# DEVELOPMENT OF TECHNOLOGIES AND ANALYTICAL CAPABILITIES FOR VISION 21 ENERGY PLANTS

## COOPERATIVE AGREEMENT NO DE-FC26-00NT40954

QUARTERLY REPORT FOR APRIL-JUNE 2001

FOR

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## 1. Executive Summary

The training of a new project team member was completed (Task 2.1). The Software Requirements Document was written (Task 2.3). It was determined that the CAPE-OPEN interfaces are sufficient for the communication between Fluent and V21 Controller (Task 2.4). The AspenPlus-Fluent prototype on allyl/triacetone alcohol production was further developed to assist the GUI and software design tasks. The prototype was also used to analyze the sensitivity of a process simulation result with respect to a parameter in a CFD model embedded in the process simulation. Thus the integration of process simulation and CFD provides additional process insights and enables the engineer to optimize overall process performance (e.g., product purity and yield) with respect to important CFD design and operation parameters (e.g., CSTR shaft speed). A top-level design of the V21 Controller was developed and discussed. A draft version of the Software Design Document was written (Task 2.5/2.6). A preliminary software development plan was outlined. At first the V21 Controller will be developed and tested in two parts – a part that communicates with Fluent and a part that communicates with Aspen Plus. Then the two parts will be combined and tested with the allyl/triacetone alcohol flow sheet simulation. Much progress was made in writing the code for the two parts (Task 2.7). A requirement for pre-configured models was identified and added to the software requirements document (Task 2.9). Alstom Power's INDVU code was ported to the PC platform and calibrated. Aspen Plus model of the RP&L unit was improved to reflect the latest information received on the unit. Thus the preparation for linking INDVU code with the Aspen Plus model of RP&L unit is complete (Task 2.14). A report describing Demo Case 1 was written and submitted to DOE for review and approval (Task 3.1). The first Advisory Board meeting was held at the Fluent Users Group Meeting on June 6th. At the Advisory Board meeting, the project was reviewed, a demonstration was made, and verbal feedback was received. Meeting minutes have been issued (Task 5.0). Global-CAPE-OPEN organization was contacted for obtaining draft specifications in CORBA that are needed for writing the interfaces between V21 Controller and Fluent. Efforts are underway to establish collaboration with Norsk Hydro, who is leading a Global CAPE-OPEN project on linking CFD and process simulation models. Because of the similarity between that project and the present project, the two project teams can learn much from each other (Task 7.0).

## 2. Technical Accomplishments

### Task 2.0 Software Integration

Task 2.1 Training
DGS took AspenPlus training during May 7-9.
MOO, a Fluent Inc. new hire, was in Lebanon, NH for a four-week (April 22-May 18) training/induction program in order to get up to speed on the V21 Controller development.

Task 2.2 User survey
More comments on the User Requirements Document, obtained from discussions with MXS and DGS, were incorporated and a revised User Requirements Document (stable for the present) was issued.

Task 2.3 Software requirements
A draft Software Requirements Document for comments was issued on May 13. This document describes the features that the software must have to deliver the functionality desired by the users (as described in the User Requirements Document).

Task 2.4 Method for data exchange

IBL and PEF determined that the data exchange between Fluent and V21 Controller could be accomplished using CAPE-OPEN interfaces. At least for now there is no need to define new APIs for this communication.

Task 2.5/2.6 GUI and Software Design

Worked on the top-level design of V21 controller based on the URD and SRD:

a) Specified major tasks and top level modules for the V21 Controller
b) Specified top-level algorithm of actions for the V21 Controller
c) Walked down 1 to 3 levels down from the top-level design and specified modules on that level, their tasks and in some cases algorithms.
d) IBL developed top-level UML diagrams of Vision 21 controller, distributed them for discussion among team members: KJC, MXS, PEF, MOO, and SEZ. Top level diagram was slightly corrected (Interpolator moved to the same level as CFD solver).

MOO and IBL issued a draft version of the V21 Controller Software Design Document (version 0.1). The current version identifies and structures the main components of the V21 Controller sub-system. The current design of the V21 Controller provides interfaces for the implementation of the key functions of the Controller: a GUI for the customization of a Unit Operation simulation, CFD database access and interpolation of pre-computed CFD results, easy integration of other simulation codes, visualization of UO computations as well as an interface for an optimization algorithm.

More *Use Cases* developed by the project team members will be added to the design document. MOO worked with SEZ to propose a format for documenting V21 Controller *Use Cases*.

