

# EcosimPro

## Modelling and Simulation Software



EcosimPro · Newsletter Nº5· December 2011

## EDITORIAL



Welcome to the fifth issue of our EcosimPro Newsletter. This new update from this information channel reports on the latest news on our modelling and simulation tool as well as on the projects under way in recent months.

Considerable achievements have been made in a number of fields during this period, from presenting the tool at specialised forums, creating new tool capabilities, release of a new PROOSIS book, the publication of EcosimPro's contribution to desalination plants and fuel cells in the specialised press, university courses and the ARES and ADEL projects. In addition, stage 3 of the ESPSS project for the European Space Agency, in collaboration with ESA, EADS Space Transportation and the Von Karman institute, kicked off in late 2011 and aims to improve the space propulsion libraries that are already available to all European users.

The EcosimPro team has continued adding new capabilities to both EcosimPro and PROOSIS. Similarly, more new libraries are being developed at a good pace. For example, a new library for the modelling of cryogenic systems, developed jointly with the CERN, is nearing completion. This project shows great potential for use in a number of centres where cryogenic systems are an important part of any system. The experience gained from modelling the LHC cryogenic system has proven essential to providing

a highly competitive product. Its official presentation will take place in May 2012 at the International Cryogenic Engineering Conference to be held in Japan.

In other news, Empresarios Agrupados (EA) has made a new and complete introductory manual available to users on the modelling of gas turbines with PROOSIS. The arduous but fruitful task of writing the manual fell to our collaborators A. Alexiou and T. Tsalavoutas of the Athens Technical University. Engineers simulating aeronautical propulsion systems now have a complete manual filled with examples of how to use the simulation tool.

As regards how to use the tool, the EcosimPro team has taught several courses on EcosimPro and PROOSIS at companies and universities. For example, thirty people attended a revamped EcosimPro course last November at the Technical School for Aeronautical Engineers in Madrid. In addition, four university students have recently joined the EA Instrumentation & Control department, where they are working on their Final Degree Projects based on simulating some of the systems of a combined cycle power plant.

This issue of the EcosimPro News Bulletin features an interview with the EA Project Manager for the Almaraz-Trillo NPP project, Angel Argüello, in which he gives details on what EcosimPro contributes to the main projects being carried out and what the benefits are of using this tool.

This Newsletter also includes write-ups on using EcosimPro as the connection to MS Excel, which aims to make it easier to use EcosimPro models in an environment that is very familiar to many if not most users.

We trust that this channel of communication will once again successfully show the many capabilities of EcosimPro and PROOSIS, their technological strengths and the numerous advances being made, day by day, by the members of their team in all realms of product use.

Pedro Cobas Herrero  
**EcosimPro Development Team Manager**



# EcosimPro

## Modelling and Simulation Software

EcosimPro · Newsletter Nº5 · December 2011

## INTERVIEW



**Ángel Argüello Tara**

**Empresarios Agrupados Project Manager**

**“The simulation of processes and systems is one of the pillars for tackling projects with high technical content”**

Ángel Argüello holds an MSc in Industrial Engineering with a specialisation in Energy Technologies from the ETS Ingenieros Industriales de Madrid (1985-1991). In 1991 and 1992, he interned at the Institute of Nuclear Fusion (DENIM). His professional career began at Empresarios Agrupados when he collaborated in 1992 as EA Project Engineer. In 2005, he became Mechanical Project Head for the Almaraz-Trillo NPP project, a post he continues to hold at present.

**Ecosimpro: EA has become one of the most important engineering groups in Europe, with the technical management capability to carry out projects of many different kinds. What role does simulation play in all this?**

**Ángel Argüello:** The simulation of processes and systems is one of the pillars for tackling projects with high technical content that our customers require nowadays.

In the area in which most of my career has been focussed, support engineering for nuclear power plants, simulation tools are widespread and used for many different tasks. Due to the nature of the majority of our projects, these tools must have checks and quality controls in consonance with those required in the systems and equipment simulated in these kinds of highly sensitive facilities.

**E: What projects have been developed from Empresarios Agrupados using modelling tools like EcosimPro? What are their main contributions?**

**Á.A.:** Many projects have benefited from the capabilities of simulation programs and, more specifically, from EcosimPro.

In my field of action, a large number of models have been developed of more and less complicated mechanical systems. These models range from the conventional systems of a nuclear power plant, which are not much different from those found in other type of power gene-

rating installation, to specific systems related to the safe operation of nuclear power plants.

