EcosimPro
Modelling and Simulation Software

EcosimPro is a powerful simulation environment capable of modelling any kind of dynamic system represented by differential-algebraic equations (DAE), ordinary-differential equations (ODE) and discrete events. It is based on very powerful symbolic and numerical methods capable of processing complex systems of differential-algebraic equations. With its clever wizards, EcosimPro provides modellers with an easy way to build consistent mathematical models.

EcosimPro has an advanced Graphical User Interface and uses a high-level, “engineer-friendly” object-oriented and non-causal language (EL) for creating reusable libraries of components.

Models can be constructed graphically by ‘dragging-and-dropping’ the required component symbols from the included libraries to a schematic window. Using EL, users can also create new components and libraries, or extend the existing ones.

EcosimPro is used by leading companies in the Aerospace and Energy sectors. European Space Agency (ESA) has chosen EcosimPro as its recommended tool for simulation in several fields, including propulsion, environmental control systems and life support, and power systems.

PROOSIS

PROOSIS is a simulation tool based on EcosimPro and developped in close collaboration with the European aerospace industry and academic institutions. PROOSIS keeps all the simulation power of EcosimPro and adds extra capabilities for modelling gas turbine engines and other related systems: single or multi-point design and off-design calculations, sensitivity analysis, inequalities, turbo-machinery map handling, etc.

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BASIC CONCEPTS

The most important concept in EcosimPro is the Component. A component contains a mathematical description of the corresponding real-world component (compressor, turbine, burner, nozzle, etc.). Components communicate with one another through their Ports. Ports define the set of variables to be interchanged between connected components. Components and ports are stored in reusable Libraries, like the COMB_CHAMBERS library for space propulsion systems. The necessary components and functions for modelling rocket engines combustion chambers are stored in the COMB_CHAMBERS library.

The development of libraries requires a user (Level 1) expert on the physical and mathematical formulation of component models and with deep knowledge of the EcosimPro modelling language EL.

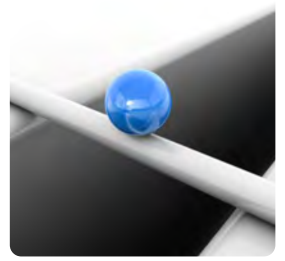
Using existing libraries, a user (Level 2) can construct a model graphically by 'dragging-and-dropping' the required component icons from one or more library palettes to a schematic window, connecting the components through the appropriate ports and editing their attributes. A model, for example, could be a single component, a sub-assembly or a complete engine and its subsystems (oil, fuel, control, etc.).

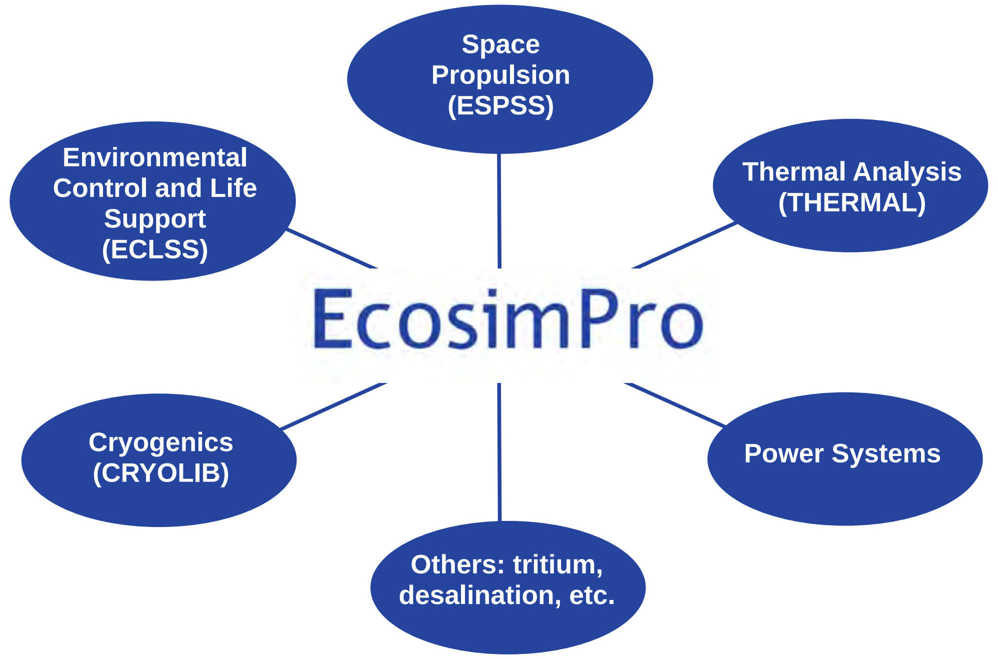
The mathematical representation of a model is called a "Partition" in EcosimPro and it is set with the help of wizards. For a given Partition, a user (Level 3) can define different simulation cases (Experiments) using either wizards or the object-oriented language EL.

