# EcosimPro PROOSIS

## Modelling and Simulation Software

EcosimPro/PROOSIS · Newsletter Nº 10 · November 2014

# FROM THE EDITORS


The EcosimPro/PROOSIS team has been a beehive of activity for the last few months creating new tools and simulation applications to meet our users' requests. For this purpose we have created Ecolabs, an idea laboratory that both outside users and our own team members can use to come up with innovations for every new version of our products.

Every idea that comes out of this lab is analyzed, prioritized and assessed for its impact and its development effort. If it is finally chosen, it is then scheduled for implementation in upcoming versions. Moreover, we back this all up by holding user workshops covering different areas of applications, which gives us ideas on the enhancements and new functions they need.

This year, we have attended to the space propulsion conference in Cologne and the ASME aerospace propulsion conference in Dusseldorf, where we presented the latest versions of our products.

This newsletter features EcosimPro applications in a wide range of areas, such as multiphase flow modeling using ESPSS, modeling desalination plants, advanced modeling of cryogenic systems for ITER, simulation of thermo-solar plants and thermal desalinization in collaboration with CIEMAT/Planta Solar de Almería, new improvements of space propulsion libraries (ESPSS) and of aeronautic gas turbines (TURBO).

In terms of new enhancements to the tools, we present a new product to export models to Hardware in the Loop (HIL) architectures using Matlab/Simulink, and the new 64 bit versions that will be released in late 2014.

The simulation area is a fascinating discipline that is become more and more popular among technical personnel at companies. This shows us how important it is for us to continue our work of ongoing improvement and of offering solutions that match what our users expect.

Pedro Cobas Herrero (pce@ecosimpro.com)
**Head of the Development Team EcosimPro/PROOSIS**
**EA Internacional**

# CONTENTS

# LATEST NEWS ECOSIMPRO/PROOSIS

## 1. ECOSIMPRO/ESPSS AT THE SPACE PROPULSION CONFERENCE

EA took part in this important conference held in Cologne (Germany) to showcase details of the new capabilities of the EcosimPro simulation tool and its ESPSS space propulsion libraries.

EcosimPro/ESPSS can be used to model propulsion systems for spacecraft and satellites, including priming processes, engine startup, simulation of fuel tanks, heat exchangers, mechanical systems and electronic pressure regulators. Therefore it can model any type liquid rocket engine cycle with one or more combustion chambers, including turbo-machinery (pumps, compressors and turbines) and cooling systems with two-phase fluids.

The new improvements to the ESPSS European Space Propulsion System Simulation (ESPSS) developed for the ESA by an EA-led consortium were presented at this forum. New items are the new modules for electric propulsion and solid/hybrid propulsion, a new library for stationary calculations, new solid/liquid and ramjet/scramjet fuel combustors and a new library for calculating orbits.

EcosimPro/ESPSS is currently being used by numerous European companies for designing new space propulsion systems. Many of the papers presented here, available on our website, included models developed with this software, demonstrating its real use in current projects now underway such as Exomars, Ariane, MPS Constellation, etc.

On the last day of the fair, the ESA organized the third workshop for EcosimPro/ESPSS users, with a strong turnout from representatives from the European space industry. There, papers were given on work done in the industry and there was a round table held to propose new improvements to the tool in the future. A new ESPSS development phase called Multiphase Flow Modelling, more detailed information on which will be later provided, will also be headed by EA.

## 2. PROOSIS AT THE ASME TURBO FAIR

EA went on the road to the ASME TURBO EXPO fair in Germany last June to present the latest version of their product PROOSIS for modelling and simulating aeronautical gas turbines. PROOSIS is currently one of the most advanced software packages in the world for modeling 0D and 1D aeronautical engines; indeed, it is used by important companies such as Airbus, Snecma, Turbomeca, etc.

PROOSIS is a mathematical simulation and modeling tool that offers flexible and reliable solutions to simulating gas turbines and other aeronautical components (cockpit environmental control system, electrical system, fuel system, etc.). It is a multi-disciplinary tool for working in groups among the different companies involved in the design and development of a new motor.

This latest version includes new capabilities such as utilities for designing and optimizing new engine configurations, new algorithms to solve systems of equations in real time and exporting models to hardware cards such as black box, etc.

Many papers were presented at the fair and are available for viewing on our website. PROOSIS was demonstrated to engineers of renowned companies of the sector such as General Electric, Pratt-Whitney, Rolls-Royce, Boeing, Airbus, etc., who were able to see for themselves how the product can help design new motors and shorten their development times.

PROOSIS is currently being used to model new open-rotor engines, which the European aeronautics industry is currently designing and testing. PROOSIS is also being used to model the Vinci and Vulcain space engines.

