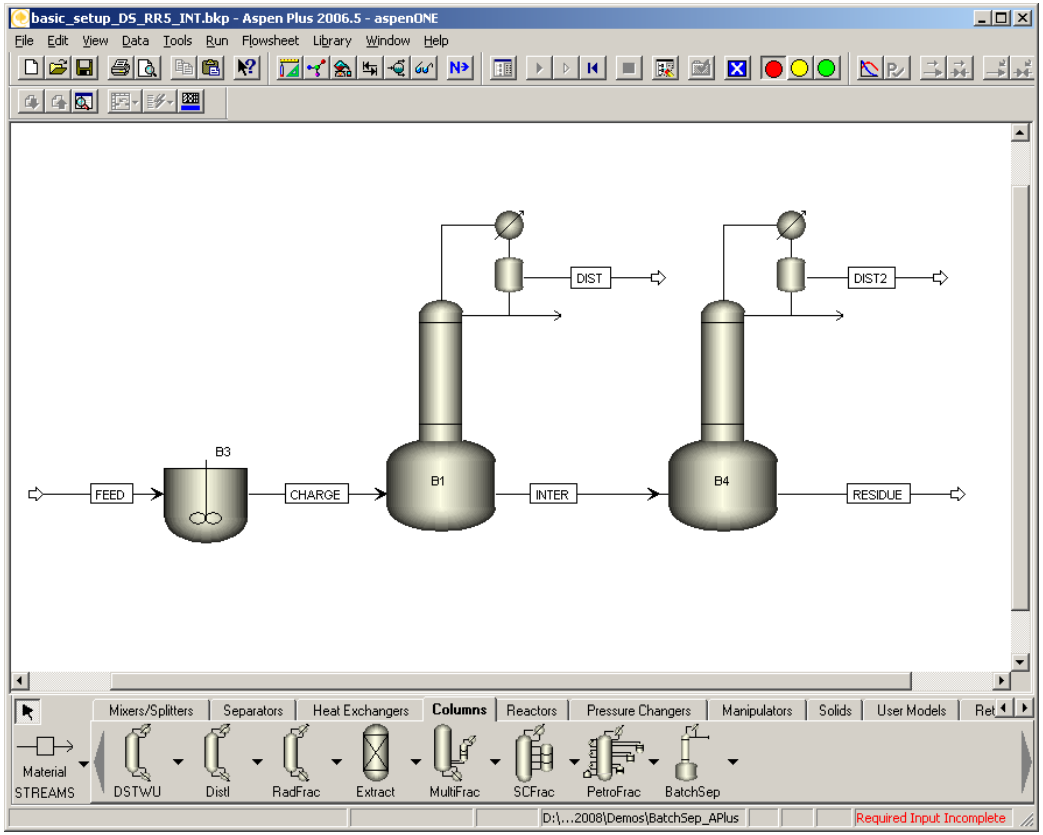
- Aspen Batch Distillation Model now also available as a unit operation in Aspen Plus



- Integration with Aspen Plus enables simulation and optimization of:
  - Batch distillation sequences
  - Entire process including other batch or continuous unit operations