In the conventional area, we can highlight the studies performed with the help of EcosimPro for the electrical power upratings of nuclear power plants in recent years.

As regards more specific systems of this type of plants and which are normally safety-related, the simulations carried out have evaluated the behaviour of the systems both in normal operation as well as in situations where some kind of undesired incident has to be handled.

Such simulations demand a very high degree of accuracy from the calculation tool, or at least the ability for it to give conservative results for validating the capabilities of the systems.

**E: The THERMAL\_BALANCE library is one of EcosimPro's many component libraries. What studies has it been used on? What are its main features and advantages?**

**Á.A.:** The THERMAL\_BALANCE library was used in many of the studies I have participated in where the systems that had to be studied were characterised by different energy exchanges being produced.

Some of the main ones worth noting are:

- Analysis of the heat sink of the plant and proposal for enhancements to improve performance of the cycle

# EcosimPro

## Modelling and Simulation Software



EcosimPro · Newsletter N°5 · December 2011

- Obtaining the design parameters for the supply of new cooling equipment to support the cooling equipment of the transformer-generator unit of electric power production
- Simulation of the heat exchangers of the essential services of the essential water cooling systems in normal operation as well as in accident operation
- Design of a cooling tower to comply with the environmental requirements of discharged water temperature
- Simulation of the cooling system of the spent fuel cooling pool at the power plant

One of the most important features of this library is how it can be adapted to the components and equipment we normally find in the systems we want to model. Fairly complex components such as heat exchangers can be simulated quickly if you know their basic design parameters. Still, to me, the main advantage is that the creators of this library are only a phone call away, which means having continuous support and advice.

**E:** Are you currently working with EcosimPro? What's the opi-

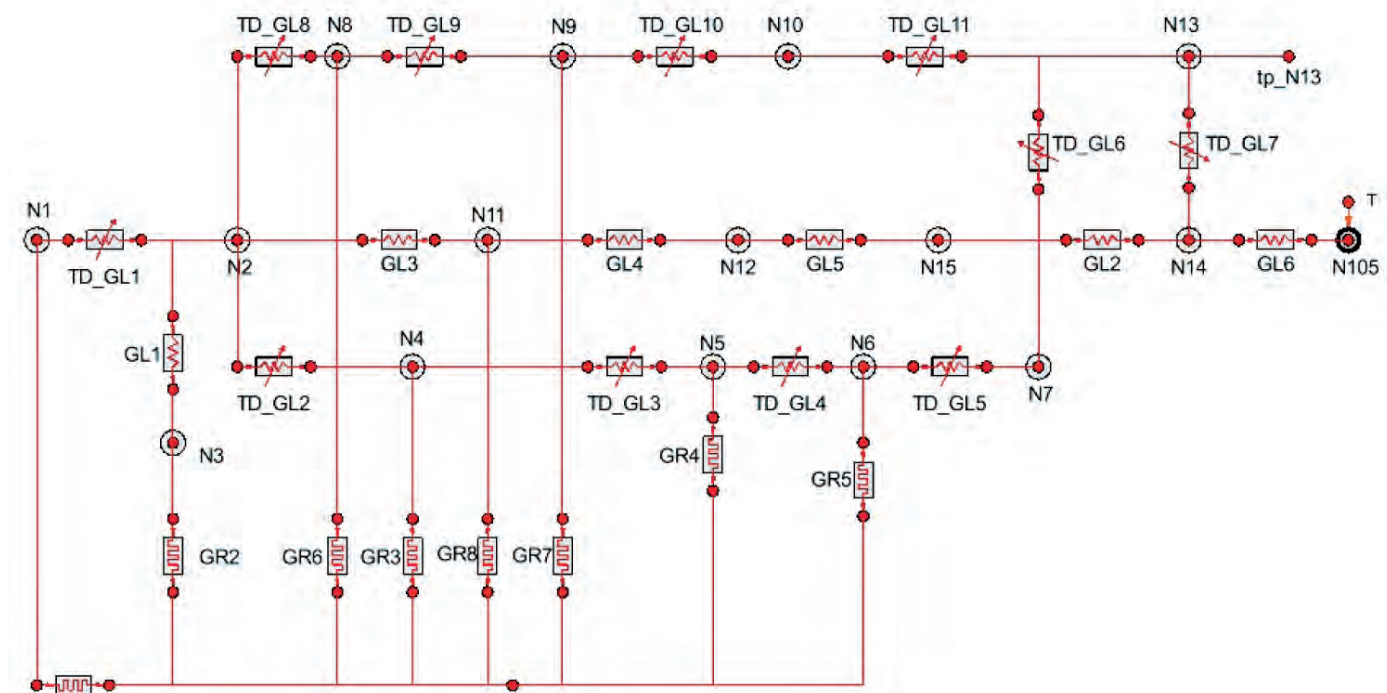
**nion regarding this tool? What characteristics give it an advantage over others on the market?**

