



Universities & Colleges use CADSIM Plus for a Variety of Research Projects & Learning Opportunities

Over the years, Aurel Systems has donated hundreds of seats of its premier process simulation software to universities and colleges all over the world.

Here are a few examples of how CADSIM Plus is being used by professors and students to further their research and learning:

Université du Québec à Trois-Rivières (UQTR) Process Optimization

Luc Laperrière and his students have been using CADSIM Plus in their research activities in UQTR's Pulp and Paper Research Centre for several years. One recent R&D project was to develop an optimization module for CADSIM Plus:

Laperrière selected CADSIM Plus for his lab research, partially because CP already has support for key quality characteristics in the form of non-flow components that can be used as input parameters for process optimizers. CP's Open Simulation Systems Architecture also allows the development of external modules such as optimization, which integrate into CP at runtime.

Laperrière's approach was to create a multi-variable, non-linear, constrained optimizer. The module finds the combination of values of independent variables that will yield a minimum value of the dependent variable. The relationship between the dependent and independent variables can be non-linear. It is constrained by specifying minimum and maximum values on each independent variable.

After careful evaluation of existing optimization algorithms, Laperrière se-

strained functions of multiple variables using a relatively small computation burden.

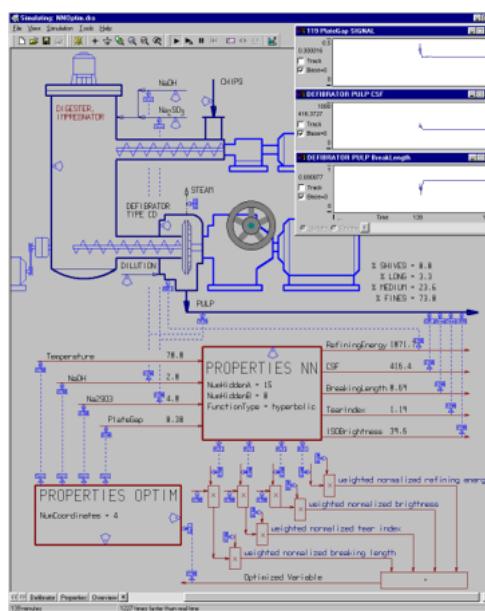
The optimizer module converges towards a function minimum using simplex moves, while the process simulation computes the functional relationships among simulated variables.

The optimizer can also use an optional modified simulated annealing simplex method. This version of the simplex method allows the optimizer to widen the search space to the region where an overall minimal point might lie, thus avoiding the local minimum 'traps.'

The developed optimization module provides valuable insights into the effects of combinations of independent variables. When combined with a projection to latent structures, or neural network module, true optimization of quality parameters can be performed. This work is ongoing.

Two of Laperrière's Ph.D. students at UQTR, Yang Li and Marie-Pierre Pinard, are currently addressing predictive modeling techniques in order to support model

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lected the downhill simplex optimization algorithm because it can perform optimization on non-linear and

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This Issue:

- Find out how universities and other learning institutions are using CADSIM Plus in their research activities

Next Issue:

- Multi-component phase equilibrium calculations with CADSIM Plus

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predictive control tools in CP. The construction of the new pilot paper mill on UQTR's campus also promises to bring interesting CP simulation projects. Luc Laperrière can be reached via e-mail at luc_laperriere@uqtr.ca.

University of Calgary (U of C) Petrochemical Library for CADSIM Plus

The University of Calgary (U of C) has hosted a number of student projects that involve CADSIM Plus:

Student Mahyar Mohajer continues the work of U of C post doctoral fellow, Kamal Morad, who began porting the Sim42 Foundation's open source petrochemical steady state simulator process modules to the CADSIM Plus Open Simulation Systems Architecture (OSSA) platform.

Similar to the Sim42 project, the original design philosophy behind the CP OSSA is to encourage the development of a community of simulation developers.

Following completion of this project, Mohajer will pursue a Masters thesis on an optimized dynamic simulation approach to phased multi-component systems using CP. He will specifically look at simultaneous methods of solving pressure flow networks in CP.

Data Reconciliation

U of C post doctoral fellow, Rodolfo Tellez, is developing a robust method of reconciling measurement inaccuracies from real processes (including process dynamics) and integrating those values into a CADSIM Plus simulation. This would allow the simulated process to continuously and accurately track the most likely state of the real process, even in the presence of inaccuracies or gaps in the measured data.

Data reconciliation of this type is required when online simulation applications are run in parallel with the actual process, using data supplied by the system's Distributed Control System (DCS). The accuracy of live data must be verified in order to assure accurate simulated results. Sensor failures and other factors can have a negative effect on data quality.

One approach to this research would identify process dynamics and relationships between variables and use multi-variable optimization methods to reconcile the calculations with measurements. A likely solution would involve the identification of measured variables, the measured value, and a weighting value for 'degree of trust' that will be passed on to the reconciliation utilities.