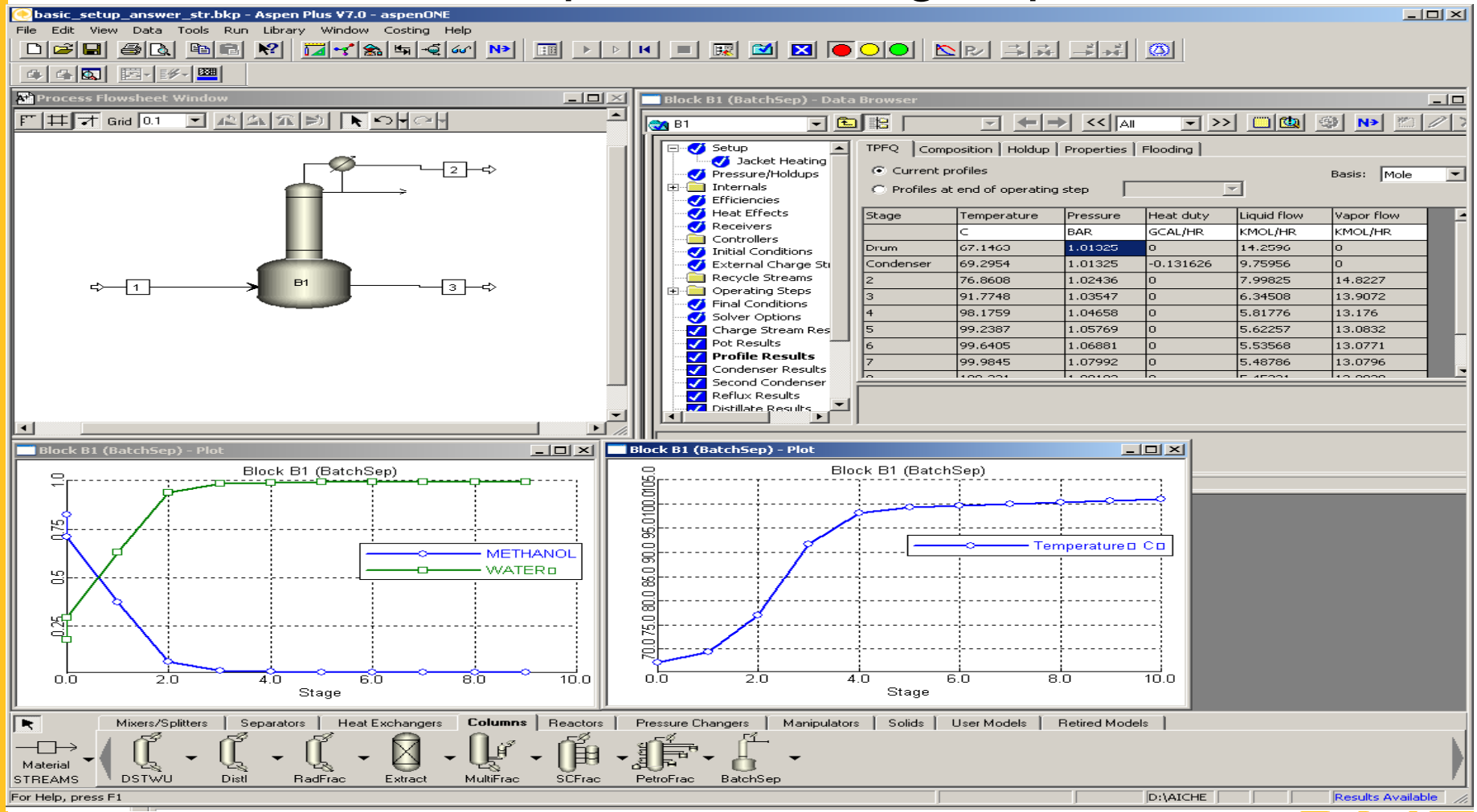
Consistent Model-Based Decision Making Integration into Aspen Plus Via OOMF

- Connect to other models and optimize the process
  - Notional buffer tanks at inlets and outlets