**Á.A.:** My relationship with EcosimPro has gone from using it as a user for years to the situation today of being in charge of a group of people who use this program as a standard calculation tool in works in progress.

From the early versions, with the understandable problems of any program at the beginning, to the powerful and highly optimized versions today, working with EcosimPro has been a gratifying and positive experience. It has been an enormous help in meeting the challenges our clients bring us, and its versatility has helped us adapt to virtually any project.

I'm not enough of an expert in the area of simulation to be able to make a thorough comparison with other programs on the market, but to me, the most substantial advantage I get from EcosimPro, even more than all its many features, is the helpfulness and eagerness of the developers of this program and its component libraries.

Time and again they've helped me get through technical challenges I've come up against in my career, and always with flying colours.





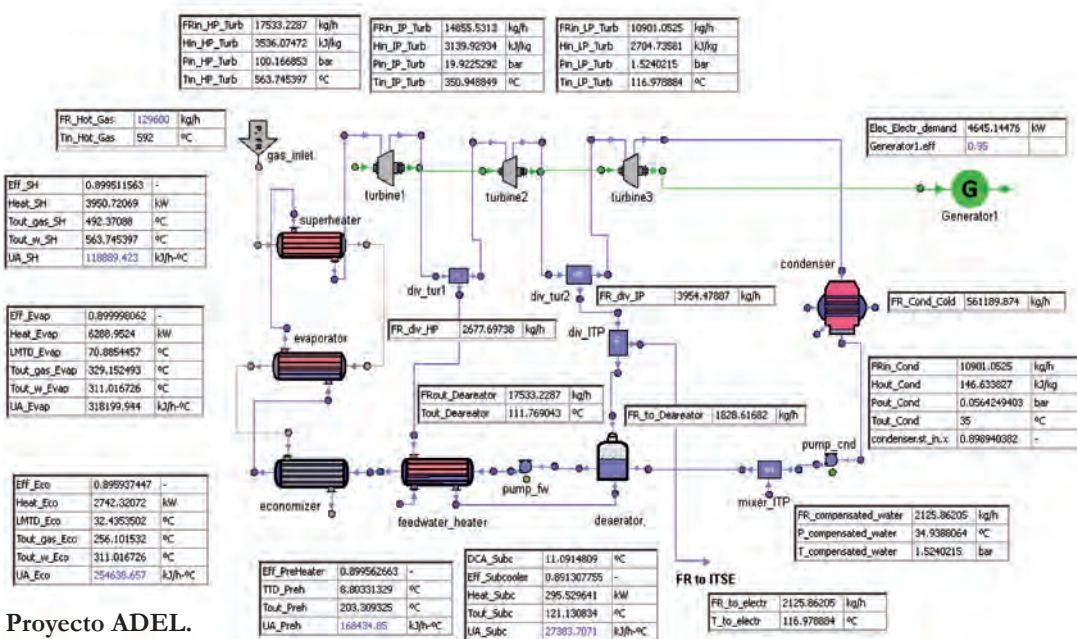


# EcosimPro

## Modelling and Simulation Software

EcosimPro · Newsletter N°5 · December 2011

## ECOSIMPRO NEWS



Projecto ADEL.

### EA forms part of the ADEL project of the 7th Framework Programme

Empresarios Agrupados is one of several European companies participating in the ADEL (Advanced Electrolyser for Hydrogen Production with Renewable Energy Sources) project included in the 7th Framework Programme of the European Union. The main aim of this project is to test the performance of a new concept of steam electrolyser that operates at intermediate temperatures (ITSE: Intermediate Temperature Steam Electrolysis).

This new system is expected to extend the life of the electrolyser by minimizing the operating temperature while maximizing energy efficiency and hydrogen output. The importance of this initiative lies in the development of the electrolyser itself as well as in the alternatives in process diagrams made.

