RFID in healthcare applications:
Simulation as a decision support tool.

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Outline

- ❑ **Context**
  - ❑ **RFID**
  - ❑ **Simulation**

- ❑ **MISTRALS pilot plants**
  - ❑ **Biobanks**
  - ❑ **Chemotherapy**

- ❑ **Conclusions / Perspectives**

Outline

Context

- Traceability improvements needed
  - Activity based costing,
  - Fights against iatrogenic incidents, adverse events, counterfeits…
  - Hospitals and caregivers overloaded
  - Increasing pharmaceutical experiments and results
    - Toxicogenomics, stem cells (cord blood)
   - On-line samples catalog (e-cancer.fr)

- Auto-ID technologies maturing
  - Memory size, (bio-)sensors, data securing, (inter-)national norms (i.e. information sharing: EPC Information Service)
  - Use within medical sector growing (reliability indicator)

Context: RFID implementation

Questions when implementing an auto-ID system:

- Which level? (product, box, pallet…)
- Which frequency? (LF, HF, UHF…)
  - Reading distance, rate, multiple tag…
- Which antennas? Where?
- What information on/off board?
- On-board sensors?
- Information use / Information System (IS) capacity
- Costs vs. impacts: Return On Investment (ROI)…
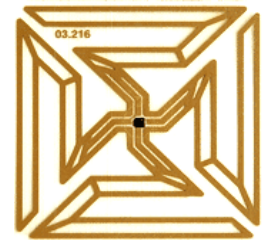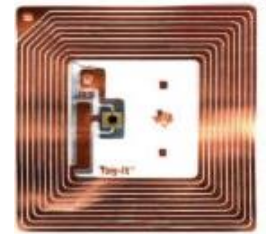
Outline
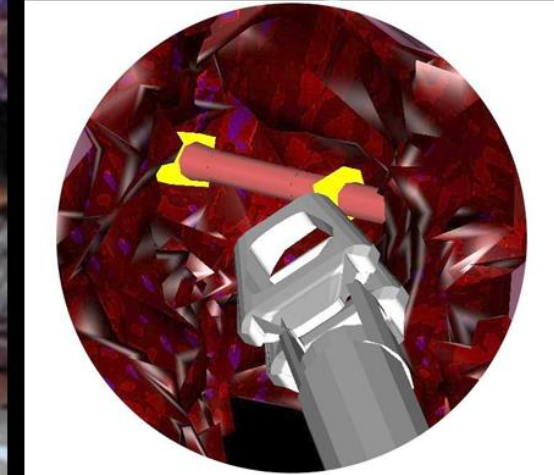
- **Context**
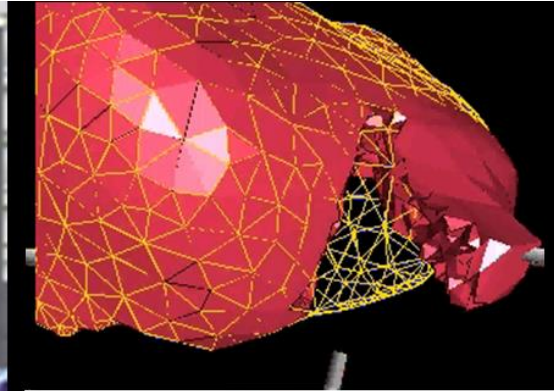 - RFID
  - **Simulation**

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  - Biobanks
  - Chemotherapy

