



# CoSMo

COMPLEX  
SYSTEMS  
MODELING

## The Complex Systems Company

BioTuesday  
March 5th, 2013  
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# CoSMo at a glance

## Profile

- Pioneer in Complex Systems modeling and simulation
- Address growing demand for breakthrough solution & services to manage increasingly Complex Systems

## Strategy

- Complex Systems modeling & simulation services for multinational companies
- Steadily increase customer base through licenses on CoSMo Software platform
- CoSMo Inside : market dissemination by licensing Core technology to leading software players (OEM)

## Vision

“The XXI st Century will be the century of Complexity” Stephen Hawking

# CoSMo, a proven option

## Scientific Origins



## Institutional Partners



## Industrial Partners



## Scientific Partners



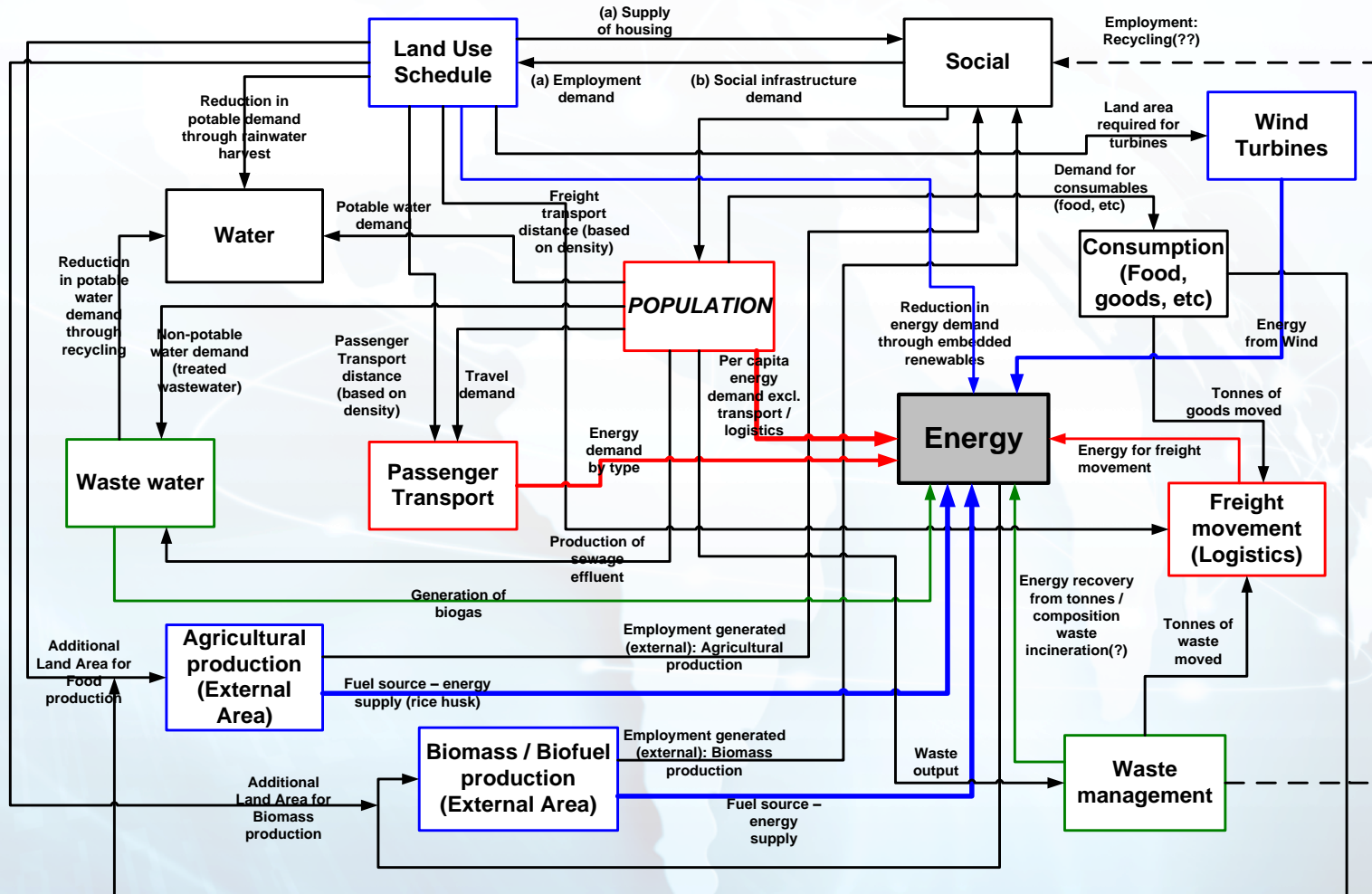
# Complexity definition



“A scientific theory which asserts that some systems display behavioral phenomena that are completely **inexplicable** by any conventional analysis of **the systems’ constituent parts**. These phenomena, commonly referred to as **emergent behavior**, seem to occur in many complex systems involving living organisms, such as **cities** or the human brain.”

