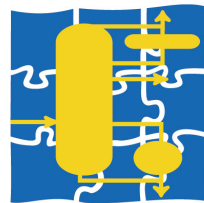


# CAPE-OPEN



**CO ▼ LaN**

**Michel PONS**

**Chief Technology Officer**

**Akzo Nobel Chemicals, Arnhem, November 17, 2005**



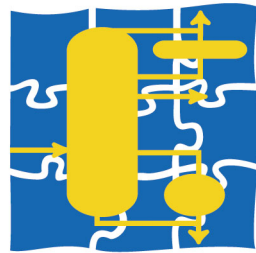
# Outline

- ▼ **What is CAPE-OPEN?**
- ▼ **What CAPE-OPEN permits for end-users?**
- ▼ **What is the CAPE-OPEN Laboratories Network?**
- ▼ **Conclusions**

CO ▼ LaN



# What is CAPE-OPEN?



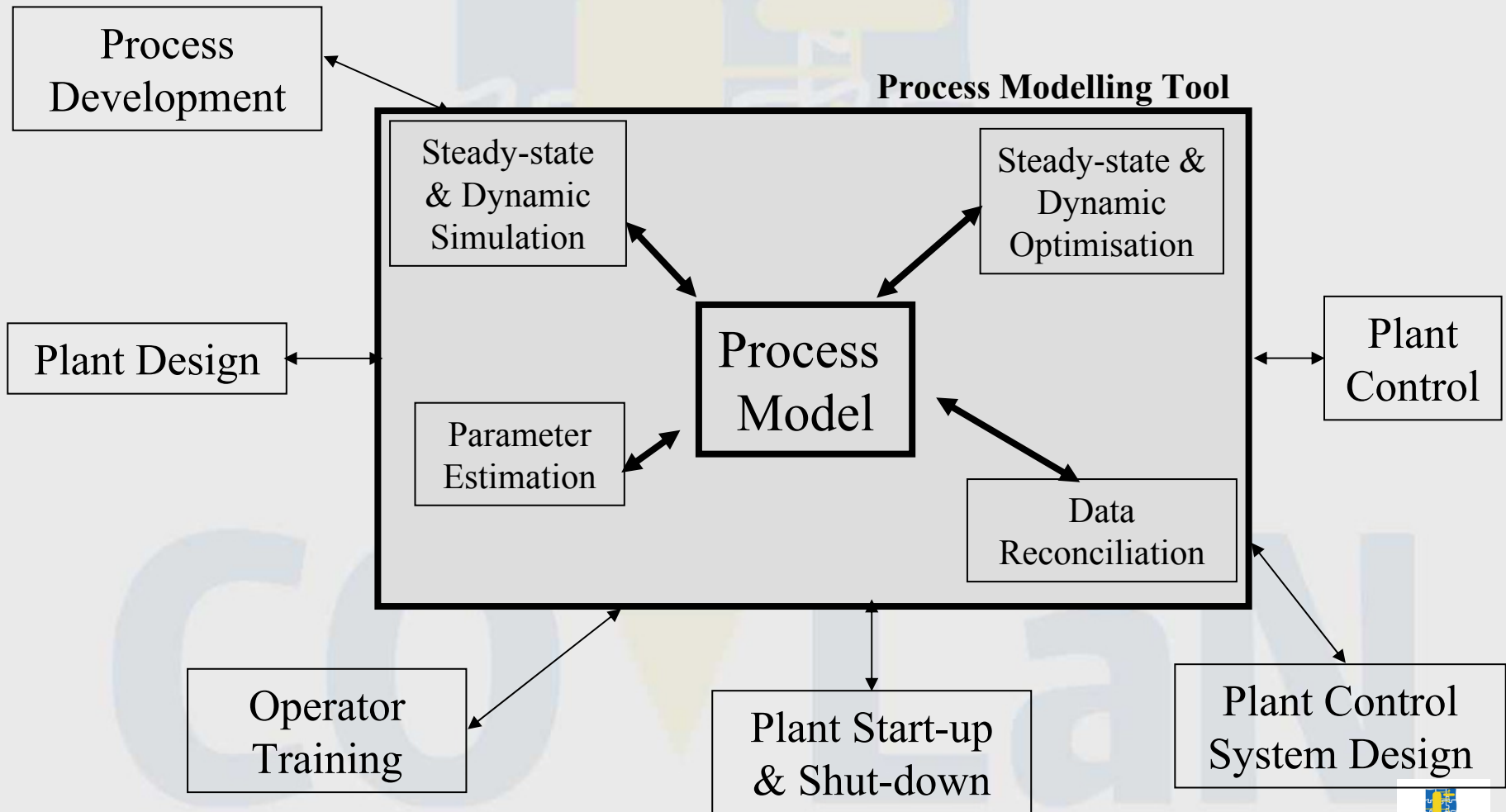
**CO ▼ LaN**



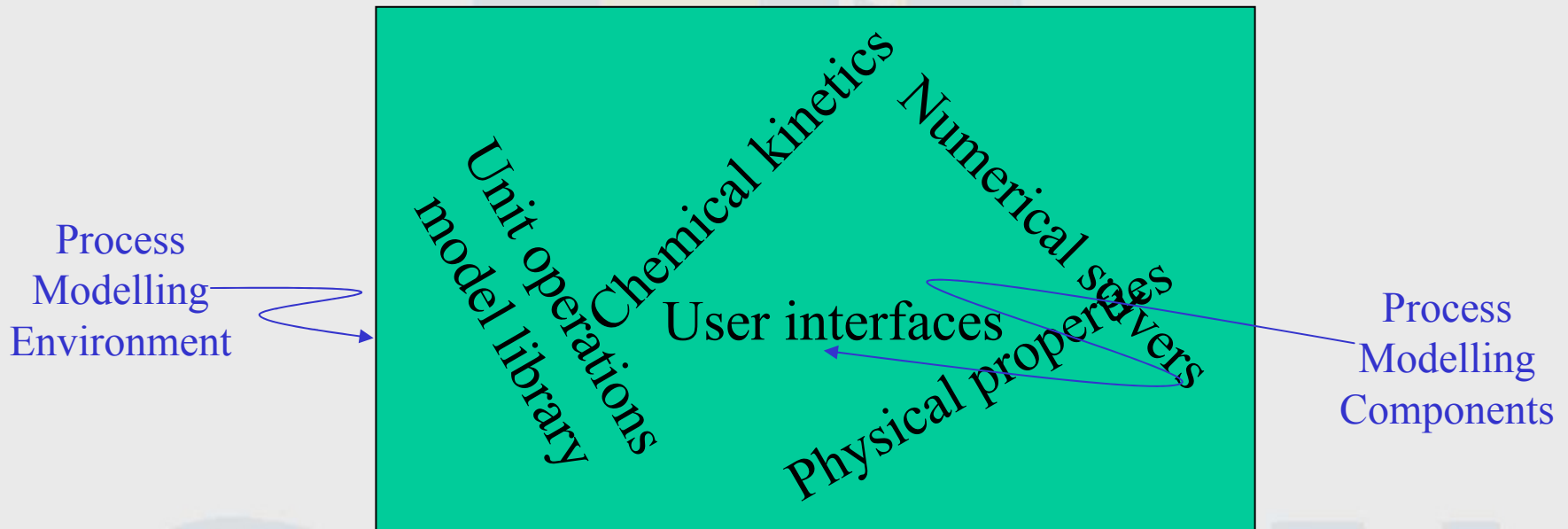
# CAPE-OPEN: a technology for integration

- ▼ A freely available industry standard for interfaces between software components making up process simulation tools
- ▼ The success of a collaboration between software vendors, end-users and academics
- ▼ A proven technology implemented in most process simulation tools
- ▼ A growing adhesion by process simulation market leaders

