

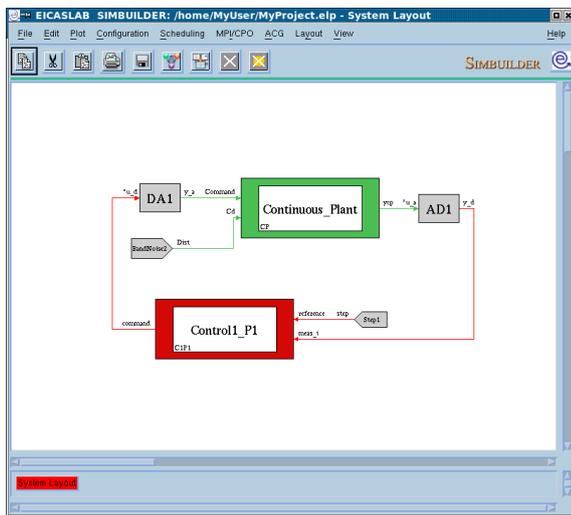
## THE SYSTEM DESIGN TOOL

SIMBUILDER is the EICASLAB tool specifically devoted to support system modelling and control design.

The SIMBUILDER tool is available in the EICASLAB base.

### SIMBUILDER OVERVIEW

The SIMBUILDER tool provides a complete and professional support to the overall control design process, offering pre-organised structures and architectures specifically devoted to system modelling and control design.



SIMBUILDER tool

### A PROFESSIONAL APPROACH FOR SYSTEM MODELLING AND CONTROL DESIGN

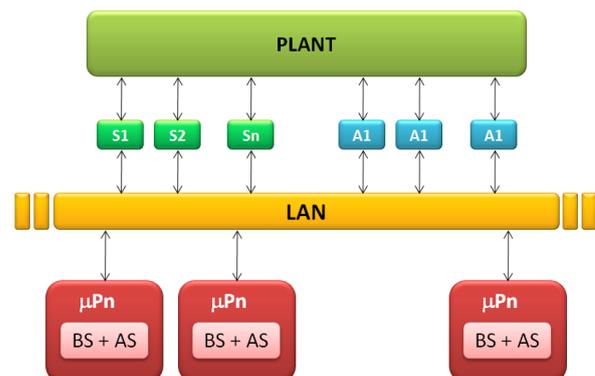
EICASLAB has been conceived and developed as a professional software suite supporting the automatic control design in all its phases and allows developing and testing embedded control system architectures at different hierarchical levels.

SIMBUILDER offers a professional approach to the control system design, giving special attention to the control hardware and software architecture, where multi-processor and multi-level hierarchical controls are considered. The control software is subdivided into control functions allocated by the designer to the different processors. Each control function has its own sampling frequency and a time window for its execution, which are fixed by the designer.

### SIMBUILDER Highlights

- Professional approach for supporting the overall control design process
- Pre-organised environment for addressing multi-processor architectures and multi-hierarchical controls
- Professional support for system modelling and control design
- Advanced activity scheduling
- Wide offer of programming modes for high flexibility and any level of control complexity

Data can be exchanged among the control functions allocated to the same processor and among the different processors belonging to the plant control system, by considering the delay time in the data transmission.



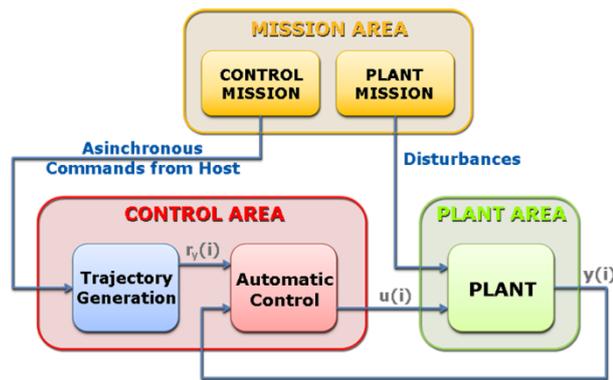


Furthermore, SIMBUILDER provides a professional support for designing system models at different levels of accuracy by means of specific and oriented libraries containing sets of predefined models and assists the user in designing its own system models. All the features and functionalities are provided at the user to assure a very high profile in conceiving, developing and implementing control systems.