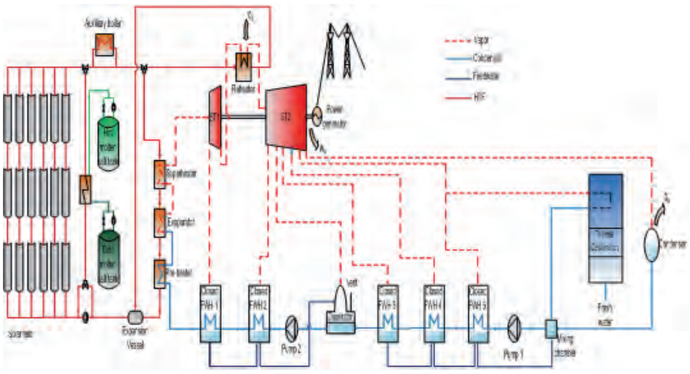
ASME TURBO Fair

## 3. COLLABORATION WITH CIEMAT/SOLAR PLATFORM OF ALMERIA

EA has started up their collaboration with Ciemat/Solar Platform of Almeria, well respected centers for research into thermosolar energy and thermal desalinization, to jointly develop the simulation of tower-and-mirror thermal solar power plants with molten salt thermal storage, and thermal desalinization systems (in this case, preferably by using solar energy for thermal energy).

The detailed simulation of electric thermosolar power plants with a central receiver - tower system (or for process heat) will include an array of heliostats, the receiver, the thermal storage, the power block and the eddy-current losses.

The simulation for thermal desalination will include the technologies for Multi-Effect Distillation (MED) and Multi-Stage Flash Distillation (MSF) with its different configurations, powered by solar energy in stand-alone mode and integrated into the Concentrated Solar Power (CSP) plants with parabolic trough or linear Fresnel technology (CSP-D mode). In addition, models of MED plants with thermal vapor compression (MED-TVC) will be implemented.



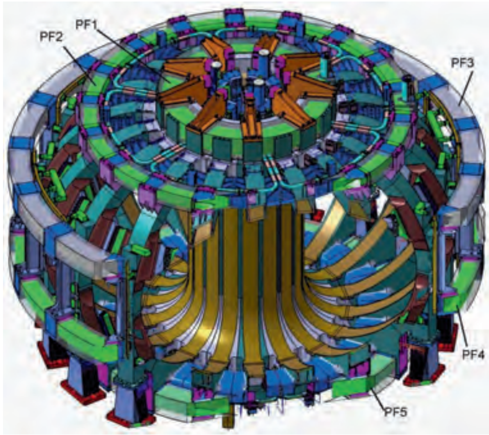
Integrated Thermal Desalination with Thermosolar Plant

## 4. SIMULATION OF THE ITER SUPERCONDUCTING COIL COOLING CIRCUIT MODELS

Ana Veleiro, EcosimPro/PROOSIS

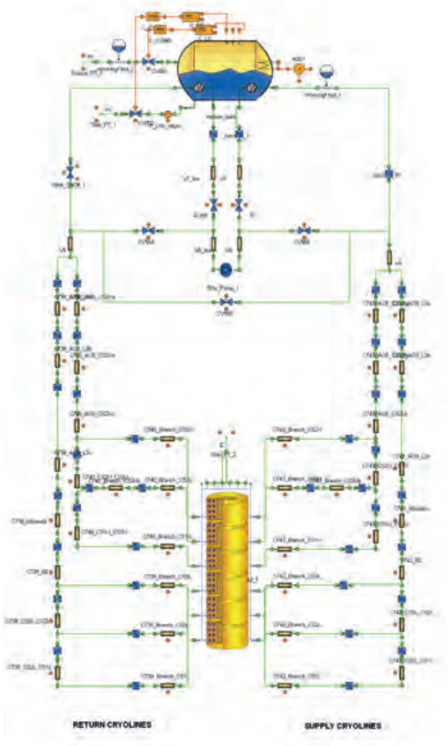
EcosimPro and CRYOLIB are being used to develop a dynamic model of the cryodistribution system that refrigerates the superconducting coil system of ITER Tokamak.

The ITER cryoplant, which will be the largest cryogenic system in the world with an installed cooling power of 64 kW at 4.5K, is responsible for the operation of the Tokamak superconducting coil system, including the Central Solenoid (CS), 18 Toroidal Field coils (TF), the Toroidal Field structure (TF-ST), 6 Poloidal Field coils (PF) and a set of correction coils (CC) that magnetically confine, shape and control the plasma inside the vacuum vessel.




ITER superconducting coil system

The model of the ITER cryoplant has been previously modeled in EcosimPro using its professional library CRYOLIB. It contains the three helium refrigerators. However, the current model does not include the superconducting coil system, which has to be included for the tool to be able simulate the operation of the complete ITER cryogenic system to guarantee cooling and stable operation of ITER magnets.




Central Solenoid model

The superconducting coil system is formed by 4 cryodistribution systems: CS, TF, TF-ST and PF/CC. Each one includes a dedicated auxiliary cold box that provides the coolant to the coil modules, a circulation pump, two heat exchangers immersed in the reservoir, cryolines, feeders and control valves for flow regulations in addition to the model of the coil cooling circuits, based on cable-in-conduit conductors. The models should be able to reproduce the magnets dynamics taking as an input the helium flow conditions provided by the cryoplant and a heat load scenario. Two aspects need to be taken into account:

- To determine the temperature of the cable-in-conduit conductor along their entire length to assure a sufficient margin with respect to the critical temperature of the conductor.

