
LMCS 2008
Jean Brunet
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SHERPA
ENGINEERING
L'intelligence
au service
des systèmes

Prestations

Études techniques et affaires

- ✓ Réalisation des travaux sur site client ou dans nos locaux
- ✓ Prestations de maîtrise d'œuvre avec apport d'expertise sur les points métiers

Transferts de connaissance

- ✓ Stages de formation inter ou intra entreprises personnalisés
- ✓ Thèmes proposés au catalogue :
  - ✓ Techniques de modélisation
    (temps réel, Bond-Graph, systèmes linéaires et non linéaires…)
  - ✓ Techniques de contrôle commande
    (Commande prédictive, asservissements hydrauliques, actionneurs électriques…),
  - ✓ Formations aux logiciels
    (Matlab, Simulink, Stateflow, Iti-Sim, EES, Phi Sim…)…

Prestations outils

- ✓ Développement d'outils métiers génériques
- ✓ Développement de bibliothèques et utilitaires

(Matlab / Simulink, Iti-Sim, Phi Sim…)

Mission de l'entreprise

Nous mettons en œuvre les concepts de **l'Ingénierie Système orientée modèle** pour la conception et la validation des systèmes opérants et des systèmes de contrôle- commandes

Nous assurons la **maîtrise d'œuvre** :

- ✓ de projet globaux d'ingénierie dans le cadre de l'Entreprise étendue,
- ✓ de la prise en charge, réalisation et validation de prototypes de systèmes de contrôle commande et de systèmes associés en identifiant les risques industriels et les moyens d'essais,
- ✓ du transfert de savoir faire scientifique et technique et la formation associée dans les domaines : automobile, aéronautique, spatial, transports, industries de production,
- ✓ en s'appuyant sur des offres produits et services pour déployer l'ingénierie système orientée modèles et capitaliser le savoir faire.

« **SHERPA** ENGINEERING »
est au centre du réseau de partenaires
« **SHERPA** GROUPE »

PhiSim

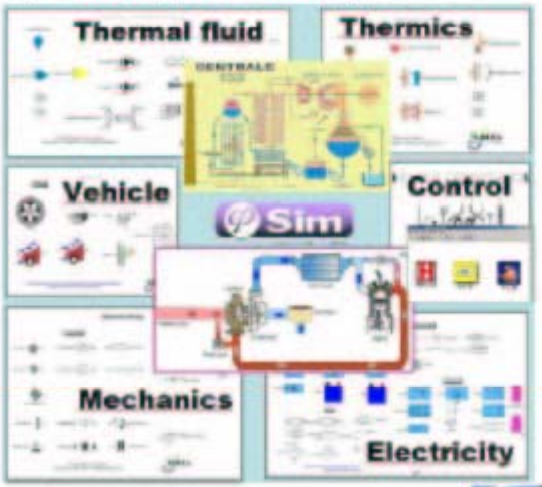
MultiPhysics Libraries

Libraries PhiSim physical cover areas: mechanical, thermal, electrical, thermal fluid monophasic, diphasiques, moist air gas mixture...

The libraries are supplied with PhiSim developed under Simulink and contains a set of standard components that cover a wide range of applications in engineering and physics.

End users can build their own specialized library from the basic and create models with multiple domains with speed and flexibility.

The basic elements of the library are the node or the capacity. In thermal fluid is, one find the source of flow rate, flow enthalpy and heat flow, the volumetric compressor, the compressor and turbine rotating, the pressure drop with different configurations (singular or valve, the regular pressure drop) heat exchanger, ...



OBJECTIVES PHISIM

Support to Model Based Engineering System

System models development :

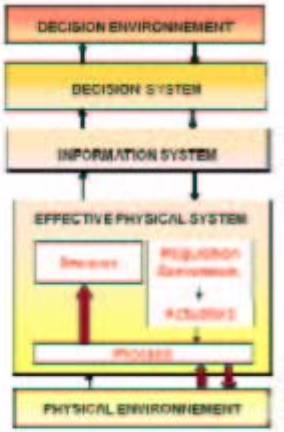
control, actuator, sensor, physics,…

Applications : thermal engine, power train, air conditionning, fuel cell, industrial process

Environmental Models

covering the control system validation cycle with different levels of abstraction

- ✓ MIL : model in the loop
- ✓ SIL : software in the loop
- ✓ HIL : hardware in the loop



Main Requirements

- ✓ Functional Requirements
  - ✓ Polymorphism to take into account the system diversity
  - ✓ Multi-Physics , multi-ports for physical sub-system
  - ✓ Model based predictive control blocks for control
  - ✓ Easily parametrable and calibrated at different levels
- ✓ Constraints
  - ✓ Real time : intégration at fixed step & compatible for compilation
  - ✓ Exportable to others targets
  - ✓ Ergonomic user interface

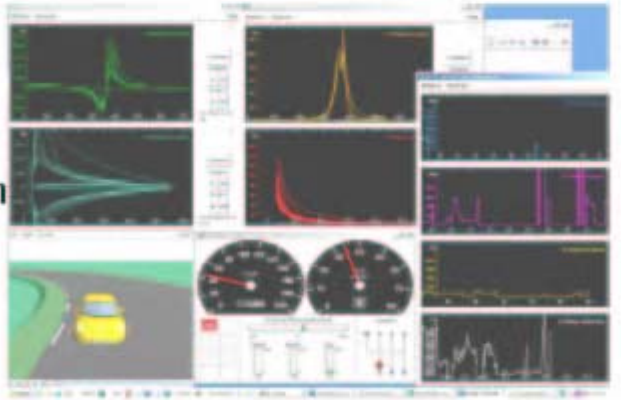
Covering of the Life cycle Needs

SEML : SHERPA ENGINE MODEL LIBRARY

CHALLENGE : real time engine simulator for all types of engine (standard & turbo ICE, Diesel, Gaz)

USE CASES:

Test of functional & performance requirements of a control system : pollution, driveability, consumption, combustion & torque, after-treatm
MIL,SIL,HIL engine control validation



Integration in CarMaker

FUNCTIONALITIES :

- -polymorphic physical component libraries
- - real time simulation in nominal & degraded modes
- -semi automatic calibration

RESULTS :