## PRE-ORGANISED WORKING AREAS

The SIMBUILDER tool is an environment where the designer can develop all the algorithms and software related to the “plant controller”, including both the “automatic control” and the “trajectory generation”. To perform such a task and to facilitate the user in the design and development of the control system architecture the SIMBUILDER tool provides three main pre-organised *Working Areas*, specifically devoted and customised to program the different parts of the project:

- the *Plant Area*, for modelling the plant to be controlled;
- the *Control Area*, for the implementation of all the control algorithms;
- the *Mission Area*, for the generation of control references and for modelling the disturbances acting on the plant.



SIMBUILDER Pre-organized areas

The *Plant Area* allows an accurate and efficient development of your plant models, providing a general and accurate model for the typical nonlinearities, such as the **hysteresis**, **friction**, **backlash** and other nonlinear effects, that typically are neglected in the control algorithm design but that may act on the frequency band of the control.

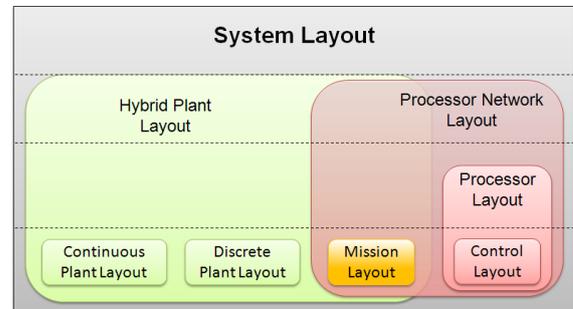
The *Control Area* allows developing the control system architecture and it is conceived to comply with different hardware and software architectures, including multi-processor and multi-hierarchical level control systems. In EICASLAB, the controls are organised in control functions belonging to the same processor and more processor blocks that can constitute a Processor Network.

The *Mission Area* is composed by two parts:

- the *Plant Mission*, devoted to model the disturbances acting on the plant;
- the *Control Mission*, devoted to generate the references of highest hierarchical level for the control.

## HIERARCHICAL LAYOUTS AND LIBRARIES

SIMBUILDER is focused on the concept of “Graphical Layout”, that represents a graphical space devoted to system programming. A set of graphical layouts organized in hierarchical levels are available for each pre-organised *Working Area* (*Plant Area*, *Control Area*, *Mission Area*).



SIMBUILDER hierarchical layout

Each Graphical Layout is devoted to a specific task (f.i. plant modelling, control design) and it is equipped with a specific and oriented *library window* which contains a set of libraries composed by *blocks*.

In particular, the user has at disposal libraries providing blocks that implement mathematical models with different levels of accuracy, taking into account nonlinear effects, such as hysteresis and friction, that are crucial and not negligible aspects in the control system design.

Moreover the SIMBUILDER tool allows the user to create its own *user libraries* containing user blocks programmed in *graphical mode* or in *ANSI C language*.

User libraries may be shared among EICASLAB users:

- collected in archives protectable with password;
- including suitable restrictions devoted to share data preserving each user *Intellectual Property Right* (IPR). Several kinds of restrictions are available, in order to guarantee different levels of protection, depending on the needs.

Special libraries, on purpose developed and customised for several application fields such as automotive, aerospace, robotics and machine tools, time series forecasting and industrial automation in general, are **available on request** and complete the wide and high professional libraries offer available in the EICASLAB Suite.

## SCHEDULING

The scheduling of all the activities involved in a control system is a key task for the successful development of the control system itself.