- Assessing the energy removed from the magnet system in order to determine the heat load to the cryoplant so that it can keep constant the temperature of the helium supplied despite a heavily pulsating heat load.

An important challenge in the simulation of these systems is the big size of the models generated due to its complexity. The CS alone contains 240 parallel cooling channels, discretised each one in the direction of the flow in order to represent with the necessary level of detail the heat load distribution. To satisfy the computational needs of this kind of models a new version of EcosimPro for 64 bits has been developed in parallel. The new version that will be released in December allows the simulation tool to handle the amount of information generated by models of huge size and makes the most of the computer resources available.

The EcosimPro model will allow control engineers to analyse and optimize the control of the cryoplant under different operating modes:

- Initial cooldown of the system
- Recooldown after magnet fast discharge
- Warm-up
- Reference plasma scenarios

In addition, it will also allow the investigation on heat load mitigation techniques for each one of the systems.

## 5. SIMULATION OF A DESALINATION PLANT

Raúl Avezuela, José Moral and Jenifer Serna, EcosimPro/PROOSIS

EcosimPro and the PIPELIQTRAN library have been used to model a large reverse osmosis desalination plant with a maximum output of 16,000 m3/h . The simulation will allow startup and shutdown sequences to be studied with a view to guaranteeing plant stability.

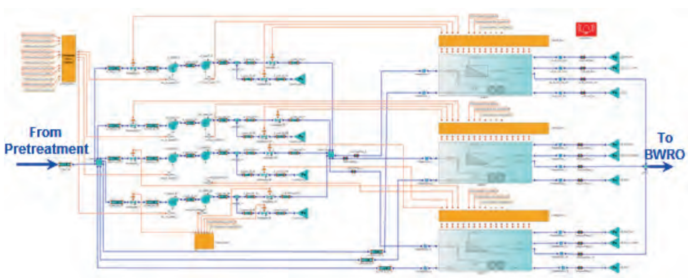
The plant is hydraulically complex for several reasons. First because the tanks between the various subsystems are not large enough, there is a strong hydraulic coupling between them. This means that the startup/shutdown and/or disturbances in a subsystem are transmitted to the rest, which could have an impact on the overall plant stability. Second because the existence of several lines that operate in parallel, and where startup/shutdown of one of them can affect the stability of the others.

The modelled desalination plant has the following subsystems: Intake (seawater intake is located several kilometres away from the plant), Low Pressure Pumping and Pretreatment, LPP+DF+UF (seawater undergoes pretreatment in the desalination plant), SWRO/RO First Stage (the first stage of the reverse osmosis process that has two permeate outputs: Front and Rear Permeate), and BWRO/RO Second Stage (Second reverse osmosis stage, applied on part of the SWRO permeate to attain the required quality).


Desalination Plant Subsystems

The EcosimPro model includes the hydraulic modelling of the system to adjust design and control parameters, as well as to identify potential operating problems and to test proposed solutions. The model therefore focuses on studying the pumping and storage systems, including the membranes and energy recovery systems to ensure the quality of the product is adequate. The chemicals that are added in association to the desalination process have not been included because they are not relevant for the study.

Hereafter is included the model schematic of the first desalination stage, as taken from the overall model where all the stages are interconnected so that their hydraulic coupling can be studied.




Schematic diagram of the 1 reverse osmosis stage, SWRO

The startup and shutdown of each of these lines is analysed to study the validity of the established design parameters, as well as to determine operating parameters such as delays in the startup of the various stages or the parameters that define the different control loops. Accordingly, special attention is paid to avoiding pump cavitation and to keeping them below the run-out flow. With this purpose in mind, the draining in the tanks and the losses due to spillover in those same tanks are avoided.

This study provides the required parameters and relevant conclusions that need to be taken into account during plant operation, such as the following:

- The startup and shutdown of new reverse osmosis lines can cause a drop in the pressure in the rest of the parallel lines, which affects the permeate flow obtained during the transient that occurs until normal operation is reset.

- On some occasions, the pump operating limits that are set out in the design do not ensure the operation at the pump optimum range, so new limits taken from the analysis of the results are suggested.

This study has located required design modifications and improved the accuracy of projected operating parameters, correcting them so as to apply values that are closer to the operating conditions. This information will allow the plant to be started up for testing considering only the equipment that is being used, and to apply parameters that will prevent problems during operation of the desalination plant.

## 6. NEW VERSION 3.0.5 OF ESPSS

Javier Vilá, EcosimPro/PROOSIS

Properties files for new fluids have been added and some of the existing ones have been optimised by extending the validity ranges and returning better results. The interpolation library for these files has also been updated.

The Ramjet component under different operating conditions has been validated: Fanno flow, heat addition and mass addition. The results obtained in ESPSS have been obtained with the corresponding analytical solutions. The adjustment of the implemented model has proven to be correct.

New components have been added to the libraries, such as an independent starter for motors, a fluid component that incorporates the wall or a tank that can receive combustion products.