# General-purpose process modelling tools

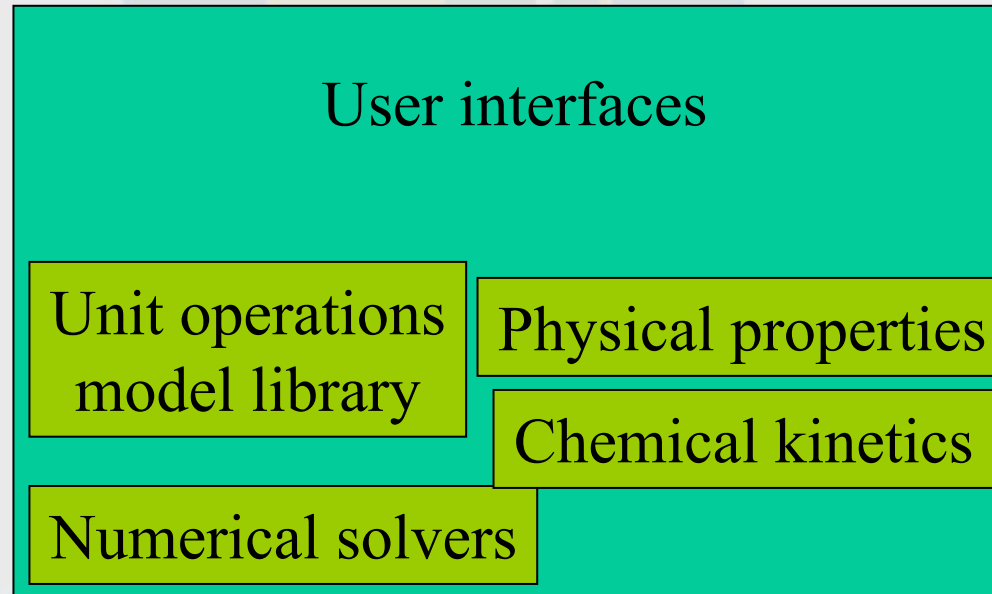


# The anatomy of process modelling tools – a (somewhat) confusing reality

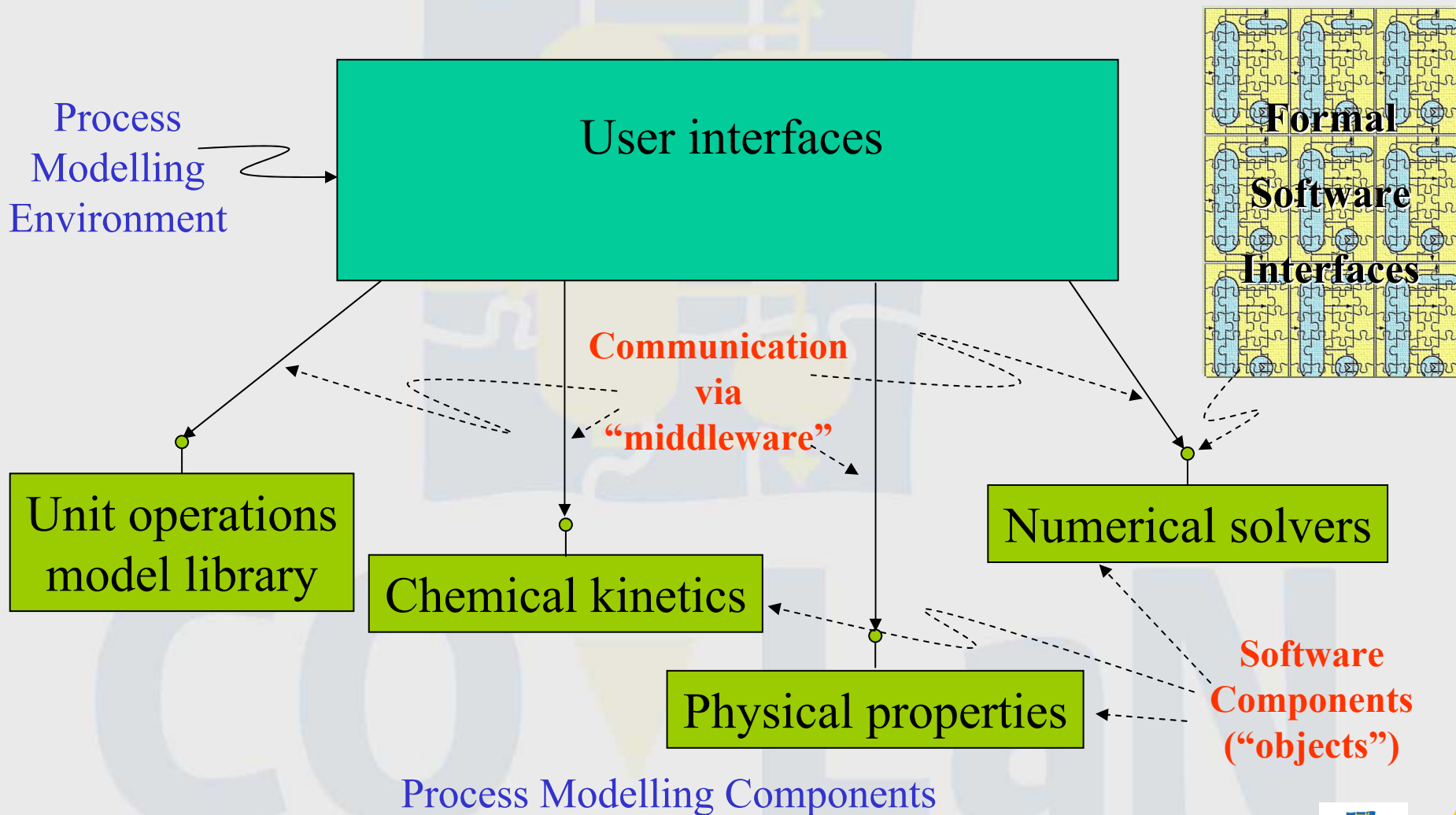


- Many interacting components...
- ...all tightly coupled with each other
- Component boundaries not always clearly delineated

# Clarify boundaries between key components



# ...and break tool into 1 PME & multiple PMCs





# Process modelling: components & environments

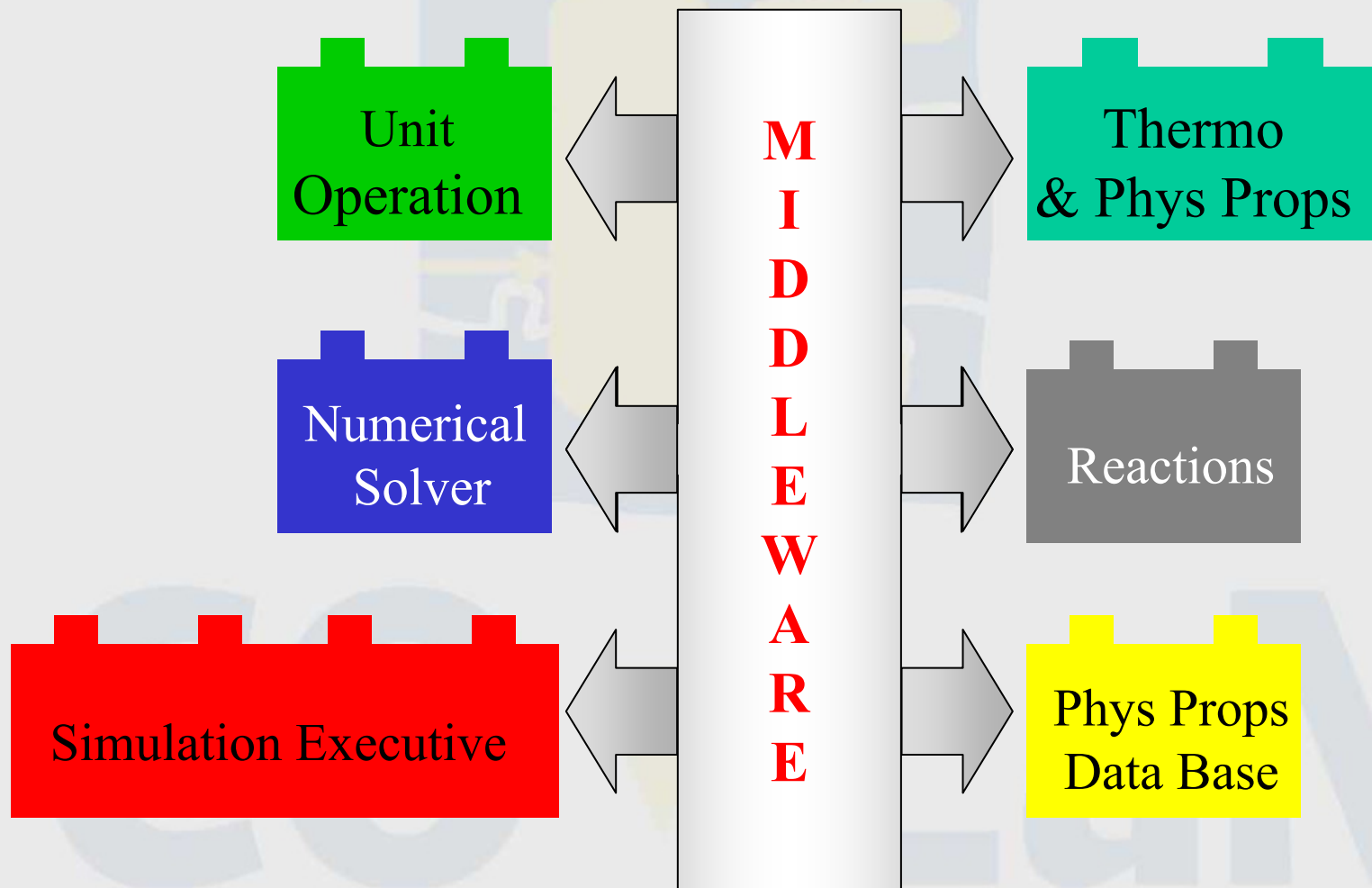
## ▼ Process Modelling Components (PMCs)

- ⇒ Well-defined pieces of software, relatively narrow function
- ⇒ Wide range of applications
  - Physical properties
  - Unit operation modules
  - Numerical solvers
  - .....

# Process modelling: components & environments

- ▼ **Process Modelling Components (PMCs)**
- ▼ **Process Modelling Environments (PMEs)**
  - ⇒ **Support construction of process model**
    - **From first-principles and/or library of unit operation models**
  - ⇒ **Support a number of model-based applications**
    - **Simulation, optimisation, ...**
  - ⇒ **May make use of one or more PMCs**

# CAPE-OPEN Components



# CAPE-OPEN Documentation Set

## ▼ Abstract CO Interface specification

- ⇒ Textual requirements
- ⇒ Use Cases
- ⇒ UML Diagrams
- ⇒ List of interfaces/Methods/Arguments

## ▼ COM/CORBA implementations

- ⇒ Interface Definition Language files
- ⇒ Type library

# CAPE-OPEN architecture

## ▼ Business interfaces

- **Domain-specific interfaces for CAPE application domain:** define interfaces to CO components involved in a CO process simulation application.

## ▼ PME Interfaces

- **Interfaces for CO simulator executives:** services of general use are defined such as diagnostics and material systems in order to be called by any CO component.

## ▼ Common interfaces

- **Interfaces for handling services that may be required by any Business and COSE/PME interfaces:** support basic functions and are always independent of Business and COSE/PME Interfaces.

# CO interfaces releases

0.9 (CAPE-OPEN)

0.93 (GCO 2001)

1.0 (GCO 2002)

Other  
Services

Planning  
& Scheduling

PME Services

SMST

Numeric

PEDR

Optimisation  
MILP, MINLP

PDAE  
Solvers

Solvers  
LAE, NLAE, DAE

Unit  
Operations

Unit Operations

Physical  
Properties

Petroleum  
Fractions

Thermodynamic and Physical  
Properties

Physical Properties  
Data Bases

Electrolytes

Reactions

Parameters Collections

Persistence

Common Interfaces

Error Handling

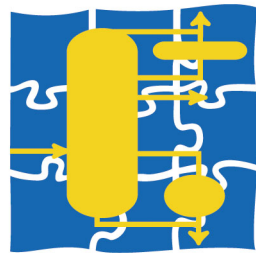
Identification

Utilities

Types and undefined values



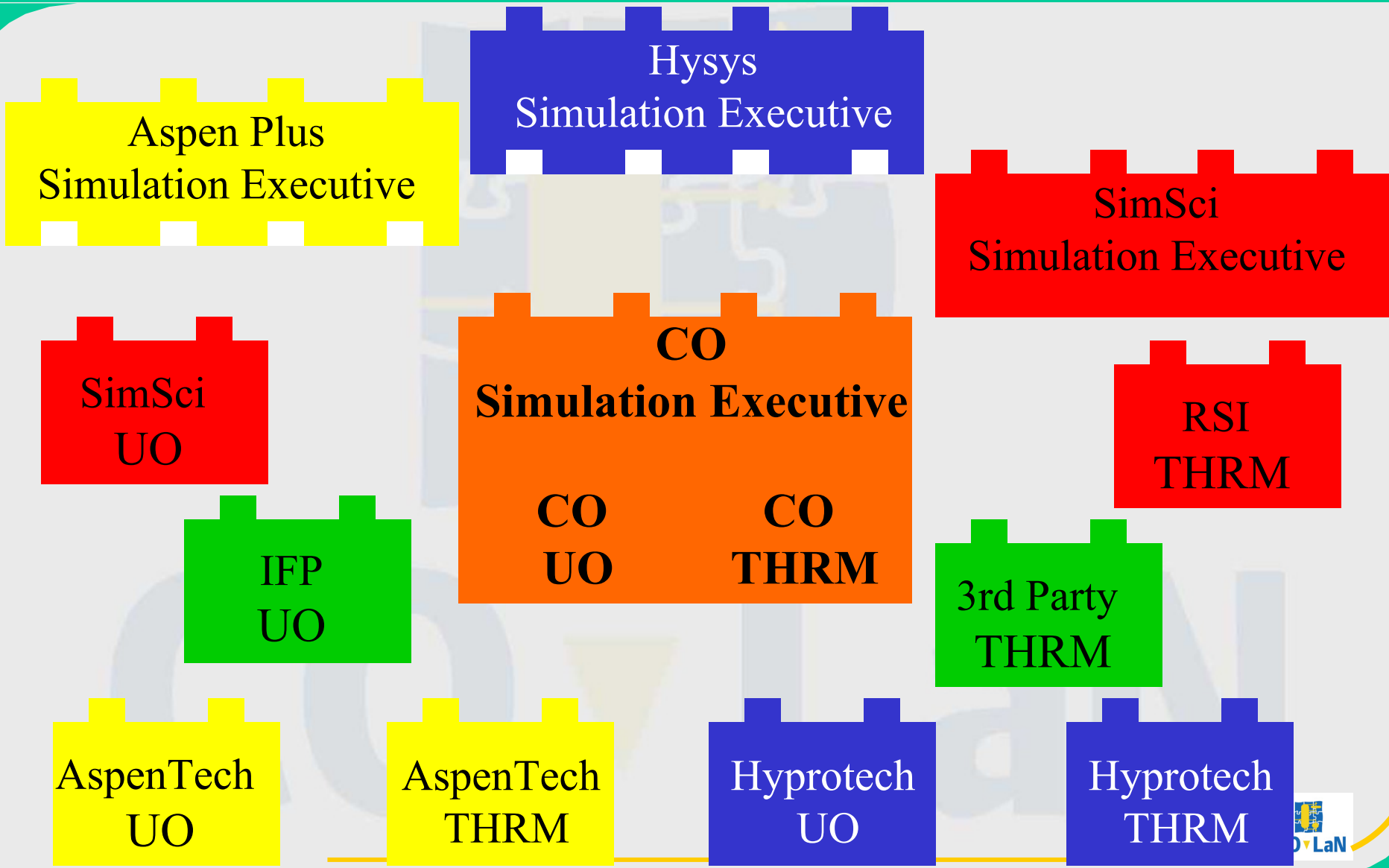
# What CAPE-OPEN permits for end-users?