One part of the ADEL work has been to carry out a dynamic simulation of a reference case proposed by the work group. This case consists

in modelling a Rankine cycle with a given set of design and operation data, connected to an electrolyser operating at 650°C whose sources of energy were thermal and electric. This simulation was then done using existing professional libraries such as THERMAL\_BALANCE and FLUID\_PROPERTIES in addition to developing new components as in the case of the electrolyser.

The same reference case was modelled with other simulation tools (TRNSYS and ASPEN).

The results using EcosimPro were satisfactory and similar to the ones obtained with these programs.

### EcosimPro gives a preview of their new CRYOLIB library at the SNE Conference

The EcosimPro team presented their new library for simulating cryogenic systems at the 37th annual meeting of the Spanish Nuclear Society, which was held in Burgos on September 28th to 30th.

Developed jointly with CERN since last February, this library is now in the final phase of validation.

The SNE conference brings together professionals from the sector every year to share their recent achievements. The paper given by the EcosimPro team, titled "A Simulator for cryogenic and cooling processes and their control at large scientific nuclear facilities with EcosimPro" previewed the capabilities of the new library and its adaptability to the particular characteristics of each system.

The library is especially geared to modelling and simulating large-scale cryogenic systems such as those used at large nuclear facilities

# EcosimPro

## Modelling and Simulation Software



EcosimPro · Newsletter Nº5 · December 2011

for scientific research to cool the superconductor magnets.

The paper showed how the compression station and cold box can be modelled, and presented the results obtained.

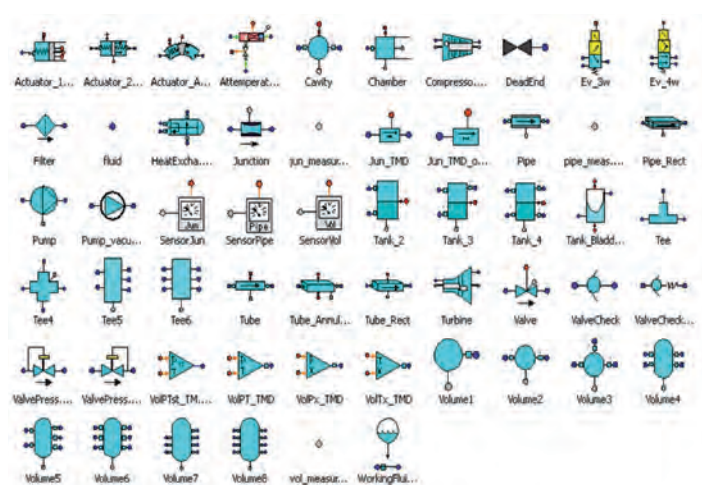
Simulation of this type of systems is particularly important in testing out control strategies, virtual commissioning tasks and training the operators.

### Successful completion of the stability study of heat recovery steam with EcosimPro

The EcosimPro group at Empresarios Agrupados has carried out a number of simulation projects for Portuguese companies. The jobs consisted in carrying out steam stability studies in heat recovery steam generators (HRSGs). These HRSGs belonged to cogeneration plants at various different refineries. The importance of these stability studies lies in that they can be simulated to check that the process works correctly.

In addition to the HRSGs, the control systems needed to operate the plant and some of the distribution of the steam produced to the refinery (high and medium pressure steam consumer units) were also modelled.

The purpose of these studies was to verify that the conditions of the steam being supplied were guaranteed even in the most unfavourable operating cases, as well as identifying any potentially critical problems at the plant.



Palette of components in the FLUIDAPRO library.

These jobs were done using the THERMAL, CONTROL and FLUIDAPRO professional libraries that contain the required components and characteristics.

These libraries can be used for in-depth analysis of transients caused by the phenomena of inertia and bubble formation.

Based on the FLUIDAPRO, another library has been developed with typical components that can be used to model steam generators (heat exchangers, economisers, super heaters, boiler drums, burners, diffusers, etc.). This new library is called HRSG.

These simulation jobs were used to double-check that the HRSGs really provided steam at the quality than the manufacturer claimed in adverse operating conditions.

They also acted as a springboard for proposing improvements in the strategies and parameters of being in tune with the control systems.

### The Instrumentation & Control Department of EA coordinates the final project of four university students

The use of EcosimPro in different departments at Empresarios Agrupados is still on the rise. In 2011, the Department of Instrumentation & Control had four university student interns who carried out their final projects under the guidance of the director of the department and the EcosimPro group.