SIMBUILDER provides a fundamental and professional support for a correct scheduling of the system in all the control design phases: it is based on time scheduling algorithms for managing multi-processor and multi-level hierarchical control architectures at any level of complexity.

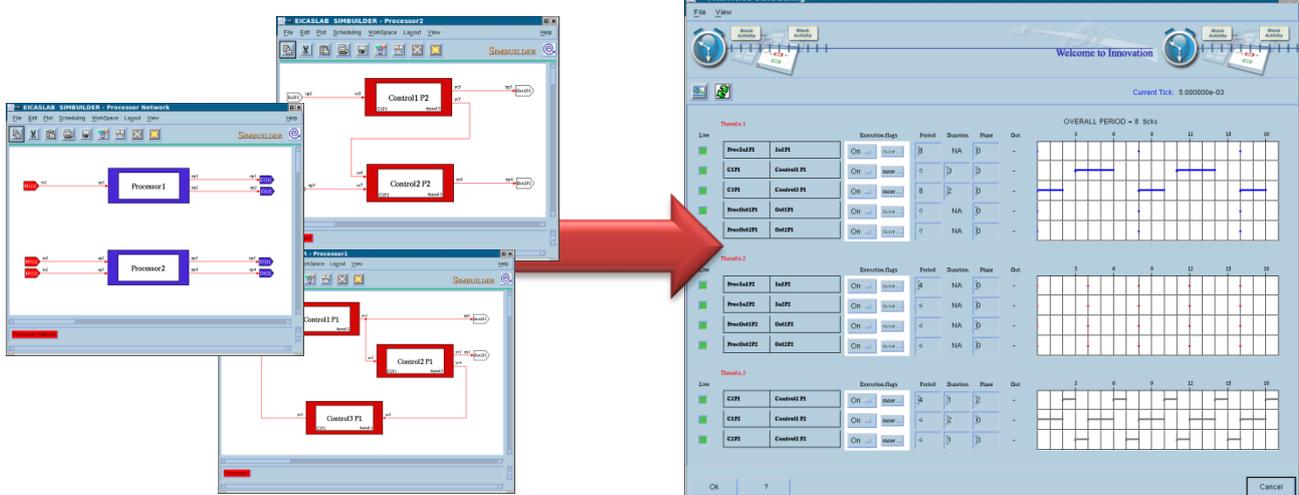
The core of the time scheduling algorithms is the **EICASLAB scheduler** that defines the order of the operations to be executed in all the operative modes, *Modelling and Like Real-time Simulation, Rapid Control Prototyping, Hardware-in-the-loop and Final Validation Test*.

To correctly schedule the activities, SIMBUILDER asks the user to provide for each one:

- the **period**, which is the sampling period of the activity;
- the **duration**, which defines the execution time of the activity;
- the **phase**, which determines the time at which the activity starts, with respect to the starting time ( $t = 0$ ).

In order to correctly develop multi-processor and multi-level hierarchical control architectures, fully compliant with real-time system applications, the designer can allocate each control activity in different processors respecting the final architecture.

Regarding the Rapid Control Prototyping, Hardware-in-the-loop and Final Validation Test, EICASLAB implements advanced multi-threading and multi-core programming techniques that allow the user to organize the scheduled control functions in **threads**, that will be distributed on the **cores** of the multi-core CPU available in a single PC platform, adequately equipped to emulate any designed control system in real-time.



Scheduling activities



## Automatic Algorithm Generation (AAG)

SIMBUILDER includes the **Automatic Algorithm Generation (AAG)** advanced feature, specifically oriented to design the control according to the EICAS control design methodology. The EICAS methodology gives a specific relevance to the plant state observer - the task of which may be extended to estimate and to predict the disturbance acting on the plant - and to the reference generator, used for computing the open-loop action.