**CO ▼ LaN**

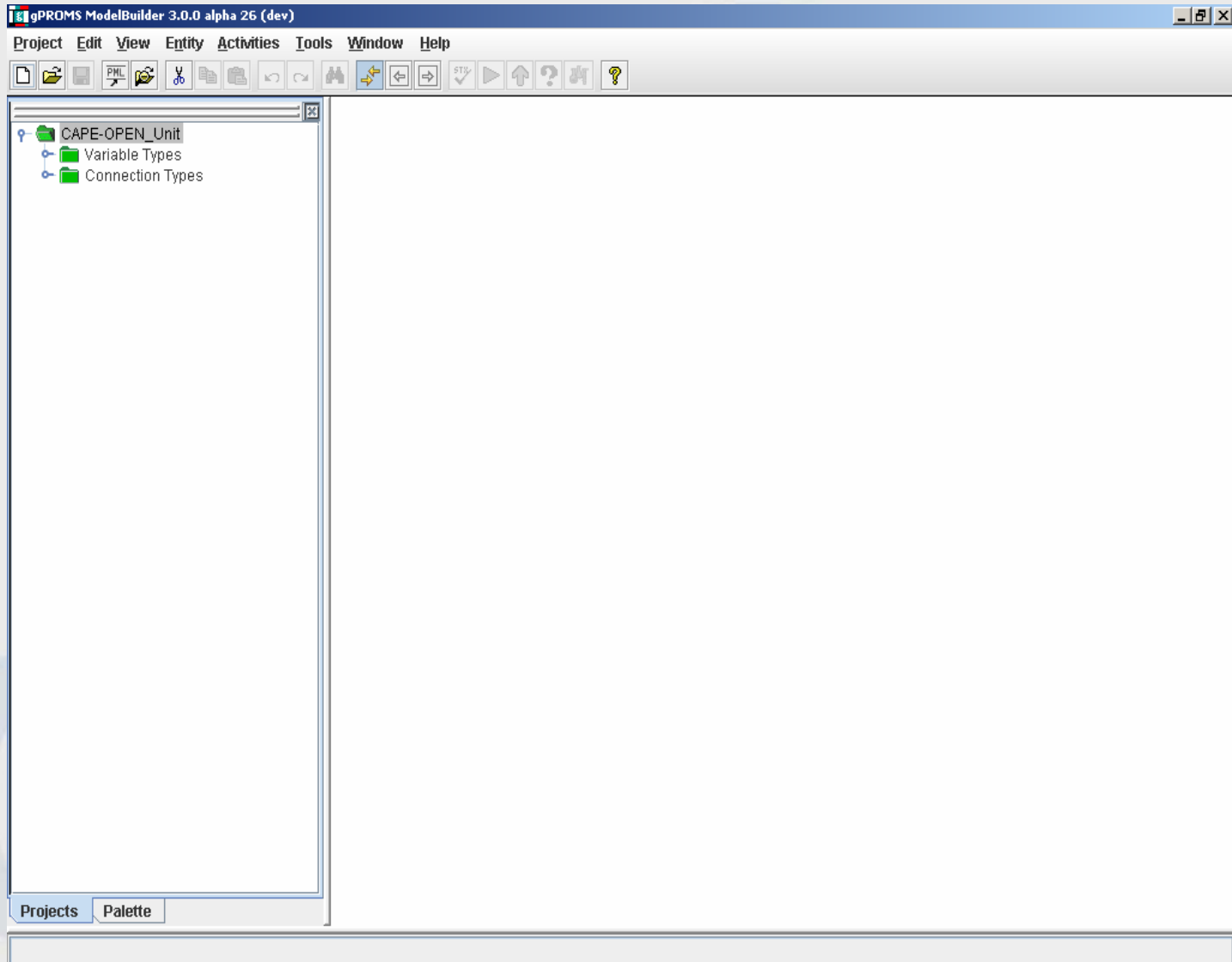


# Interoperability





# Load CAPE-OPEN library in ModelBuilder



# Load/Create Mixer Model

The screenshot shows the gPROMS ModelBuilder interface. The left pane displays a project tree with 'PHMixer2' selected. The main editor shows the following code:

```
4 PORT
5   MidInlet AS CO_Material
6   TopInlet AS CO_Material
7   TopOutlet AS CO_Material
8
9 VARIABLE
10  junction_mass_specific_enthalpy AS mass_specific_enthalpy
11  junction_mass_fraction AS ARRAY(TopOutlet.no_components) OF mass_fractions
12  outFlow AS ARRAY(TopOutlet.no_components, 1) OF mass_flowrates
13  pressure AS no_type
14  DeltaP AS no_type
15  input_energy_rate AS energy_rate
16 # flashResult AS ARRAY(TopOutlet.no_components*3 + 11) of no_type
17
18 EQUATION
19
20 FOR i := 1 TO TopOutlet.no_components DO
21   0 = TopInlet.mass_flowrate * TopInlet.mass_fraction(i)
22     + MidInlet.mass_flowrate * MidInlet.mass_fraction(i)
23     - ( TopOutlet.mass_flowrate * TopOutlet.mass_fraction(i) );
24
25 END
26
27 TopOutlet.enthalpy_flow * TopOutlet.mass_flowrate = TopInlet.enthalpy_flow
28   * TopInlet.mass_flowrate + MidInlet.enthalpy_flow * MidInlet.mass_flowrate
29   + input_energy_rate ;
30
31 # Out flows
32 TopOutlet.mass_flowrate = TopInlet.mass_flowrate + MidInlet.mass_flowrate;
33
34 TopOutlet.mass_fraction = junction_mass_fraction ;
35
```

Callouts in the image point to the mass balance equation (lines 20-24) and the energy balance equation (lines 27-29).

# Launch CAPE-OPEN export

The screenshot shows the gPROMS ModelBuilder 3.0.0 alpha 26 (dev) interface. The 'Tools' menu is open, and 'Export to CAPE-OPEN...' is highlighted. The project tree on the left shows 'CAPE-OPEN\_Unit' and 'PHMixer2'. The main workspace contains a table with the following data:

Port	Connection type	Dimensions	Direction	X	Y	Port set
MidInlet	CO_Material		Inlet	0	0,524	MidInlet
TopInlet	CO_Material		Inlet	0	0,238	TopInlet
TopOutlet	CO_Material			1	0,231	TopOutlet

Buttons for 'Add...', 'Edit...', and 'Delete' are visible below the table. The bottom of the interface has tabs for 'Interface', 'Specification', 'Topology', 'gPROMS language', and 'Properties'.

No need to change model for CAPE-OPEN exportation

gPROMS supports CAPE-OPEN Material Object



# Crypt gCO file

**Export to CAPE-OPEN**

Export directory: & Components\gPROMS\Unit plug\Test 100305 **Browse**

Unit name: PHJunction

Overwrite previously generated TASKs and PROCESS

Saved variable set	Include

Encryption password: afgsjhj

Decryption password (optional):

**General** | Ports | Parameters

**Export** **Cancel**

Exportation leads to a single file being created (extension gCO). Easily deployable.

Encrypting the gCO file enables deployment to other parties and ensures consistency

# Define ports options and parameters settings

The screenshot shows a dialog box titled "Export to CAPE-OPEN" with a close button (X) in the top right corner. It contains two main sections: "Ports:" and "Port variables:".

**Ports:**

Port	Direction	Connection	
MidInlet	Inlet	<input checked="" type="radio"/> Obligatory	<input type="radio"/> Optional
TopInlet	Inlet	<input checked="" type="radio"/> Obligatory	<input type="radio"/> Optional
TopOutlet	Outlet	<input type="radio"/> Obligatory	<input checked="" type="radio"/> Optional

**Port variables:**

Port variable	Direction	
enthalpy_flow	<input checked="" type="radio"/> Get	<input type="radio"/> Send
mass_flowrate	<input checked="" type="radio"/> Get	<input type="radio"/> Send
mass_fraction	<input checked="" type="radio"/> Get	<input type="radio"/> Send
pressure	<input checked="" type="radio"/> Get	<input type="radio"/> Send
temperature	<input checked="" type="radio"/> Get	<input type="radio"/> Send

At the bottom of the dialog, there are three tabs: "General", "Ports" (which is selected), and "Parameters". Below the tabs are two buttons: "Export" and "Cancel".

Ports connection may be mandatory or optional

# Parameter default settings

The screenshot shows a dialog box titled "Export to CAPE-OPEN" with a close button (X) in the top right corner. The dialog contains a table with the following data:

ID	Name	Lower bo...	Default va...	Upper bo...	Units	Fixed value
DeltaP	Pressure...	0.0	100	1000.0	Pa	
input_en...	Energy rate	0.0	1	1000.0	J/s	

Below the table, there are three tabs: "General", "Ports", and "Parameters". The "Parameters" tab is currently selected. At the bottom of the dialog, there are two buttons: "Export" and "Cancel".

Each parameter is provided with a lower and upper bound as well as a default value.