Morad, Mohajer and Tellez are part of the Process Systems Engineering

group in Chemical and Petroleum Engineering at the University of Calgary. Further information on the group and these projects can be obtained by contacting Brent Young via e-mail at byoung@ucalgary.ca.

University of Toronto (U of T) Lime Kiln Simulation

Students at the University of Toronto are beginning a project to use CADSIM Plus to develop a dynamic process simulation model of a lime kiln to study control problems. Their research may lead to the development of a lime kiln module for CP.

The development of representative lime kiln simulation models has been a focus of attention since the early 1980's. Most of the existing models predict steady state conditions. However, the development of a control strategy requires an understanding of the transient response of the lime kiln. Therefore, a dynamic model of a kiln, such as those made possible by CP, is required.

A parametric study on such a dynamic model is the first step towards devising an effective control strategy, as it would help in understanding the kiln's response to operational variation. Based on the model response patterns, different control strategies could be

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Ingenious + Aurel = Alliance Partnership

Ingenious and Aurel Systems have announced that they have formed an Alliance Partnership to cooperate in the development of Operator Training Solutions for the chemical, petrochemical and pulp and paper industries. Both Aurel and Ingenious have a common interest in providing a dynamic chemical process simulator that has excellent qualities for Operator Training Simulation.

Ingenious' ProDyn training interface will be integrated with Aurel's CADSIM Plus core process simulation technologies to form a new computer based training product. This alliance

will combine Aurel's expertise in pulp and paper and water-based process engineering, with Ingenious' chemical calculation know-how, petrochemical and refining expertise, low cost engineering centre and Operator Training experience, to produce a powerful new training tool and training services. Pro-Dyn, powered by CADSIM Plus, will be marketed by both companies.

Ingenious Inc is based in Houston, Texas with a satellite office in India: Axiom Engineers Pvt. Ltd. Together the group has many full time engineers, each with several years of relevant experience. Ingenious offers services in

the following areas: planning and scheduling, process simulation and control, production planning and feasibility studies, engineering services and operator training. Their product suite includes ProDyn ProPlan, ProSched and ProOnline. Information on Ingenious' solutions and free product demos can be found at www.ingenious.cc.

Contact Dinu Subbaiah of Aurel Systems via e-mail at dinu.subbaiah@aurelsystems.com or, Vibhu Sharma of Ingenious Inc. via e-mail at sharma@ingenious.cc.



Tech Corner: How to Use a Split Range Controller

The following is an example of how to use the standard split range controller in CADSIM Plus. The split range controller is often used in the following situations:

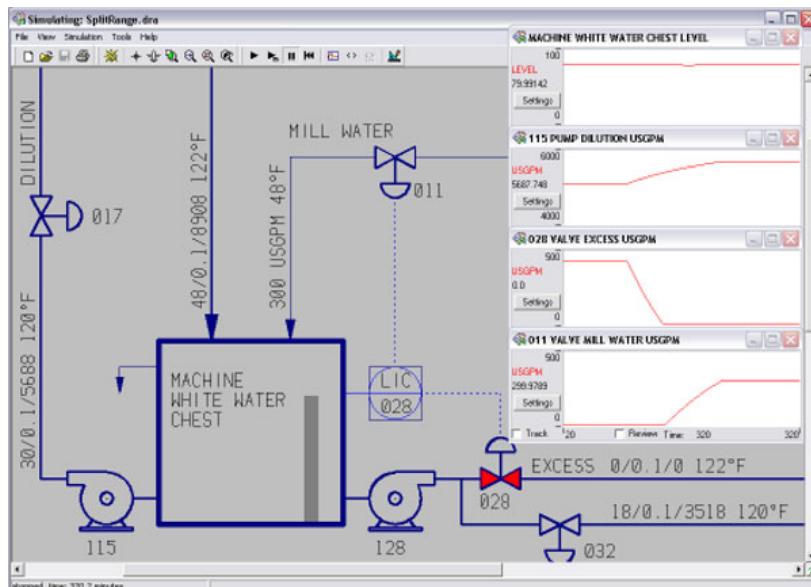
- **Makeup to tanks:** when one stream that is used for level control is insufficient, another stream is substituted.
 - The level of a tank is controlled by sending excess flow to another part of the process, but if conditions change, a makeup has to be applied instead.

Example: the excess water from a Machine White Water Chest is sent to another part of the process, but if there is insufficient water, mill water will be used as makeup.

Two controllers that both control level would not work well in this example because each controller would fight the other. A split range controller is a single controller, but its output is split into two ranges.

During the first half of the split range controller's output, the level control will be done by sending excess flow away from the tank through valve **028** as shown in the figure. At half way point, the flow through valve **028** will be shut off, and the mill water valve **011** starts to open.