There has been further progress on the upgrading of the combustion chambers for solid and hybrid propellants, including new parameters to define the geometry or the fuel consumption in the direction of the axis, among other options.

New typical cases for the application of the libraries have been added and amply documented so as to allow users to understand easier the operation of ESPSS and to build their own models. These examples cover different common applications of the tool: a design case for a rocket engine with the STEADY library, a transient case for that same engine and a case of priming of a piping network. They can all be used as templates to create more complex customised systems.

Apart from these upgrades, and thanks to users, there has been an ongoing process of correcting bugs in all components.

## 7. MULTIPHASE FLOW MODELLING PROJECT

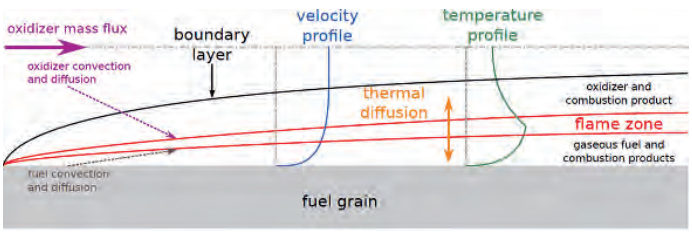
José Moral, EcosimPro/PROOSIS

The ESPSS (European Space Propulsion System Simulation) library that has been developed and validated for ESA by EAI in collaboration with other industrial and R&D centers and university partners, constitutes a shared and standard software for performing analysis and simulation of space propulsion systems, including chemical and electrical propulsion cycles, ground support equipment & operations, and ground/qualification tests.

To explore and develop new ESPSS's capabilities ESA has recently launched the project "Multiphase Flow Modeling" where Empresarios Agrupados will lead the project in collaboration with ONERA, Von Karman Institute (VKI), Roma Sapienza University and KopooS as subcontractors. The project aims to enhance the ESPSS libraries, which will be extended to improve the simulation of solid and hybrid propulsion engines and the coupling of propulsion systems with vehicle dynamics. Furthermore the robustness and accuracy of the 1D fluid simulation will be improved by implementing new discretization methods and updating the existing ones allowing for multi-species aspects, and extending the physical formulation for two-phase and multi-component flow.

### Simulation of New Advanced Propulsion Systems

Satellite manufacturers are presently evaluating hybrid chemical propulsion as an alternative thrust unit for the GEO transfer, between the usual chemical propulsion (bi-liquid) and the new trend of electrical propulsion (ACS-engine). This hybrid chemical propulsion is in line with the CleanSpace objectives, i.e. use of green propellants, and has a simpler design compared to the bi-liquid engine, still allowing for re-ignitability within a wide operational range and having a throttling capability. It guarantees shorter transfer time and reduced cost of operations compared to the all-electrical propulsion.




Physics of hybrid propulsion with polymeric fuel

The development of these technologies require fast and accurate simulation tools. Therefore, the extension of the fluid/solid properties database, the development of analytical correlations for

the 1D simulation of the heat and mass exchange between the grain and the fluid, as well as the grain regression will be needed.

### Coupled Simulation of the Propulsion System and Vehicle Dynamics

In order to evaluate the performances of the propulsion system being designed under different operating conditions along the mission, or under failure modes, the coupling of the propulsion system dynamics with the motion of the vehicle is needed.

A first prototype of the SATELLITE library, for the coupled simulation of the propulsion system and the integration trajectory and attitude motion of the space vehicle has been already developed, showing the capability of the tool for such kind of simulations. In this workpackage, it is proposed to extend and validate this version of the library to allow different scenarios (ascent, re-entry, Earth orbit, solar orbit, etc..) and different levels of perturbation accuracy, from Keplerian orbits to medium accuracy orbit propagation, allowing the ESPSS-user a fast evaluation of the modelled propulsion system linked to the motion of the spacecraft.

### Advanced Numerical Schemes for Robustness Improvement

In the current formulation of the ESPSS libraries, two different methods were used for the discretization of the 1D partial derivative equations; a centered scheme and the Roe scheme (the user can select which method to use for the simulation). The Roe splitting has been commonly accepted as one of the most accurate techniques available today. It is less dissipative than the centered scheme and then is preferable in some applications, however the related drawback is represented by an increase in the computational cost. Additionally, the Roe scheme cannot be extended with new physical effects or equations without changing the entire structure of the scheme itself. Since one of the points of the ESPSS libraries is their flexibility to be extended for the simulation of new propulsion concepts, these drawbacks of the Roe scheme becomes quite important. The present activity will explore different approaches to improve the robustness and efficiency of the simulations with ESPSS while reducing the risk of wrong model input/options.

### Extension of Two-Phase Physical Formulation

The formulation used so far in the libraries is based on the homogenous equilibrium hypothesis, where the liquid, vapour and non-condensable gas coexist at the same temperature and pressure in each node. Recently, a new formulation has been proposed, where different temperatures for each phase of the fluid are considered. In the present activity it is proposed to extend this new formulation taking into account the different flow regimes (annular flow, bubble flow, slug flow, etc) in the formulation of the library, as well as the validation of the new formulation with test cases.