- - drastic reduction of design & calibration time
- - 1ms sample time

Partners : IPG

Customers

Group VOLVO

PSA , RENAULT

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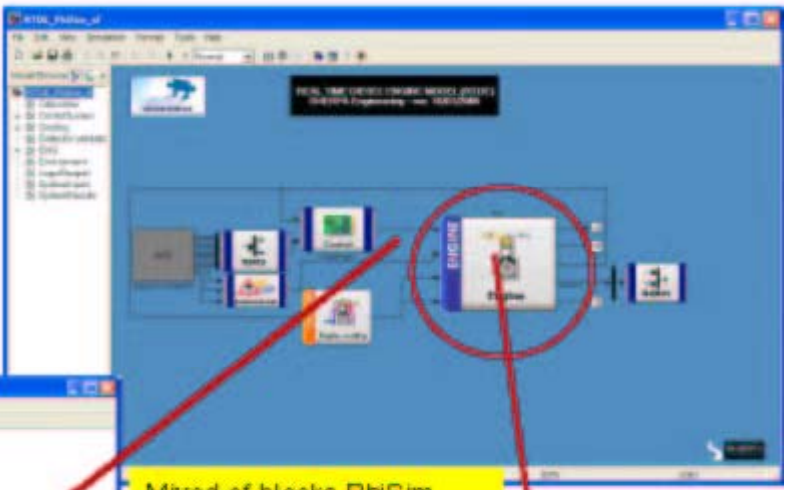
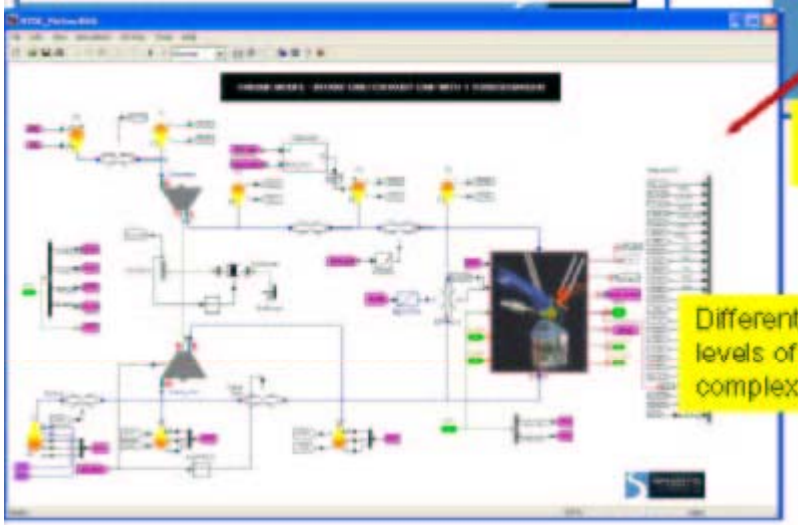
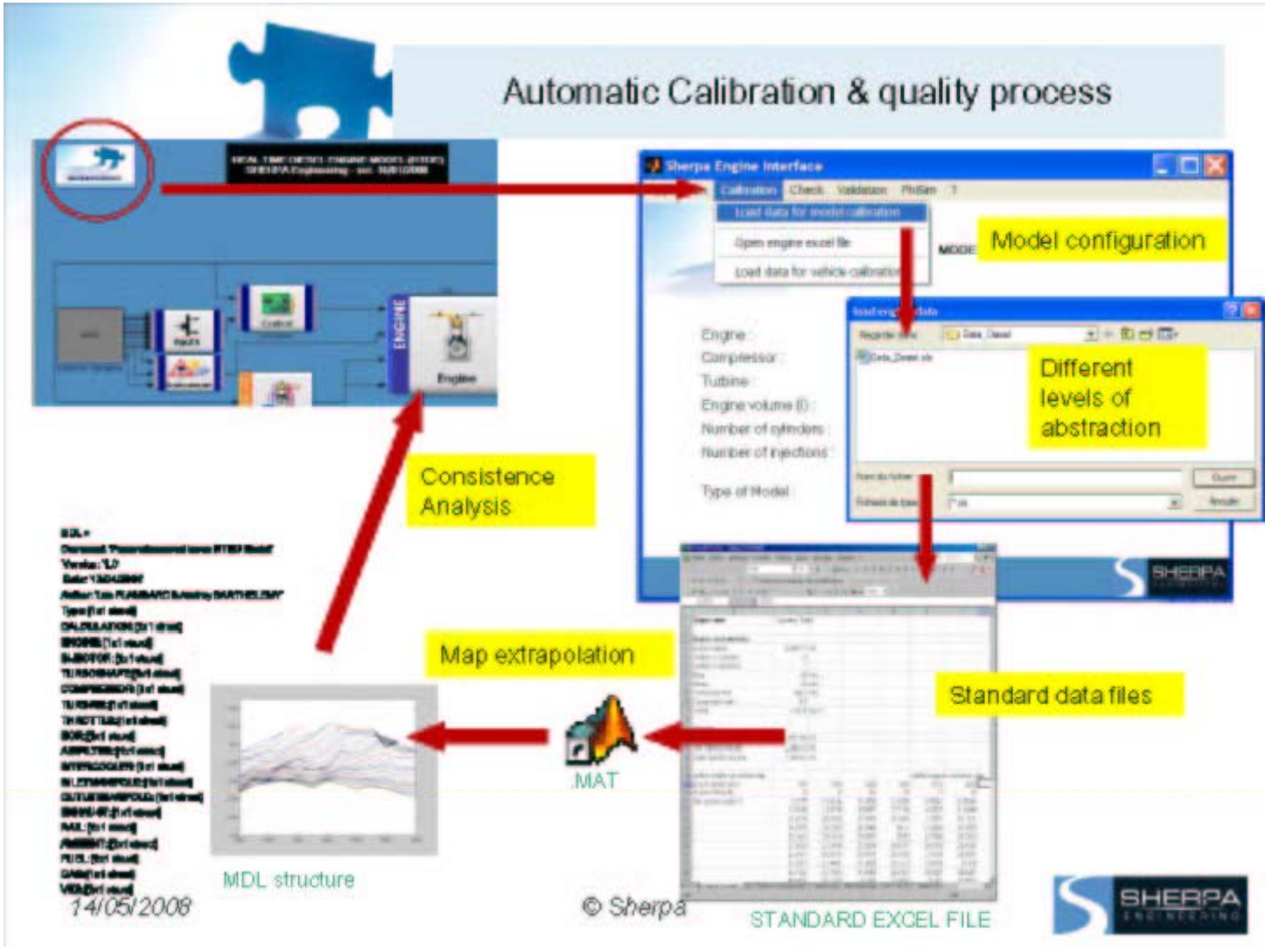
Sherpa Engine system model





Mixed of blocks PhiSim and Simulink

Different levels of complexity


Automatic Calibration & quality process
Sherpa Engine Interface
Model configuration
Different levels of abstraction
Consistence Analysis
Map extrapolation
Standard data files
.MAT
MDL structure
STANDARD EXCEL FILE
14/05/2008
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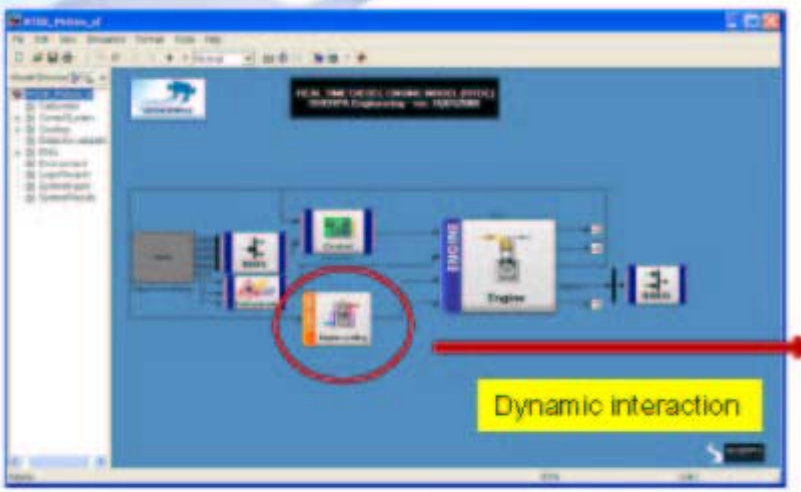
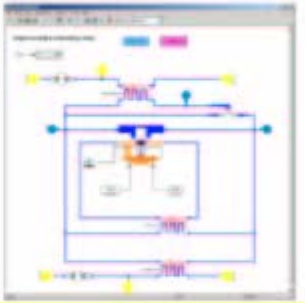
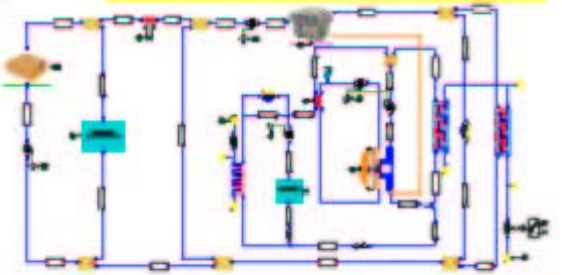
Cooling model





