# PS0020: MODEL DEVELOPMENT PACKAGE

ProSimulator Model Development package is a totally integrated set of simulation software development modules for process plants. It is used by simulation engineers to configure, test, and document dynamic simulation models for process and power plants. The model configuration is template based and easy to build. The package consists of the following sections:

- Simulation database
- Simulation model library
- Instructor configuration utility
- Operator station configuration utility
- Graphic builder
- Model view / debugger

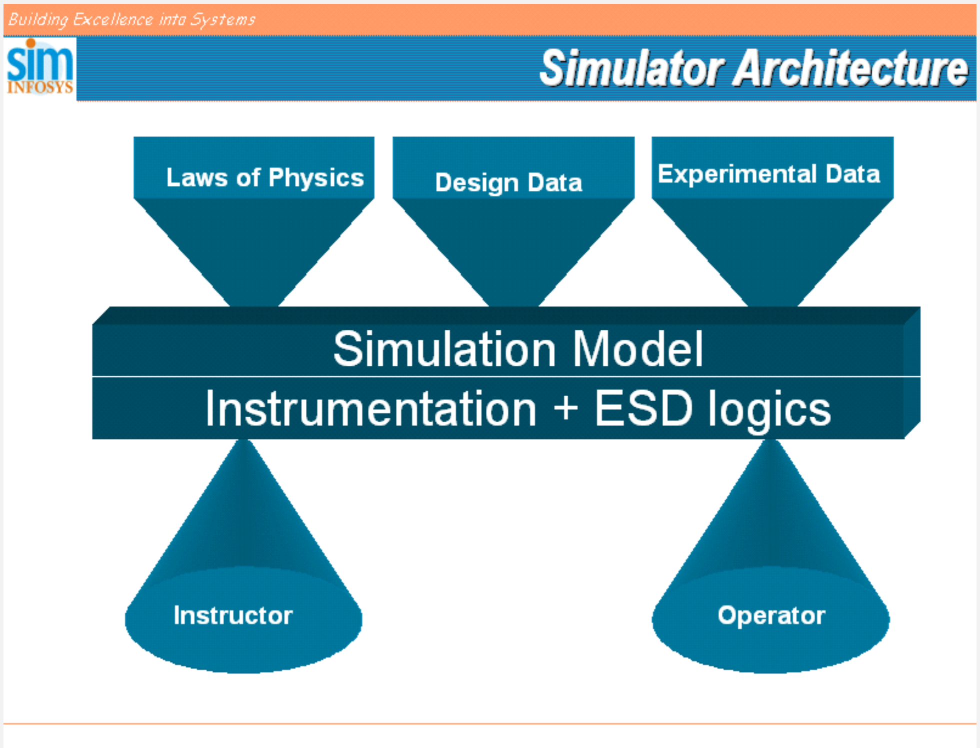
Library modules are typically equipment, unit operation and functional modules. Modules that simulate unit operations include: compressors, distillation sections, drivers, heat exchangers, pumps, valves, and vessels. Some modules provide structural functions for the model, such as: source, sink, divider, mixer, and pressure node. Other modules provide instrumentation and logic functionality, for example, control processors, level transmitters and compressor surge controllers.

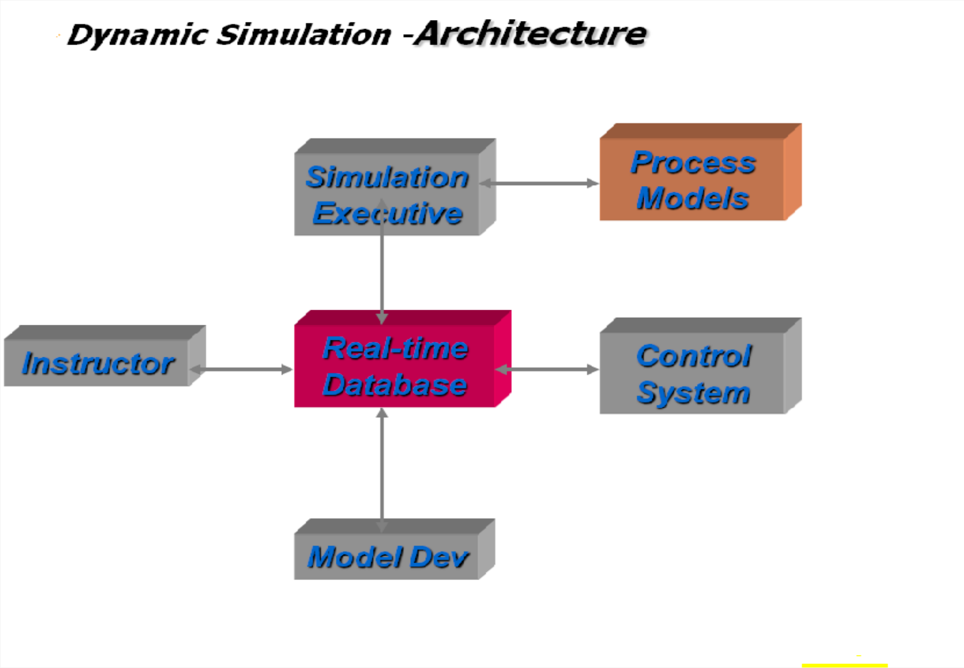
The model development tool kit requires Microsoft Visual C++ compiler and the same will be provided in the Engineering station.