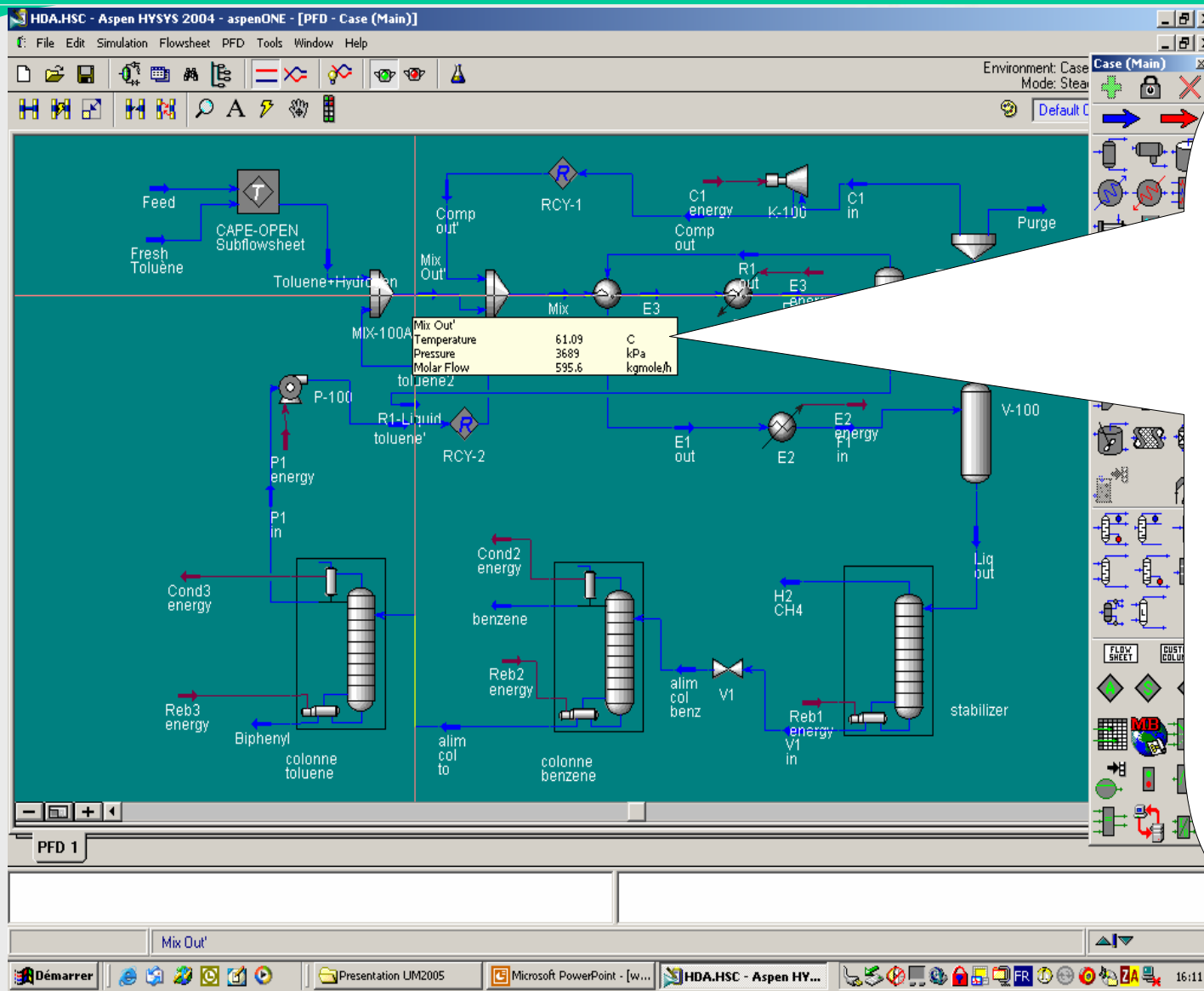


# Running gPROMS model in HYSYS.Process

CO ▼ LaN



# HDA process model in Aspen HYSYS 2004



Since gPROMS mixer model involves basic material and energy balances, results with Aspen HYSYS 2004 native mixer and gPROMS mixer should be strictly the same.



# Native mixer deleted and solver on hold

The screenshot displays the Aspen HYSYS 2004 interface. The main window shows a process flow diagram (PFD) for a chemical process. The diagram includes several units: a feed stream, a CAPE-OPEN Subflowsheet, a compressor (C-100), a mixer (MIX-100B), a reactor (R-1), a separator (V-100), and three distillation columns (colonne toluene, colonne benzene, and stabilizer). Energy streams are labeled with 'E1', 'E2', 'E3', 'Cond1', 'Cond2', 'Cond3', 'Reb1', 'Reb2', and 'Reb3'. A callout box with a white background and black border points to a specific location in the diagram, containing the text 'Mixer deleted'. The status bar at the bottom of the window indicates 'Solver Holding'. The bottom-left corner shows a warning message: 'Warning : Fluid Pkg Transition -- Not Solved'. The bottom-right corner shows a table of convergence status for the columns:

Unit	Status
Column Flowsheet stabilizer	Not Converged
Column Flowsheet colonne benzene	Not Converged
Column Flowsheet colonne toluene	Not Converged

Mixer deleted

# Replace native Mixer

The screenshot displays the Aspen HYSYS 2004 interface. A context menu is open over a mixer unit (R1), with the 'Add Operation...' option selected. The flowsheet includes several units: a compressor (K-100), a mixer (MX-100B), a reactor (R1), a condenser (E2), a reboiler (E3), a distillation column (V-100), and three other distillation columns (colonne toluene, colonne benzene, and stabilizer). Energy streams are labeled with 'energy' and 'in/out'. The status bar at the bottom shows warnings for fluid package transitions and convergence issues for the stabilizer and benzene columns.

Warning : Fluid Pkg Transition -- Not Solved  
Warning : Fluid Pkg Transition -- Not Solved  
Warning : Fluid Pkg Transition -- Not Solved

Column Flowsheet stabilizer Not Converged  
Column Flowsheet colonne benzene Not Converged  
Column Flowsheet colonne toluene Not Converged

# Select CAPE-OPEN 1.0 UNIT Ops

The screenshot displays the Aspen HYSYS 2004 interface. The main window shows a process flow diagram (PFD) with several units: a reactor (R1), a distillation column (C), a vessel (V-100), and three columns (colonne toluene, colonne benzene, stabilizer). Energy streams are labeled with 'energy in/out' and 'E1-E3'. The UnitOps dialog box is open, showing a list of available unit operations. The 'CAPE-OPEN Unit 1.0 Ops' option is highlighted in the list. The status bar at the bottom indicates convergence warnings for the stabilizer, colonne benzene, and colonne toluene units.

**UnitOps - Case (Main)**

Categories:

- All Unit Ops
- Vessels
- Heat Transfer Equipment
- Rotating Equipment
- Piping Equipment
- Solids Handling
- Reactors
- Prebuilt Columns
- Short Cut Columns
- Sub-Flowsheets
- Logicals
- Extensions
- User Ops
- Electrolyte Equipment
- Refinery Ops
- Upstream Ops

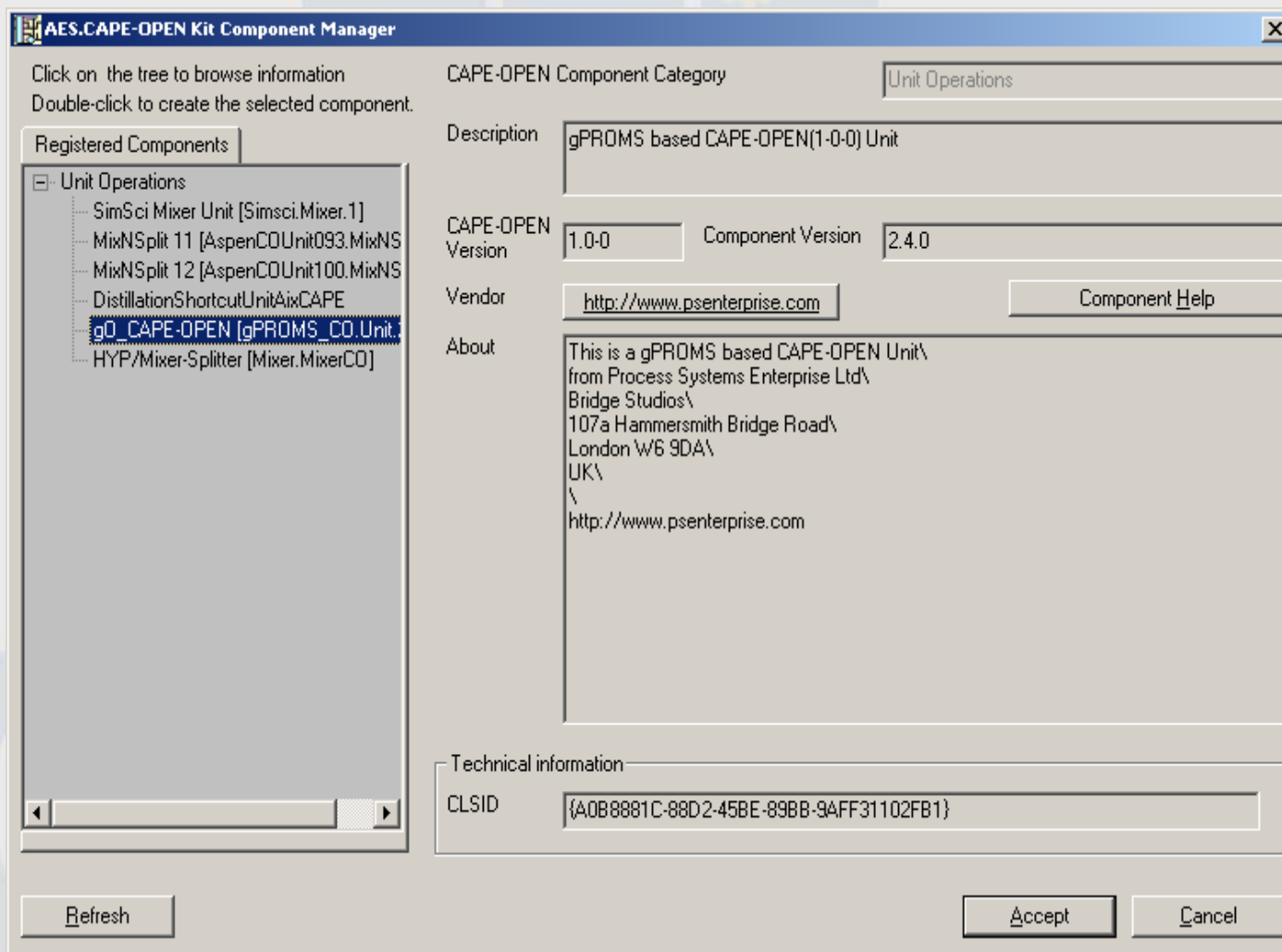
Available Unit Operations:

- 4 Stripper Crude
- Absorber
- Adjust
- Air cooler
- Aspen Hydraulics Sub-Flow
- Baghouse Filter
- Balance
- Black Oil Translator
- Boolean And
- Boolean CountDown
- Boolean CountUp
- Boolean Latch
- Boolean Not
- Boolean OrDly
- Boolean Or
- Boolean Or
- Boolean XOR
- CAPE-OPEN Unit 1.0 Ops**
- Cause And Effect Matrix
- Column Sub-Flowsheet

Warning : Fluid Pkg Transition -- Not Solved  
Warning : Fluid Pkg Transition -- Not Solved  
Warning : Fluid Pkg Transition -- Not Solved

Column Flowsheet stabilizer Not Converged  
Column Flowsheet colonne benzene Not Converged  
Column Flowsheet colonne toluene Not Converged

# Select gO:CAPE-OPEN wrapper



# Select the gCO file to be used

The screenshot displays the Aspen HYSYS 2004 interface. An 'Ouvrir' (Open) dialog box is open, showing a file explorer for 'Presentation UM2005'. The file 'PHJunction.gCO' is selected. The file type is set to 'Cape-Open Unit Files (\*.gCO)'. Below the dialog, the main process flow diagram (PFD) is visible, showing three distillation columns: 'colonne toluene', 'colonne benzene', and 'stabilizer'. The diagram includes various streams, reboilers (R1, R2, R3), condensers (E1, E2, E3), and a tee junction (TEE-100). The status bar at the bottom shows warnings: 'Warning : Fluid Pkg Transition -- Not Solved' and 'Warning : Fluid Pkg Transition -- Not Solved'. The console window displays the following messages:

```
Column Flowsheet stabilizer Not Converged
Column Flowsheet colonne benzene Not Converged
Column Flowsheet colonne toluene Not Converged
```

# Enter generic GUI provided by HYSYS

The image shows a software dialog box titled "CO-100" with a close button in the top right corner. Below the title bar is a search or filter field. The main area is titled "General properties" and contains several input fields and a dropdown menu:

- Unit Type:** gPROMS\_CO.Unit.2.4.0
- Unit Name:** CO-100
- Unit description:** gPROMS based CAPE-OPEN(1-0-0) Unit
- Report to be integrated in the HYSYS Report:** No CAPE-OPEN report provided by the Unit
- Report result from LAST unit execution:** (Empty text area)

At the bottom of the dialog, there are four tabs: "Material Connections", "Unit Variables", "General" (which is selected), and "Thermo". Below the tabs is a yellow status bar with the text "Not Solved" and a "Show Unit GUI" button.

