

# Refined Methods

Program that can process data in sequence using several computers helps improve refinery production

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A collaboration between Brazil's biggest company, Petrobras, and the University of São Paulo (USP) and State University of Campinas (Unicamp) that began more than 15 years ago is still bearing fruit. A software solution that can process data in sequence, using several computers, to analyze the history of the behavior of aging reservoirs of oil and gas is one of the results. Other results are the creation of a research group in the field of numeric simulation and petroleum reservoir management, and the establishment of a center of excellence in industrial automation.

Two projects were launched at first – one at Unicamp and the other at USP, both supported by FAPESP's Partnership for Technological Innovation (PITE), one in 1996, and the other in 1997. Both were implemented in partnership with Petrobras. Denis José Schiozer, a professor at Unicamp's School of Mechanical Engineering (FEM), says that his team was asked to find a way to distribute simulations of reservoirs among networks of machines for a specific application. This involves calibration of numerical models used to forecast oil production, a task that takes a lot of time and a huge computational effort. "This is done often today, and on clusters of computers, but at the time it was a new concept," he says. "We developed software that has evolved ever since and is used today by both us and by Petrobras."

Schiozer says that the numerical models created to forecast oil production contain many uncertainties, since so many of the variables of the reservoirs, such as the properties of rocks and fluids, are unknown. "That is why the engineers, geologists, and geophysicists make the initial model and then, as the reservoir continues to produce, calibrate that model in order to reproduce the true response," he said. "This gives us a more reliable prediction of production and takes less time. It used to take us as long as six months to make the extraction forecasts. With the new system, it takes only a few weeks."

The work at the chemical engineering department of USP's Polytechnical School (Poli) resulted in a program used to optimize production at Petrobras's oil refineries. "The objective was to obtain the highest production levels possible, but at lower cost," says Claudio Oller do Nascimento, project coordinator. "The program we developed enabled us to perform an integrated optimization of all the processes and operations involved in oil refining."

The USP software has updated and improved the Petrobras Advanced Control System (Sicon). The practical result has been an additional gain of US\$0.25 per barrel of refined petroleum.

Today, the total value of this gain, at the company's 11 refineries in Brazil and four in other countries, amounts to US\$80 million a year. This

0,25

per barrel of refined petroleum is the additional gain made possible by the new software



The Duque de Caxias refinery in Rio de Janeiro is one of the Petrobras units that uses the new software

happens because the computer program optimizes refinery operations and makes it possible to extract the more important derivatives – the ones that have a higher value-added – from the crude oil.

#### LONG-STANDING COLLABORATION

The relationship between USP and Petrobras began back in 1988. “In just three years,” Nascimento recalls, “we trained 42 engineers in refinery automation.” These were Petrobras employees who set aside two days every week to study at Poli’s chemistry department. The 1997 PITE project evolved in 2000 into the establishment of the Center of Excellence for Applied Industrial Automation Technology (Cetai), under a cooperation agreement between the company and the Foundation for Support of the University of São Paulo (FUSP). The center occupies 225 sq. meters of space inside the Poli chemical engineering department. One of its main objectives is to transform research and development into technology that can be used to optimize petroleum refining.

Cetai brings together several divisions of Petrobras to participate in industrial automation research, development, and educational activities. “Together with USP, we have organized courses to train specialists in optimization and the creation of new predictive control algorithms,” says Antonio Carlos Zanin, senior consultant to Cetai

and a Petrobras employee for 29 years. The technologies developed at the center seek to improve the productivity and profitability of the company’s industrial processes by using advanced process engineering and automation tools.

Cetai operates as a virtual refinery, and simulates the functioning of a real industrial unit. “We have developed several types of mathematic models, with varying degrees of complexity. They are continually adjusted to represent the behavior of Petrobras refineries, evaluate their performance, predict the future trajectory, and determine the best options for their operational parameters and conditions,” Zanin explains.

For Unicamp, one of the benefits of working with the company has been the establishment of Unisim, a research group that celebrated its 15 year anniversary in 2011 and has worked with Petrobras to develop several simulation models to more reliably predict oil production. According to Unicamp’s Schiozer, coordinator of Unisim, the most common applications are methodologies used to adjust production strategies and evaluate the risks associated with different levels of profitability.

“The results of the initial investment were so positive that Petrobras has been financing our research group for 15 years and we have just signed a new agreement for four more years,” says Schiozer proudly. ■

#### PROJECTS

1. *Using parallelization to determine the history of production at a network of stations using PVM (Parallel Virtual Machine)* – No. 1995/03942-7 (1996-1999).

2. *Development of integrated optimization of the units of a petroleum refinery* – No. 1996/02444-6 (1997-2001).

#### GRANT MECHANISM

1. and 2.: Partnership for Technological Innovation (PITE)

#### COORDINATORS

1. Denis José Schiozer – School of Mechanical Engineering (FEM), Unicamp  
2. Cláudio Augusto Oller do Nascimento – Polytechnical School, USP

#### INVESTMENT

1. R\$184,667.97 (FAPESP) and R\$261,000 (Petrobras)  
2. R\$266,786.21 (FAPESP) and R\$573,000 (Petrobras)

#### FROM OUR ARCHIVES

*The benefits of a partnership*  
Issue no. 58 – October 2000

*Unicamp and Petrobras develop software to monitor reservoirs*  
Issue no. 51 – March 2000

*Petrobras’s technological breakthrough*  
Issue no. 37 – November 1998