Consistent Model-Based Decision Making Integration into Aspen Plus Via OOMF

- Water-methanol separation using Aspen Plus



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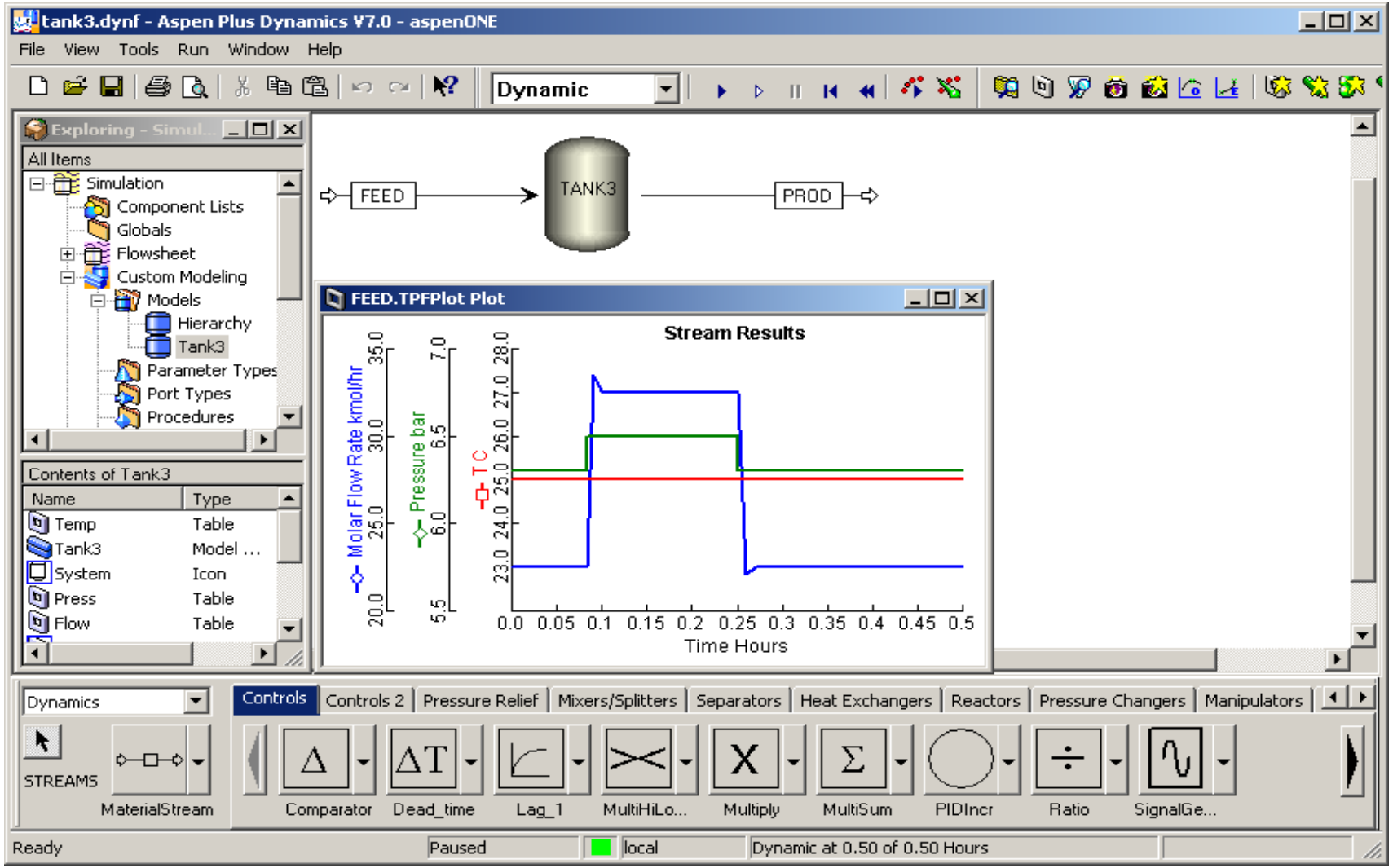
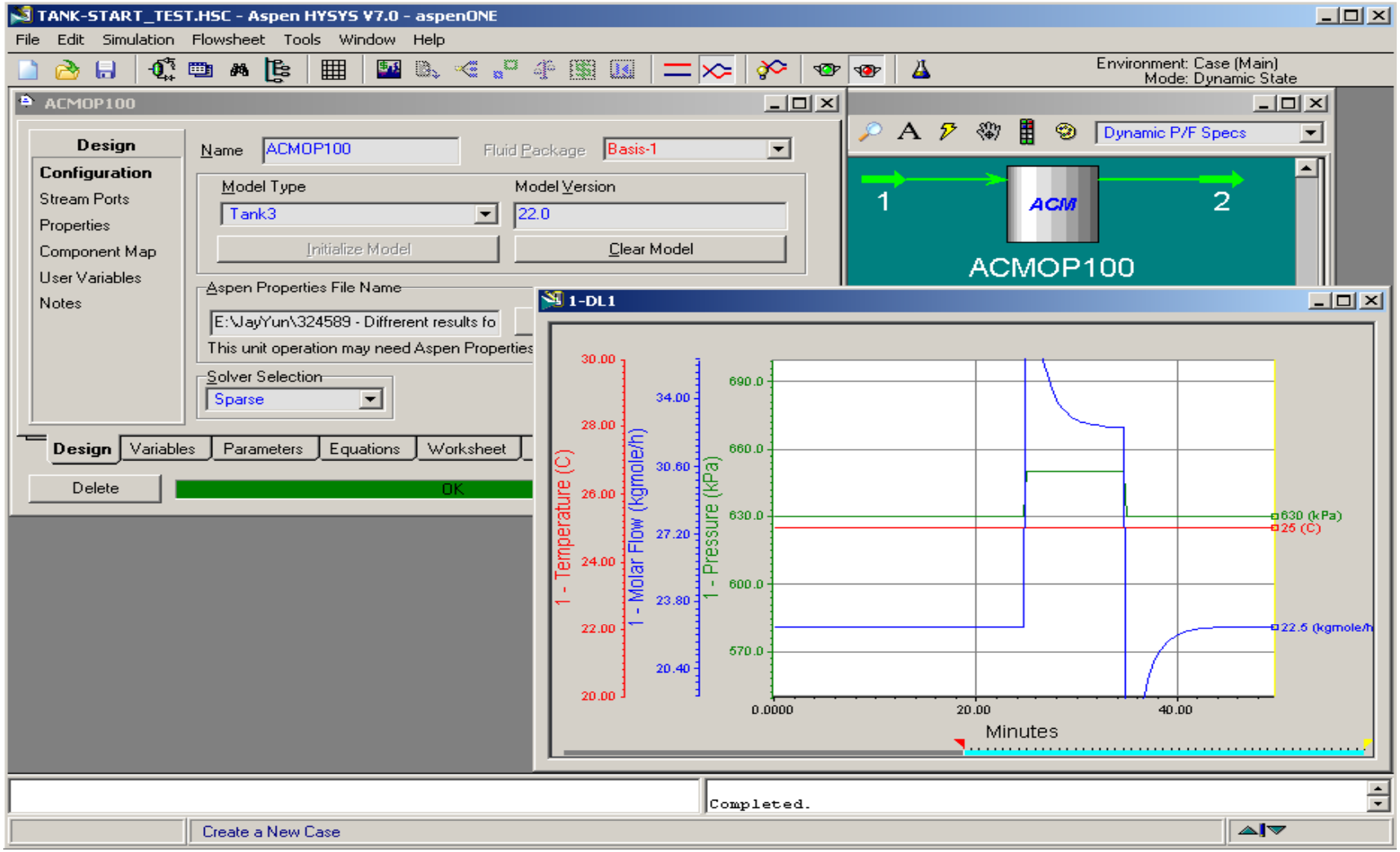
Consistent Model-Based Decision Making
Custom Dynamic Tank Model



