

RODIC - Rapid recOnfiguration of manufacturing systems: a model-based software engineering and human Interaction Coupled approach

Réunion Aelos

10 mars 2022

Context



Vichy (Allier) factory, ... have been partially reconfigured to produce « gel hydroalcoolique » (*L'usine nouvelle, Mars 2020*)

Context



PSA ... reconfigured production chains to produce
« breathing machine » (*L'usine nouvelle*, Avril 2020)

Context – RODIC

- ▶ Reconfigurable Manufacturing Systems (RMS) are currently considered as one of the most promising ways to make companies more adaptable to strong uncertainties
 - ▶ manufacturing systems must be designed in a modular form
 - ▶ a configuration therefore corresponds to an assembly of these modules
 - ▶ whether they are software or hardware
- ▶ Reconfiguration phases :
 - ▶ (i) detection of the need for reconfiguration,
 - ▶ (ii) design of alternative configurations,
 - ▶ (iii) choice of the configuration to be applied,
 - ▶ (iv) production stop,
 - ▶ (v) reconfiguration,
 - ▶ (vi) production restart.

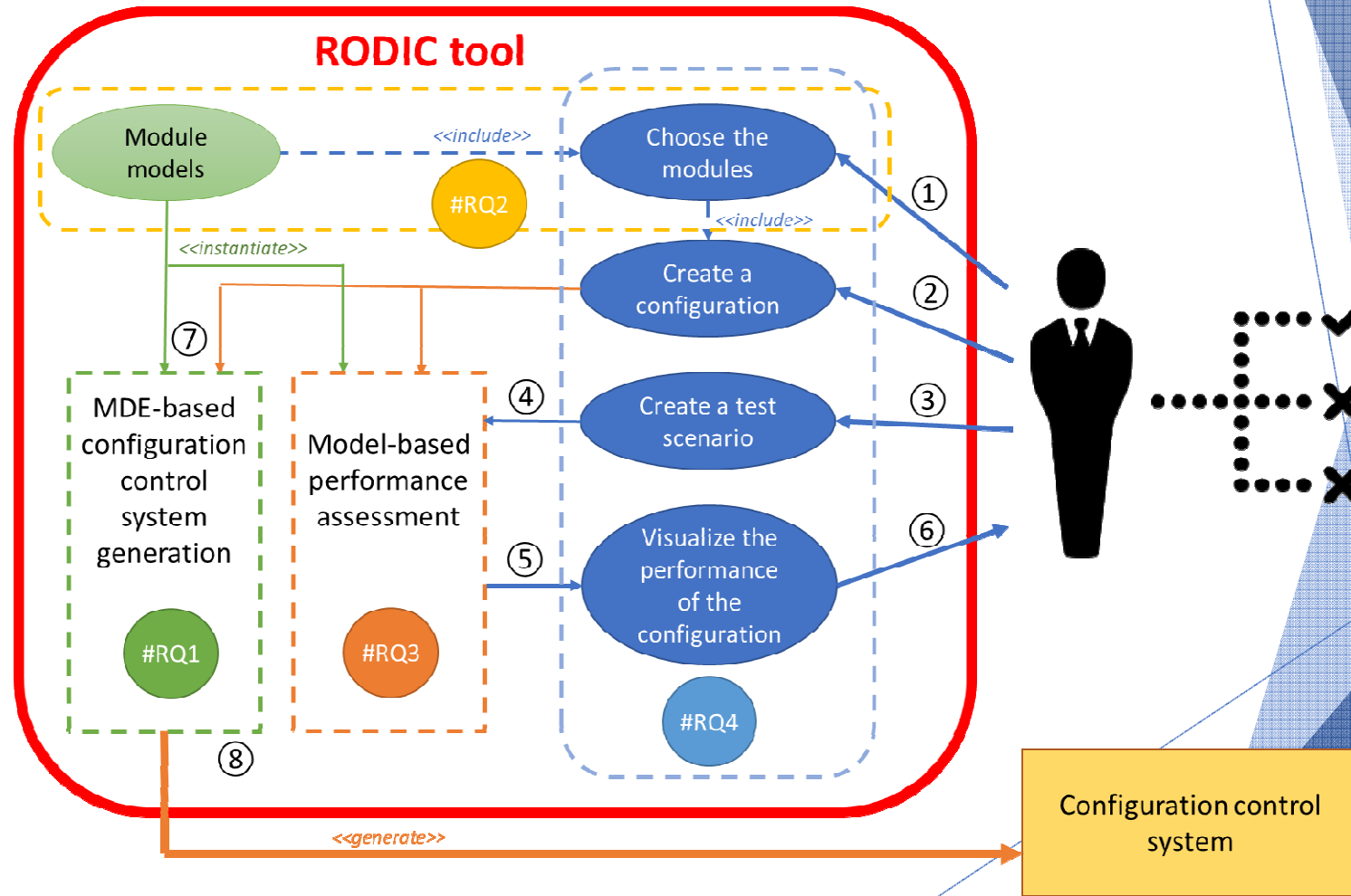
} Costly steps