- Conclusions / Perspectives

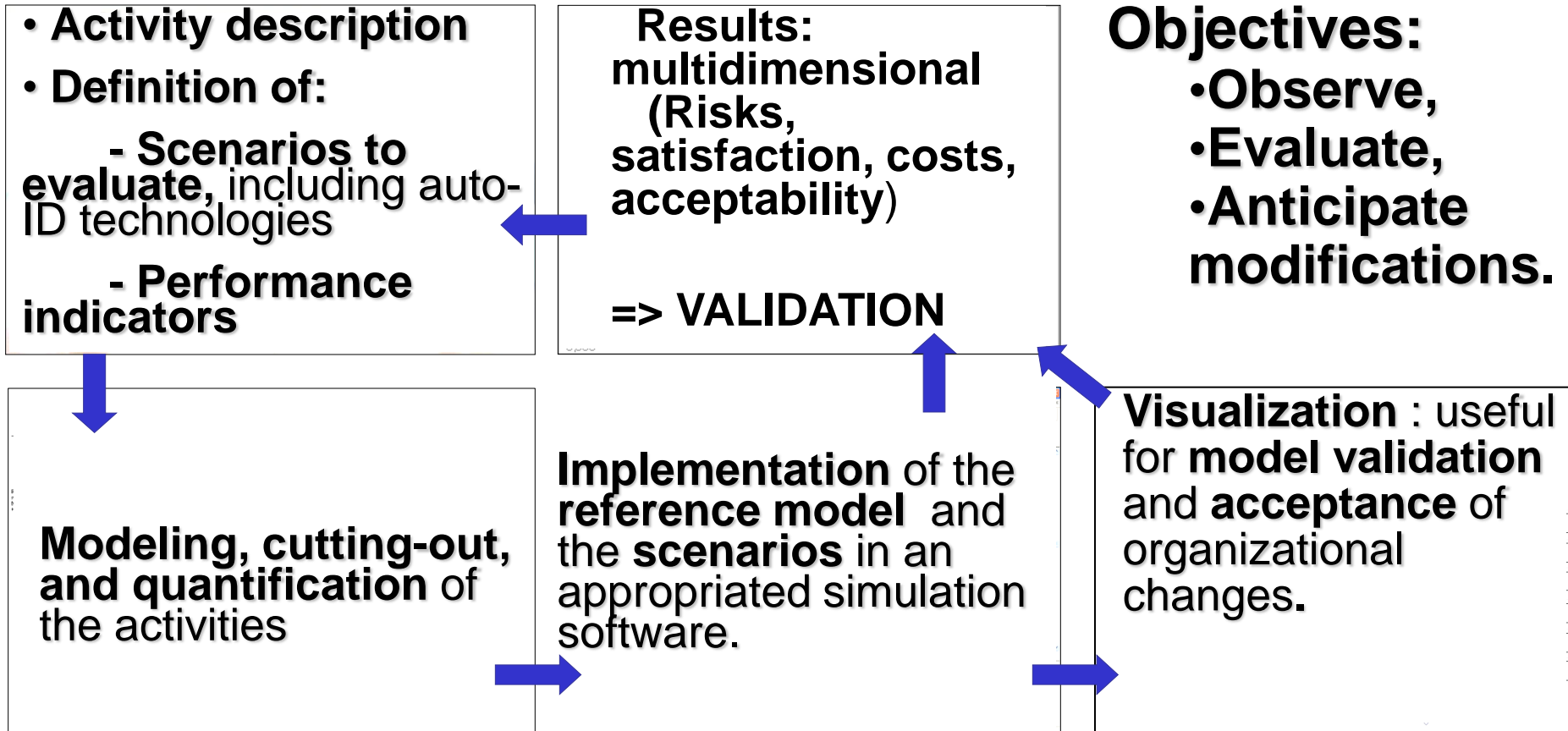# Uses of simulation

- Education,
- Training,
- Observation,
- …

Surgery simulation with visual and force feedback

S. Cotin, G. Picinbono, C. Forest et al.

Simulation: a decision support tool
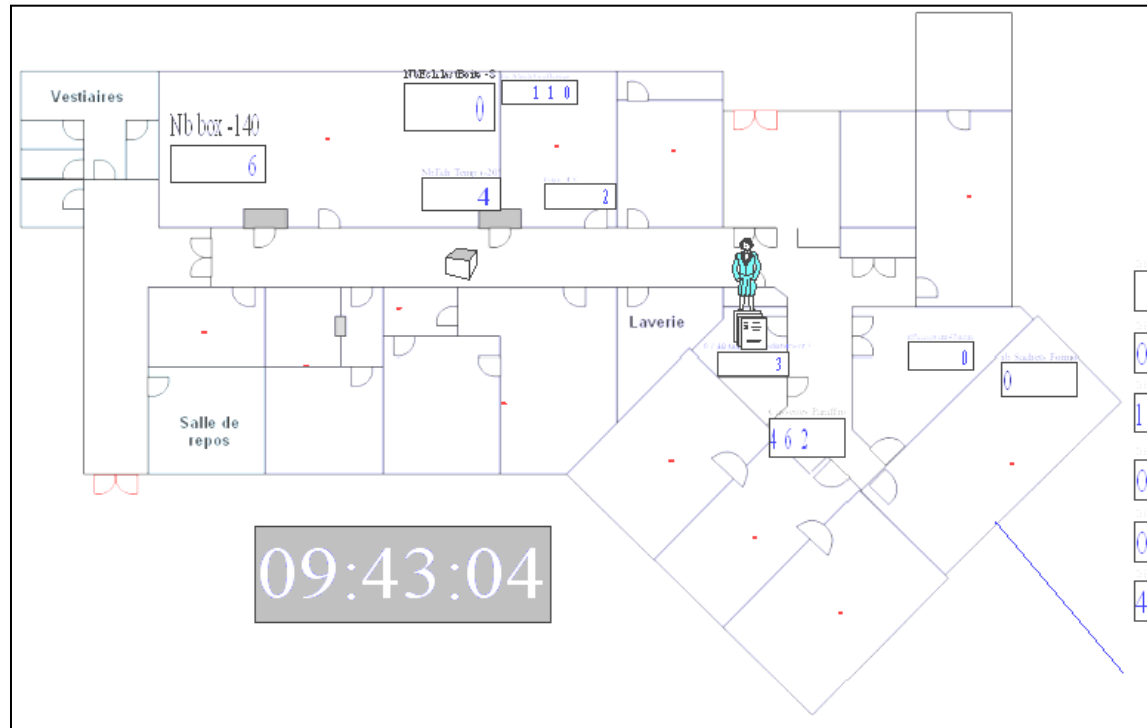
Steps of a simulation study