Experiments can run either in batch mode or graphically using the Monitor application. A log file with the user-defined level of information is produced for debugging.

From a working experiment and through a wizard, different types of Decks can be generated for delivering a model to a customer (Level 4 user).

EcosimPro also gives engineers a multi-domain simulation environment for modeling a wide variety of phisical systems which can be used jointly.





MAIN FEATURES

• EL modeling language for the creation of new components and libraries. Its non-causal approach allows the modeler to focus on the physical formulation instead of coding issues. Its object orientation allows developing extendible and easy to maintain libraries. Furthermore existing C/C++ and FORTRAN functions can be called from the EL language, and interaction with XML files is easy through the XML parser.

• The symbolic mathematical kernel automatically extracts the mathematical model from the graphical schematic. The user selects the governing input variables (e.g. valves opening law) and the internal algorithms generate robust mathematical models through symbolic manipulation and equation re-ordering. The tool also allows selecting any iterative variables when non-linear equation systems are formed, and provides valuable information about the mathematical problem to be simulated by the solvers.

• The available internal solvers allow dealing with stiff or non-stiff dynamic problems (DASSL, RK4 and Adams-Moulton). The algebraic problems are tackled by an improved Powell's hybrid based method. Convergence issues can be addressed with the help of the simulation log, in which the evolution of the variables, residues, simulation errors and statistics are summarized.

• Common calculations, such as transient and steady simulations, parametric and optimization calculations can be quickly configured through the intrinsic graphical experiment wizards. Any type of calculation can be performed using EL language.

• Models and calculations can be encapsulated and encrypted in a stand-alone application (deck) with user defined accessible input/output variables. The deck can be used in command line mode, through a graphical user interface, or integrated into C or FORTRAN applications by means of standard interfaces (SAE ARP 4868 and SAE AS4191).

• Moreover, with the EcosimPro toolbar for Ms Excel, models can be directly integrated into stand-alone spreadsheets.

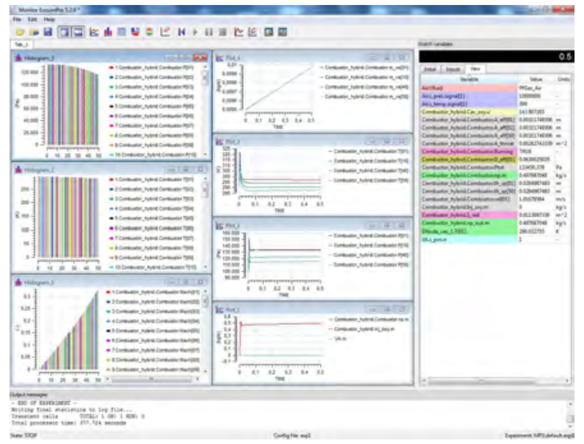
• It is also possible to interact with PROOSIS models from MATLAB. Furthermore, the model can be exported as an encapsulated S-Function block, which means it is possible, for example, to develop the engine with EcosimPro and the control system with Simulink.

• A model can also be exported ready to be used in a HIL system through Simulink. Or it can be connected to SCADAs, other models or hardware using OPC technology.

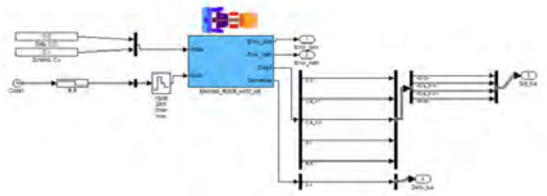
• EcosimPro offers a platform for collaborative work within and between companies. The included source code versioning control system (SVN) integration allows tracking and managing all changes to libraries, models and calculations made by any user. The deck exporting and external tools integration allows safe sharing of models between companies.