## 8. NEW VERSION OF TURBO LIBRARY

Alex Alexiou, National University of Athens (NTUA)

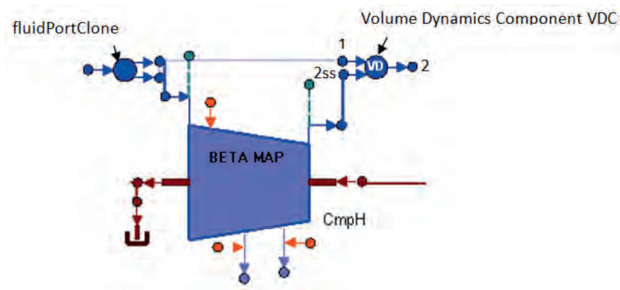
A new version of the TURBO library (4.0) is now available in order to improve the accuracy of transient calculations and further facilitate multi-disciplinary calculations within PROOSIS. In addition, a number of minor modifications have also been implemented to correct errors and improve component modelling and/or handling.

### Transient modelling capabilities

Accurate prediction of gas turbine transient operation is important for stable operation, controller design and fault diagnosis. Transient simulations models should take into account a number of phenomena such as shaft and volume dynamics, heat soakage, tip clearance changes and control system delays and lags (e.g. of sensors, actuators, valves).

The previous version of the TURBO library accounted for shaft dynamics while heat soakage effects were only accounted in ducts and turbomachinery components through the **Casing** component. Heat transfer in the burner component and turbomachinery component blades and discs was not considered. The latter is also required in tip clearance calculations.

For modelling volume dynamics phenomena, a dedicated component (named **VDC**) is now available in the TURBO library. A switch allows the user to set the volume dynamics calculation on or off. Inside the **VDC** component the continuity, momentum and energy equations are employed in integral form to relate the flow quantities at the inlet and outlet of individual engine components. An example of its use is demonstrated in the following figure for the case of a compressor.

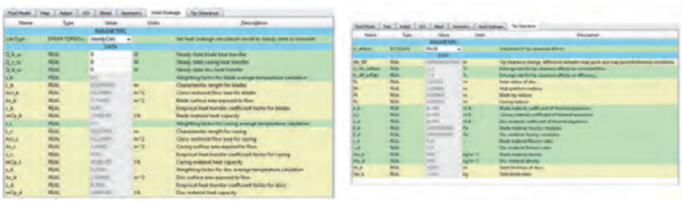



Implementing Volume Dynamics in Compressor Component

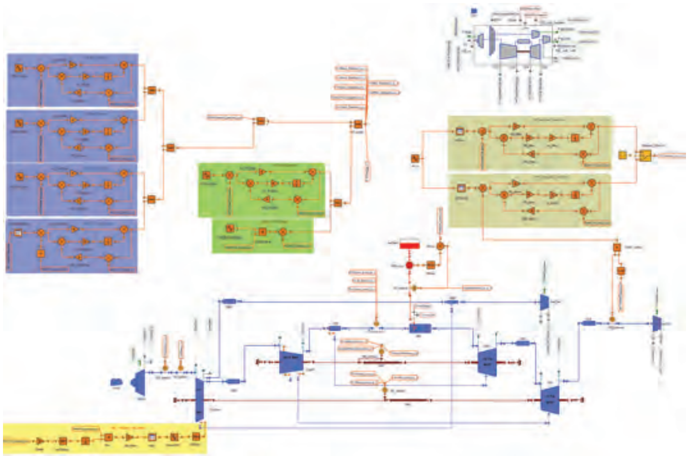
In order to obtain the metal temperatures of casing, disc and blades, the heat port in compressor, fan and turbine components are removed in the new version of the TURBO library and all heat soakage calculations are now performed within these components. The same approach (heat port removal) is also followed for the **Duct**

component making this port redundant. Heat Soakage effects are also added in the **Burner** component.

Tip clearance calculations are now defined in compressor and turbine components. Correction scalars for isentropic efficiency and mass flow rate due to changes in tip clearance are based on the tip clearance change value and user-provided exchange rates.



Heat Soakage and Tip Clearance Tabs in Compressor Customer Editor



Turbofan engine model with control system

### Control

The control system receives pressure, temperature, rotational speed and fuel flow signals from the engine sensors. The previous version of TURBO library includes the **Probe** component which does not include sensor dynamics and is not compatible with the PROOSIS CONTROL library since a different port is used. For these reasons and in order not to affect backwards compatibility, a new set of components is developed for simulating sensors for total temperature (**sensorTt**), total pressure (**sensorPt**), static pressure (**sensorPs**), rotational speed (**sensorN**) and fuel flow rate (**sensorWf**). These components use the PORTS_LIB outlet analog_signal port to communicate with the control system while sensor dynamics are taken into account assuming first order lag. In addition, two components representing a basic fuel pump (**fuelPump**) and a fuel tank (**fuelTank**) are created.