The development toolkit software shall have the ability to:

- Build custom property packages
- Add proprietary reaction kinetic expressions
- Develop specialized unit operations for other process plants
- The simulation software shall permit on line view of the internal process model variables, permit models to be created and modified off line, and permit simultaneous development of two or more models.

The Simulation Model Development Tool is the core of the model development environment. The user trained in simulation model development environment will be in a position to modify the model using this proprietary tool.


Building Excellence into Systems
Simulator Architecture
Laws of Physics
Design Data
Experimental Data
Simulation Model
Instrumentation + ESD logics
Instructor
Operator


Dynamic Simulation -Architecture
Simulation Executive
Process Models
Instructor
Real-time Database
Control System
Model Dev

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Standard library routines available for the following items.

- Sources (air, water, steam, coal, fuel oil, fuel gas, feed)
- Sink
- Centrifugal Pumps
- Fans
- Heat Exchangers
- Compressors
- Distillation
- Evaporators
- Ejector
- Heater
- Multi component Flash
- Cyclone separators
- Filters
- Steam drum, Deaerator, Drain Tank
- Waterwalls (natural circulation, forced circulation, once-through)
- Superheater, Economizer
- Combustion
- Coal Pulverizer
- Steam Turbine Stage
- Gas Turbine
- Mixed properties
- Pressure flow network
- PID Controllers
- Indicators
- Switches
- Manual Loading Stations
- Valves
- Safety Valves
- Thermodynamics Properties
- Steam Table
- Logic & Interlocks
- Mixing nodes
- Flow Conductances (options include parallel, and series)
- Pipe flow (options include laminar, and turbulent)
- Pressure nodes (options include single node, and multiple node matrix)

The simulation model development environment has all the relevant simulation algorithms like the following.

- Euler Integration
- First order Lag
- Matrix Solver
- Scale
- Pulse
- Zero Limiter
- Boolean
- Power
- Random Number Generator
- Return Max Value
- Return Min Value
- Interpolation
- Timers
- Pulse Generator
- Logical Functions, such as Flip-flops
- Limit between Max and Min Values

**Instructor Station Configuration**

This tool is to configure the Instructor Station features like Initial conditions, failure, disturbance etc. This tool is template based and easy to use.

**Operator Station Configuration**

This tool is to configure the Operator Station features like tag details, groupings, etc. This tool is template based and very easy to use. Also one can import/export data from/to XL file. The tool support various DCS like Centum CS3000, VP, Honeywell TDC3000, Experion, Fox I/A and ABB.

**Graphics Development Tool**

Graphics Development Tool kit enable the user to draw graphics for the simulation model. ProSimulator uses Glg Toolkit of Generic Logic Inc for Graphics development. We use a cross-platform RAD tool for developing dynamic data driven graphics and visual components. The Toolkit includes an interactive Graphics Builder for creating 2D and 3D dynamic graphic displays.