Consistent Model-Based Decision Making Integration into Aspen HYSYS Via OOMF



Consistent Model-Based Decision Making

Dynamic models can be shared for better decision making.

- Author dynamic model in high level modeling environment
  - Aspen Custom Modeler
- Integrate the dynamic model with overall process model
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  - Aspen HYSYS and Aspen HYSYS Dynamics
- Improve process model accuracy, reliability and deployment.
  - Better knowledge management
- Workflow enabled by common computational engine
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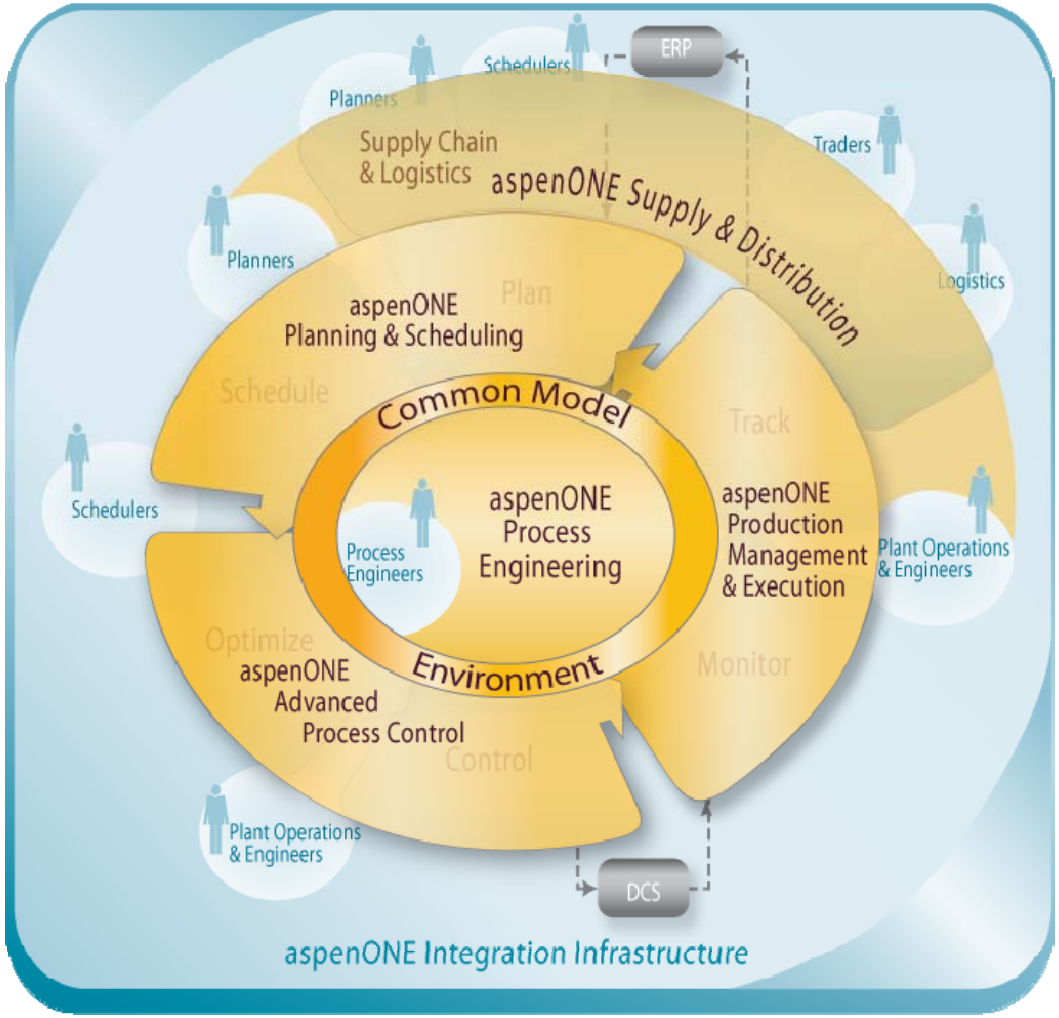

- Common Model Environment
  - Enables use of consistent models in Engineering, Planning and Scheduling, Advanced Control, Optimization, and Operations
- Sample implementations of sharing of dynamic model in engineering were described in this paper.
  - The next paper will describe how similar models are used across Engineering, Planning and Scheduling, and Operations in the refining industry

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