- **Activity description**
- **Definition of:**
    - **Scenarios to evaluate,** including auto-ID technologies
    - **Performance indicators**

Results: multidimensional (Risks, satisfaction, costs, acceptability)

=> VALIDATION

Objectives:
- **Observe,**
- **Evaluate,**
- **Anticipate modifications.**

Modeling, cutting-out, and quantification of the activities

Implementation of the **reference model** and the **scenarios** in an appropriated simulation software.

Visualization : useful for **model validation** and **acceptance** of organizational changes**.**

Service model: Processes and activities

Objects modeled are (individual) human resources, boxes, products, containers…

Simulation: microscopic / dynamic systems
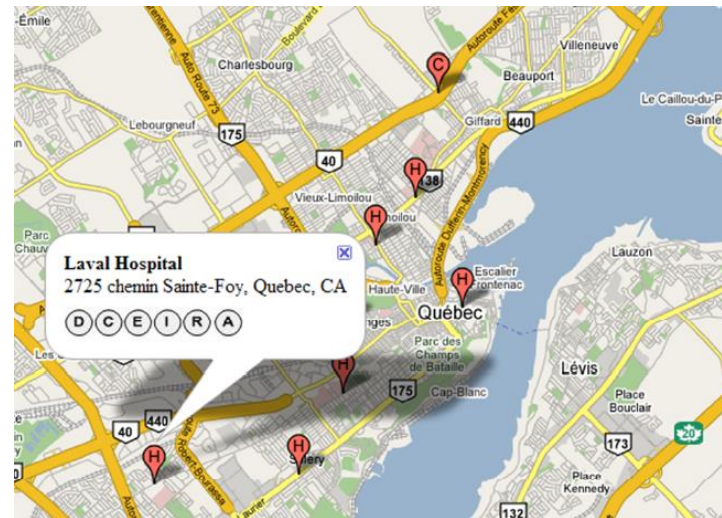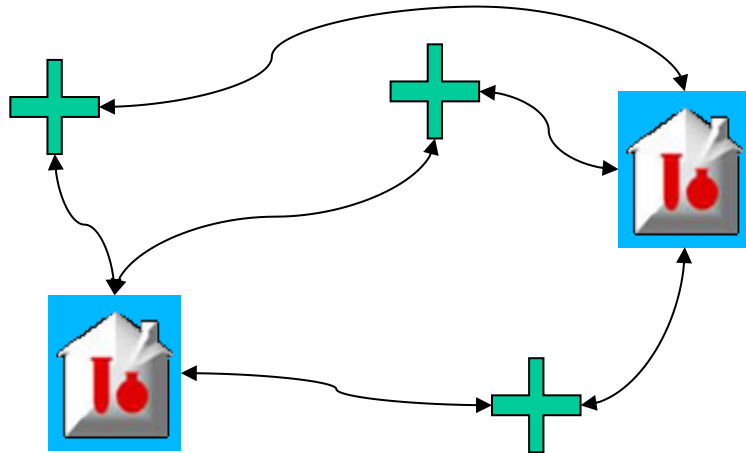
Use of finite elements simulation

- Radio-communication trials

- Device resistance to
  - shocks
  - temperature
  - …

Picts: Ansys user manual

Evaluation of technology deployment scenarios:

Interactions between manufacturers, pharmacies, laboratories, hospitals…

➔ Example: What if pharmaceutics manufacturers attach RFID tags to all (first rank) packages?