Conventional cooling loop

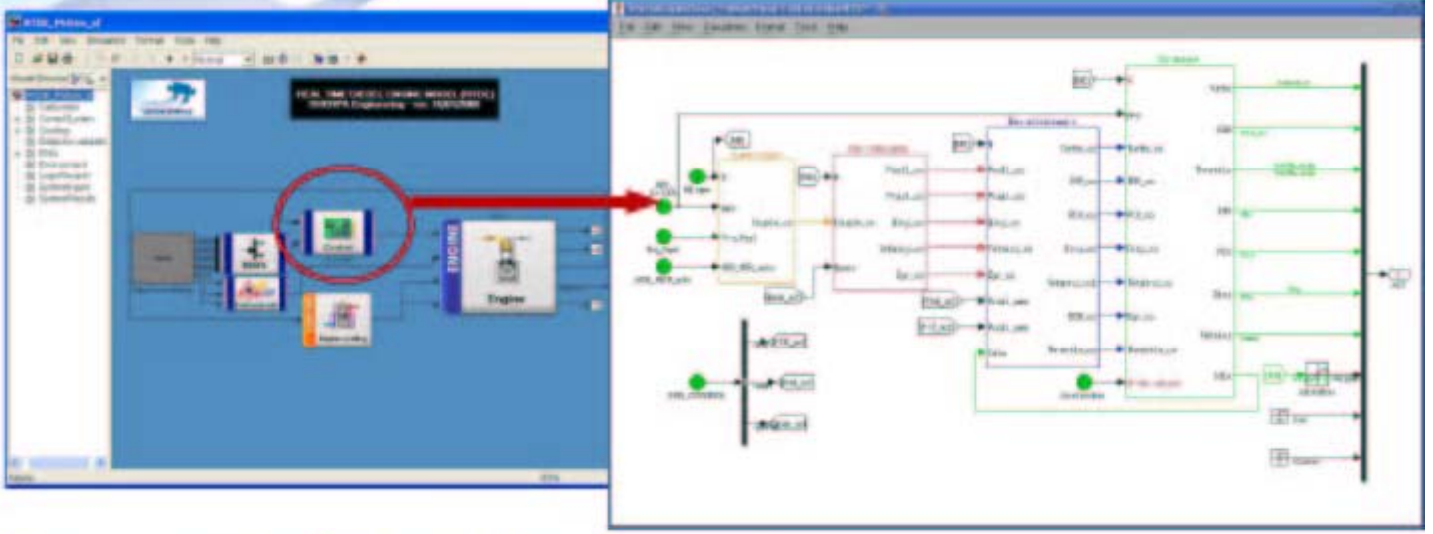


Hot and cold loop of hybrid vehicle

Taking into account of water/oil/air thermal effects (under hood, water circuit, ...) and interaction with engine

Tests of cooling strategies on consumption

Engine control model



The engine simplified ECU model takes into account:

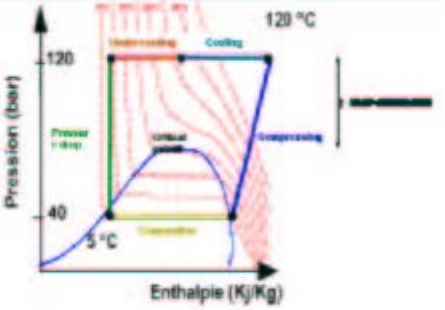
- Actuators of air circuit (EGR, Turbo, VVT, …)
- Actuators of fuel injection
- Engine strategies: idle speed, slow down, injection break, …

Model based approach
Makes easier the calibration

SHERPA PHISIM AIR CONDITIONNING MODEL

CHALLENGE :

Generic package for Air Conditionning system design & validation : control, instrumentation, cold loop, heating loop, car compartment

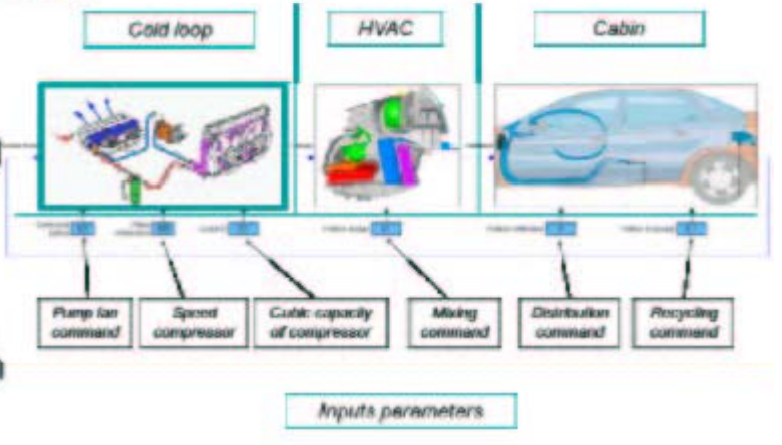


USE CASES:

Sizing & validation of physical system architecture
calibration & validation of hierarchical control
Tests plan definition

FUNCTIONALITIES :

-Diphasic Fluid (CO2, R134a,New..)
- dry&wet air diagram
- model based generic control : supervision, sequencing, regulation , defaults management , nominal & degraded modes, calibration



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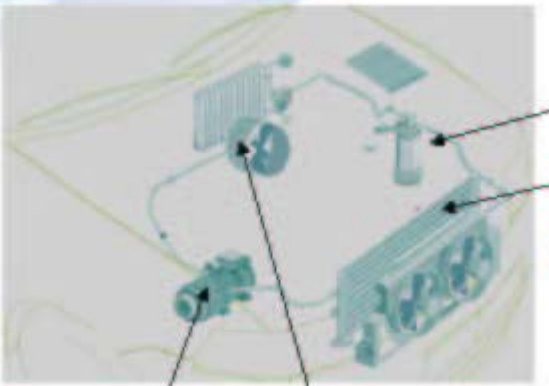
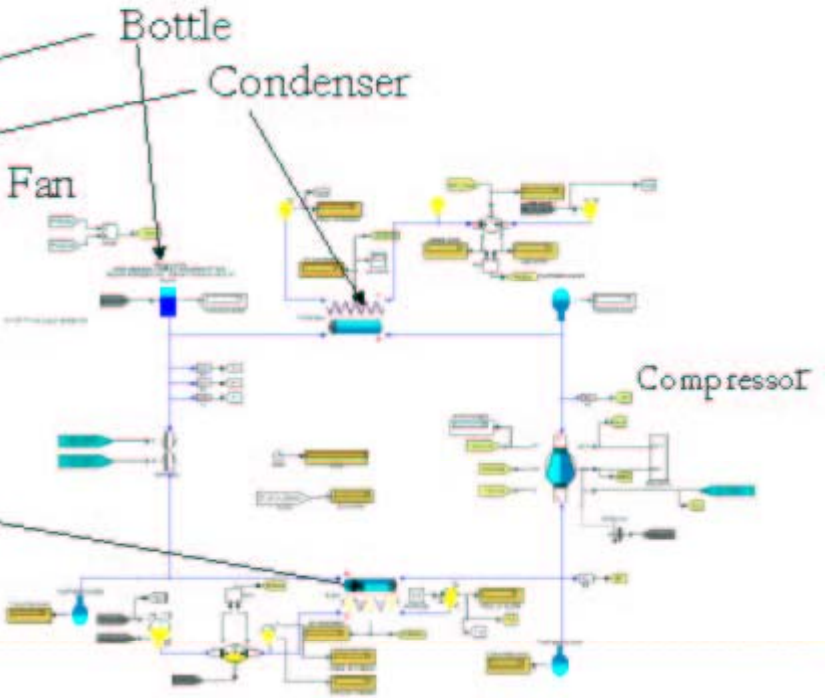
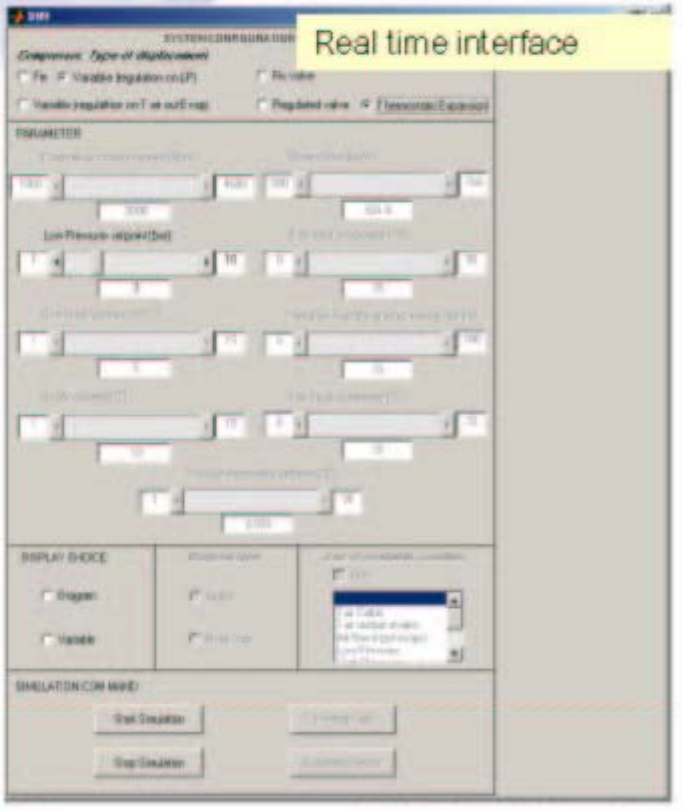
AC Loop Modeling