SEZ reviewed the Global CAPE-OPEN Reaction Kinetics proposal (GCO-WP2-T2.2) from the standpoint of the requirements for the present project. Feedback on the GCO proposal was supplied to Michael Halloran, AspenTech liaison to the GCO Project.

IBL, PEF, and MOO discussed the coding conventions to be used in the project and wrote a draft document on coding conventions.

Fluent-Aspen Plus Integration Prototype

SEZ added capability to switch between the Aspen Plus and Fluent CSTR models. Aspen Plus Duplicator and Selector blocks were added to model alternate simulation trains in the allyl alcohol flowsheet (Figure 1). The Duplicator block copies the reactor feed stream into each alternate train. One train contains the Aspen Plus and the other contains the Fluent CSTR model. The products of the alternate trains are connected to the Selector block. The user can select between the two CSTR models by selecting the product stream from the desired CSTR on the Selector Input Specifications sheet. The user must also activate the desired CSTR block and deactivate the one to be ignored. This switching capability allows one to use the all Aspen Plus simulation results to initialize the subsequent flowsheet simulation containing the Fluent CSTR model.

The following reactions take place in the CSTR:

- allyl Alcohol + acetone $\rightarrow$ n-propyl propionate (NPP) (medium-fast kinetics)
- acetone + n-propyl propionate $\rightarrow$ triacetone alcohol (fast kinetics)
- acetone + methanol $\rightarrow$ 1,2 butanediol (slow kinetics)

The CFD model accounts for the turbulent mixing limitation on the chemical reactions by using the eddy dissipation model in Fluent.

SEZ added two additional distillation columns to the allyl alcohol flowsheet (Figure 1). C2 gives the allyl alcohol as the top product and C3 gives triacetone alcohol as the bottom product. The unwanted byproducts leave in stream C3D, top of column C3. The number of trays in column C1 has been increased so that most of methanol can be removed in stream C1D--the recycle back to the PORXN reactor.

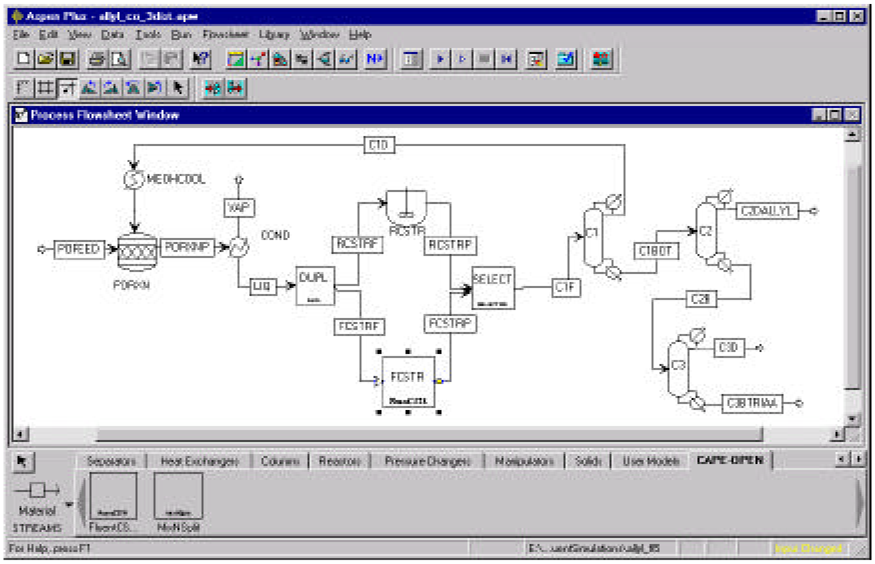


**Figure 1. Allyl Alcohol Flowsheet**

SEZ developed a tabbed GUI form for the Fluent CSTR. The three tabs are General, Solve, and Display.

On the General sheet (Figure 2), one can specify Fluent startup options:

- Case and data filenames
- Fluent release and versionand parameter values:
- Shaft speed (rpm). It is now possible to study the impact of CSTR shaft speed on the overall process performance.