**Simulation Library**

- Compressors
  - Based on regressed compressor curves (including surge calculations)
  - Discharge temperature based on polytropic coefficients single-stage/Multiple-stage
- Drives - Electrical drive (constant speed) and Steam drive
- Gas fired Heaters with Stoichiometric Combustion
- Heat Exchangers
  - Two phase adiabatic flash on process streams
  - Process-to-process
  - Process-to-utility
  - Thermosiphon or kettle reboilers
  - Partial, total or subcooled condensers
  - Correction factors for multiple passes
- Pumps - Simple (fixed discharge pressure) and Rigorous
- Sinks - Boundary exit points to simulate downstream pressures
- Sources - Boundary entry point for the flow sheet

- Isothermal Flash sets the product stream phase split
  - Trays (single Tray, Trayed Sections)
  - Absorption
  - Stripping
  - Narrow boiling
  - Wide boiling
  - Multiple feeds, vapor and liquid side draws
  - Pressure drop and weeping calculations
  - Stream component and overall K-value adjustments
- Valves
  - Linear
  - Equal Percentage
  - Modified equal percentage
  - Quick acting
  - Fail open/close/none
- Vessels
  - Handles Liquid-full systems and vapor underflow
  - Vertical/horizontal

  - VLE/No VLE
  - Decant water
- Distillation, Light end Distillation, Absorber, stripper, Fractionator
- Reactors: CSTR, PFR, FBR, Fluidized bed Reactor

Vessels and Separators: Vessels are modeled with all appropriate equipment characteristics. Each vessel has a cross-sectional area and total volume. Vapor phase pressure is determined by vapor inventory, temperature and available vapor volume. All vessels will be modeled with the same size as the actual equipment. The phase equilibrium of the separator is normally determined by the upstream processing equipment and then accumulated and then accumulated in the separator. In most cases, entrainment rates are not simulated unless specified by instructor malfunction.

Heat Exchangers: The dynamic response of the heat exchanger will be provided by considering the heat transfer rate as a function of the operating conditions. Air coolers and shell / tube heat exchangers are simulated as single units.

Hot and cold side temperatures in heat exchangers are normally dynamically calculated. Stream specific heats, heat of vaporization / condensation (where applicable) and overall heat transfer are used in the temperature calculations. Heat transfer is a function of tube and shell side flows, area for heat exchange and exchanger driving forces using AMTD and LMTD. Dynamic conditions in the plant may lead to temperature differences being negative or zero. Under such circumstances, mathematical solutions will not be possible with LMTD. Use of AMTD does not present any mathematical problems.

Mass inventories are used to determine the applicable system time constants.

Some exchangers will be simplified (ie. air cooling, etc.) using the assumption of constant temperature on one side to calculate the outlet temperature of the important process fluid.

Ambient air temperature will be provided as a instructor variable (inputs) These parameters will affect heat exchanger performance.

Heat exchanger fouling, by the instructor, is incorporated as an external parameter to the heat exchanger module and will influence the overall heat transfer.

Motors: The proposed simulation and scope of simulation will not include the power supply systems. Therefore, the simulation of motors will be simplified, but include a reasonable approximation of the motor run-up / run-down time. If speed is controlled, the speed controller will properly alter the motor speed to the desired setpoint.

Filters: In general, filters are modeled in a simplified manner. The filter efficiency will assumed to be ideal. Plugging will be an instructor variable and the appropriate loss of flow will be determined by a loss of system conductance.

**Thermodynamics Options:**

The thermo pack has the following major components:

- Pure component basic property database
- Pure component property estimation
- Petroleum fraction property prediction from MW / BP/ Sp. Gravity
- Mix property calculation

The following properties are available:

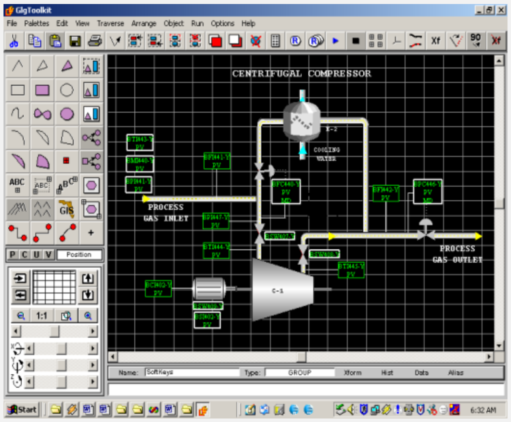
- Molecular weight
- Density
- Watson K
- Carbon number
- Enthalpy
- Specific heat
- Thermal conductivity
- Viscosity
- Surface Tension
- Pour point
- Flash point
- Critical temperature, pressure