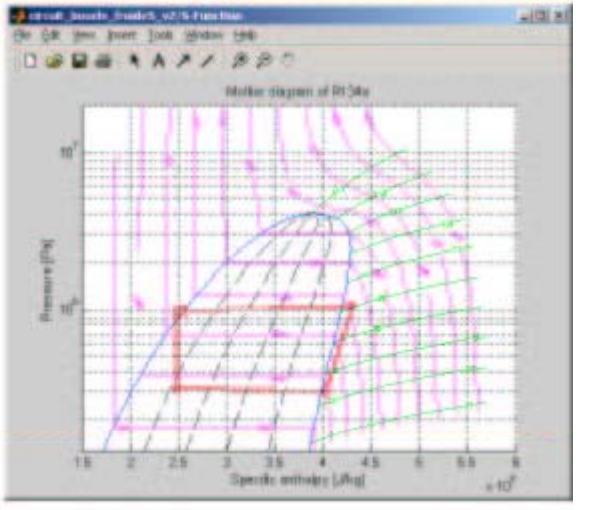


AC Loop Modeling

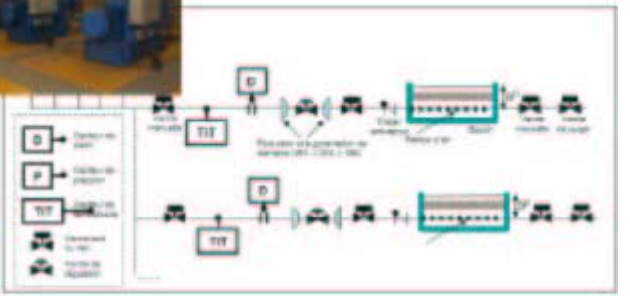


Tool fully integrated with Matlab

Mollier diagram of the model



AIR DISTRIBUTION SYSTEM FOR WATER TREATMENT

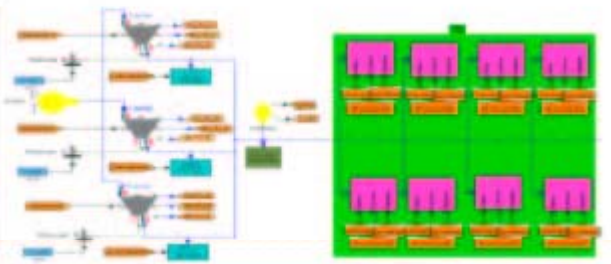


CHALLENGE : validation « model in the loop » of the sequencing (operating modes and control law before start up.

APPROACH:

- modelling & simulation of pumping station (5 compressors) , distribution circuit (4 lines) and exhaust lines (40 valves)
- simulation & checking of performances requirements satisfaction

RESULTS : Recommandations concerning the control strategy , the calibration setting an the pressure/flow control law (multivariable decoupling)



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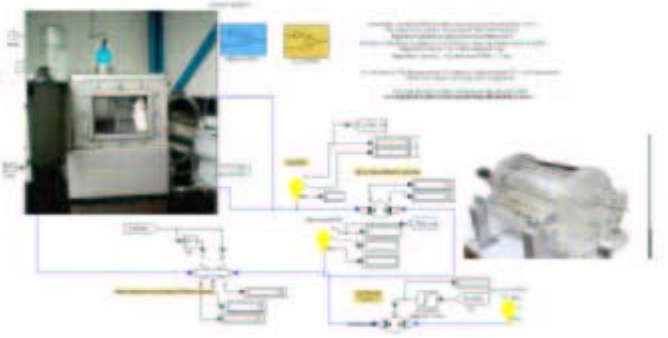
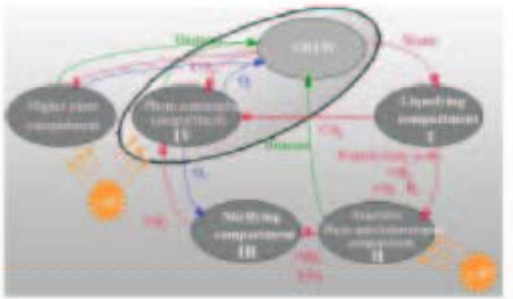
BIORAT MODEL (ESA)

CHALLENGE : O2 loop control of mouse compartment for closed loop space demonstrator



APPROACH: Gaz /Liquid exchange, O2/CO2, photobioreactor PhiSim modelling
Model based predictive control definition & calibration by PCR tool box



RESULTS : Model based predictive control law implemented in PLC

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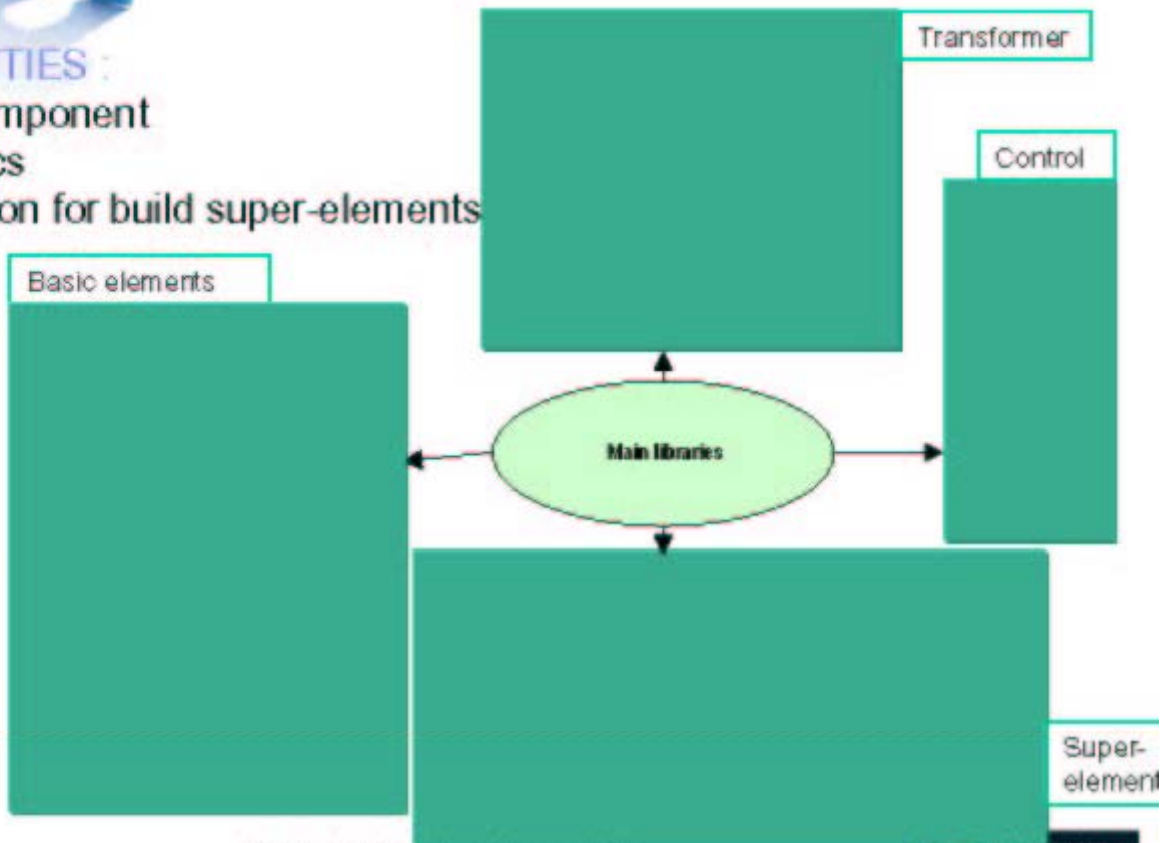
PhiSim libraries

FUNCTIONALITIES :

- Physical component
- Multi-Physics
- Encapsulation for build super-elements



Thanks to a ***limited number of basic elements****, a large set of physical phenomenon can be handled.* ***More specific elements*** *can be developed or derived from these.*