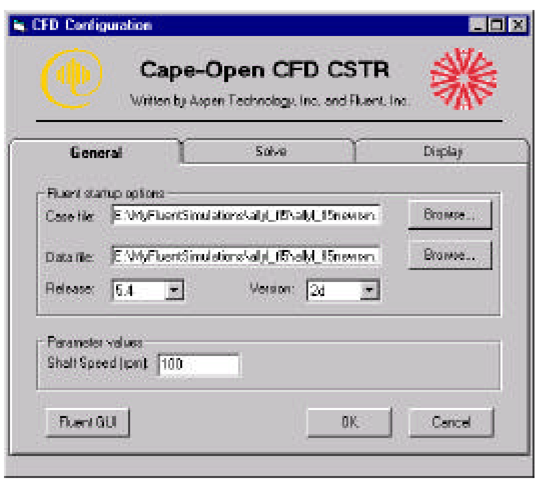


**Figure 2. General sheet on CAPE-OPEN CFD CSTR form**

On the Solve sheet, one can specify the following options:

- Maximum number of Fluent iterations per Aspen Plus iteration
- Reinitialize data file to original data file specified on the General sheet. By default, a temporary data file is saved at each Aspen Plus iteration.
- Save Fluent data file

On the Display sheet, one can use the Display button to view contours for species mass fractions (for example, Figure 3) without having to invoke Fluent's GUI.

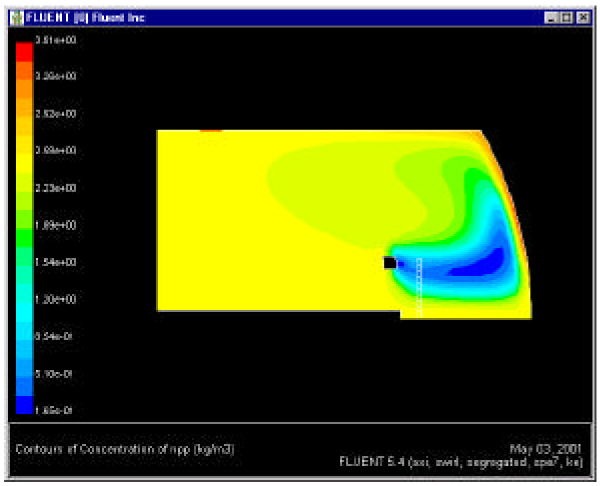


**Figure 3. Contours of species mass fraction in the CSTR**

On all the sheets a Fluent GUI button is provided so that the user can access the Fluent GUI directly.

SEZ enhanced the prototype with the following modifications:

- modified the prototype to save the Fluent data file at each Aspen Plus iteration. Using the most recent Fluent results at each iteration helps to improve the convergence of the overall Aspen Plus flowsheet. The user can reinitialize Fluent to use the original data file using the Reinitialize data file option on the Solve sheet of the CAPE-OPEN Fluent CSTR form.

- added Help, About and Vendor information to the CAPE-OPEN Fluent CSTR model. This information is available by right clicking on a CAPE-OPEN Fluent CSTR model instance on the Aspen Plus process flowsheet diagram.

- added the –gu option to Fluent execution command so that the Fluent GUI does not come up automatically when running Aspen Plus. If the user does want to bring up the Fluent GUI during an Aspen Plus iteration, he/she can click on the Fluent icon in their Taskbar.

- used the Microsoft Visual Basic Package & Deployment Wizard to generate an installation kit for the CAPE-OPEN Fluent CSTR model. The kit, along with installation instructions, was distributed to the software developers.

Using the integrated Fluent-Aspen Plus prototype, SEZ performed a sensitivity analysis to determine how product purity and yield (triacetone alcohol in column C3 bottoms) react to varying the CSTR shaft speed (85-400 rpm).