A split range controller has two outputs for the two valves,



which must be mapped to the overall output of the controller. In order to program the split range controller , it is helpful to make a table mapping Out1 and Out2 to the overall Output.

A table appropriate for the split range level control for this example appears below. In the table, **maximum** will mean that the valve position when fully open (100%). Alternatively, substitute an appropriate maximum flow rate, if the flow is being adjusted directly in a simplified simulation.

The CADSIM Plus split range controller describes the limits of **Out1** and **Out2** with four variables (fourth column) shown with the appropriate settings if

controlling valve position from 0 through 100%. The first part of these variable names (before the underscore) refers to the overall **Output** and the second part refers to the limit of one or the other split outputs.

Output	Out1 (valve 028)	Out2 (valve 011)	Controller limits
0	maximum		at0_Limit1 = 100
0 to 50	max down to 0		
50	0		at50_Limit1 = 0
50		0	at50_Limit2 = 0
50 to 100		0 up to max	
100		maximum	at100_Limit2 = 100

The tank level controller is tuned the way it would be if it were a single output controller (hint use TuneLev.xls provided with CAD-SIM Plus for efficient Lambda tuning).

The simulation charts show the seamless level control as dilution demand in-

creases. Valve **028** first shuts off, then the mill water makeup starts and is increased with demand. 

Umetrics SIMCA Multivariate Prediction Integrated with CADSIM Plus

Umetrics is a world leader in providing multivariate modeling and analysis software with their SIMCA line of products.

SIMCA provides scientists and engineers with the tools to master the data explosion and make decisions quickly and confidently. Large data sets are quickly reduced to a few informative graphs.

Umetrics' Projection to Latent Structures (PLS) models allow much better visualization of the combination of effects

of multiple variables than what can be possible with Neural Networks and similar products.

With the addition of dynamically linked SIMCA-QP prediction engine from Umetrics, multivariate models are now easily integrated into any CADSIM Plus simulation.

For more information and pricing, contact Aurel or Chris Ambrozic via e-mail at chris.ambrozic@umetrics.com. Umetrics' website can be found at www.umetrics.com.





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Did you know...

To quickly add a link from CADSIM Plus to your Excel spreadsheet, right-click any item in an equipment or stream dialogue box during simulation mode and select **Copy Link as Excel Cell DDE Text**. Then, paste this into the desired cell in Excel.

To refresh the Excel data while the simulation is running, in Excel choose **Edit > Links**, select them, and then click **Update Values**.

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tested and the most effective control strategy could then be implemented.

The model could also be used as an operator training tool to familiarize new operators with the kiln behaviour during operational changes. As a long term objective, a kiln model could be incorporated into a process simulation of the entire chemical recovery section in a pulp mill. Such a study would help in analyzing control strategies and thermal efficiency of the entire chemical recovery cycle. Contact Manan Paul via e-mail at manan@chem-eng.utoronto.ca for more information

University of British Columbia (UBC)

Modeling of Kraft Pulp Air Emissions

Allan Jensen is a doctoral student at the University of British Columbia (UBC) who is using CADSIM Plus to model Kraft pulp mill air emissions.

In Canada and the U.S., environmental focus is returning to sulphur compounds, controlling the release of non-condensable gasses (NCG). In a Paprican survey of mills, problems with odorous emissions were reported, many expressing a need for additional information or research in the field.

Jensen's research will utilize computer simulation techniques to model the emissions of the odour causing TRS (Total Reduced Sulphur) compounds from sources of NCG within the pulping and recovery areas of a Kraft mill. An overall mill heat and material balance, including a complete sodium sulphur balance, is being constructed using CADSIM Plus to determine present emission levels and thus establish a baseline for further calculations.

The balance will include generation and emissions estimates of the targeted TRS compounds. The goal is to gain a better understanding of how the air contaminants are generated, how they move between process units, and where they are eventually emitted from the mill. The aim of this research is to provide an additional tool to assist in designing for "closure" of air emissions sources within a Kraft mill. Contact Allan Jensen via e-mail at ajensen@ahlundberg.com for more information.

San Juan College (SJC)

Intelligent Tutor System

San Juan College, in conjunction with Ingenious Inc., is developing a web-based system to allow technicians to gain hands-on laboratory experience without the need of traveling to a site-based lab.

The rapid growth of web-based education has created a need for revised methods of presenting the traditional hands-on laboratory experiences that are critical to the education of technicians.

CADSIM Plus is being used as a core simulation component in this project, which will see the development of competency based experiential virtual laboratory exercises, for use in a distance learning environment within a technical discipline.

CADSIM Plus is substituted as a virtual lab of tanks, pumps, valves, controllers and heat exchangers. Students are taught unit operations and how to tune controllers. Ingenious' ProDyn OTS software is used as a front end training tool that can also be used over the web. For more information, contact Doyle Meyer via e-mail at meyerd@sanjuancollege.edu.