*John L. Casti, Encyclopedia Britannica*

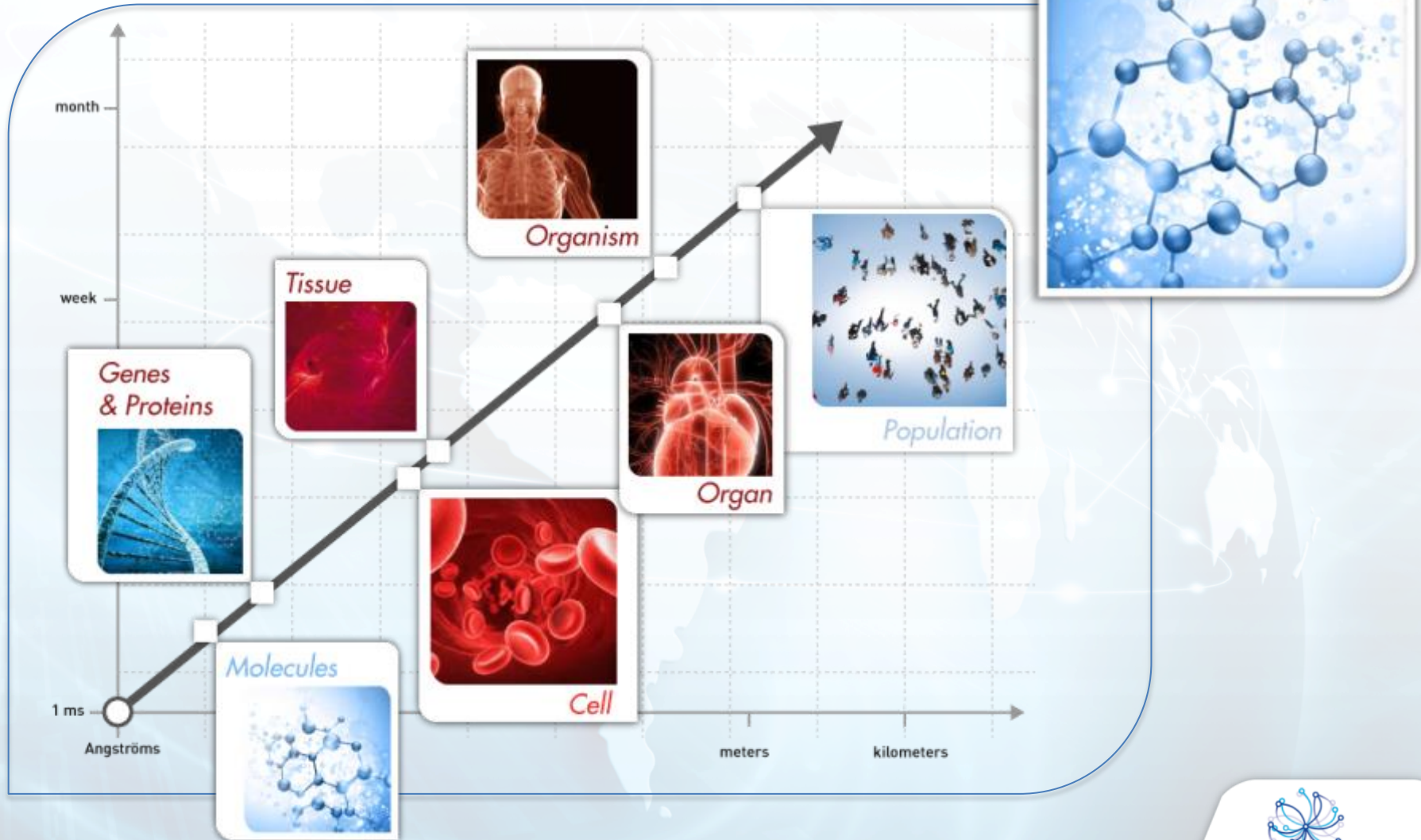
# Manage Complexity in Cities



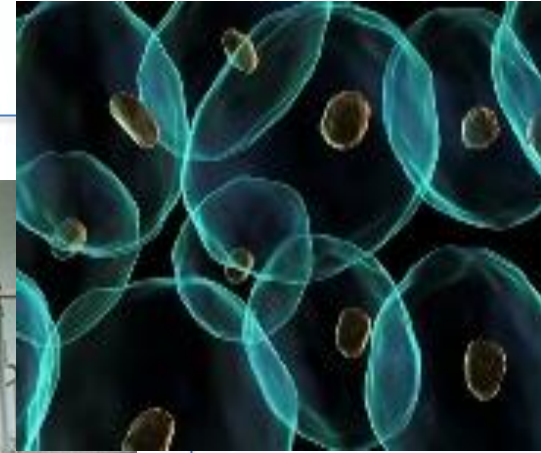


# Manage Complexity in Medicine

Bio Pharma



# Manage Complexity in Bioproduction



# What If ?

Modeling and  
simulation could help predict our future...

Complex Systems Modeling & Simulation : definitions

**Modeling:** “Looking backward”

Using existing data to describe system / phenomena

**Simulation and scenarii:** “Looking forward”

Using a model to predict outcomes based on “what if” assumptions