Multi-Level Simulations

Configure & calculation requests

Results are used as parameters and kept

Microscopic level

-Physical properties (RF comm.)

-Biologic material behavior

-HEP calculations

…

Mesoscopic level

-Material and organizational configuration of the service

-Human behavior

-Error rates

…

Macroscopic level

-Overall strategies (technology deployment)

-Collaboration / cost sharing

-Sum of errors

…

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Mutualisation **I**nformatique des **S**ystèmes **T**echnologiques pour la **R**echerche ph**A**rmaceutique et **L**a **S**anté

Consortium regrouping industrials
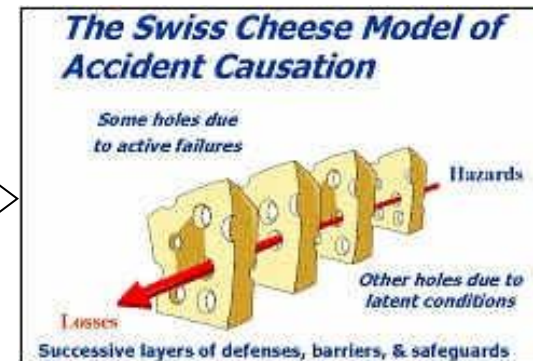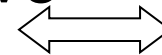(TagSys, STMicroelectronics, SPS, Psion, IBM),

the Centre Microélectronique de Provence Georges Charpak of the Ecole des Mines de Saint-Etienne
(Dpt. PS2 et SFL)

and health professionals
(Institut Paoli-Calmettes : IPC, CHU de Nice)

MISTRALS simulations

☐ Data acquired preparing the pilot plant:
- Precise description of the processes
- Quantification of each request

☐ Outputs from the pilot plant:
- RFID communication feasibility
- Number of alerts (=> incidents)

☐ Objective: evaluate RFID configurations
- Applied at the item/box/pallet level
- Considering that most errors have both systemic and human parts

The Swiss Cheese Model of Accident Causation

Some holes due to active failures

Hazards

Other holes due to latent conditions

Losses

Successive layers of defenses, barriers, & safeguards

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Biobanks first results

The harder part estimating the ROI for RFID deployment:
  Reorganization

Scenario	Human resources use
(+)RFID & pen-size reader	**-23.6%**
(+)X/Y Antenna	**-1.5%**

…but may allow sockets to be reused.
(saving nitrogen containers, rooms, etc…)

=> When to assign samples to empty sockets? Which samples?

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Chemotherapy

Chemotherapy application:

- Workload test:
  - Installation of a hood in the clean room (model validation)
  - Production for another hospital (including transport)
    - ⇒ Usefulness of sensors
- Reliability test (**risks** performance indicator):
  - On-tag Vs. on-database information
  - Tag reliability vs. tag price
- New scenario to take into account:

  Home chemo-care slow deployment / generalization
  - ⇒ New optimization problems:
    - ⇒ Physicians assignment for reactivity
    - ⇒ Vehicle routing
    - ⇒ Garbage collection
  - ⇒ Interest in a physiological (human) model

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Conclusions

☐ Simulation is a good tool for estimating the impacts of RFID technologies in healthcare

  ■ It allows observing many performance indicators,

  ■ An adapted modeling helps trying many scenarios (using spreadsheets)

  ■ It allows trying multiple devices before investing in their development

☐ New usages and organizations can be tested via simulation, but require farther analysis to modify the simulation models

Perspectives

- Implement the chemotherapy scenarios

- Propose and evaluate solutions for the optimization problems raised by the new scenarios (empty sockets assignment, home-care deployment, …)

- Propose a macroscopic model to compare local vs. global deployment

Perspectives

- Improve the human models
  - Performance Shaping Factors (fatigue, repetition, distraction, interruptions…)
  - Learning / degradation of competencies,
    =>Task assignment strategies,
    - =>Differentiate between real and acknowledged abilities

- From pilots, auto-identification should allow for better observation, and so a better modeling, of activities and human behavior.

That's all, folks!!!

Thanks for your attention!
    … and for your questions??

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