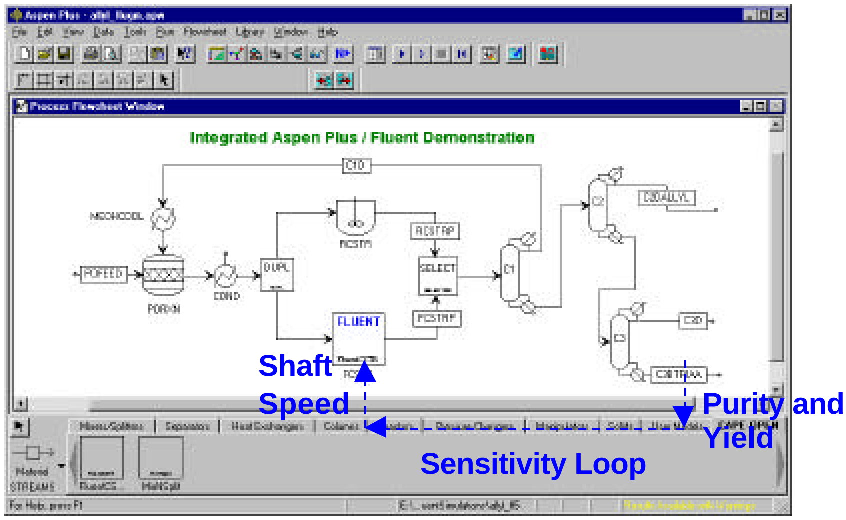


**Figure 4. Sensitivity analysis: product purity and yield as a function of the CSTR shaft speed**

As expected, the results show that the Aspen Plus RCSTR results match those when using the Fluent CSTR with the Finite-Rate reaction model only (i.e., Eddy Dissipation turned off). In this case, the tri-acetone alcohol flowrate is approximately 11,000 lb/hr (solid blue line in Figure 5). The purity of the product stream is very close to 1.0 since the kinetic reaction rate favors the generation of triacetone alcohol (solid blue line in Figure 6).

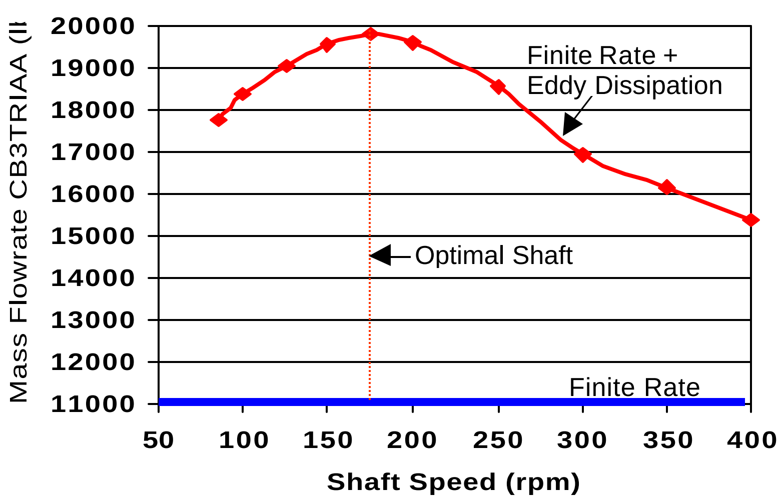


**Figure 5. Sensitivity of product yield to shaft speed**

The red lines in Figures 5 and 6 show the product yield and purity, respectively, at different shaft speeds when using Fluent's combined Finite Rate/Eddy Dissipation reaction model. These results show that turbulent mixing significantly affects the performance of the overall process. At the optimal shaft speed of 175 rpm, the triacetone alcohol mass flowrate of nearly 20,000 lb/hr is almost double the amount produced when considering only reaction kinetics (i.e., Finite-Rate).

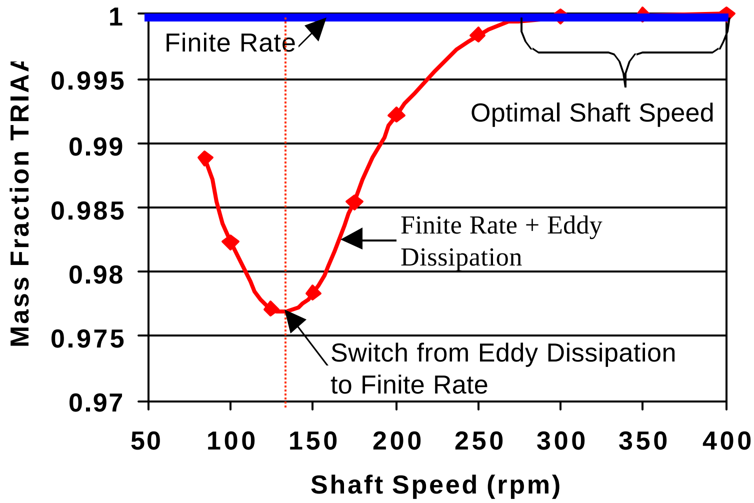


Figure 6. Sensitivity of Product Purity to CSTR Shaft Speed

Figure 6 shows that the highest product purity is obtained at shaft speeds over 275 rpm. The mass fraction of triacetone alcohol decreases as shaft speed decreases and goes through a minimum at a shaft speed near 130 rpm. At this point, the reaction rate for the third reaction, which produces an impurity, switches from kinetics controlled to turbulent mixing controlled.

The sensitivity analysis shows that the optimal shaft speed depends on the product requirements and there is a tradeoff between purity and yield.

In summary, the integration of process simulation and CFD provides additional process insights and enables the engineer to optimize overall process performance (e.g., product purity and yield) with respect to important CFD design and operation parameters (e.g., CSTR shaft speed). The integrated Aspen Plus/Fluent results are closer to the true optimum than those available from using either technology alone.