# Connect inlet and outlet ports to streams

The screenshot shows the Aspen HYSYS 2004 interface. The main window is titled 'UnitOps - Case (Main)'. On the left, there is a 'Categories' list with radio buttons for various equipment types. The 'Available Unit Operations' list shows '4 Stripper Crude' selected. The 'CO-100' unit operation configuration window is open, displaying a table of ports and materials. The table has columns for Port ID, Port type, and Material. The 'TopInlet' port is highlighted in yellow, and the 'TopOutlet' port is also highlighted. The 'Material' column for 'TopInlet' is set to 'R1-Liquid' and for 'TopOutlet' is set to 'toluene2'. A 'Purge' stream is shown on the right side of the unit. The status bar at the bottom of the unit window displays 'Not Solved' in yellow. The bottom of the screen shows a Windows taskbar with various icons and the system clock.

Port ID	Port type	Material
MidInlet	Material	benzene
TopInlet	Material	Biphenyl
TopOutlet	Material	H2 CH4
		Purge
		R1-Liquid
		toluene2

Material Connections | Unit Variables | General | Thermo

Not Solved

Show Unit GUI

Warning : Fluid Pkg Transition -- Not Solved  
Warning : Fluid Pkg Transition -- Not Solved  
Warning : Fluid Pkg Transition -- Not Solved

Column Flowsheet stabilizer Not Converged  
Column Flowsheet colonne benzene Not Converged  
Column Flowsheet colonne toluene Not Converged

# Set up the gPROMS model

The screenshot shows the 'CO-100' unit configuration window with the 'Feed, Product Streams and Material Ports' tab selected. A table lists the ports and their associated materials. The 'TopOutlet' row is highlighted in yellow, and a callout bubble points to it.

Port ID	Port type	Direction	Material name
MidInlet	Material	Inlet	Toluene+Hydrogen
TopInlet	Material	Inlet	toluene2
TopOutlet	Material	Outlet	Mix Out'

At the bottom of the window, a yellow bar displays the status 'Not Solved'.

All ports connected

The screenshot shows the 'CO-100' unit configuration window with the 'Unit Specific Data and Public Variables' tab selected. A table lists the variables and their settings. The 'Energy rate' row is highlighted in yellow, and a callout bubble points to it.

Name	Type	Mode	Lower bound	Upper bound	Value	Validat
Energy rate	Real	IN	0	1000	1	
Pressure Drop	Real	IN	0	1000	100	

At the bottom of the window, a yellow bar displays the status 'Not Solved'.

Initial parameter settings



# Set energy input / pressure drop to zero

gPROMS Cape-Open Unit Object

**gPROMS Cape-Open Unit Object**   PSE

Unit Properties | Input Parameters | Report | Ports | Log | About

Parameter	Type	Value	Lower bound	Upper bound	Units
Energy rate	Real	1	0	1000	J/s
Pressure Drop	Real	100	0	1000	Pa

Change Value

Close

Energy rate

Value: 0 J/s

Lower Bound: 0

Upper Bound: 1000

OK Cancel

gPROMS Cape-Open Unit Object

**gPROMS Cape-Open Unit Object**   PSE

Unit Properties | Input Parameters | Report | Ports | Log | About

Parameter	Type	Value	Lower bound	Upper bound	Units
Energy rate	Real	0	0	1000	J/s
Pressure Drop	Real	100	0	1000	Pa

Change Value

Close

Pressure Drop

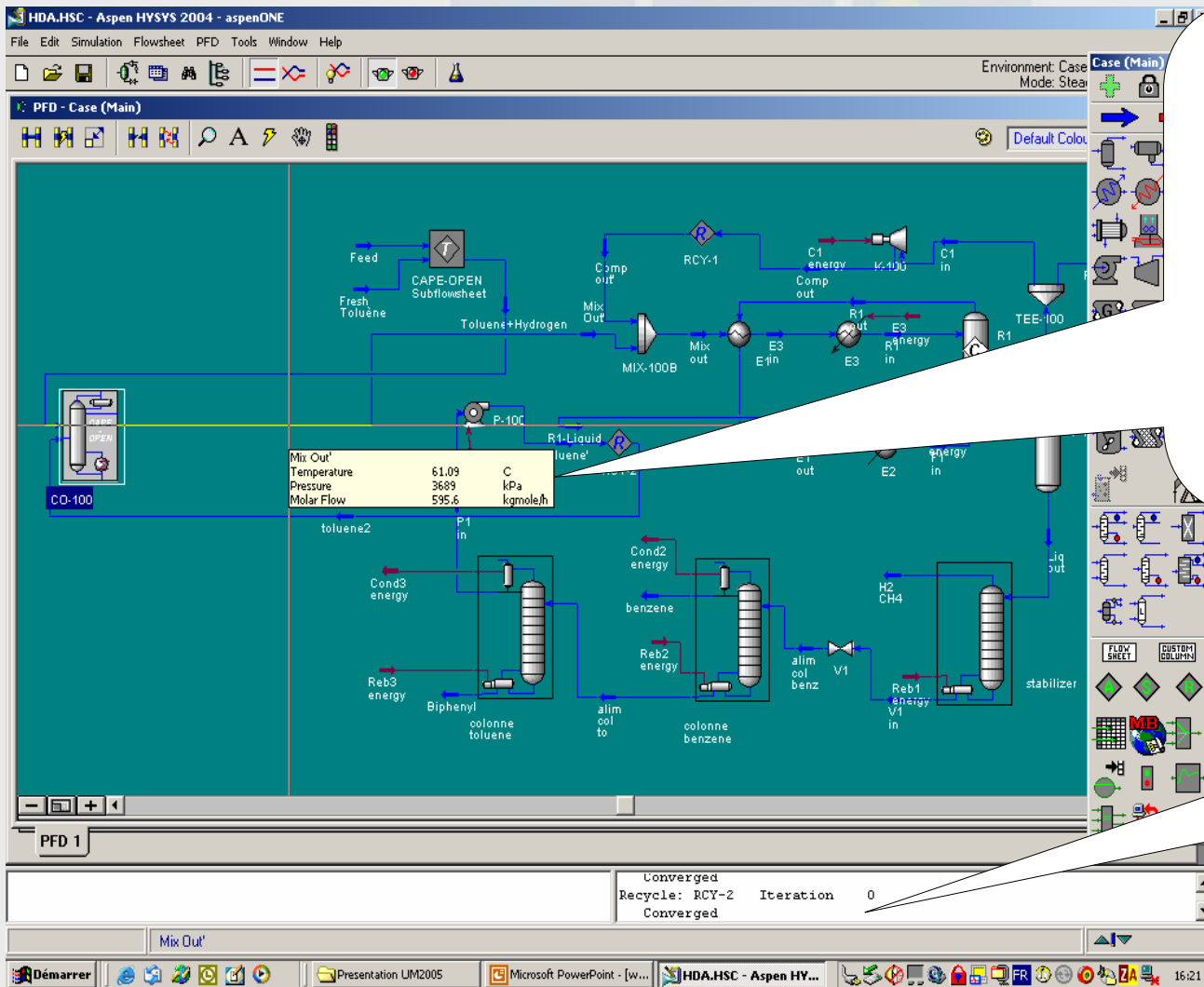
Value: 0 Pa

Lower Bound: 0

Upper Bound: 1000

OK Cancel

# gPROMS Mixer output results



Results obtained are strictly the same as with native Aspen HYSYS 2004 mixer model.

Simulation converged.

# Direct Benefits

**Cheaper, better and faster** design, operation and control of processes

## ⇒ Plug-and-play

- Ability to seamlessly integrate a component from the library of foreign objects (unit operations, thermo models, solvers etc.).
- Ability to seamlessly integrate in-house proprietary components in commercial environments.

## ⇒ Niche software

- Ability to link specific niche modules to the simulators. Small and niche software vendors will provide CO-compliant components.

## ⇒ Return On Investment

- Individual studies will cost less because of the technical advantages of being able to mix-and-match.
- Plug-and-play capacity will stimulate the market and create new opportunities.

# Plug and Play

## ▼ SASOL

⇒ Reactor models made CAPE-OPEN compliant:

- to be independent from process simulators in which they are used.

## ▼ SHELL

⇒ In-house thermo server (SPPTS) made CAPE-OPEN compliant:

- same code accessible in all process simulators Shell is using.

## ▼ US DOE and Alstom Power

⇒ Fluent CFD models embedded in 0D process simulators through CAPE-OPEN interfaces

# Niche software

## ▼ Already available

- ⇒ MultiFlash (Infochem): thermodynamic server
- ⇒ ChemSep: rate-based distillation model

## ▼ To be made available

- ⇒ CosmoTherm (Cosmologic): thermodynamics
- ⇒ TACITE dynamic pipe: unit operation

# Return on Investment

## ▼ HTRI

⇒ Xchanger Suite will need to support only one type of interface in order to be pluggable in all process simulators

## ▼ SIMULIS Thermodynamics

⇒ Marketed on internet as an affordable thermodynamic component

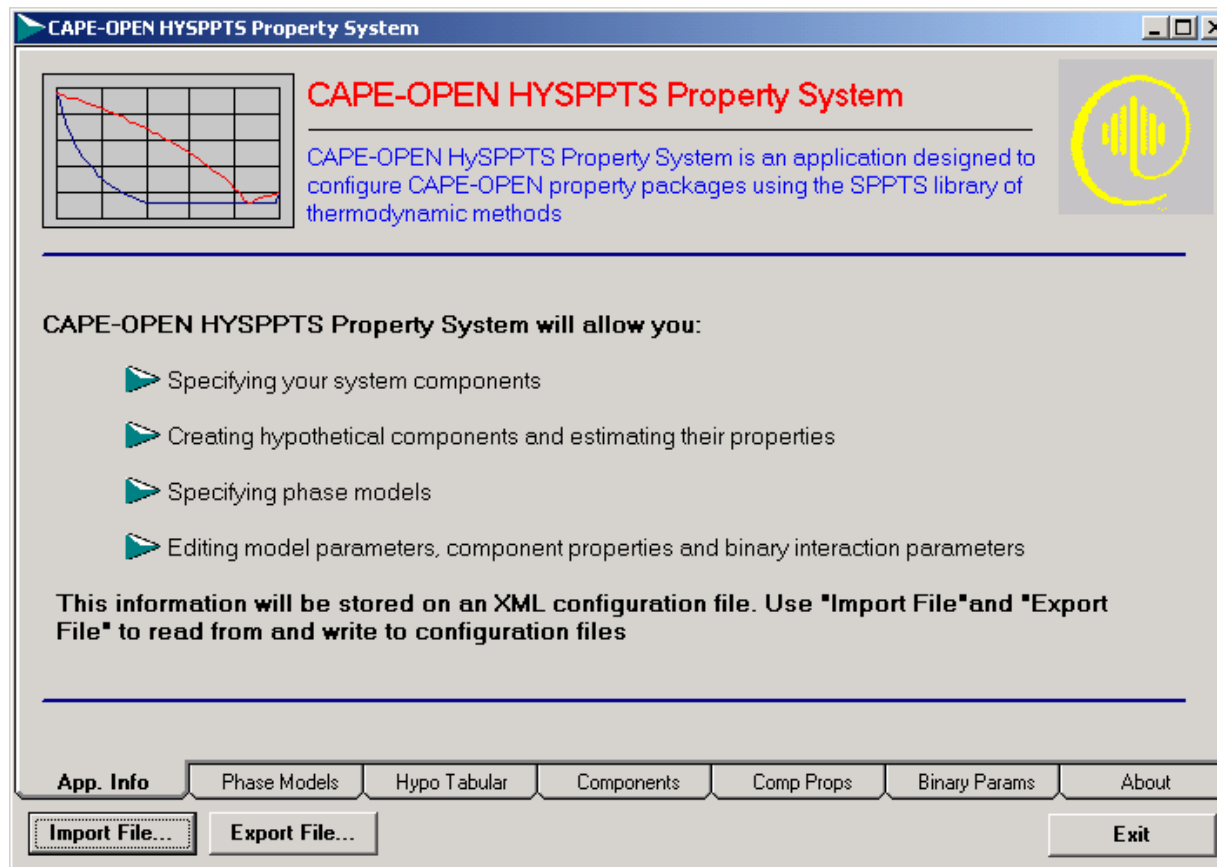
# CoSPPTS

## Cape/Open - Shell Physical Properties and Thermodynamic Software

- Motivation
  - Use of existing Shell methods and data in commercial programs
  - Consistent and fast implementation of results of own research
- Functionality
  - Access to main Shell methods
    - Equations of state: SMIRK and CPA
    - Activity model Shell-NRTL/Henry
    - Shell pure component and binary database
  - COSPPTS front end (GUI)
    - Selection of models and components
    - Data entry for pseudo components and model parameters (overwrite)