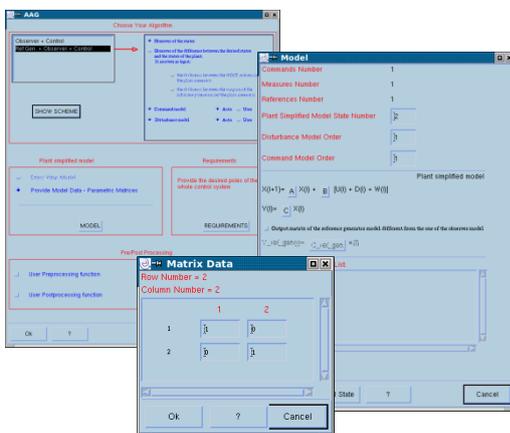
In synthesis, the control is performed by the resultant of three actions:

- the *open loop action*, which is given by the commands necessary to track the reference signals computed on the basis of the plant simplified model;
- the *plant disturbance compensation*, which is computed on the basis of the disturbance predicted by the plant state observer;
- the *closed loop action*, which is computed as the action necessary to correct the plant state error with respect to the reference.

The plant disturbance compensation is an original control feature, which allows to reduce significantly the control error.

The designer can choose among three control basic schemes and for each one he has the option of selecting control algorithms at different levels of complexity.

Starting from the control system requirements and from a simplified model of the plant to be controlled, AAG automatically generates the whole control algorithm.



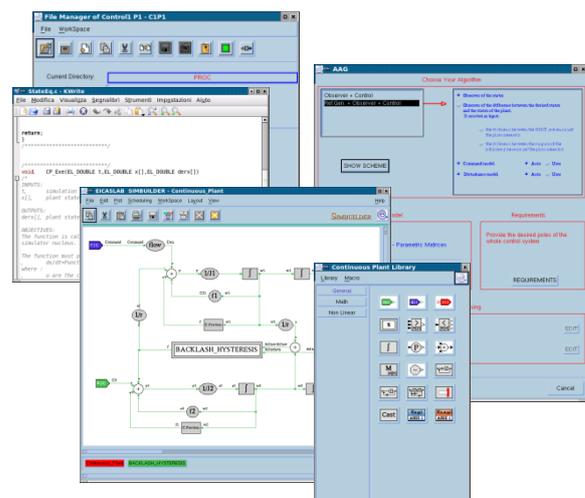
Automatic Algorithm Generation (AAG)

## PROGRAMMING MODES

For describing each *Working Area* SIMBUILDER provides a set of blocks that can be programmed in one of the following modes:

- the *graphical mode*, where the block is described by means of a graphical layout programmable by inserting in it the blocks of its related library;
- the *ANSI C mode*, where the block is easily programmable in ANSI C language by means of an open and customisable pre-organized structure that provides a complete set of template files and libraries, allowing to focus only on the specific and crucial aspects to be programmed;
- the *library mode*, where the user can configure the block by relying on library models available in SIMBUILDER;
- the *library and ANSI C mode*, where the block is developed through a combination of pre-defined libraries and ANSI C language programming;
- the *AAG mode*, where the control algorithms are automatically generated by the Automatic Algorithm Generation feature above described.

The wide offer of programming modes available in SIMBUILDER provides the user with all the flexibility for programming control systems of any level of complexity.



Programming Modes: ANSI C, AAG, Graphical

## CONFIGURATION MANAGEMENT

EICASLAB allows to manage *single like real-time configurations* and *multiple like real-time scheduling configurations*.

The “*single like real-time configurations*” allows performing like real-time simulations with fixed scheduling data.