To generate a more realistic operating scenario, SEZ modified the integrated Fluent-Aspen Plus flowsheet for the production of a single product, triacetone alcohol. In the updated process as shown in Figure 7, propylene oxide is converted to allyl alcohol via a liquid phase isomerization using methanol as a solvent. This reaction is carried out in a stoichiometric reactor (PORXN) based on fractional conversion. By adding acetone, the CSTR converts the allyl alcohol to tri-acetone alcohol and an undesirable by-product, n-propyl-propionate. Using the distillation column C1, the mixture is stripped of methanol that is cooled and recycled back to the isomerization reactor. A second distillation column is used to remove the tri-acetone as a bottom's product.

To do the above, SEZ extended the CAPE-OPEN compliant FLUENT CSTR model to handle two input streams—1) the allyl alcohol and methanol solvent from the isomerization reactor and 2) an acetone feed stream (ACETFF). As with the previous allyl alcohol flowsheet, SEZ is performing a sensitivity analysis to determine how product purity and yield (tri-acetone alcohol in column C2 bottoms) react to varying the CSTR shaft speed.

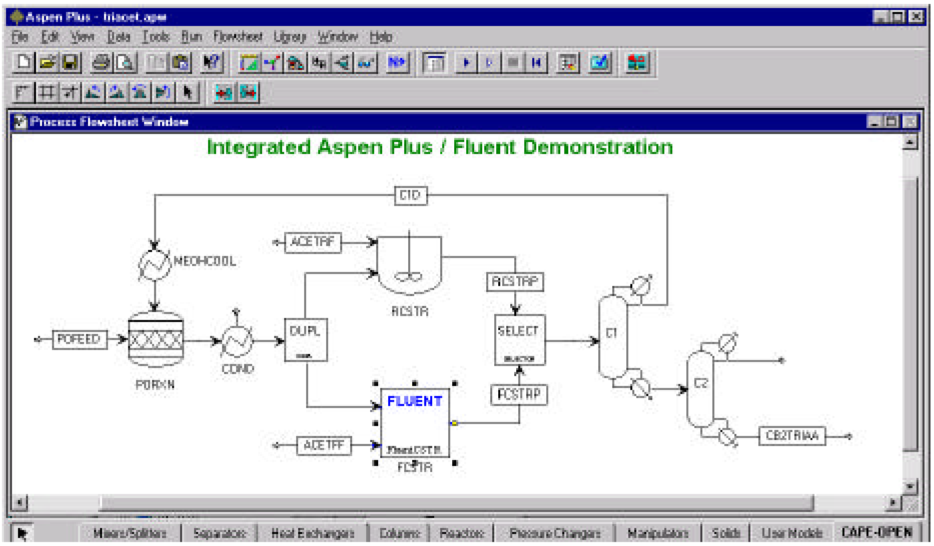


**Figure 7. New triacetone alcohol flowsheet**

Task 2.7 Step One

PEF outlined a preliminary development plan: In an intermediate Step A, IBL will implement part of the V21 Controller that interfaces with Aspen Plus (in COM). Fluent's journal/transcript file facility will be used to test this part of the V21 Controller. The first test will be that of the Fluent-Aspen Plus prototype developed by SEZ. In an intermediate Step B, MOO will implement the part of the V21 Controller that interfaces with Fluent (in CORBA). The intermediate Step B will be tested with a test harness developed to mimic Aspen Plus. Steps A and B will proceed in parallel. After successfully testing the two steps, the codes will be merged and tested.

InstallShield 6.0 (bundled with VC++ 6.0) was tested for further use in project. It was confirmed that it could perform required tasks with very minor efforts from a developer. Wrote test software to check CAPE-OPEN link to Aspen Plus by COM interfaces and performed automatic CAPE-OPEN unit registration for Aspen Plus through InstallShield software. Basic functionality could be achieved.

MOO compiled the Cape-Open CORBA IDL interfaces and implemented the corresponding wrapper classes required for the software integration task. PEF is also implementing wrapper classes, as well as providing Scheme (programming language) based Fluent "hooks" to the wrapper classes.