RODIC considers (iii) choice of the configuration to be applied

- ▶ RODIC project aims at improving this process
 - ▶ by proposing a tool
 - ▶ allowing an operator in charge of the reconfiguration
 - ▶ to consider more simply and quickly the configurations
 - ▶ he wants to test

RODIC: Big Picture



RODIC : multi-disciplinary approach

▶ 3 distinct scientific disciplines:

- ▶ cognitive psychology for the cognitive analysis of the operator's activity and the definition of the interaction to be set up with the tool,
- ▶ industrial engineering for the contextualization of the work, the design of the configurations and the definition of the performance indicators with respect to the enterprise architecture, and
- ▶ software engineering for the phase of
 - ▶ verification,
 - ▶ generation and
 - ▶ evaluation of the proposed configurations.

UBS Lorient

INSA Strasbourg
+
LS2N CP3S (PSI)

LS2N
NaoMod
+
LS2N AeLoS

Projet RODIC

▶ Title:

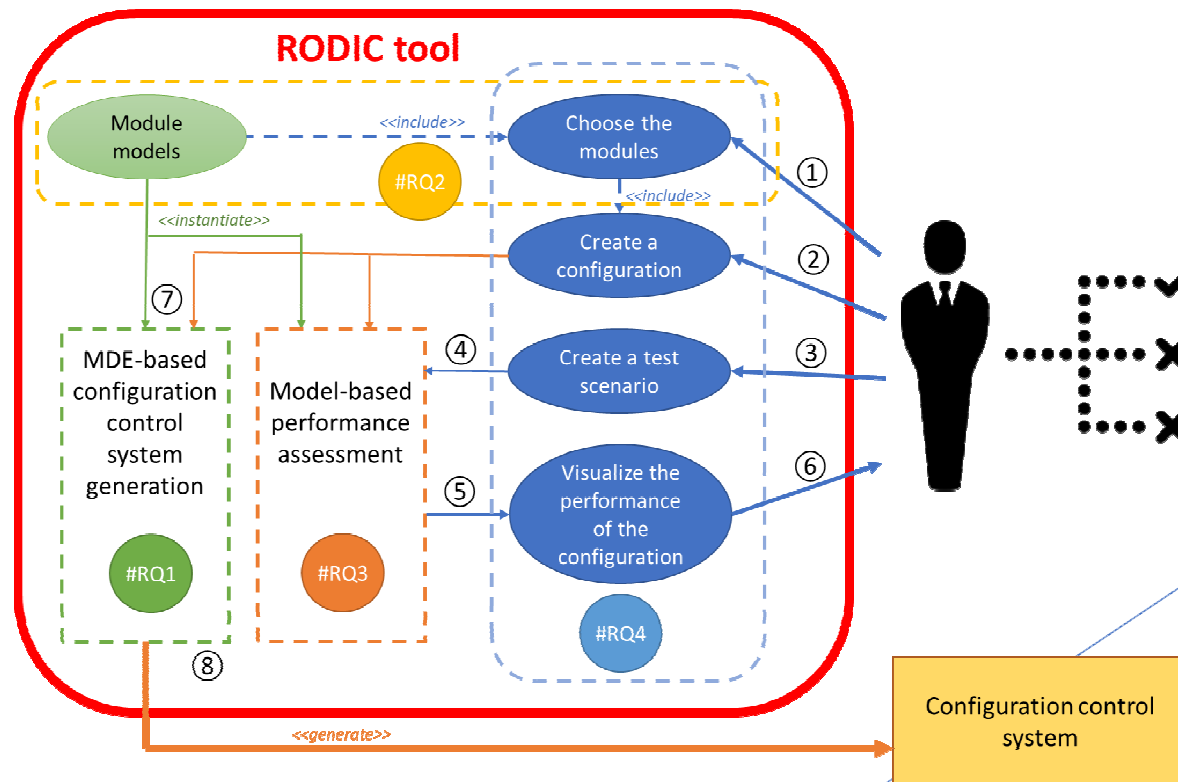
- ▶ Rapid recOnfiguration of manufacturing systems: a model-based software engineering and human Interaction Coupled approach