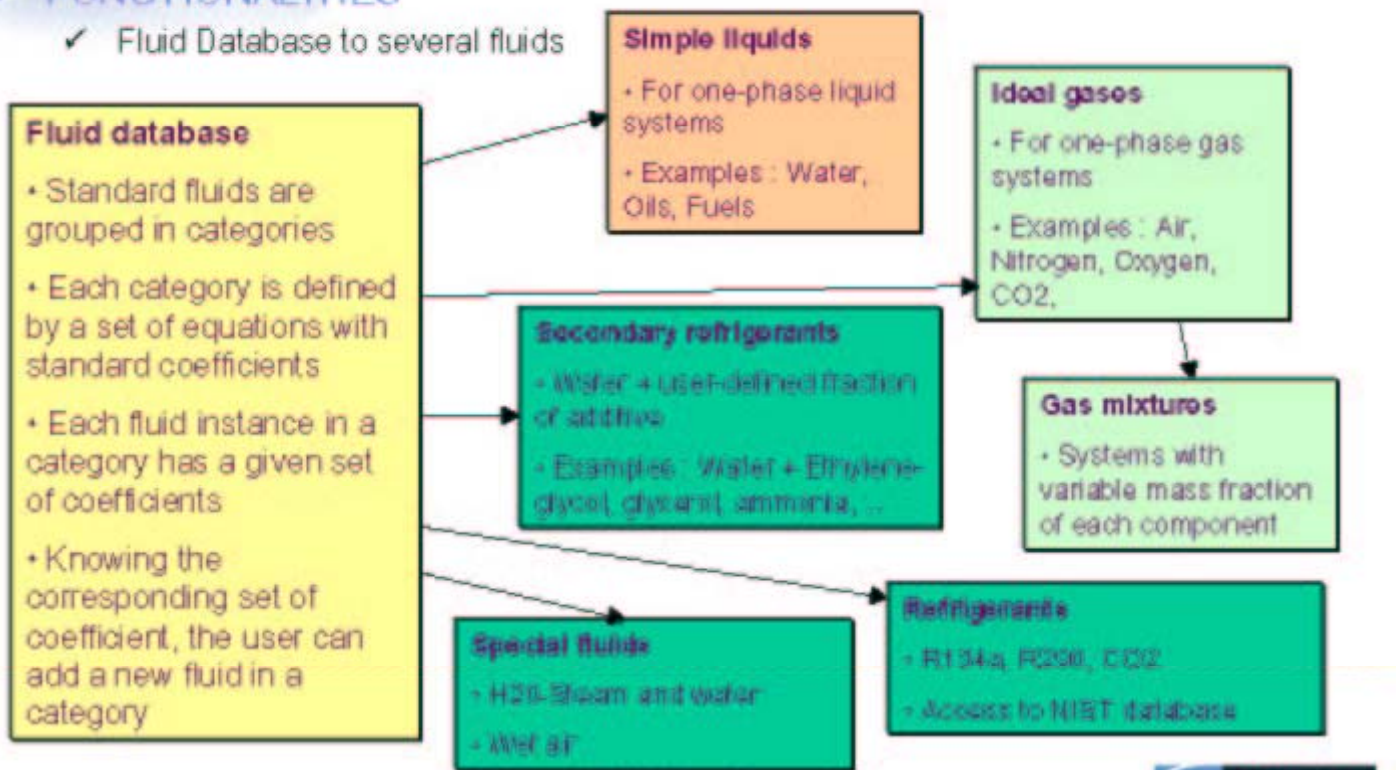
Model based predictive control Libraries

- **Monovariable Predictive control with intenal models**
  1st, 2nd, 3rd order with/witout delay , with feedforward of measured disturbances
- PLC Libraries (Schneider, OMRON)
- Simulink libraries
- Code C identical between the plate-formes
- Easy implementation :norm IEC 1131-3

Thermal-Fluid Libraries

✓ FUNCTIONALITIES

✓ Fluid Database to several fluids



PhiSim - Multi-physics system modeling toolbox

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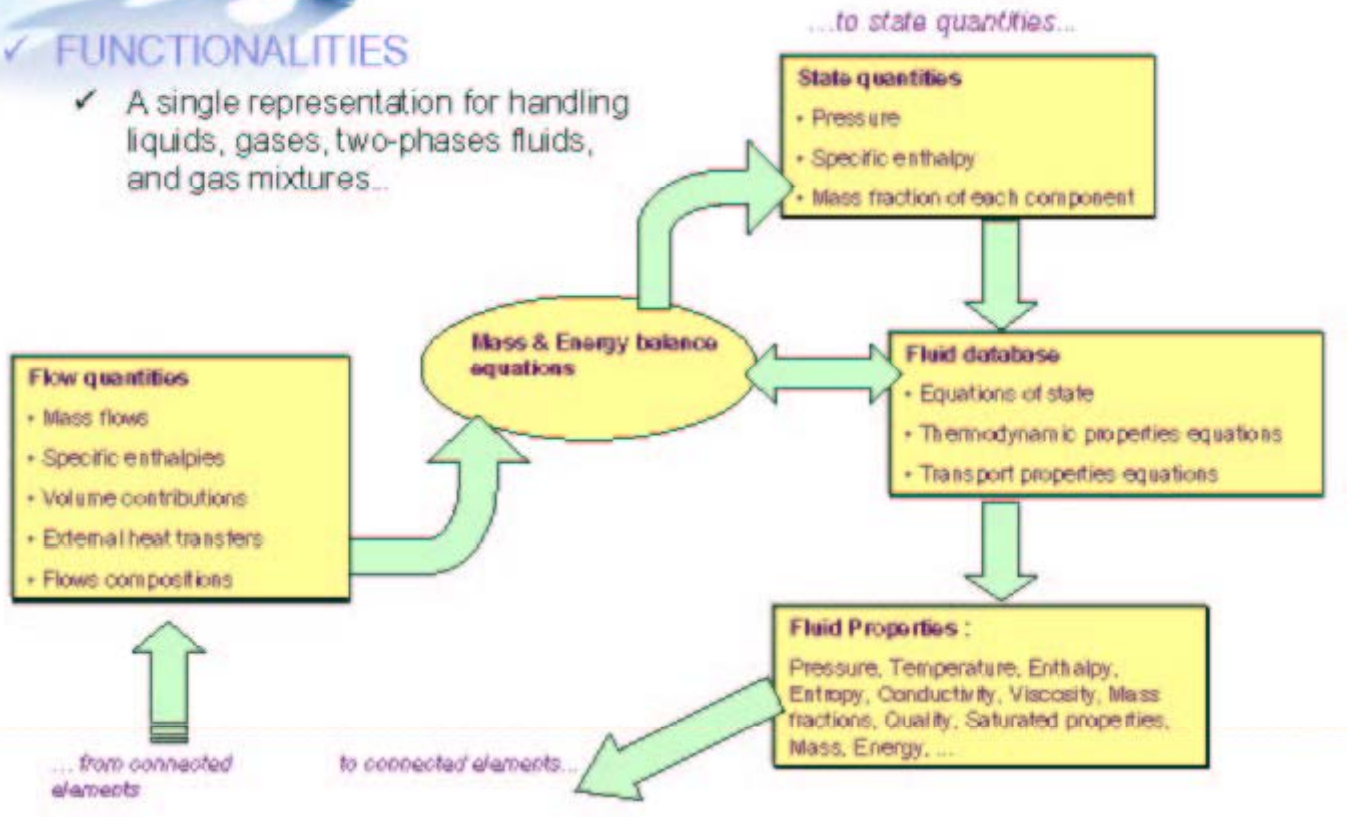
Thermal-Fluid Domain

✓ FUNCTIONALITIES

- ✓ A single representation for handling liquids, gases, two-phases fluids, and gas mixtures...