The common objective of all the projects was to model the various different systems that comprise a combined cycle power plant, as well as the most important control macros. To that end, each project focussed on a different system. In the end, the systems that were modelled were:

- Heat recovery steam generator system
- Steam system
- Condensate system
- Feedwater system

To develop the respective models, commercial professional EcosimPro libraries were used, such as FLUID\_PROP, FLUIDAPRO and HRSG. It is also worth noting that the work done in the area of control, in terms of implementing macros, necessitated creating new components specific to the control of these systems.



# EcosimPro

## Modelling and Simulation Software

EcosimPro · Newsletter N°5 · December 2011

### Modelling and simulation of the closed circuit Air Renewal System using Ecosimpro

The ECLSS library (Environmental Control and Life Support System) was used for the modelling and simulation of the closed circuit ARES (Air renewal System).

ARES is the result of over 20 years work carried out by the EADS Space transportation engineers in R&D in closed circuit processes for space habitats.

These activities were financed by EADS-ST and co-financed by ESA (European Space Agency) and by DLR (German Aerospace Centre).

ARES is part of the environmental control and life support system of a space station and is designed for its integration into the MLM (Multipurpose Laboratory Module) of the ISS (International Space Station).

The rack of the ARES consists of the following systems: Carbon Dioxide Concentration (CCA), Carbon Dioxide Reduction (CRA), Oxygen Generation (OGA), Multi-Filtration, Control and Power.

The most important functions of the Life Support System of the MLM are the following: to generate breathable oxygen from water, to eliminate and concentrate the CO<sub>2</sub> produced in the cabin, to



Front View of the OGA Equipment.

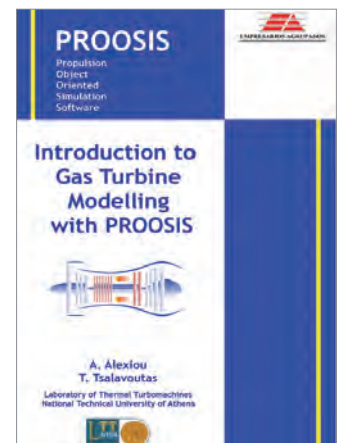
convert the CO<sub>2</sub> into water and methane and to recover the water produced for use in the water management system of the ISS.

The EcosimPro model of the ARES includes sub-models of the CCA, CRA, OGA and the control system. It was used to design the control strategy of the equipment and to predict the performance of the system in the event of variations in key process parameters.

### Publication of new book: Introduction to the Modelling of Gas Turbines Using PROOSIS

PROOSIS collaborators A. Alexiou and T. Tsalavoutas, of Athens National Technical University, have been working on the publication of a new book Introduction to the Modelling of Gas Turbines Using PROOSIS.

It is a complete user manual that contains many examples of usage and that can be used as a reference book by engineers working on the simulation of aeronautical propulsion systems.



PROOSIS Cover of the book.

### Compartmental simulation of pharmacokinetic systems using EcosimPro

Bastet Biosystems, in collaboration with the research group M2TB (Multilevel Modelling and Emerging Technologies in Bioengineering) is working on the development of a set of libraries for the modelling of compartmental pharmacokinetic systems using Ecosimpro.

The project, known as LibPK, is one of the lines of product evolution in the area of biotechnology that Bastet Biosystems is working on, and it covers three business areas: support to biotechnology companies for the design of new pharmaceuticals, support to universities and groups for education and research, and new customized services for socio-sanitary suppliers based on e health systems.

# EcosimPro

## Modelling and Simulation Software



EcosimPro · Newsletter N°5 · December 2011

The main goal of this project is to create an initial version of the LibPK at the beginning of 2012, to be complemented with features that facilitate parametric identification, the conversion of non-compartmental pharmacokinetic models into compartmental ones, and their combination with other tools for the design and analysis of pharmaceuticals and metabolites. Bastet Biosystems' secondary goal is to develop a second system of libraries for human physiological modelling, based on LibPK.

To carry out this activity, Bastet Biosystems will make use of the concept of pharmacokinetic system as a simplified physiological model, and add on anatomical, metabolic and molecular characteristics at different scales.

### European Space Propulsion Libraries using EcosimPro

Empresarios Agrupados (EA) is participating as the main player in the construction of the standard space propulsion libraries for the European Space Agency (ESA).