# The City of Tomorrow

What if we could...

- Predict the impact of infrastructure decisions on CO<sub>2</sub> emissions
- Run scenarios on virtual cities
- Evaluate emergency plans using numerical simulations



# Predict the impact of infrastructure

GRANDLYON

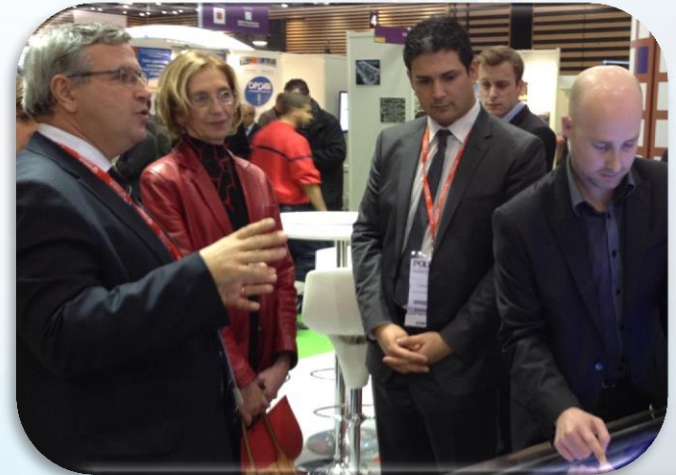
communauté urbaine

2012



## visitors:

Delphine BATHO,  
Nicole BRICQ,  
Bernard RIVALTA  
Gérard COLLOMB,  
Benoit QUIGNON,  
Bruno CHARLES,  
Jean-Jacques QUEYRANNE.