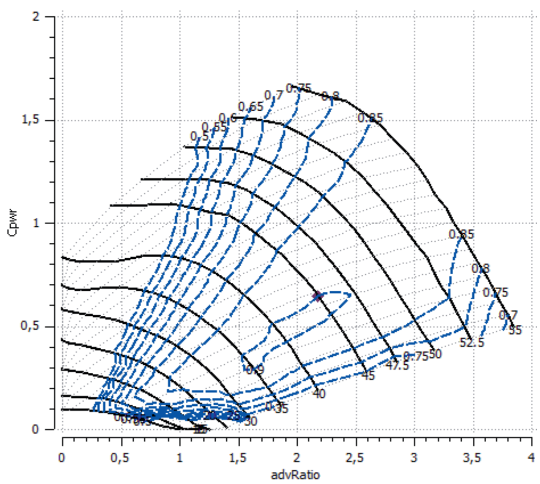
Components with variable geometry have also been modified to accept control input signals. Variable bleed operation may occur both in compressors and ducts with bleeds. To model this operation, two additional options have been included in the relevant bleed type switch. Next, analog_signal inlet ports are added in duct and compressor components with bleeds. For the case of compressor variable stator vanes, an analog_signal inlet port is added in compressor components with map defined off-design performance. Next, the variable geometry switch is modified to include an additional option where variable geometry is present but modified according to the control signal.

With the addition of sensor components and the modified variable geometry components, transient calculations can now be combined with an engine control system built entirely with components from the PROOSIS CONTROL library as shown in the following figure.

### Other changes

In an effort to homogenize PROOSIS libraries, variables in the TURBO library use the UNITS of MATH library 3.2.1. In the same spirit, an interface component between the mechanical port of the TURBO library and that in PORTS_LIB is also available to allow connection of the relevant TURBO library components with components from other libraries. The RANGE directive is now used when declaring pressure, temperature, density and efficiency variables.

A new propeller component has been implemented that uses a map of power coefficient, efficiency and advance ratio for different blade angles and map auxiliary coordinate BETA. This map can now also be viewed in the Monitor. There is a new MFT pre-process procedure that does not require running the map generation experiment for plotting these maps in the Monitor. Following the modifications described earlier the **Casing** component and Heat, Sensor and BnSensor ports will be removed in future versions of the library (deprecated).




Propeller map plot

Finally, the TURBO library reference manual has been updated to reflect the new capabilities, improvements and corrections while a dedicated library is available that incorporates all the examples presented in the manual (TURBO_REF).

## 9. ESTIMATE OF PARAMETERS USING THE ELECTRIC SYSTEMS LIBRARY AND ECOSIMPRO/PROOSIS

Víctor Pordomingo, EcosimPro/PROOSIS

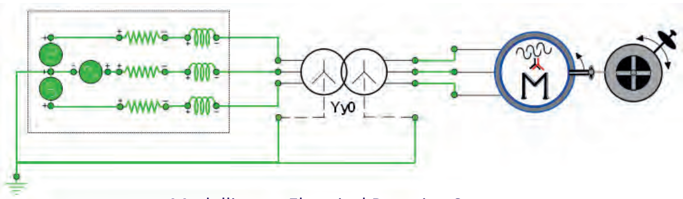
The problem of estimating or identifying parameters may be efficiently tackled and solved with the new capabilities of the EcosimPro/PROOSIS optimisation toolbox. The components that are available in the ELECTRIC SYSTEMS library allow users to estimate the parameters of their electrical simulation models to adjust their response as closely as possible to the real behaviour.

In general, the information manufacturers provide about a given component/equipment item does not include all the information required for the simulation model. The electrical simulation models are based almost entirely on equivalent circuits. Their parameters are not easy to measure or are confidential. Additionally, the available information is generally limited to characteristic curves of the component or equipment item behaviour, such as performance curves for a transformer or torque/slip characteristics in induction motors.

The joint use of the ELECTRIC SYSTEMS library and the parameter estimator that is integrated within EcosimPro/PROOSIS allows the parameters of the equivalent circuit to be simply and intuitively estimated from the curves provided by the manufacturer. Users can rely on wizards to generate experiments to estimate parameters of the corresponding model partition, which allows the estimate criteria to be established.

Once the estimate experiment has been generated, its simulation will automatically search for the values of the parameters that generate a behaviour of the model as close as possible to the one described by the available curves. The monitor displays the results of the model for those values, and displays the generated curves superimposed on the reference curves.

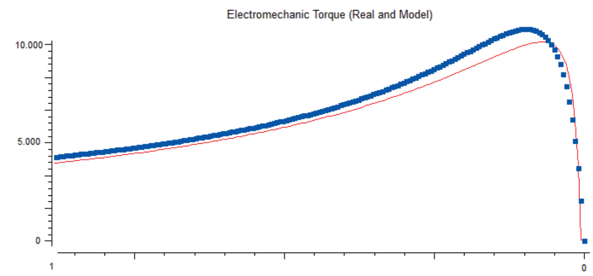
An example of this used the induction motor and transformer models included in the ELECTRIC SYSTEMS library to develop a complete process that could simulate and estimate the parameters of a real system. The model consists of four parts:




Modelling an Electrical Pumping System

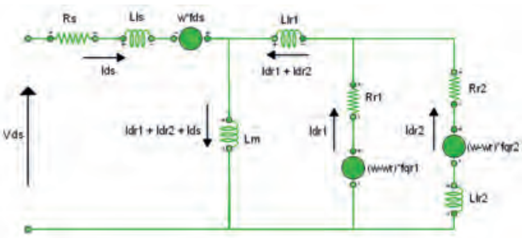
- A power source with outgoing impedance to model the limited power of the system (1906 MVA, 17 KV).
- Three-phase, star-star step-down transformer (17 KV/6.6 kV).
- Dual cage induction motor (2500 KW).
- Mechanical load associated with the pumping system.