PhiSim - Multi-physics system modeling toolbox

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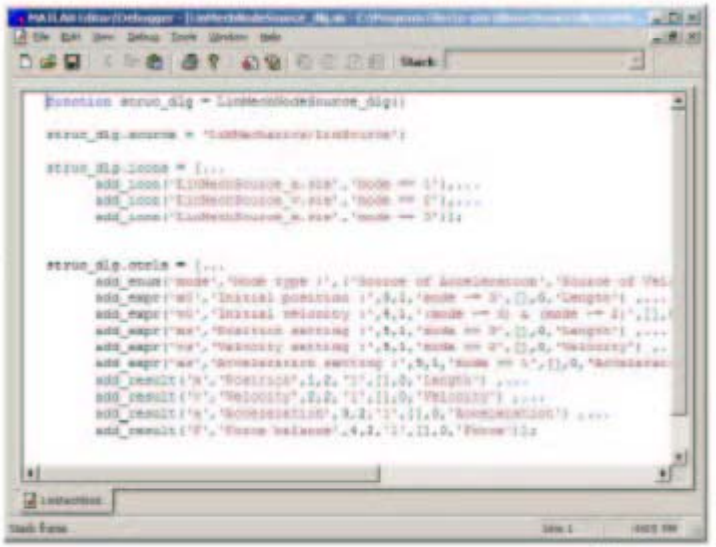
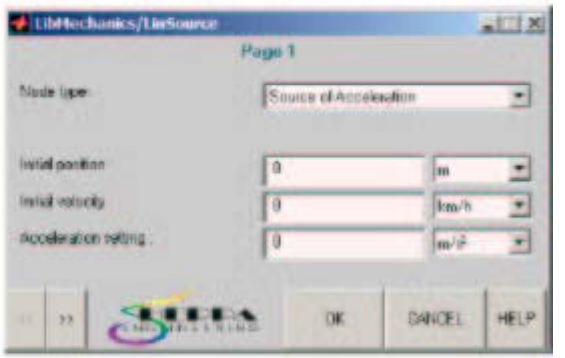
Dynamic dialogs and Polymorphic modeling

✓ FUNCTIONALITIES

- ✓ Advanced dialog boxes created from a standard definition file



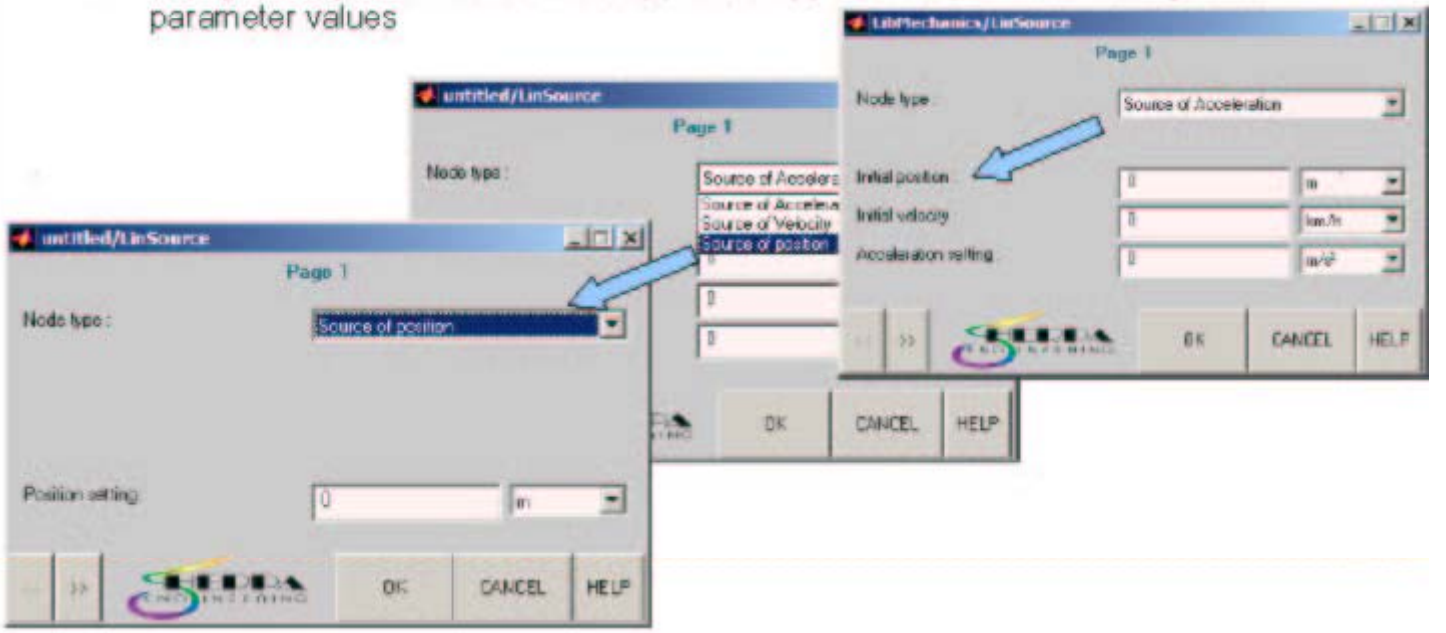


PhiSim - Multi-physics system modeling toolbox

Dynamic dialogs and Polymorphic modeling

✓ FUNCTIONALITIES

- ✓ Polymorphism to take into account the system diversity
- ✓ dialogs are dynamic, i.e. controls appear/disappear when the user changes the parameter values



Polymorphism for Inputs / Outputs

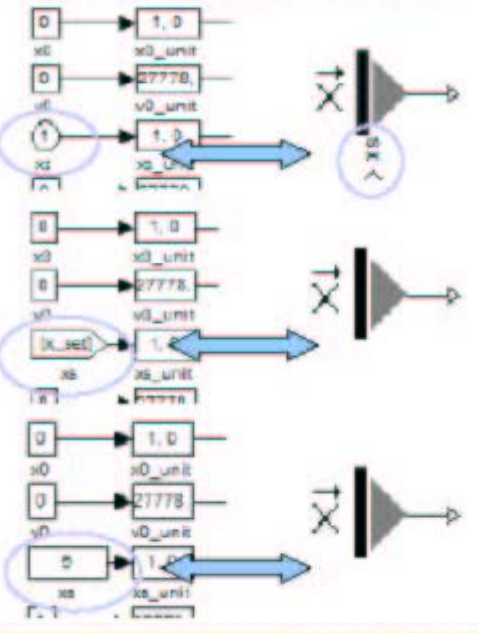
✓ FUNCTIONALITIES

✓ Giving simple keywords in the dialog, the user can change any parameter to...

... an Input port

... a From tag

... a constant or a workspace variable

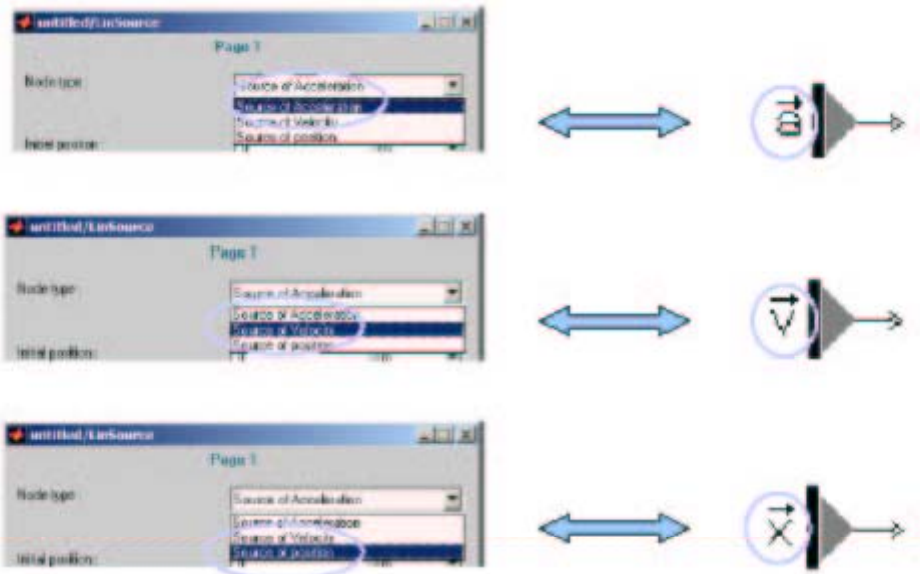


An equivalent feature is also available for results with Output ports, Goto tags, and ToWorkspace blocs.