▶ Partners:

- ▶ Université de Nantes (LS2N) - Nantes
2 software engineering teams
1 industrial engineering team
- ▶ Université Bretagne Sud (LAB-STICC) - Lorient
1 team of cognitive psychology
- ▶ INSA Strasbourg (ICUBE) - Lorient
1 industrial engineering team
- ▶ Start and duration : 1er Mars 2022 - 48 mois
- ▶ ANR grant: 497 195 € (additional grants under negociation, IUT, Région)
- ▶ Complete cost: 1 329 501 €

Organisation

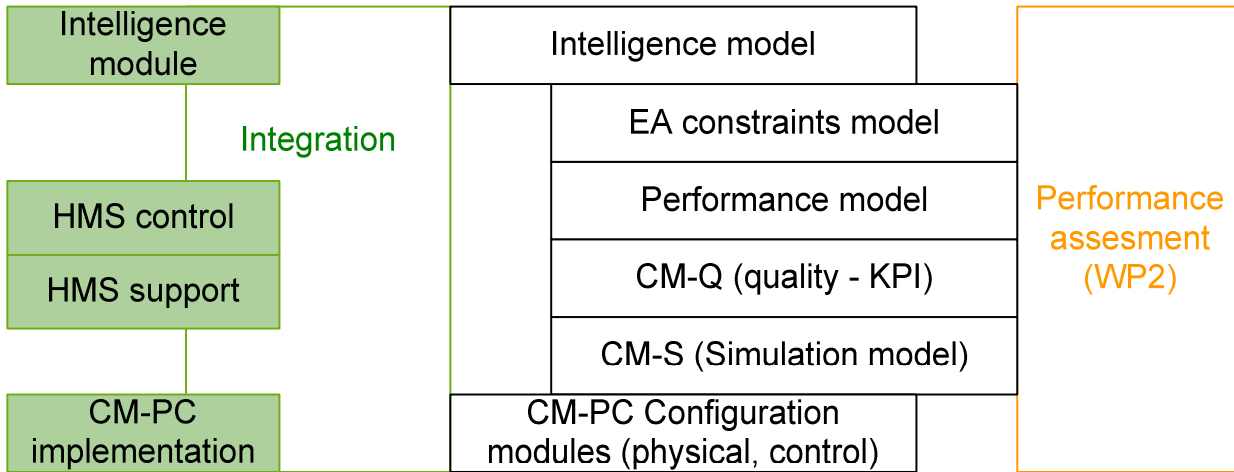
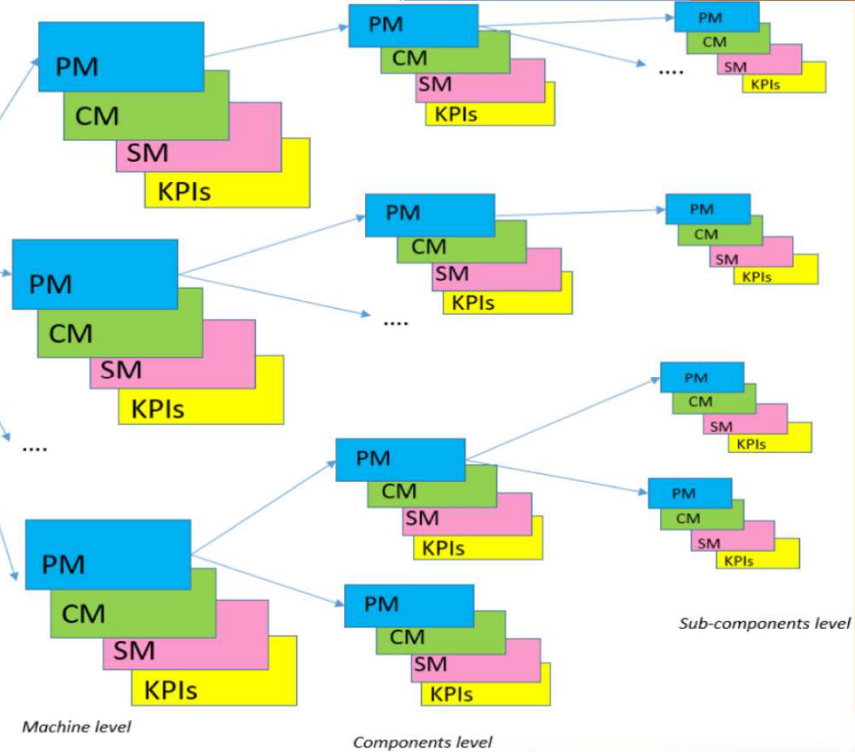
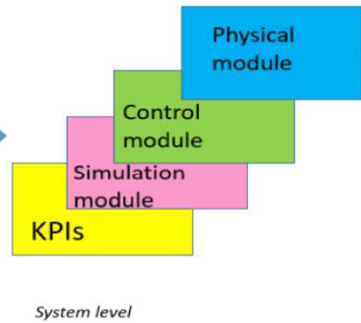
- ▶ 4 internship students are about to start
- ▶ 3 phd students will start in the fall and an engineer