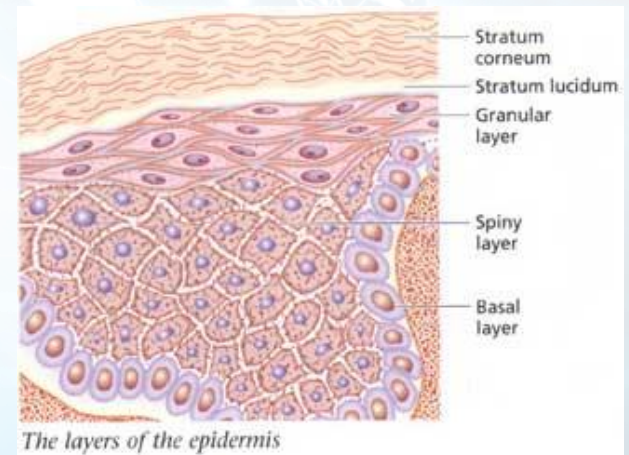
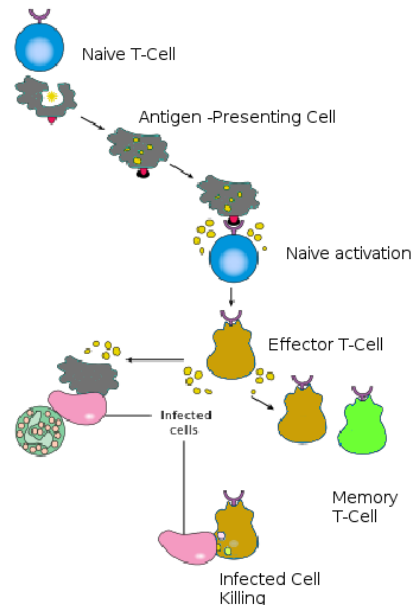
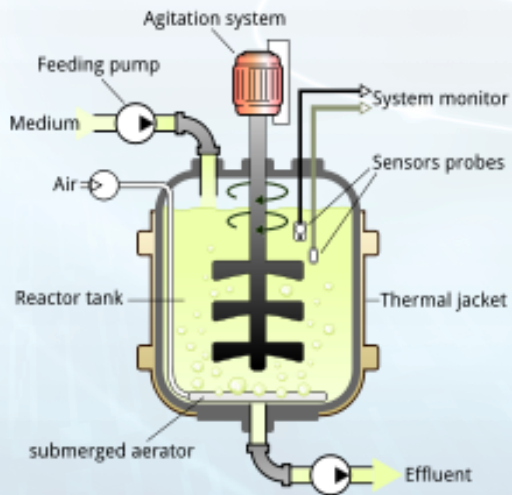
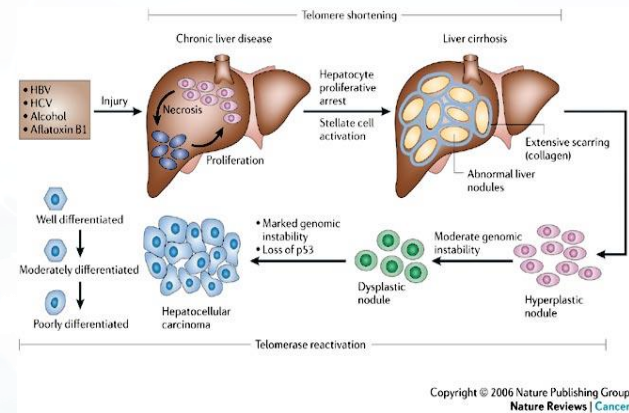
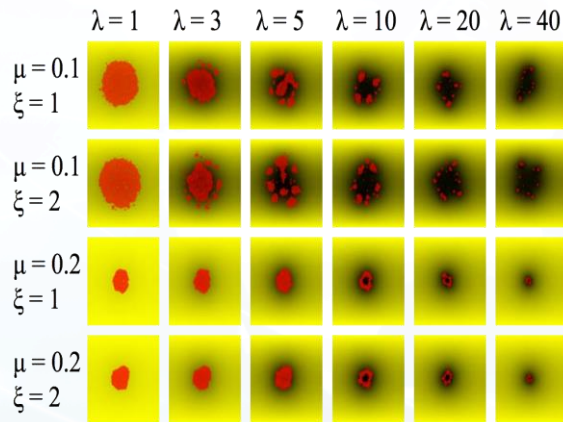
# Medecine Tomorrow

What if we could...

- Screen potential drugs in virtual biosystems?
- Evaluate therapies in virtual patients?
- Predict real-world health outcomes and costs?
- Validate production process in-silico?



# Ongoing projects





# CoSMo technology : a descriptive approach

## [1] Entity:

heterogeneous building blocks

- **State**
- Transition **Rules** (intrinsic dynamics)

## [2] Environment:

- “**Neighbors**” representation
- **Interactions** between entities:

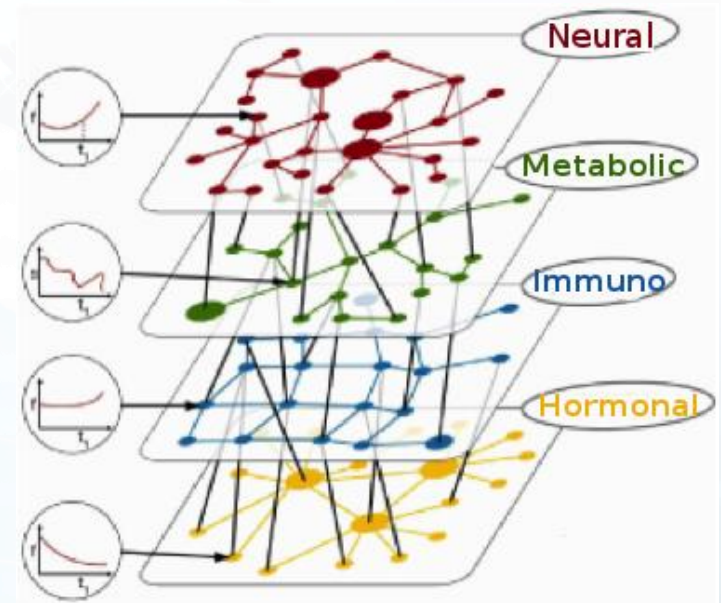
## [3] Scheduler: timing

- **Ordering** of Rules application (imposed dynamics)

