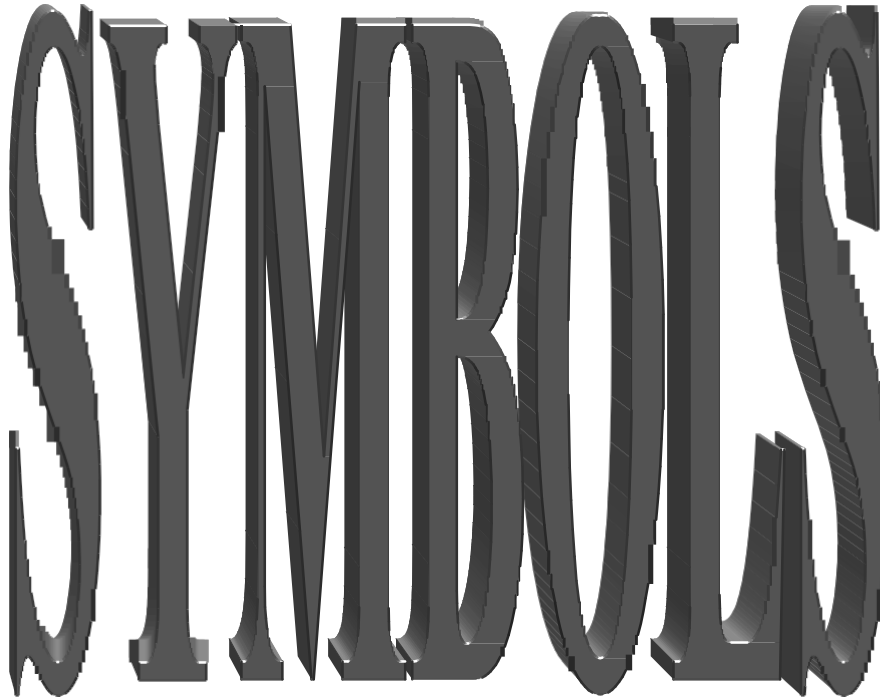


A technical note on SYMBOLS Sonata™



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SYMBOLS software overview

SYMBOLS acronym stands for **S**ystem Modeling by **B**ondgraph Language and **S**imulation. It is a modeling, simulation and control systems software for a variety of scientific and engineering applications. Created out of 25 years of research in system modeling, SYMBOLS is capable of dealing with large systems. Being a powerful research tool, it can help avoid unaffordable, sophisticated fabrications. Yet, we can know precisely the response characteristics of the simulated system (inclusive of any defects and faults introduced at will!). Laboratories, dissertation works at masters and doctoral level in academia can benefit immensely from this software. And lastly, large size *Field Problems of Industry* can be modeled and simulated in such a fashion that one has to work with SYMBOLS to believe its capabilities.

A.1 SYMBOLS Sonata

SYMBOLS Sonata is the next generation modeling tool running in Microsoft Windows 95/98/2000/XP/NT 4.0 environment. User can easily model a system either in Bond graph form or by using its powerful object oriented encapsulation, called **Capsules**.

A capsule is an object derived from a bond graph or other capsules. Each capsule contains information of its internal model, equations, external ports and mathematical relations. In SYMBOLS Sonata, block diagram elements are in fact constructed using capsules. Hence when user draws a block-diagram using these elements, the software brings the powerful validation tool through notion of causation used in bond graphs. Capsules are grouped according to their field of application. Often particular sub-models require different graphs, equations or expressions to be used according to its implementation. For instance, the type of connections in different ports of a transistor would impose different causal patterns, which in turn require different equations and parameters. SYMBOLS Sonata uses **Generic capsules**, which are master sets of several capsules for each causal pattern, and internally retrieves the appropriate capsule transparent to the modeler.

A model in SYMBOLS Sonata may be created using combination of bond graphic elements, block diagram elements in capsulated form or other capsules. Even models can be created purely using capsules. Sub-model capsules can be imported from the huge capsules library or can even be created by the modeler. The pre-cast capsules are not Pandora's boxes. They can be opened using the Bondpad editor and customized according to modeler's need. Modelers may personalize and organize capsules created by them to separate their capsule group from other users.