Task 2.9 Parametrizing CFD runs

The issue of making simple geometric changes in an existing CFD model was discussed in development team meetings. This will be handled by using pre-configured models, from which a user may select a desired configuration. One kind of pre-configured model will consist of a set of case files with different geometric configurations (e.g., a set of CSTRs with different feed locations). Another kind consists of case files with different levels of grid resolution for the same geometry. Then based on a user-specified geometric parameter (e.g., vessel diameter), a case file with an appropriate grid resolution is chosen. Another idea is to launch a program such as MIXSIM (a software that simplifies the creation of mixing tank geometry). The need for pre-configured models has been entered as a requirement in the SRD. The actual implementation and testing of the different ideas will happen only toward the end of the software development phase.

Task 2.14 Step Five

(1) Chung Hsu (Alstom Power) ported the INDVU code to the PC platform and hard-wired the INDVU code to accommodate the RP&L split backpass configuration.

(2) Lorraine Miemiec (Alstom Power) reviewed the relevant RP&L board data and blueprints, constructed the INDVU stand-alone case, and calibrated the surface effectiveness factors and damper positions over a range of loads.
(3) Paul Hansen (Alstom Power) upgraded the Aspen Plus case of the RP&L unit to reflect the latest information received on the unit.
(4) Randy Field and others at AspenTech reviewed the stand-alone RP&L Aspen Plus case with library modules and found it to be reasonably simulated. In addition, AspenTech offered preliminary suggestions as to how to implement the INDVU code in the context of AspenPlus design specifications.

**Task 3.0 Select Demonstration Cases**

Task 3.1 Demo Case 1
The milestone/deliverable on the selection and discussion of the ALSTOM Power Case 1 was submitted to the DOE.

**Task 5.0 Advisory Board Activities**
The first Advisory Board meeting was held at the Fluent Users Group Meeting on June 6th. At the Advisory Board meeting, the project was reviewed, a demonstration was made, and verbal feedback was received. Meeting minutes have been issued. Written feedback on the Advisory Board meeting has been received from Dupont. The team is awaiting additional feedback from other panel members before issuing the Advisory Panel report. Participants from P&G and Dow Chemical have been recruited to be panel members. At least 2 more individuals will be solicited to serve on the Advisory Board, in order to ensure that a sufficient number are in attendance at each Board meeting.

**Task 7.0 Project management**

- There was a delay in obtaining the Year-1, second round of funding from DOE. Because of the delay, the execution of Intergraph subcontract was postponed. The postponement does not affect any of the project milestones, however. This was discussed with the DOE Project Manager Diane Madden.
- The GCO was contacted for obtaining draft specifications in CORBA, which are needed for establishing communications between the V21 Controller and Fluent. Usually only the members of GCO consortium have access to the draft specifications. Fluent's request was discussed in a GCO committee meeting and the "acceptance procedure" for the early release of the documents to Fluent was initiated. It was determined that one of the projects under GCO, lead by Norsk Hydro, is similar to the current project, and a collaboration between Fluent and Norsk Hydro was encouraged by GCO. A teleconference between Fluent and Norsk Hydro was conducted on June 25th. Both the parties agreed to take the following steps: Norsk Hydro will receive access to the Vision 21 project documentation (URD, SRD, SDD) and the project web site. Fluent will receive early access to the GCO draft specifications on CORBA IDL and reaction kinetics, documentation on the COM-CORBA bridge, and the implementation notes on a CORBA skeleton. There will be a follow up teleconference on August 21st to further discuss the collaboration and the technical documents.
- WVU finalized a sub-contract to maintain Mr Lapshin on this project for one year beginning May 1, 2001.
- The project web site was completed on June 27th and access was given to the project participants. The access will be extended to others after a review of the web site by DOE.

Presentations

- MXS and SEZ made a presentation entitled "Software Integration for the Simulation of Power Plants of the Future" at the Fluent UGM in Manchester, NH on June 6.
- MXS participated in a panel discussion on Vision 21 organized by Dr. Larry Ruth at the International Joint Power Generation Conference in New Orleans, LA on June 7.

**3. Issues and Resolution:**

3.1 The CAPE-OPEN interfaces generated by the initial European CO Project do not cover reaction kinetics. As a result, we are currently specifying reaction kinetics information directly in Fluent. The proposal for the Global Cape Open Reaction System is described in GCO-WP2-T2.2. A subset of the functionality is required for integration of Fluent reactor models in Aspen Plus. We will need to get the following Aspen Plus reaction information into Fluent via CAPE-OPEN interfaces:

- Number of reactions
- Number of reaction components and their IDs
- Stoichiometric coefficients and rate exponent
- Reaction phase
- Reaction parameters for the Arrhenius kinetic rate expression including the pre-exponential factor, temperature exponent, activation energy, reference temperature, concentration basis (i.e., molar, molal, mole fraction), Reversible/Irreversible parameter and third body efficiencies (if available)

It appears that the first four items listed above have been specified in the GCO ICapeReactionsPackage. There is a GetReactionParameter method to cover the fifth item, but it is unclear what parameters will be supported.