# CoSPPTS

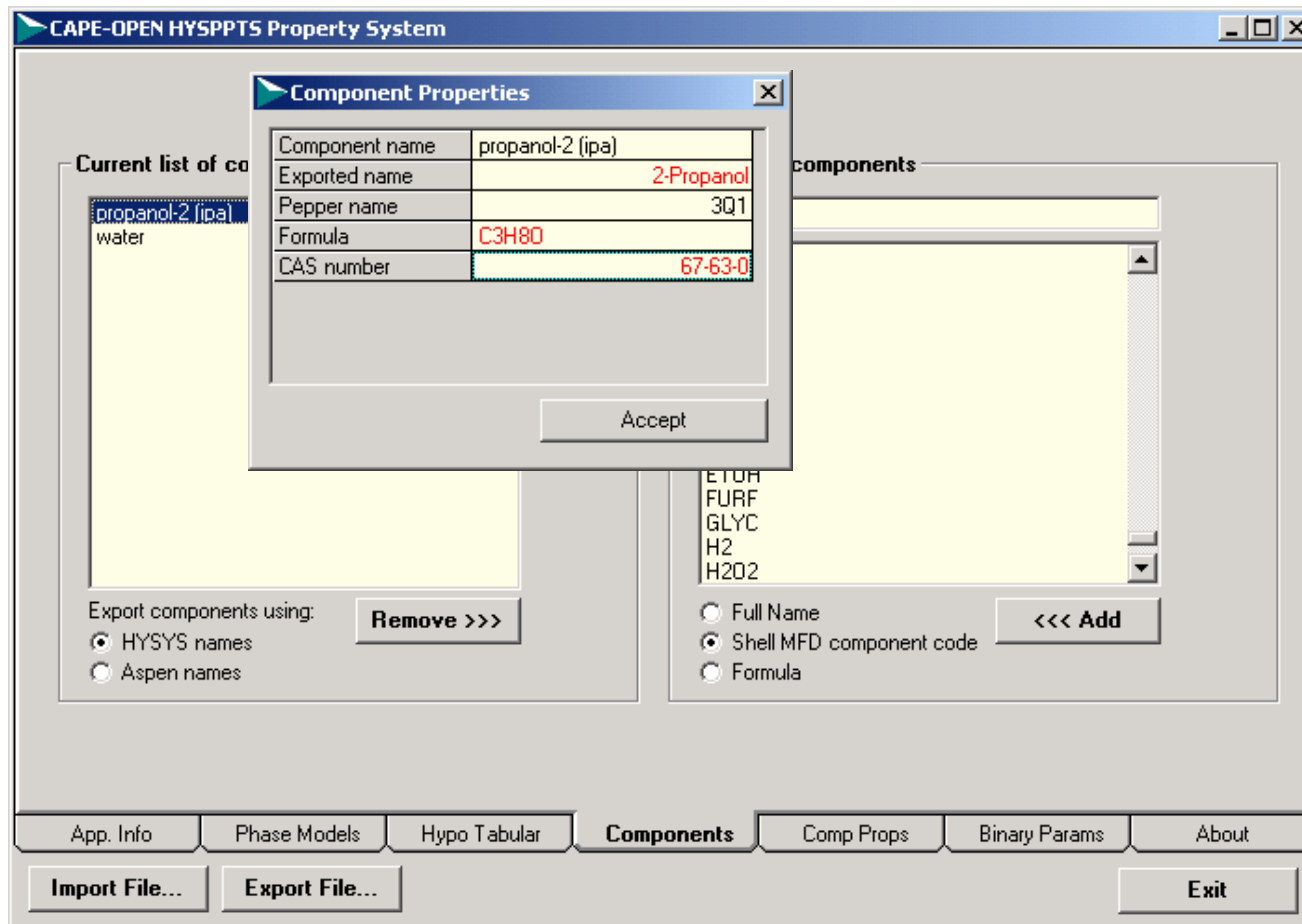
## GUI of the tool – start up window





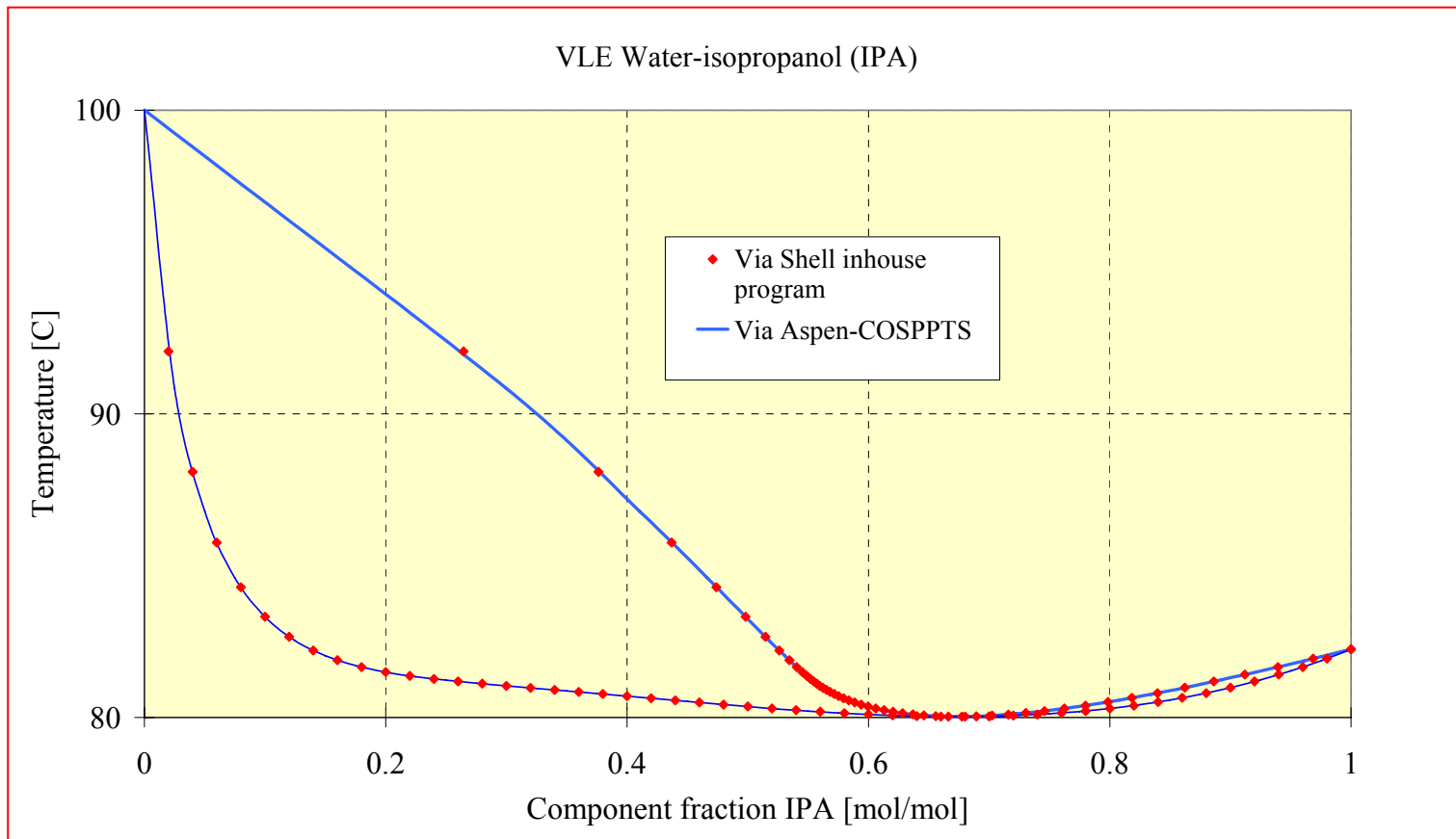
# CoSPPTS

## GUI of the tool – selection of components



# CoSPPTS

## Consistency check: own program versus AspenPlus



# National Energy Technology Laboratory

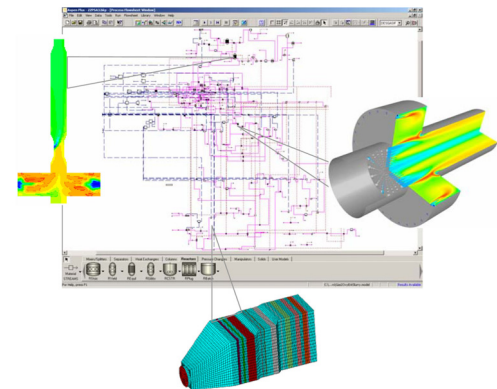
## *Office of Science, Technology & Analysis*

- **Goal**

- Reduce the time, cost, and technical risk of developing advanced power generation systems

- **Objectives**

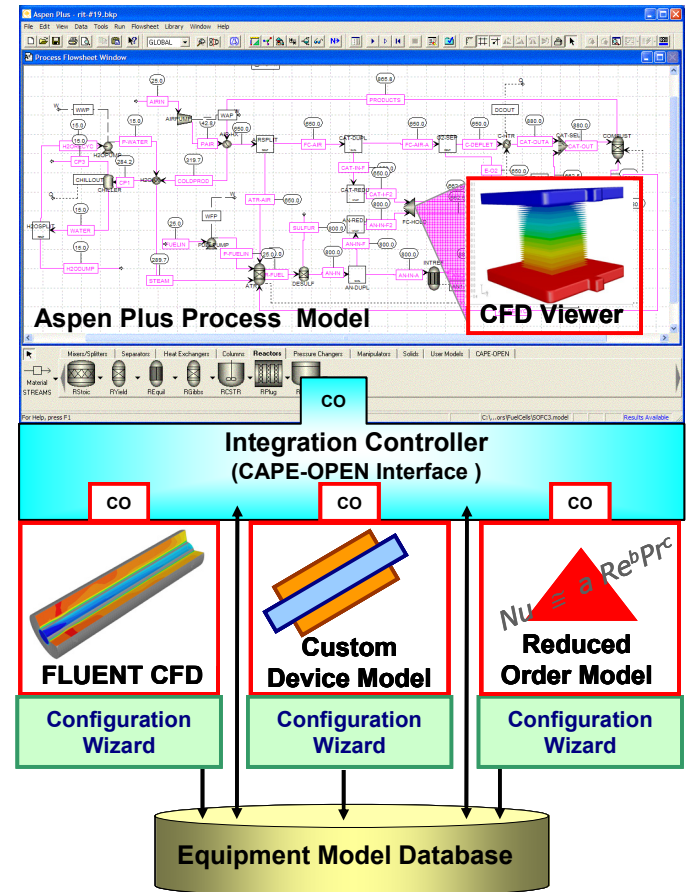
- Apply wide range of modeling and simulation technology
  - Computational chemistry, CFD, process simulation
- Develop integrated, multiscale simulation capabilities
  - Use co-simulation frameworks
  - Exploit open standards
- Couple with advanced visualization and high-performance computing
- Demonstrate virtual power plant simulations