Polymorphism for icons

✓ FUNCTIONALITIES

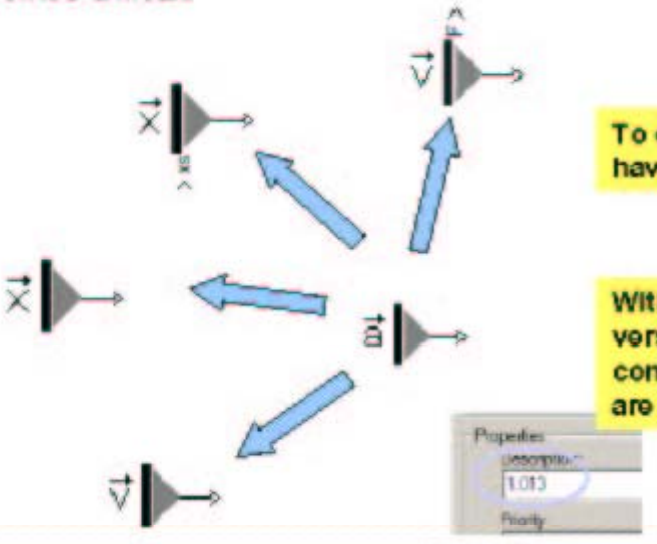
✓ Different icons can be assigned to a single element. The icon is then displayed dynamically with respect to the model behavior chosen by the user.



Versioning of components

✓ FUNCTIONALITIES

- ✓ The consequence of polymorphism is that a component can have a large number of copies of itself in the models. Then, ensuring evolutions of the original copy becomes difficult.



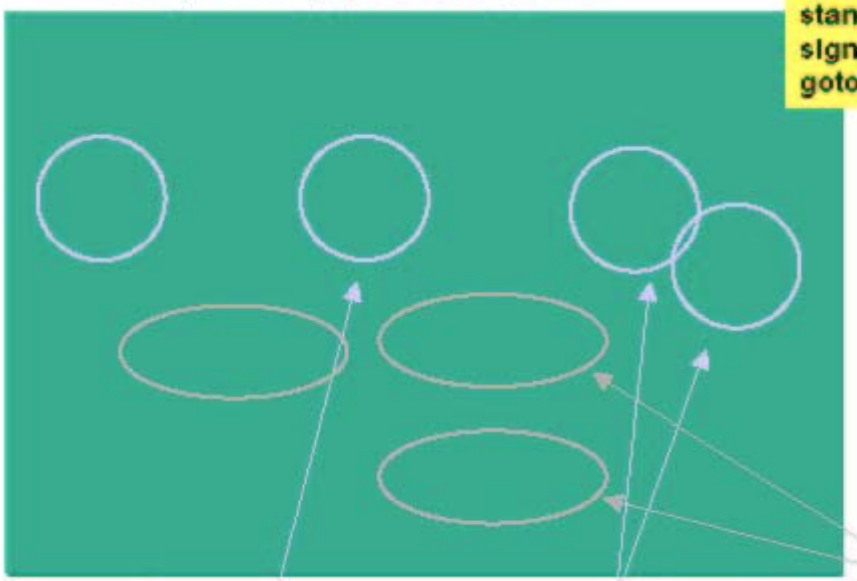
To overcome this problem, components have a version number.

With further releases, a component version might be increased. Then models containing "old' copies of the component are automatically updated.

Nodes / Elements concepts

✓ FUNCTIONALITIES

✓ multi-ports for physical sub-systems



In PhiSim, physical links are single standard Simulink signals. Feedback signal is automatically handled using goto/from blocs.

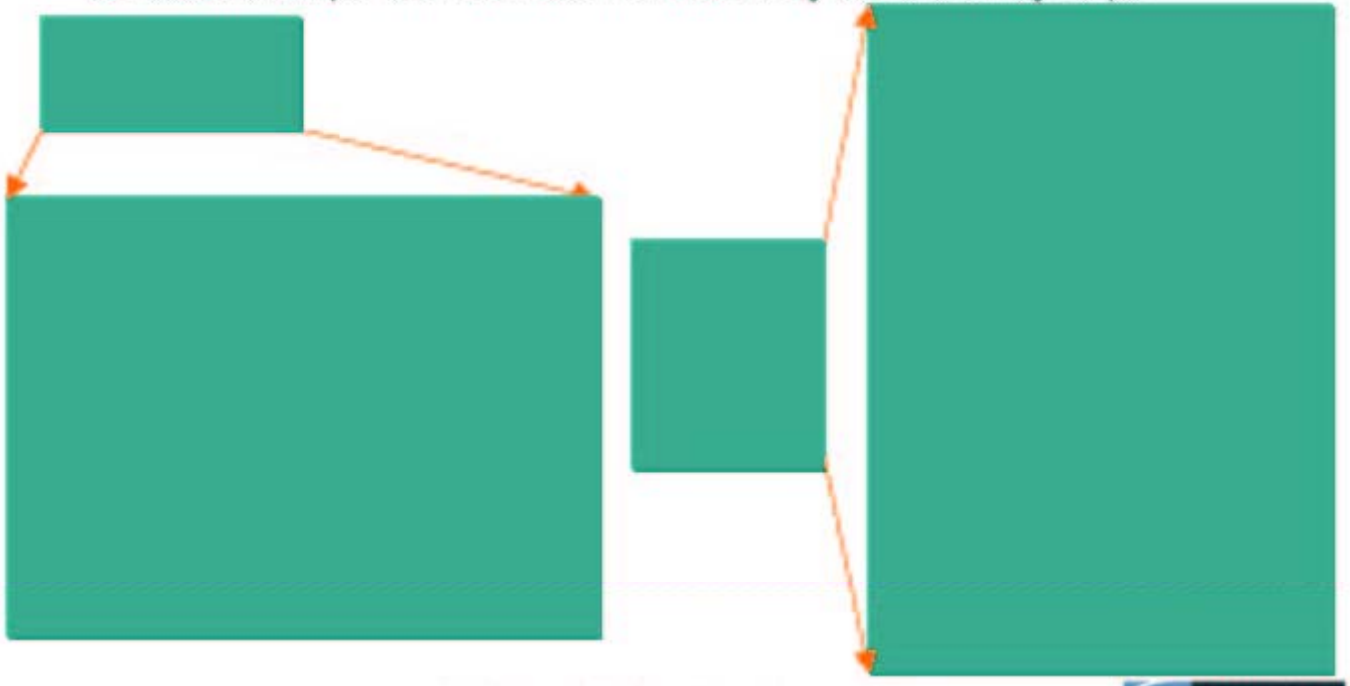
To ensure a valid connection and an appropriate exchange of physical data, basic models are divided into 2 main categories : Nodes and Elements

Elements visually connect through an input signal port. They calculate extensive variables.

Nodes visually connect through an output signal port. They calculate intensive variables.

Multi-level encapsulation

- FUNCTIONALITIES
  - From the assembly of basic models, one can create a more complex model which can become a super-element model with a cornding icon and dialog. respo



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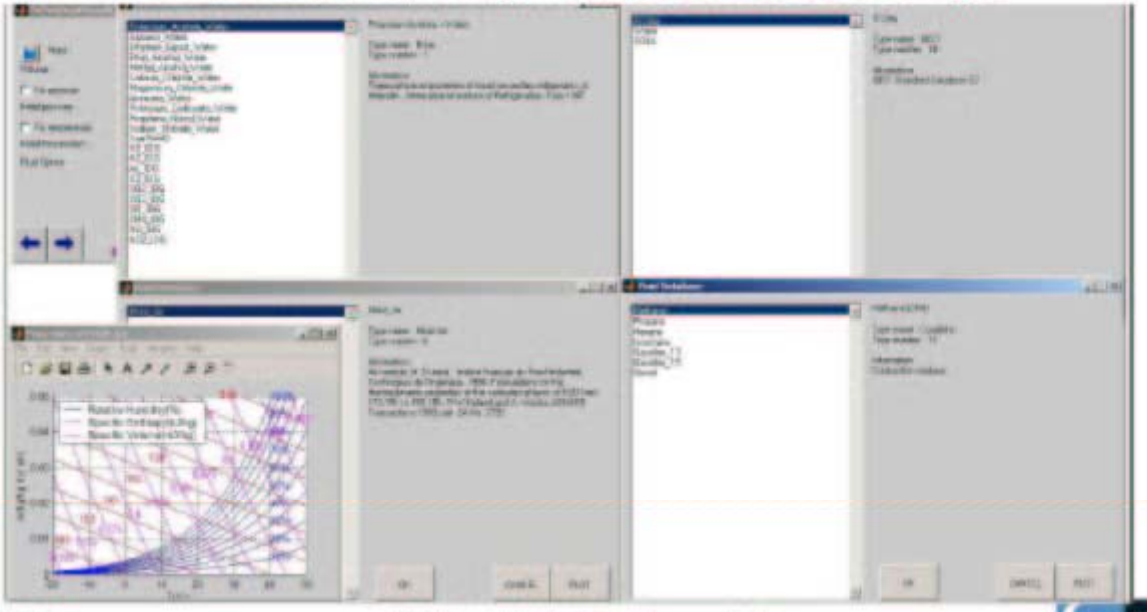
Thermal fluids libraries