AspenTech is scheduled to do some prototyping work in the area of GCO Reaction Kinetics towards the end of this calendar year. Most likely, this would become part of Aspen Plus 12.

As a temporary workaround, SEZ plans to provide access to Aspen Plus reaction kinetics information via a SimulationContext method in the ICapeUnit interface (in the same way as IassayUpdate provides access to Aspen Plus petroleum assay data.) It is important to stress here that this interface would be specific to Aspen Plus. A COM model which would rely on this reaction kinetics interface would only run in Aspen Plus.

When the CAPE-OPEN reaction kinetics interfaces are standardized, the Fluent CSTR would be modified to support the new interface instead of the Aspen Plus-specific one implemented via SimulationContext.

3.2 CAPE-OPEN parameters cannot be used as design specifications in Aspen Plus. They also cannot be accessed in Aspen Plus model analysis tools (e.g., sensitivity analysis, optimization). This is a known deficiency with the CAPE-OPEN implementation in Aspen Plus. Therefore, we cannot use shaft speed as a design spec or as a manipulated variable in a sensitivity analysis in Aspen Plus 10.2. AspenTech recently removed this development item from the Aspen Plus 11.1 release. It is now targeted for release in an Aspen Plus 11.1 Service Pack.

3.3 ICapeIdentification and ICapeUnitParameter are empty interfaces in the current publicly available Cape-Open CORBA IDL (version 0.9.2) specification. MOO has provided interim definitions for these interfaces based on the Cape-Open documentation on Unit Operations. The issue of undefined interfaces as well a proposal for a Thermo-Chemical Reactions interface is being pursued by MXS with the GCO draft standards committee as reported under the Project Management section.

**4. Progress forecast for the next quarter**

- Task 2.5/2.6 GUI and Software Design
  - Write software design document
  - Conduct a design review meeting

- Task 2.7 Step One
  - Write software development plan
  - Develop test harness for the Cape-open wrapper classes
  - Code and test Controller-Aspen and Controller-Fluent interfaces.
  - Develop Vision21 controller version 0.1
  - Run test case1

- Task 2.10 Step Two
  - Start working on a second demonstration of the Aspen Plus – Fluent interface that includes a fuel cell.

- Task 2.14 Step Five
  - Initiate linkage of INDVU program with ported AspenPlus via USER2 block. Replace mill module and air preheater blocks with AspenPlus modules. Set up solution strategy with design specs.

- Task 3.2 Selection of Demo Case 2
  - Pursue identification of advanced cycle case.

- Task 5.0 Advisory Board Activities
  - Find at least 2 additional individuals to serve on the Advisory Board.

- Task 7.0:
  - Complete subcontract to Intergraph
  - Pursue collaboration with Norsk Hydro

**5. Project Milestones**

| Task Number | Milestone/Deliverables | Completion Date | | |
|---|---|---|---|---|
| | | Original | Revised | Actual |
| 1.0 | Project Management Plan | 1-30-01 | | 1-23-01 |
| 2.2 | User Requirements Document (URD) | 3-15-01 | | 3-28-01 |
| 2.3 | Software Requirements Specifications (SRS) | 4-15-01 | | 5-13-01 |
| 2.6 | Software Design Documentation | 5-15-01 | 7-15-01 | |
| 2.7 | Software Development Plan | 6-30-01 | 8-15-01 | |
| 2.7 | Working Test Case 1 | 6-30-01 | 7-15-01 | |
| 2.10 | Working Test Case 2 | 9-30-01 | | |
| 2.12 | Working Test Case 3 | 1-15-02 | | |
| 2.13 | Working Test Case 4 | 3-30-02 | | |
| 2.14 | Working Test Case 5 | 1-1-02 | | |
| 2.15 | Working Test Case 6 | 6-15-02 | | |
| 2.17 | Working Test Case 7 | 9-15-02 | | |
| 2.17 | Beta version of Controller | 9-15-02 | | |
| 2.18 | User documentation for Controller | 12-30-02 | | |
| 2.20 | Integrated Software suite and demonstration | 6-30-03 | | |
| 3.1 | Demonstration Case 1 selection | 1-31-01 | 5-15-01 | 4-30-01 |
| 3.2 | Demonstration Case 2 selection | 8-30-01 | | |
| 4.1 | Demonstration Case 1 simulation completed | 6-30-02 | | |
| 4.2 | Demonstration Case 2 simulation completed | 6-30-03 | | |
| 4.3 | Report on Demonstration Case simulations | 7-30-03 | | |
| 5.1 | Advisory Board Meeting | 3-31-01 | | 6-6-01 |
| 5.2 | Advisory Board Meeting | 9-30-01 | | |
| 5.3 | Advisory Board Meeting | 3-31-02 | | |
| 5.4 | Advisory Board Meeting | 9-30-02 | | |
| 5.5 | Advisory Board Meeting | 3-31-03 | | |
| 5.6 | Advisory Board Meeting | 7-30-03 | | |
| 7.0 | Quarterly reports to DOE | Every quarter | | 1/30/01, 4/20/01, 7/20/01 |
| 7.0 | Final project report | 12-31-03 | | |