Rodic - WP3

- ▶ Approche en couche / vues
- ▶ Des modèles à construire
- ▶ Des propriétés à vérifier

Configuration



RODIC project

Thèse - Erica Capawa Fotsoh

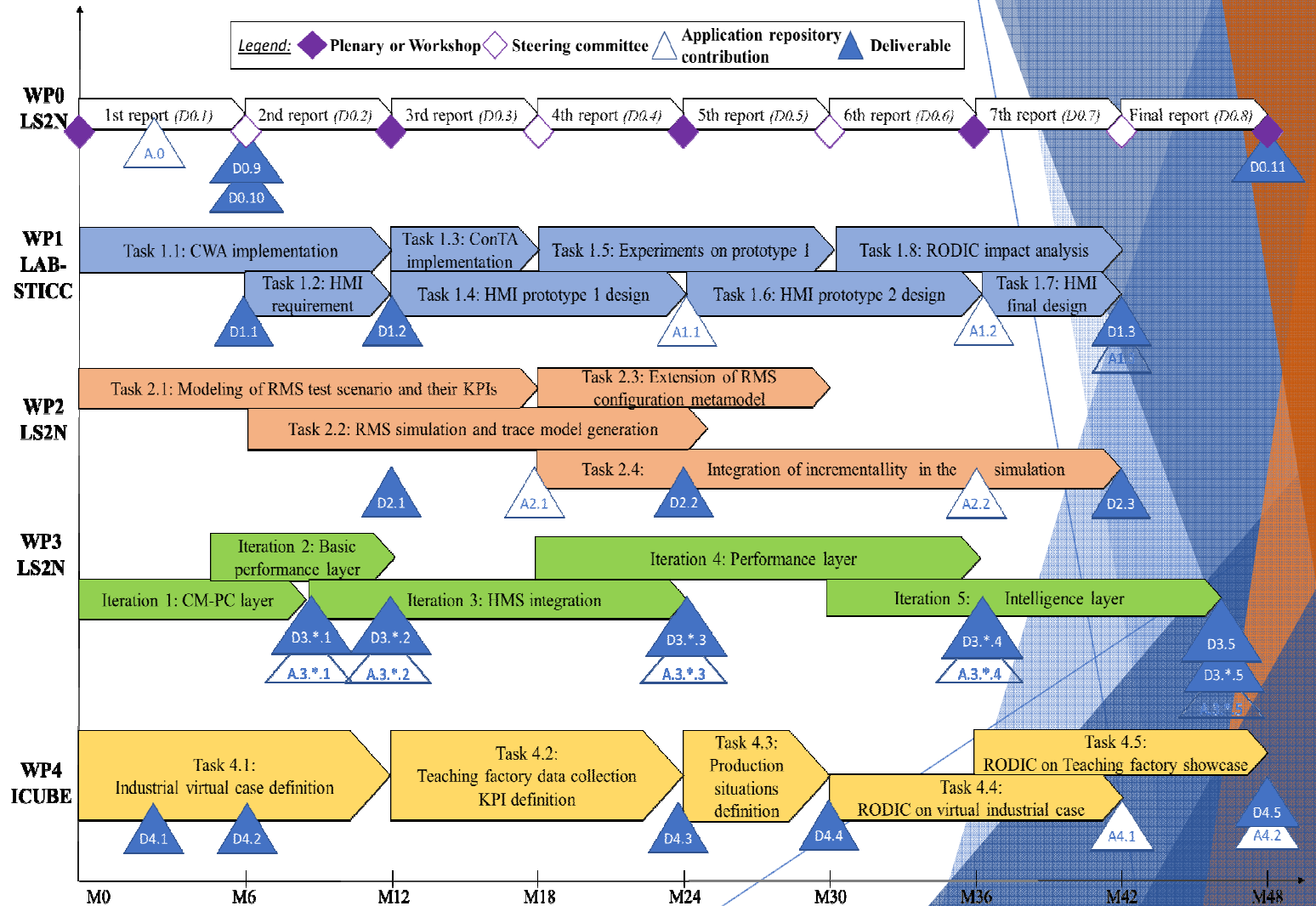
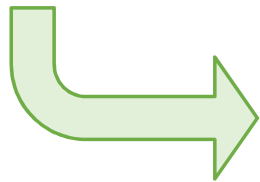
Rodic - WP3 challenges

Multi-level model-driven engineering for generation and verification of configurations:

- ▶ An original feature of the module models is the modular and reconfigurable vision of the models, enabling the manufacturing control itself to evolve.
- ▶ The multi-level paradigm means we have the same concepts at different abstraction level, e.g. execution, simulation, performance, etc. Heterogeneous modelling means that one model is a composition of other (simpler) models that focus on one point of view.
- ▶ Innovation will focus on the composition of models, meta-models and views that should stay loosely coupled and consistent. This problem will also be perceived from the evolution point of view.
- ▶ Behind the module models view lies the problem of model (and meta-model) integration, consistently with the specific views e.g. the simulation view, the execution view, the performance view...
- ▶ The verification of properties (correctness, consistency, safety, liveness) of heterogeneous systems, i.e. made of several points of view is still challenging. We will improve previous techniques [30] in the case of manufacturing systems.
- ▶ Others challenging areas of formal verification such as time hybrid systems (continuous/discrete) or hardware/software hybrid systems are considered to be out of the verification scope.