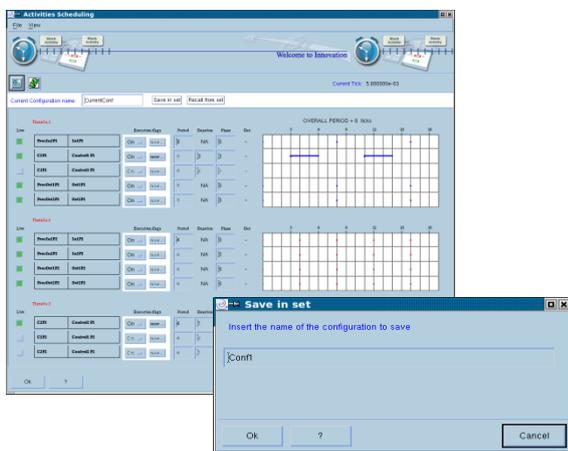
With the “*multiple like real-time scheduling configurations*”, the user can save like real-time configurations containing set of scheduling data corresponding to the list of activities that may be dynamically enabled or disabled by the user on the basis of the occurrence of a given event, either during the like real-time simulations (*like real-time configurations*) or during the experimental trials executions.

The use of the like real-time configurations allows implementing higher hierarchical levels of controls similar to discrete-event control systems, such as Fault Diagnostic Isolation Recovery (FDIR) strategies.

Moreover, the user can save in a database data configurations for project backup:

- configurations containing all the project data and source code, useful to a complete project backup;
- configurations containing only the project data, such as all the parameters and the initial states files, useful as project data backup.

EICASLAB allows to recall the saved configurations, providing the possibility to retrieve a complete or a partial set of the saved data, depending on the user demand, or to remove configurations from the database.



Scheduling configuration management

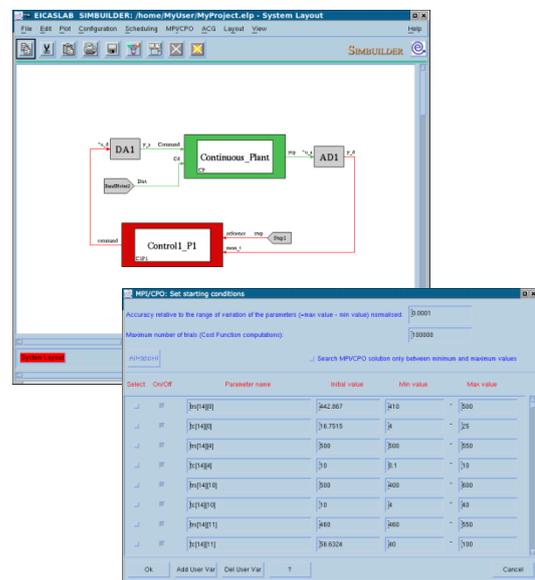
## DATA PLOTTING AND RECORDING

During the like real-time simulation and the experimental trials execution, EICASLAB allows to visualize, on the PC screen, the dynamic behaviour of a set of predefined variables of interest, by means of the SIM tool or the RCP Manager tool. Moreover, EICASLAB allows recording on the PC disk sets of predefined variables for accurate post-processing data analysis carried out by means of the POST tool.

The selection of the variables for SIM and RCP plotting, as well as for the POST recording, is fully carried out and managed through an easy and friendly GUI available in SIMBUILDER.

## MODEL PARAMETER IDENTIFICATION AND CONTROL PARAMETER OPTIMISATION: MPI/CPO CONFIGURATION

In order to support the user in the control system design phase, EICASLAB provides the MPI/CPO Manager that is the powerful tool for performing the model parameter identification and control parameter optimisation. The overall MPI/CPO process may be configured in SIMBUILDER.