## [4] Compound:

Entity, node of descriptive hierarchy

- (Sub)entities
- **Scheduler**
- **Environment** (of sub-entities)



$$\text{Complex Systems Model} = [1 + 2 + 3 + 4]$$

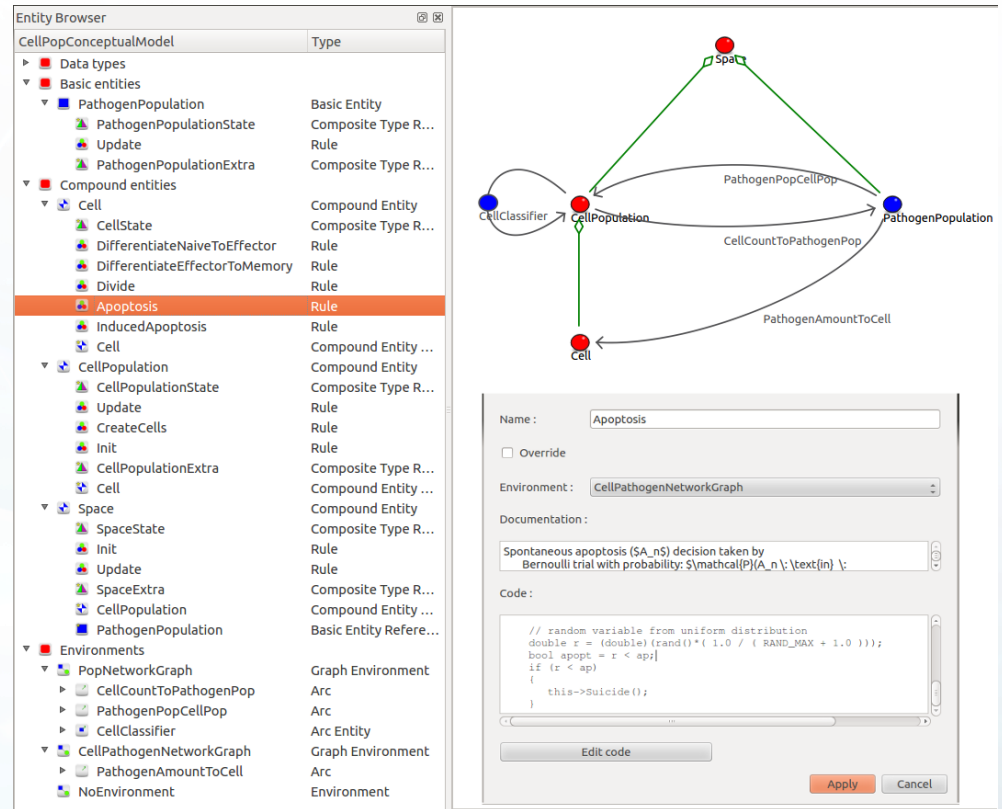
# CoSMo software suite

1 FORMULATION  
OF THE PROBLEM

2 TRANSLATION IN  
CoSMo LANGUAGE

3 MODELING

4 SIMULATION



The Entity Browser window displays a hierarchical tree of entities and rules. The 'Apoptosis' rule is highlighted. The Apoptosis configuration window shows the following details:

- Name: Apoptosis
- Override: ☐
- Environment: CellPathogenNetworkGraph
- Documentation: Spontaneous apoptosis (SA\_n5) decision taken by Bernoulli trial with probability:  $\text{Symathcal{P}}(\text{A}_n) \cdot \text{text{in}} \cdot \text{}$
- Code:

```
// random variable from uniform distribution
double r = (double)(rand()*( 1.0 / ( RAND_MAX + 1.0 )));
bool apopt = r < ap;
if ( r < ap )
{
    this->Suicide();
}
```
- Buttons: Edit code, Apply, Cancel

## A single tool for complex systems modeling & simulation

Fast and flexible Describe both **static** and **dynamical** aspects of the system, identify **emerging properties** through simulation