The space propulsion libraries are being developed under contract with ESA and in cooperation with other European collaborators such as Astrium, the Von Karman Institute, Koopos, CNES, CE-NAERO, etc. The first phase of the ESPSS 1 finalized in 2009 and was aimed at:

- Development of a standard, modular and shared software for the modelling of space propulsion systems on a common platform based on EcosimPro
- Reduction of development time and of costs of the propulsion systems

Once the first version was available, it was confirmed that it could be expanded as an essential tool for the development of new propulsion components and to prepare for future missions.

The second validation phase (ESPSS-2) finalized in 2010 with the following goals:

- Updating of the existing components in order to attain more robustness and calculation speed
- Inclusion of validation cases by comparison of simulation results with tests (priming cases, HMTB motors, filling of tanks, etc)

After the successful finalization of this validation phase (ESPSS-2), the third phase started in 2011 with the main goals of perfecting

several areas such as:

- Updating of the modelling of tanks (surface tension effects and dissolution of gases) and of the non-homogenous flow of the two-phase model
- Creation of a new professional library for steady-state models required in parametric studies for the design of motor cycles
- Implementation of mission analysis cases and of electrical propulsion components
- Integration of validated optimization cases as examples for the optimization of the design of systems

We expect to deliver this third phase of the ESPSS Project at the end of 2012. Nowadays many European firms use EcosimPro and its ESPSS libraries to model complex space propulsion systems.





# EcosimPro

## Modelling and Simulation Software

EcosimPro · Newsletter Nº5 · December 2011



## FAQs: Connecting EcosimPro to Excel

EcosimPro can be integrated and can communicate with other applications, including Microsoft Excel.

This is the case of connection to Excel, which allows the user to benefit from the power of this Microsoft Office program in simulations done with EcosimPro.

### Simulation Toolbar for Excel

The simulation toolbar is used to simulate EcosimPro experiments in Excel.

The toolbar has the features required so that the user can execute the experiment from Excel and interact with the model in the same way as in the Monitor (new integration, steady-state, save status, etc).

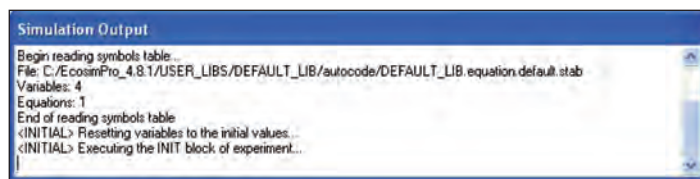
To install it, ExcelRegister.exe is used, which is provided with the Ecosimpro installation.



### Opening an experiment in Excel

The connection of an experiment to Excel is carried out by means of its .dll file, previously generated with EcosimPro.

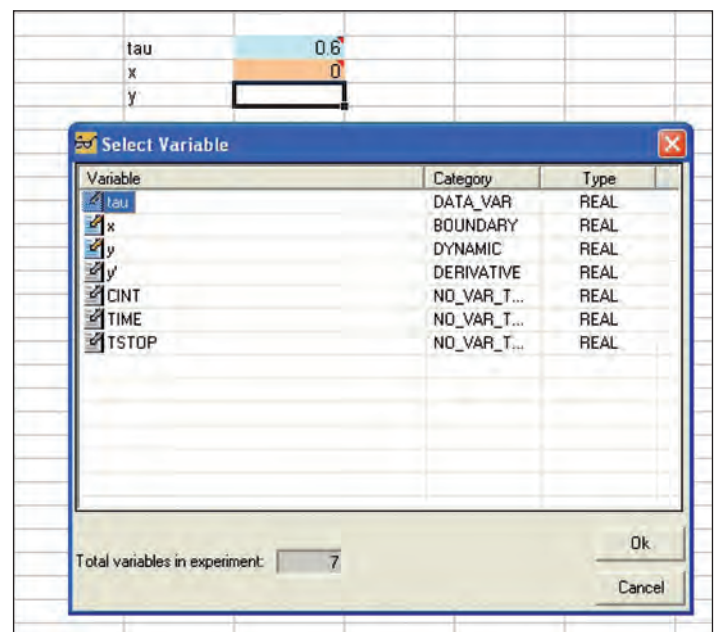
All the user needs to do is use the “Open Experiment” button on the simulation toolbar in a new Excel spreadsheet. A dialogue box will appear to select the .dll of the desired experiment.