# Advanced Process Engineering Co-Simulator (APECS)

- Combines process simulation with custom engineering models and computational fluid dynamics (CFD)
- Complies with the process industry CAPE-OPEN software standard
- Offers fast reduced order models (ROMs) and parallel computing for improved performance
- Exploits advanced visualization for equipment and process analysis
- First of a kind development by NETL and its R&D technology partners
- Recognized with 2004 R&D 100 Award

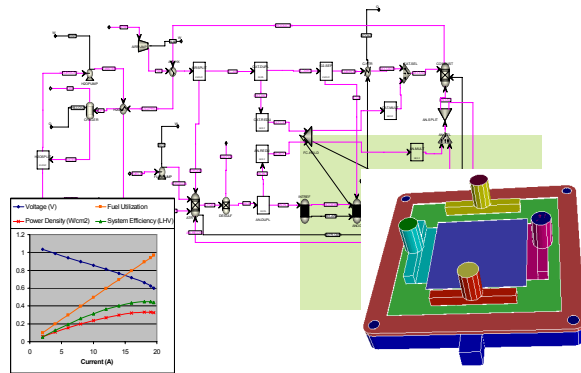


APECS Software Integration Framework

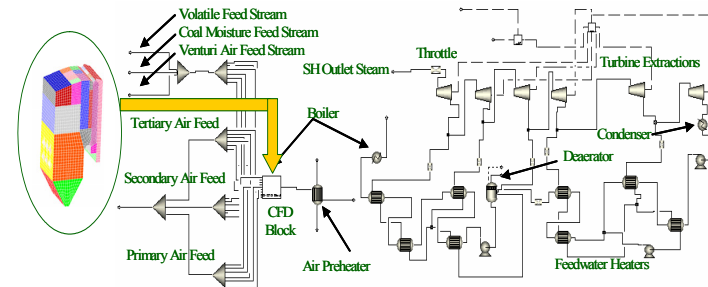


# APECS Power Generation Applications

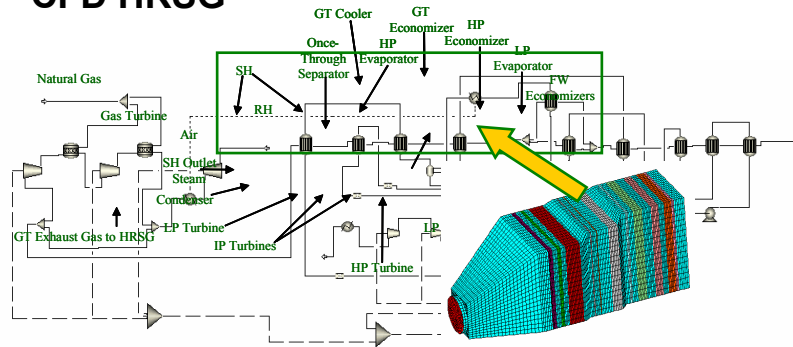
- Fuel Cell Auxiliary Power Unit (APU) with 3D CFD SOFC



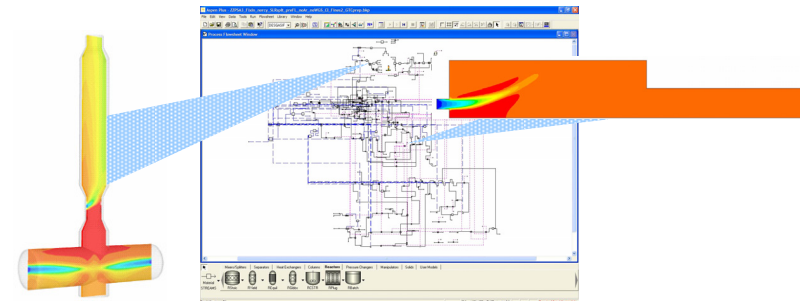
- ALSTOM Conventional Steam Plant (250MWe) with 3D CFD Boiler



- ALSTOM NGCC (250MWe) with 3D CFD HRSG

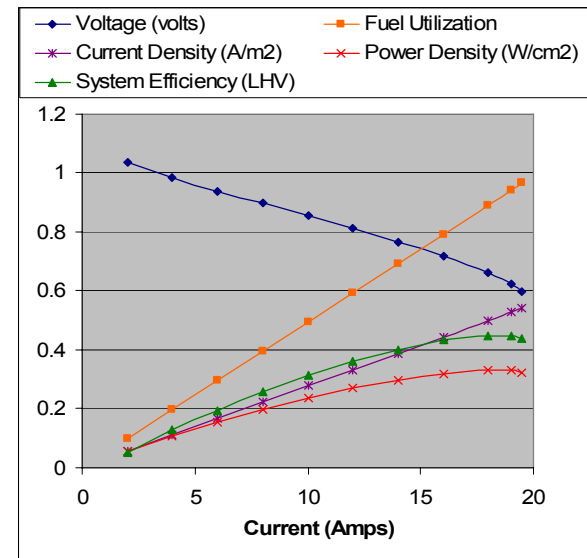
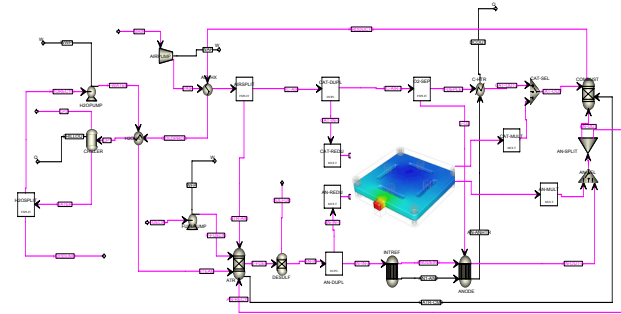


- FutureGen Plant (250MWe) with 3D CFD Gasifier and 2D CFD Turbine Combustor



# APECS Application - SECA Fuel Cell APU System

- Aspen Plus process model of Auxiliary Power Unit (APU)
- FLUENT 3D CFD model of SECA solid oxide fuel cell
- Optimize process efficiency by varying CFD parameter (fuel cell current)
- Maximum system efficiency (LHV) of 45% at 18 amps
- Maximum system power of 4.3 kW
- Convergence in 6-10 Aspen Plus iterations requiring 45-60 minutes of CPU time



Zitney, S.E., Prinkey, M.T., Shahnam, M., and Rogers, W.A. (2004), "Coupled CFD and Process Simulation of a Fuel Cell Auxiliary Power Unit," In *Proc. of the ASME Second International Conference on Fuel Cell Science, Engineering, and Technology*, Eds. R. Shah and S.G. Kandlikar, Rochester NY, June 13-16, 2004, Paper 2490, pp. 339-345.



# APECS Application - FutureGen Power Plant

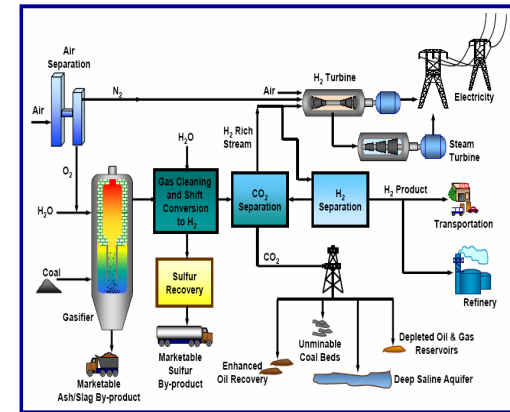


- **FutureGen Power Plant**

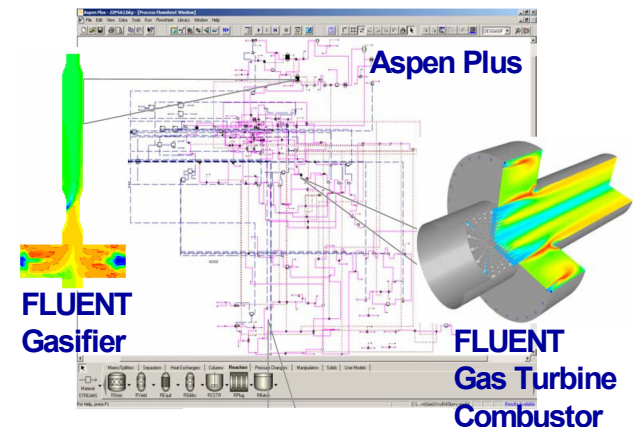
- IGCC with CO<sub>2</sub> capture and H<sub>2</sub> production (275 MWe)
- Large, integrated plant with aggressive design goals
- New, innovative equipment with lack of design data

- **APECS Application**

- Process model
  - Aspen Plus steady-state
  - Over 250 equipment items
- CFD models
  - FLUENT 3D Gasifier
  - FLUENT 2D GT Combustor



FutureGen Process Diagram



FutureGen APECS



# CO-LaN

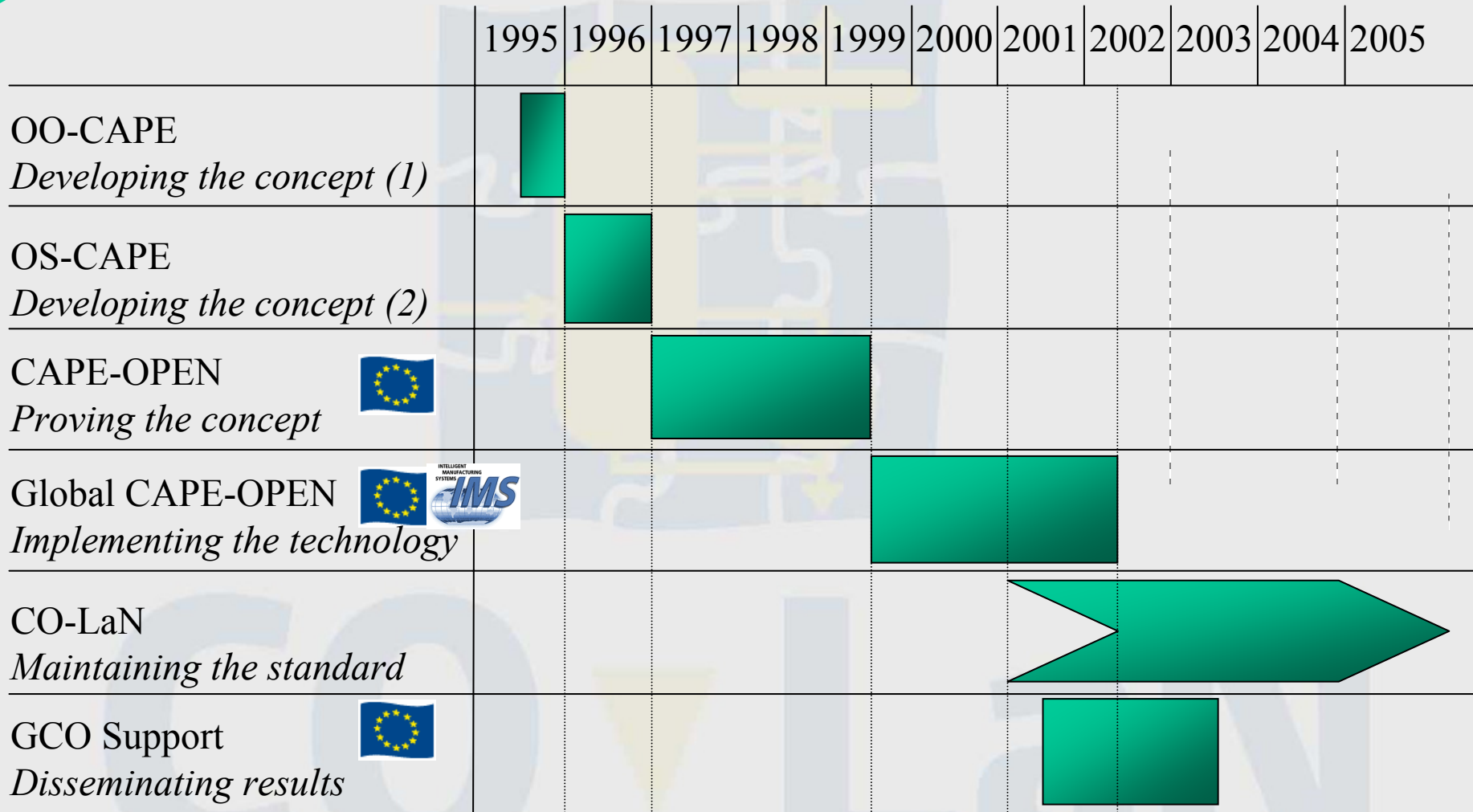
## CAPE-OPEN Laboratories Network

**A group of end users taking responsibility  
for putting resources together to support  
ongoing work on the standard**