It starts by taking the characteristic driving torque/slip curve for the motor, and then creating a parameter estimation experiment on its model so as to define the resistances and inductances of the equivalent circuit from the electrical model of the induction motor. This yields the following approximation for the corresponding combination of parameters.




Characteristic Motor Torque/Slip (real and estimated)

The induction motor used is dual-cage and has a star connection. This kind of motor can be type 1 or type 2 according to the caging. The motor used in the simulation is type 2, and its model is based on an analysis on coordinates dq as per the following equivalent circuit:



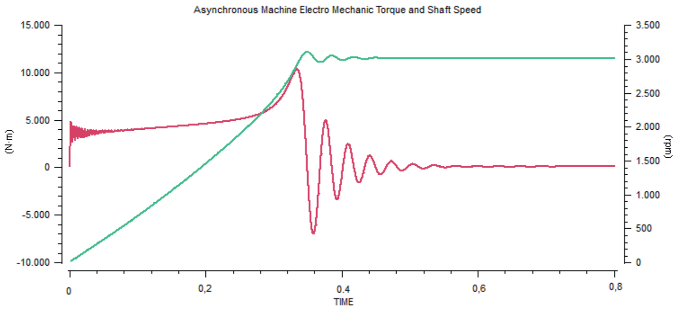

Equivalent circuit of the motor on the d axis (similar for the q axis)

The parameters to estimate are therefore determined by those circuits, with the values obtained as follows:

| Rs | Lls | Lm | Rr1 | Llr1 | Rr2 | Llr2 |
|---|---|---|---|---|---|---|
| 0.112 Ω | 0.007 H | 0.179 H | 0.272 Ω | 0.002 H | 0.112 Ω | 0.002 H |

The modeller's experience is an important factor in configuring the estimator, since he can direct the calculations towards the most

suitable values in each case. Once the configuration parameters for the model of the induction motor are known, the system in Figure 1 is modelled configured with those values to contrast the results with the real measurements available on startup times for shaft speed and torque, obtaining the expected results:




Shaft speed and starting torque for the estimated parameters

As was done with the ELECTRIC SYSTEMS library, the results can be extrapolated to other fields, and can affirm that the parameter estimator is a significant increase in capacity in any library without having to create new models specifically developed for estimation processes. By starting off with reference curves, the user can easily find the values of the system parameters that best fit the results to the available samples.

## 10. HARDWARE IN THE LOOP (HIL)

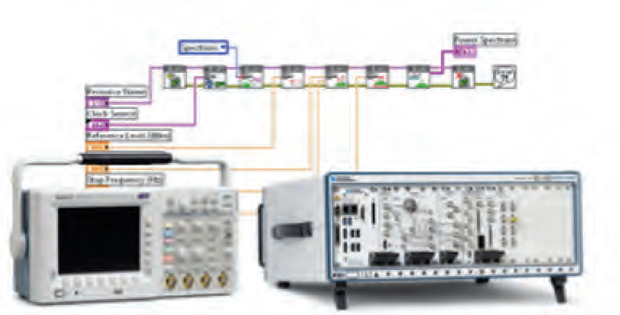
FERNANDO CARBONERO, ECOSIMPRO/PROOSIS

### Hardware In the Loop

The Hardware In the Loop concept (hereinafter, HIL), refers to the including of physical devices (hardware) into the simulation process. A typical example would be the simulation of a plant using software that would be controlled by a real physical controller, i.e., the same one that would perform this duty in the actual plant. This allows, for example, validating a control system without putting the plant or the lives of its workers at risk.

The concept may or may not be associated with the concept of Real-time (RT). We can imagine many processes in which a momentary loss of control would not affect the result. For example, the control of the temperature in a blast furnace has such a high time constant that any loss of the control process for a few seconds would have a negligible effect. However, loss of control during the take-off of an aircraft for even the shortest period of time could be catastrophic.

Moreover, in the case of the blast furnace, we would probably wish to speed up the simulation with respect to real time, to be able to study in just a few minutes the behaviour of several process hours; indeed, waiting several hours to perform different tests of the controller would not make much sense.