When the experiment is loaded a window appears in Excel: Simulation Output, which is equivalent to the window that appears at the bottom of the Monitor.

### Assigning variables to Excel cells

The values of the variables in the experiment can be observed from Excel, and the user can operate on them and modify parameters and boundary conditions.



To do this, the variables have to be linked to Excel cells. This assignation of variables is carried out using the button “Assign Variable to Selected Cell:” on the simulation toolbar; a list will appear with all the variables that can be assigned.

To eliminate variables linked to the spreadsheet, use the button “Delete Variables from Selected Cell:” 



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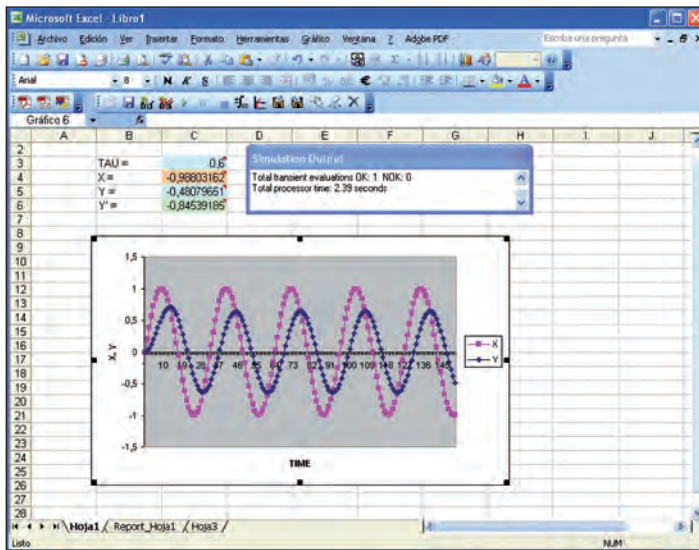
## Modelling and Simulation Software



EcosimPro · Newsletter Nº5· December 2011

### Running an experiment

Running an experiment and acting on it is done in the same way as in the Monitor, ie based on the simulation toolbar.



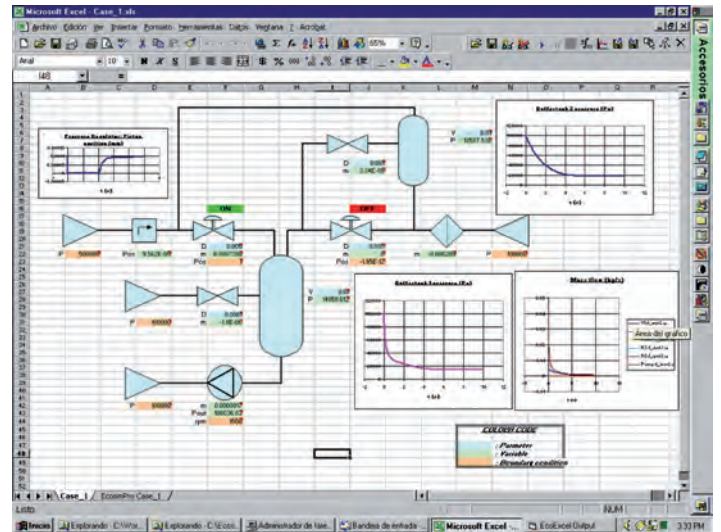
When an experiment is run on Excel via Play Experiment, the user can observe the updating of the variables and the evolution of the simulation in the “Simulation Output” window. Based on this simulation, the second page of the spreadsheet will show the values over time of all the linked variables.

This can be very useful for generating graphs showing the evolution of these variables.

### Advantages of connecting to Excel

Connecting Ecosimpro experiments to Excel increases EcosimPro’s capabilities, as it combines the strong simulation power of Ecosimpro with a popular user interface.

It allows a user to carry out simulations in a customized Excel environment without losing EcosimPro’s simulation capabilities.



### Example of an EcosimPro experiment executed from Excel

All this implies that the capabilities of the Monitor are increased with all the features of Excel and opens a wide range of applications and interactions with the experiments.

Please feel free to send us any suggestions you may have for the EcosimPro newsletter, whether these have to do with content, articles or interviews that you would like to see published in coming issues. We look forward to receiving them. With your collaboration, we can continue to improve and expand the newsletter sections that are most relevant to you.

## SUGGESTIONS

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