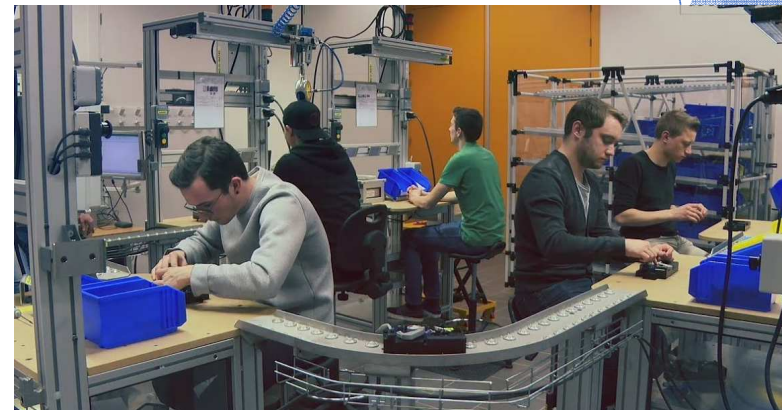
Rodic - WP3 organization

► Approche itérative



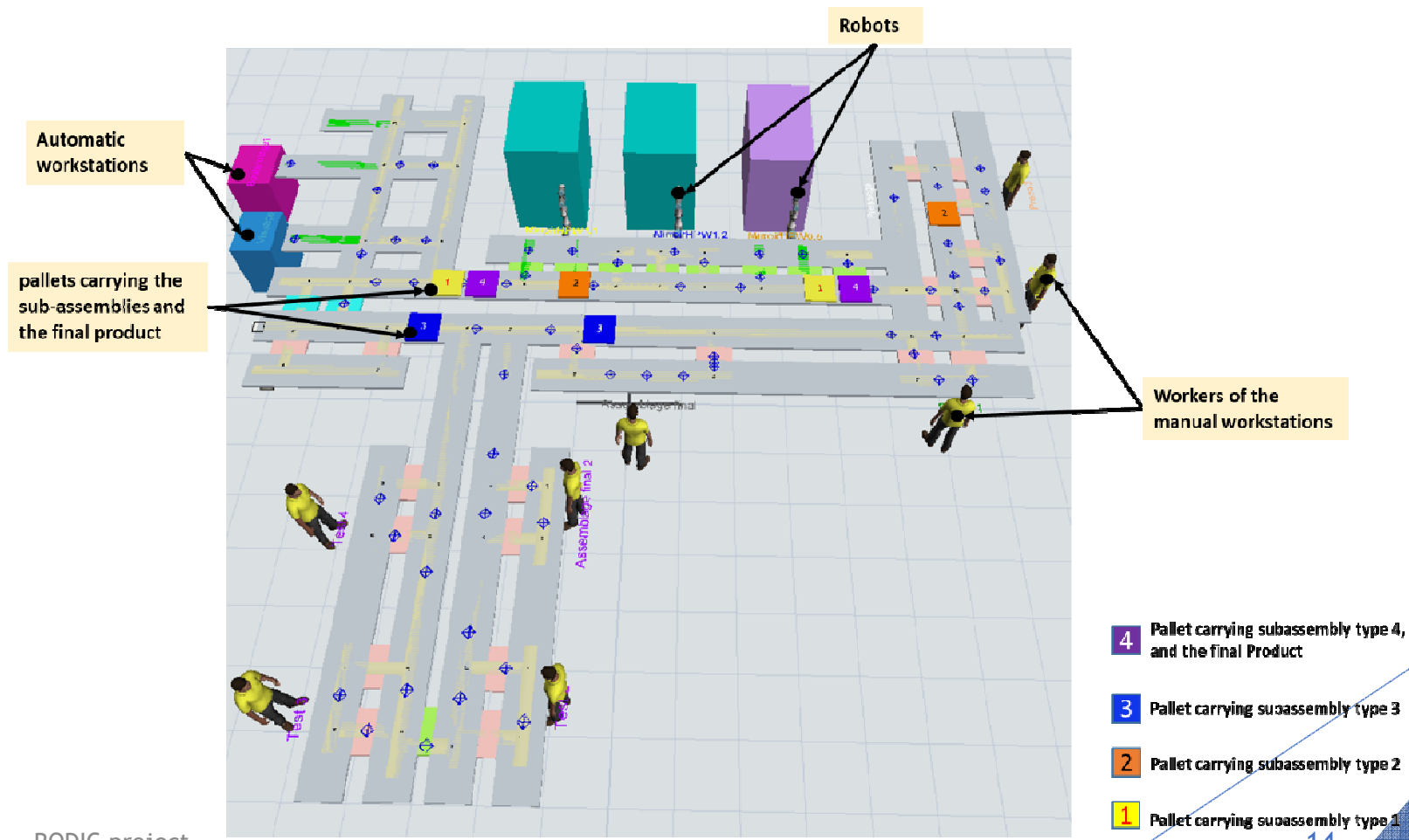
Exploitation plans – RODIC

- ▶ Exploitation n° 1:
 - ▶ Implementation and validation of RODIC tool
- ▶ Exploitation n° 2:
 - ▶ Application and experiment with a real industrial case study
- ▶ Exploitation n° 3:
 - ▶ Deployment in the Teaching-factory of Haguenau