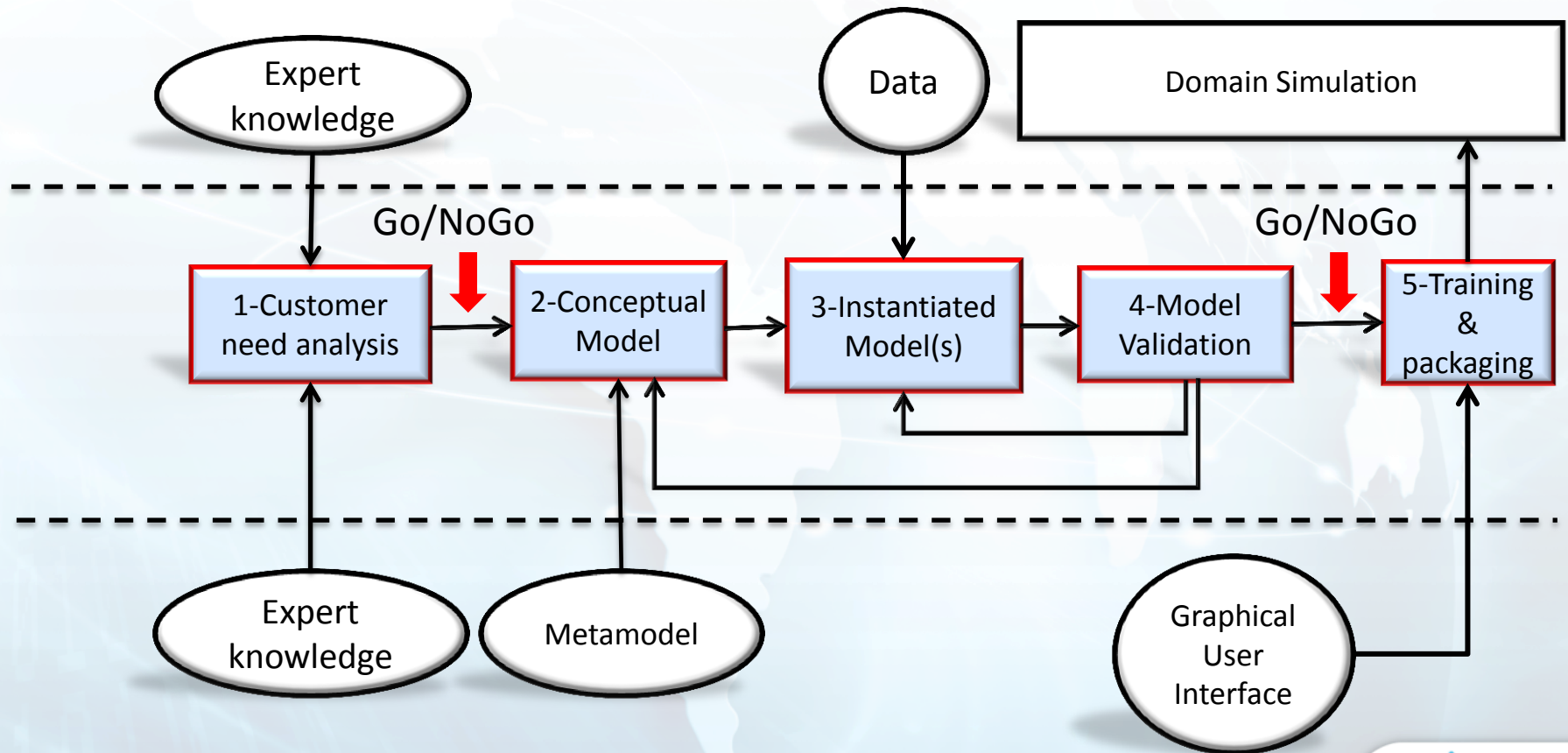
### Tool benefits

- Fast and flexible **data integration** and configuration by importing from **database** or from a user interface
- Study **critical regimes** and achieve understanding of your system by creating **scenarios**
- **Visualize, Analyze** and export the results
- Support evidence based decision

# The CoSMo Modeling Process

## A 5-phase iterative process

**Pharma:** concrete industrial situations, engineers, scientists, management



**CoSMo:** complex systems, modelers and developpers

# Conclusion

- The design and management of complex systems is now a key to competitiveness
- CoSMo offers a modeling and simulation platform as well as a unique methodology in the field of complex systems
- A diversified project portfolio
- A team of complementary experts : management, science, engineering
- Leading development partners : **EDF, Veolia, SigN, Pharma ...**
- Wide range of applications : urban planning, biology/ pharma, industrial systems





**CoSMo** COMPLEX  
SYSTEMS  
MODELING  
SOLUTIONS

Manage Complexity