Level 1: Modelling of new components

Level 2: Graphical modeling of systems



Level 3: Simulation results visualization



Level 4: Simulating an EcosimPro model from Simulink

APPLICATION FIELDS

The existing EcosimPro application libraries make it a useful tool in a wide range of applications:

Standard libraries

EcosimPro includes a set of standard libraries for general purpose modeling. This libraries include disciplines such as control, mechanical, electric and electronic systems or thermal networks. Besides, common mathematical functions and constants or basic functions for performing optimization experiments are also included.

Space Systems

Several off the shelf libraries are available for the simulation of space applications:

- ESPSS (European Space Propulsion System Simulation), a state-of-the-art tool for modelling rocket engines validated by the industry through experimental tests
- Environmental Control and Life Support Systems including typical phenomena and equipment such as cabins, crew, heat exchangers, pipes, chemical reactions, etc.
- Power and electrical systems, thermal control, AOCS simulation, etc.

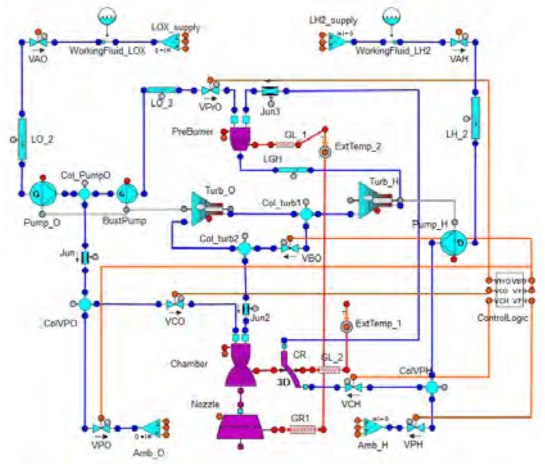
Power Plants

Several off the shelf libraries are available for all sort of analysis of industrial gas turbines and power plants:

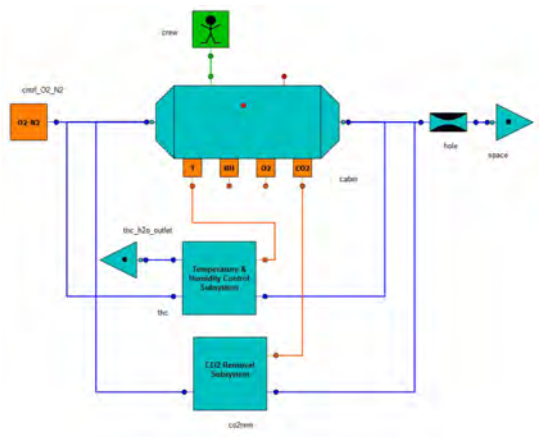
- Fluid analysis of complex systems linked to heat transfer processes and control diagrams
- Thermal balance studies of cycles in the operation of power plants
- Industrial processes such as chemical reactions, distillation, evaporation and boiling, etc.

Other applications:

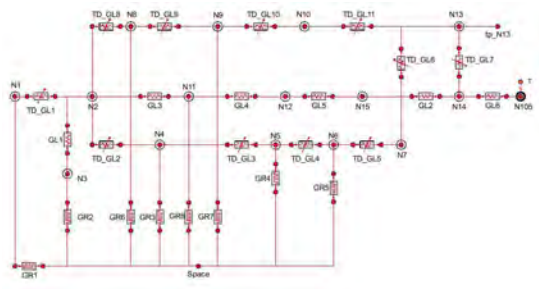
- Gas turbine systems (only in PROOSIS): simulation of any gas turbine configuration together with its auxiliary systems such as fuel supply or lubrication
- Cryogenic systems: dynamic simulation of large cryogenic installations
- Tritium: transport phenomena and physico-chemical processes related to the extraction and purification of tritium for Fusion Nuclear Energy
- Desalination systems: reverse osmosis process and thermal desalination
- New incoming applications under development such as renewable energies and smart grids



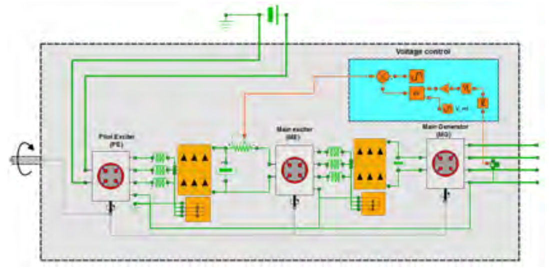
Staged combustion cycle engine model



Life support system model



Thermal network model



Synchronous three stages generator model