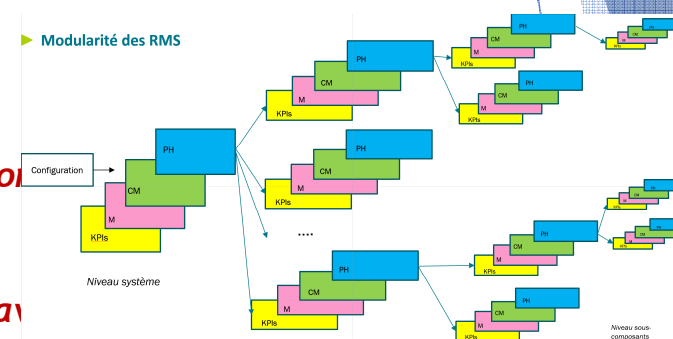
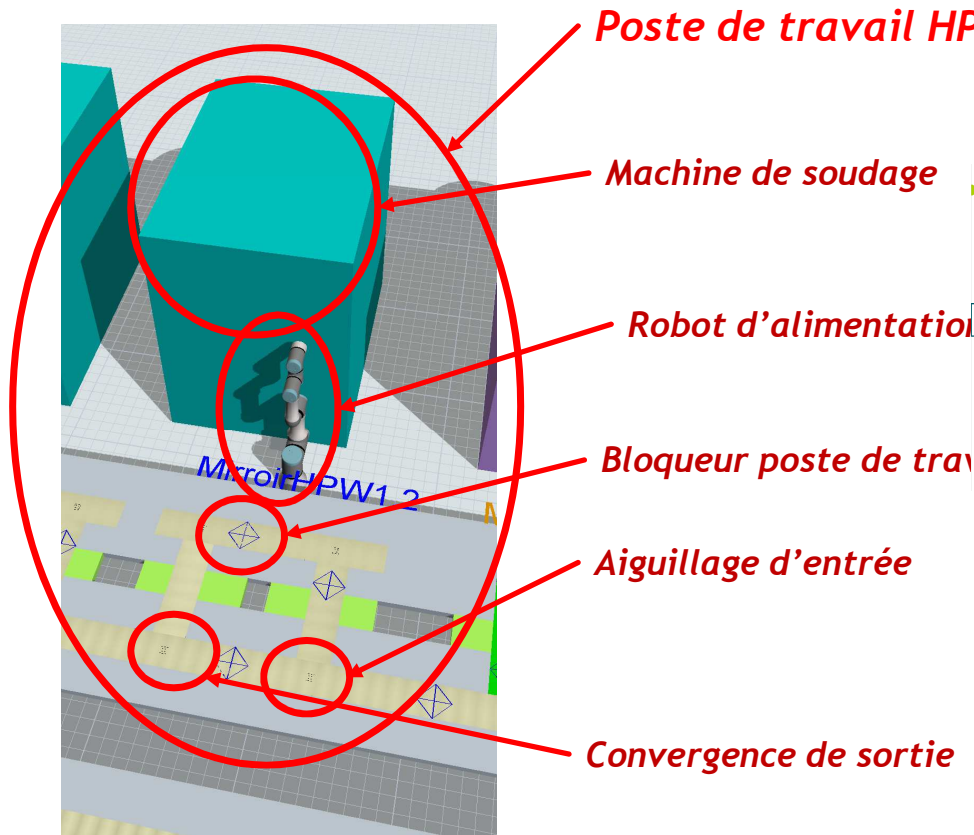


Case study : Living packet

A production line configuration



Modular approach



Une vision fractale du système

Current evaluation of a configuration using simulation