**6. Personnel initials, List of Abbreviations and Glossary**

| Personnel Name | Affiliation | Initials |
|---|---|---|
| Woodrow Fiveland | ALSTOM Power | WAF |
| John L. Marion | ALSTOM Power | JLM |
| David G. Sloan | ALSTOM Power | DGS |
| Herb Britt | AspenTech | HB |
| Randy Field | AspenTech | RF |
| Steve Zitney | AspenTech | SEZ |
| Joe Cleetus | CERC | KJC |
| Igor Lapshin | CERC | IBL |
| Lewis Collins | Fluent | RLC |
| Paul Felix | Fluent | PEF |
| Ahmad Haidari | Fluent | AH |
| Barbara Hutchings | Fluent | BJH |
| Maxwell Osawe | Fluent | MOO |
| Lanre Oshinowo | Fluent | OSH |
| Madhava Syamlal | Fluent | MXS |
| Bob Fisher | Intergraph | RJF |

| Name | Description |
|---|---|
| ActiveX | A Microsoft technology built on top of COM that extends the basic capabilities of OLE to allow components to be embedded in Web sites. |
| API | Application Programming Interface. |
| C++ | C++ programming language. |
| CERC | Concurrent Engineering Research Center, WVU |
| CFD | Computational Fluid Dynamics |
| CAPE-OPEN | Computer Aided Process Engineering – Open Simulation Environment Interface definitions for exchanging information with process simulation software. (www.quantisci.co.uk/Cape-Open). |
| CASE | Computer Aided Software Engineering. |
| COM | Component Object Model – Refers to both a specification and implementation developed by Microsoft Corporation that provides a framework for integrating software components. |
| CORBA | The Common Object Request Broker Architecture is a specification of a standard architecture for object request brokers (ORBs). A standard architecture allows vendors to develop ORB products that support application portability and interoperability across different programming languages, hardware platforms, operating systems, and ORB implementations. (www.omg.org) |
| CSTR | Continuous Stirred Tank Reactor |
| DCOM | Distributed Component Object Model – An extension of COM that allows software components to be distributed over a network. |
| GCO | Global CAPE-OPEN, an extension of the CAPE-OPEN project. (www.global-cape-open.org) |
| GUI | Graphical User Interface |

| | |
|---|---|
| IDL | Interface definition language, which is used for defining the communications between software components linked through a middleware. |
| INDVU | ALSTOM Power in-house code for the analysis and design of the gas side of a powerplant. |
| Java | Java programming language. |
| Middleware | Connectivity software that consists of a set of enabling services that allow multiple processes running on one or more machines to interact across a network. |
| OLE | Object Linking and Embedding. Builds on COM to provide services such as object "linking" and "embedding" that are used in the creation of compound documents (documents generated from multiple tool sources). |
| PFD | Process Flow Diagram |
| Python | Python programming language |
| RP&L | Richmond Power and Light power plant. |
| SDD | Software Design Document |
| SRD | Software Requirements Document |
| Swing | A Java GUI tool kit. |
| UML | Unified Modeling Language |
| URD | User Requirements Document |
| Use Case | The specification of a sequence of actions, including variants, that a system can perform, interacting with actors (users) of the system. |
| Visual Basic | Visual Basic programming language |
| V21 Controller | The software being developed in this project for linking CFD and other proprietary equipment-level models with process simulation models. |
| WVU | West Virginia University |
| XML | Extensible Markup Language: A metalanguage -- a language for describing other languages -- which lets one create their own markup language for exchanging information in their domain (music, chemistry, electronics, hill-walking, finance, surfing, CFD, process simulation). |