✓ FUNCTIONALITIES

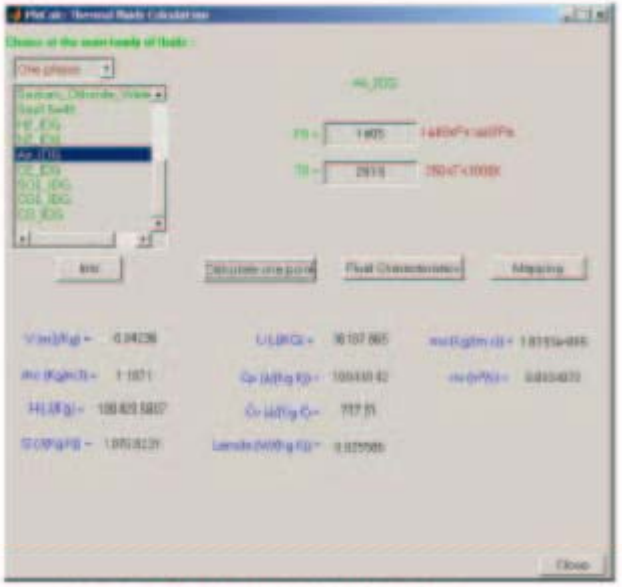
- ✓ Compatible with a large number of fluids like (liquid, gas or semi-perfect real gas mixtures, pure or mixed refrigerants refrigerant. Basis of this single generic elements can be used to integrate into a single model sub-systems of hydraulic power units, steam circuits, circuits tires, cooling circuits, circuits air-conditioning ...



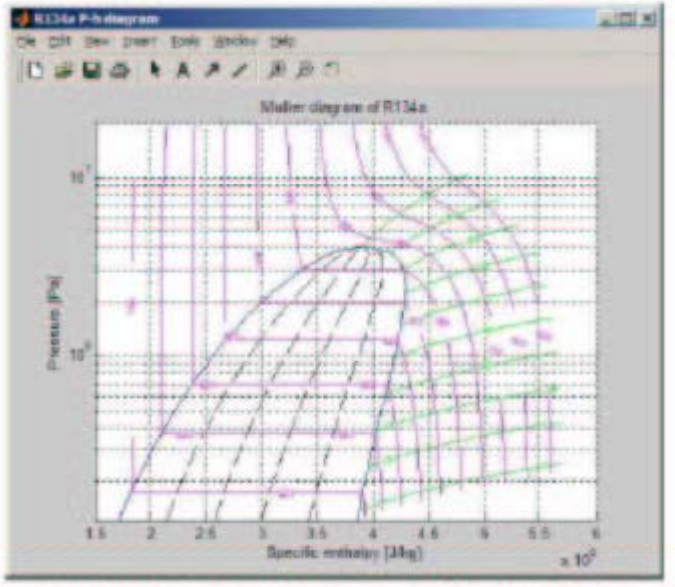
Tools: Thermal fluids properties calculation

✓ FUNCTIONALITIES

- ✓ A simple calculator for thermal fluids properties for several fluids : one-phase, two-phase, gas, liquid, moist gas, ...



Thermal fluids properties calculation



Mapping on several points and layout diagram of the fluid

Tools: Singular Pressure drop characterization

✓FUNCTIONALITIES

✓ **From the experimental data of the pressure drop**

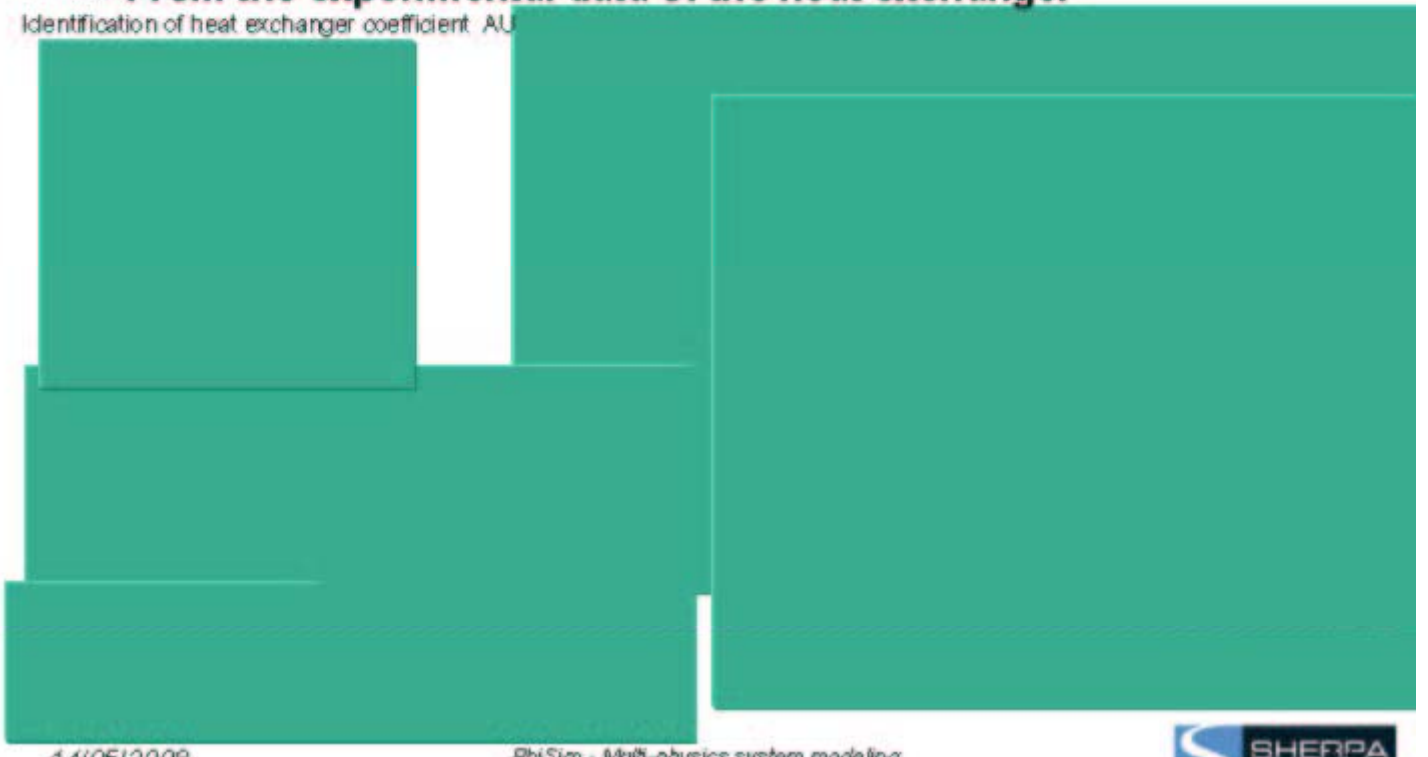
Identification of the coefficients ksi and beta

Tools: Heat exchanger characterization

✓FUNCTIONALITIES

✓**From the experimental data of the heat exchanger**

Identification of heat exchanger coefficient AU



Conclusion

Access to international market by developping product offer in complement with service offer in Model Based Engineering System domain

- ✓ Developp applicative model packages :
  - Multi-physics libraries ,
  - Thermofluid standard applications ; control + operative subsystem
  - Calibration tool
  - Training & maintenance
- ✓ Increase the product notoriety to do more service and attract customers website (demo, licence)