Real Time Devices of National Instruments

### An EcosimPro / PROOSIS model in Simulink

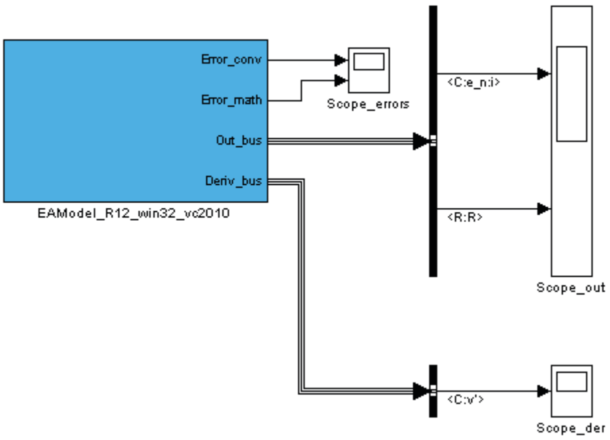
A new Simulink S-Function that allows connecting a PROOSIS model has been implemented in the new version of PROOSIS 3.4.14, and will soon be implemented in EcosimPro. This functionality is on top of the connections to MATLAB that already exist in the program, although it has special characteristics.

One of the goals is to be able to use the PROOSIS model totally independent of the MATLAB one. To do this, we start with an encapsulated model in a DECK. This, in and of itself, offers a number of advantages:

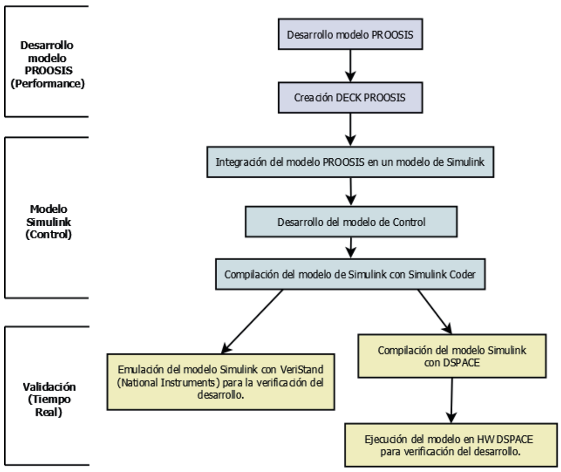
- All the files needed to run the model are grouped in the DECK.
- The model input files are encrypted, thus preserving their security. Furthermore, they can be packaged inside the compiled model, thus making it easier to export them to Real-time environments where file readings are not allowed.
- The input and output variables selected will be the only ones visible in S-Function, and therefore, the MATLAB user will be get a simple model.
- Variables that have not been declared as input or output are hidden from the MATLAB user, thus making it possible to hide confidential or sensitive information.

The S-Function can perform the calculations continuously or discretely. Discrete calculation would be used in Real-time. Communication is established each time the integrator has to evaluate the residual function. This is important when variable step or multi-step integrators (like RK4) are used, as it increases the accuracy of the results.

The entire S-Function preparation process is done comfortably and quickly using dialogs. The final result includes a basic Simulink schematic that can be worked with immediately or that will facilitate the work of the MATLAB modeller.




PROOSIS S-Function Block in Simulink




Development diagram for Real-time model

### Real Time Devices of National Instruments

A Real-time model has to be run on a specific hardware. This hardware is prepared to ensure the correct connection and synchronization of the model with the real plant, if there is one, monitoring that all maximum time limits are met (the model could be too heavy in processing time to be run on the hardware, and thus would be invalid from the real-time perspective).

A large number of real-time devices are available on the market. Each has its own requirements from the point of view of model programming. The first platform to which the mathematical kernel of the PROOSIS model has been adapted is that of National Instruments. Specifically, this implementation would work with the hardware that works with the Phar Lap operating system.

Thanks to National Instruments' Veristand application, the PROOSIS model can be pre-evaluated in an all-software environment before it is transferred to the physical device.

Other platforms will be included in the future.

### Conclusion

A new functionality has been created for the integration of a PROOSIS model into a Simulink model by way of a new S-Function. This achieves enhanced data integration and reliability with respect to previous connections.

The S-function has been designed to facilitate the use of the resulting Simulink model in a real-time environment.

It is now possible to carry PROOSIS models to Real Time Devices of National Instruments with the Phar Lap operating system.

## 11. 64 BIT ARCHITECTURES IN ECOSIMPRO AND PROOSIS

BERNARDO DE BLAS, ECOSIMPRO/PROOSIS

The next versions of EcosimPro and PROOSIS to be released at the end of the year have been designed for the first time for 64 bit technology. This change affects both the main program as well as the various simulation platforms. From the practical standpoint, the user will be able to install the program in 32 or 64 bits.

Moreover, he can choose between a set of simulation platforms that add new ones to the existing ones and which include 64-bit support for users of Visual Studio 2010 and 2013 compilers.

Changing to 64 bits is justified because it permits creating large simulation models that could not be handled before. In the new 64-bit architectures, the memory and register directories are expanded from 32 to 64 bits. In terms of programming, this will provide more memory for programs, since the addressable memory capacity with 64 bits is significantly larger than in 32 bits.

Another improvement of this architecture is the new 64-bit integer management, which speeds up a number of operations. In terms of how the operating system manages it, 64-bit programs can forgo on the compatibility layer used by 32-bit programs, so the operating system makes better use of resources.

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Modelling and Simulation Software

PROOSIS
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