# Making a visionary idea a reality



# Need for an organization

- ▼ **A standard can't live by itself**
  
- ▼ **A standard needs to be**
  - ⇒ **Distributed**
    - **Dissemination, free distribution, accompanying software, training programs**
  - ⇒ **Supported**
    - **Information, documentation**
  - ⇒ **Maintained**
    - **Corrections, debugging**
  - ⇒ **Improved**
    - **Upgrade, extensions**

# CO-LaN

- ▼ **Not-for-profit organisation open to all CAPE actors**
  - ⇒ Established on February 8, 2001 ([www.colan.org](http://www.colan.org)).
- ▼ **Full Members: pay fees**
  - ⇒ End user organisations: operating companies, process licensing companies, engineering companies.
- ▼ **Associate Members: pay no fees**
  - ⇒ All others: software suppliers, universities, government, other non for profit institutions.

# CO-LaN missions

## ▼ User priorities for CAPE-OPEN interface standard

- ⇒ Work with software vendors to clarify user priorities for process modelling software component/environment interoperability and also promote communication and co-operation among CAPE software vendors to insure that the CAPE-OPEN standard actually translates into commercially valuable interoperability.

## ▼ Dissemination

- ⇒ Promote the CAPE-OPEN interface standard to end-users and distribute CAPE-OPEN information and technology internationally.

# CO-LaN missions (cont.)

- ▼ **CAPE-OPEN specifications life cycle management**
  - ⇒ Organise the maintenance, evolution, and expansion of the specifications following user priorities.
- ▼ **Testing, interoperability facilitation**
  - ⇒ Supply compliance testers to support development of components, organise interoperability tests between suppliers of Process Modelling Components and Process Modelling Environments, sponsor consultancy services on CAPE-OPEN.
- ▼ **Training/Migration facilitation**
  - ⇒ Ensure that training module guidelines and tools to facilitate component wrapping are developed and available.

# Activities

## ▼ Disseminate

- ⇒ Web site, documents, CO Update Newsletter.
- ⇒ « CAPE-OPEN Tour » days.

## ▼ Develop independent testers and software

- ⇒ CO-LaN Tester suite, wizards, logger.

## ▼ Facilitate Interoperability

- ⇒ Use software made available in any combination.
- ⇒ Sponsor consultancy by CAPE-OPEN experts.

## ▼ Organize targeted Special Interest Groups on standards

- ⇒ Trigger projects.
- ⇒ Open to all members.

# CO-LaN SIGs as of November 2005

## ▼ Thermo: specification upgrade

- Leader: Werner Drewitz, BASF AG
- **Development of revision 1.1 as well as extension to solids**

## ▼ Unit: Unit Operation extension

- Leader: Marcel van Maasdam, Shell Global Solutions
- **Extension to dynamic simulation**

## ▼ Interoperability support

- Leader: Peter Banks, BP
- **Further progress on interoperability**

# CO-LaN progress over the last 2 years

## ▼ Membership

- ⇒ Number of members doubled

## ▼ Adoption of the technology

- ⇒ Commercial, academia, in-house

## ▼ Support actions for CAPE-OPEN implementation

- ⇒ Endorsement by major organizations



# Full Members (as of November 2005)

- ▼ Air Liquide (Philippe Arpentinier)
- ▼ BASF AG (Ronald-Alexander Klein)
- ▼ BP International Ltd. (Peter Banks/Malcolm Woodman)
- ▼ Institut Français du Pétrole (Bertrand Braunschweig)
- ▼ The Dow Chemical Company (Werner Merk)
- ▼ Shell Global Solutions (Ray Dickinson)
- ▼ TOTAL (Jacques Bousquet)



# Associate Members (as of November 2005)

- ▼ Chemstations
- ▼ Belsim SA
- ▼ SHMA Pvt Ltd.
- ▼ SINTEF
- ▼ US EPA
- ▼ US DOE/NETL
- ▼ ProtechSoft
- ▼ Valladolid Univ.
- ▼ Bucarest Univ.
- ▼ Peter Banks
- ▼ Hans-Horst Mayer
- ▼ Richard Baur
- ▼ Jasper van Baten
- ▼ Honeywell
- ▼ Infochem
- ▼ Univ. Polyt. Catal.
- ▼ ProSim SA
- ▼ HTRInc.
- ▼ Fantoft Process
- ▼ SIMSCI-ESSCOR
- ▼ RWTH LPT
- ▼ DIPPR
- ▼ University of Maribor
- ▼ Dechema e.V.
- ▼ AspenTech
- ▼ Carnegie Mellon
- ▼ RWTH I5
- ▼ RSI
- ▼ EPCON
- ▼ CPERI
- ▼ Cosmologic
- ▼ CAPEC-DTU
- ▼ PSE Ltd
- ▼ Virtual Mat. Group
- ▼ TUHH
- ▼ Fluent
- ▼ TUV NEL Ltd
- ▼ INP Toulouse
- ▼ Processium
- ▼ VTT
- ▼ ChemSep.org



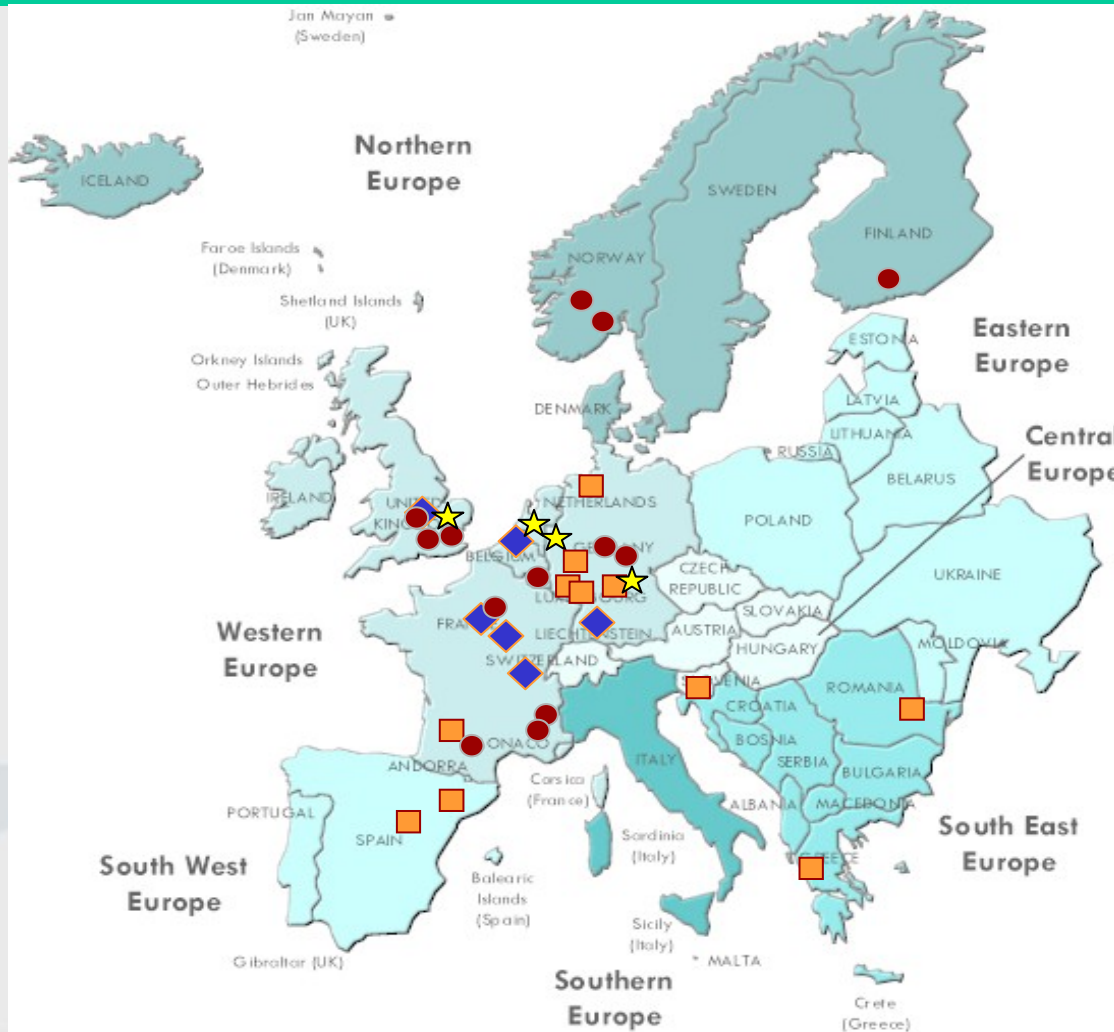
# 48 Members worldwide in November 2005



● 23 Software suppliers    ◆ 7 Operating Companies    ▲ 2 Governmental    ■ 12 Universities    ★ 4 Individuals



# European membership



- 23 Software suppliers
- ◆ 7 Operating Companies
- ▲ 2 Governmental
- 12 Universities
- ★ 4 Individuals



# What does CO-LaN bring?

- ▼ CO-LaN members are at the “learning edge”, acquiring the ability to create business and technology architectures that take full advantage of transparent access to CAPE resources.
  - ⇒ Web site with public and private access
  - ⇒ Repository of specification documents
    - **Supports standards dissemination and development**
  - ⇒ CO Tester Suite for validation and testing
  - ⇒ CO wizards

# Network of Experts

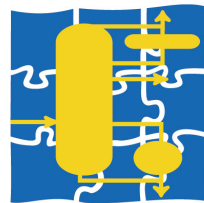
- ▼ The best CAPE-OPEN Experts contribute to CO-LaN SIGs
- ▼ Meet in CO-LaN activities
- ▼ Meet at CAPE Conferences and Software vendors Users meetings
- ▼ Ask any question!

# Conclusion

- ▼ Significant results obtained
- ▼ Commercial implementations available
- ▼ Proven technology
- ▼ Major benefits already from Unit and Thermo
- ▼ Use it!



# CAPE-OPEN



**CO ▼ LaN**

**Michel PONS**

**Chief Technology Officer**

**Akzo Nobel Chemicals, Arnhem, November 17, 2005**