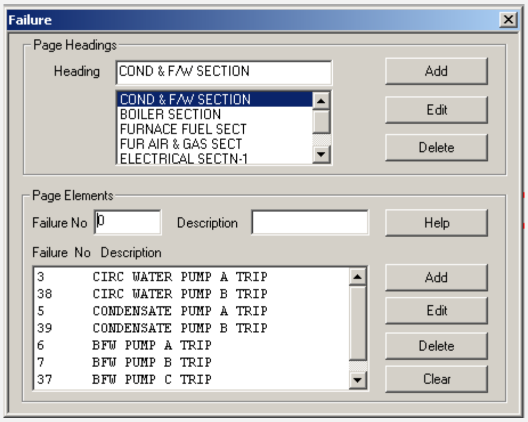
- Accentric factor
- Compressibility factor
- FBP, IBP
- Vapor pressure
- Weathering
- Equilibrium K Value
- ASTM/TBP/EFV conversion
- Saturated properties of Steam, Water
- Solubility
- % Recovery @366 Deg C

ProSimulator can also be integrated with any other 3rd party MVPC controllers. This integration can be done either using OPC/OLE compliance.

**User Manual**

The Model Development Package User Manual provides complete information to the simulation engineer about the organization of the software package, description of all Algorithms in the Libraries, procedures and tasks required for the dynamic simulation project, and several examples. Each of the above nine topics is a chapter in the manual.



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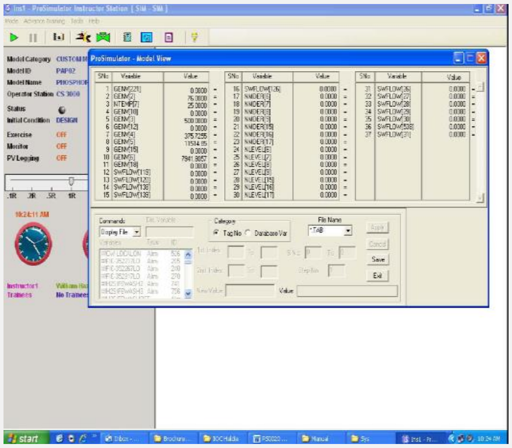

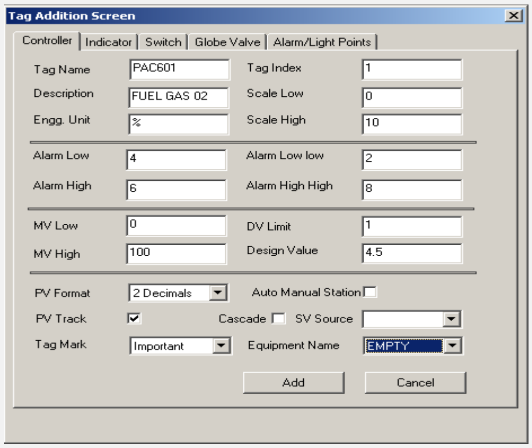


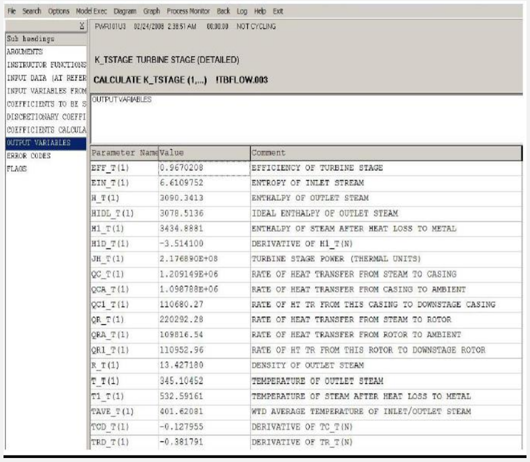


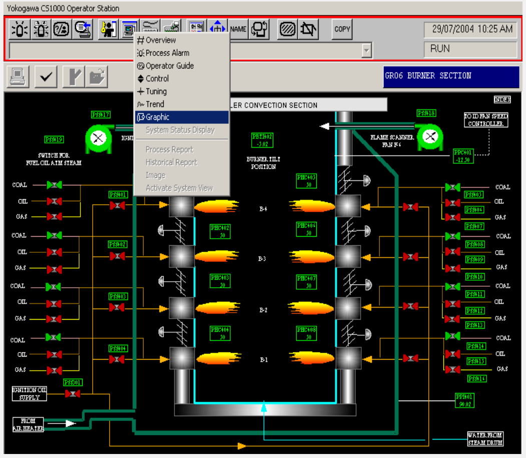


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