MPI/CPO configuration

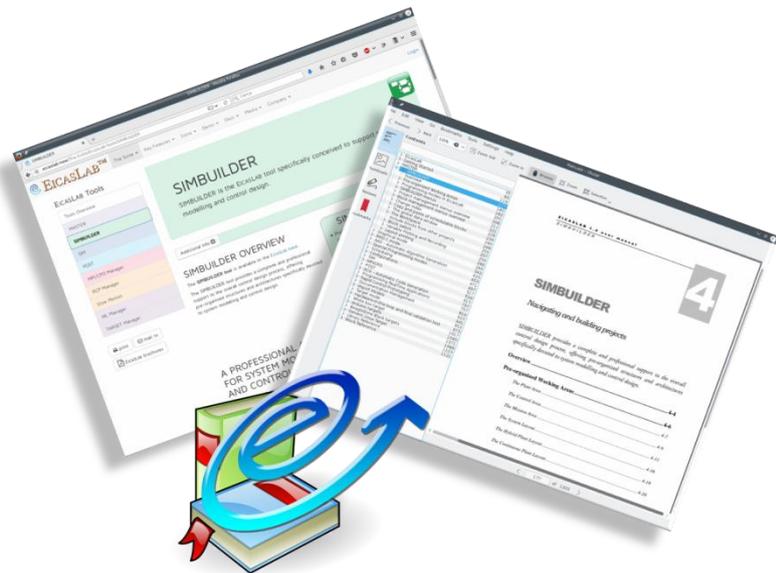


## MANUAL & DOCUMENTATION

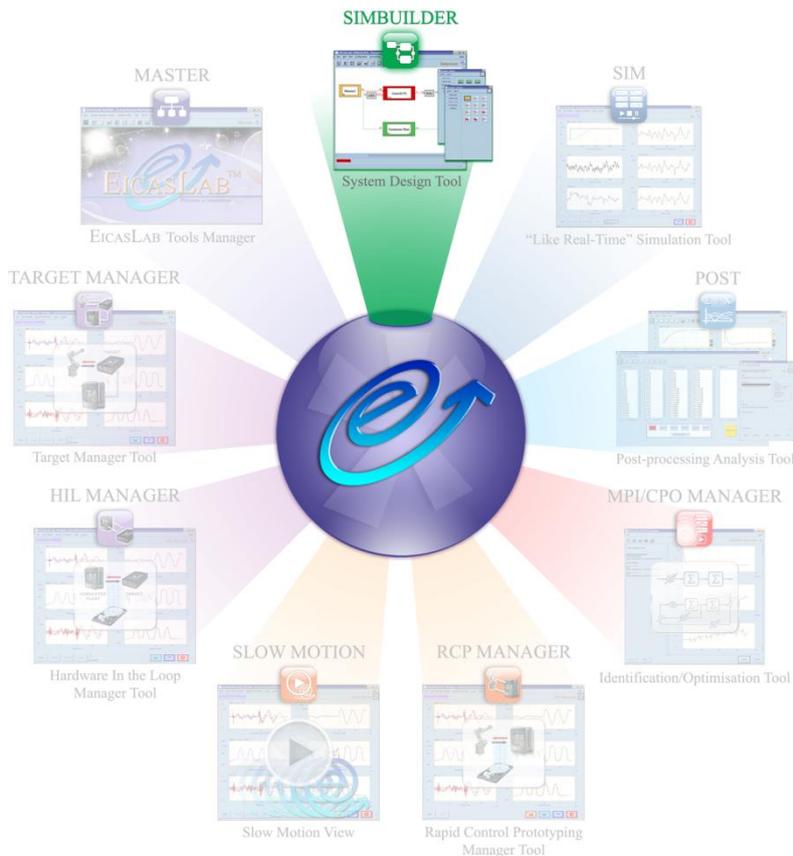
SIMBUILDER provides the user with all the necessary support during the control system development and implementation:

- a specific chapter of the EICASLAB User Manual is devoted to illustrate the overall SIMBUILDER capabilities and help the user to make profit in using the EICASLAB software in system modelling and control system design;
- the EICASLAB website can be directly accessed to get information, to contact us, to ask additional support for designing control systems or enjoy the advantages of the EICASLAB Consultancy services.

Our service support is always at disposal of our Customers with the aim to guarantee the best assistance.



Welcome to EICASLAB Suite.  
Welcome to Innovation!



excellence and passion  
in automatic control design

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