Default capsules library supplied with SYMBOLS Sonata is grouped into 12 categories.

Block diagram	Economics	Electrical	Electronics
Equation	Functions	Hydraulic	Logic
Mechanical	Source	Structural	Thermal

Unclassified capsule may be created and stored in a general category called "Users".

Each of these categories contains several capsules. These capsules can be downloaded from the Web site <http://www.htcinfo.com>. More and more capsules are added each month along with any related databases only after extensive testing by our experts.

A.1.1 Key features of SYMBOLS Sonata - Bondpad module

- Integrated development platform,
- Predefined capsule embedding and user capsule creation tools,
- Vectorise / Scalarise of capsule ports to a single or multiple bonds,
- On site, immediate modification and drag tools,
- Easy cut, copy, paste and rotation routines for quick editing,
- Straight, curved and multistage bond drawing,
- Multiple model editing and interaction,
- Integrated equation viewer and function descriptor module,
- Online suggestive model validation and error checking,
- Complete C++ compatibility, compilation and error checking,
- Qualitative fault diagnosis module,
- Export routine for MATLAB®.

... and many other features !

A.1.2 Key features of SYMBOLS Sonata - Simulator module

- Integrated simulation environment,
- Easy to access control panels,
- Multiple and intelligent entry mode,
- Online plotting, pause, stop and resume options,
- Online parameter variation through sliders during simulation,
- Continuous run simulation, Multiple simulations of different systems at the same time,
- Simulation extension facility,
- Advanced post simulation plotting facilities,
- Online code editing and compilation,
- Different integration methods for stiff equations,
- Multi-run facility with interpolated or discrete parameter values,
- Event handlers and notification messages,
- Direct debugging and variable tracking,
- Improved external data and chart interpolation routines,
- Facility to customize and distribute solutions to clients,
- Export routine for Microsoft Excel® Datasheet.

A.1.3 Key features of SYMBOLS Sonata - Controls module

The new control systems module is a powerful mathematical tool for modeling linearized systems in analog, digital or state-space domain. The modeler starts with his bond graph or object model and the model is converted to its state-space or transfer function form to work with this module. Key features and modifications to this module are

- Online information on commands and functions,
- Direct or derived entry of analog and digital transfer functions, matrices, quadruples etc. and algebra between them,
- Easy maintenance of variables and display through projects,
- Capability to deal with large dimensions,
- Improved plotting of Bode, Nyquist, time response plots, etc.,
- Many additional forward and inverse transformation routines,
- Readymade routines for filter design,
- Advanced control systems tools like optimal control, Riccati and Lyapunov equation solver,
- Additional digital control system tools including simulation,
- Onetime multi-line and multi-command interface,
- Easy matrix partitioning and augmenting facility,
- Transfer function entry or derivation made easier,
- New component and sub-component accessing syntax,
- Strict variable type checking,
- Operator enhancement for algebra between different types,
- Huge previous display and command line storage in project files,

- Plot and display customization facility,
- Branch zooming of root loci till minutest details,
- Export/Import routines for MATLAB®.

The SYMBOLS SONATA may also run in other operating systems through WINE (A translation layer - program loader capable of running Windows applications on Linux and other POSIX compatible operating systems. Windows programs running in Wine act as native programs would, running without the performance or memory usage penalties of an emulator, with a similar look and feel to other applications on your desktop. Please visit <http://www.winehq.org> for more know-how and download).

A.1.4 Areas of Application

SYMBOLS Sonata is regularly being used for modeling of variety of systems and in teaching courses in system dynamics, robotics and control systems. Some significant applications have been in following areas.

Vehicle dynamics, Rotor dynamics, Robotics and Kinematics, Mechanism synthesis, Vibration isolation, Phase transformations, Launcher dynamics, Grinding processes, Electronic devices, Power electronics, Mechatronics, Hydraulic devices, Acoustics, Pumps and Compressors, Magnetic equipment, Energy systems, Solar panel loading, Electrical machines, Thermal engines, Structures, Controller design, Active components, Economic systems, Quality control, Condition monitoring, Fault diagnosis, Optimization, Measurement and Instrumentation systems.