An Integrated Framework for Diagnosis and Maintenance of Machining Systems

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1 Maintenance's role in modern production systems

- **Purpose** of industrial maintenance:
  - to insure that production systems are in working order
  - to maintain their functions throughout their life cycle
- More **tactical** and **strategic** role into today's manufacturing plants
- **Evolving** from **curative** maintenance to a **preventive** maintenance, or even reliability based maintenance
- **Use** of TPM (Total Production Maintenance) methodology and **integration** in MES (Manufacturing Execution System)
- **Objective:** to propose an **open architecture** which will offer **support** for the **optimization** of **preventive**, **predictive** and **corrective** maintenance using **reliability based analysis**.

1 Maintenance's role in modern (occidental) production systems

Consumer market is **changing,** product **life cycle** is **shortening**

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reducing strongly the **delay** to release a new product
more captivity, better control manufacturing cost!

↓

Occidental companies have to better understand their process to gain productivity and competitivity to face Asian development

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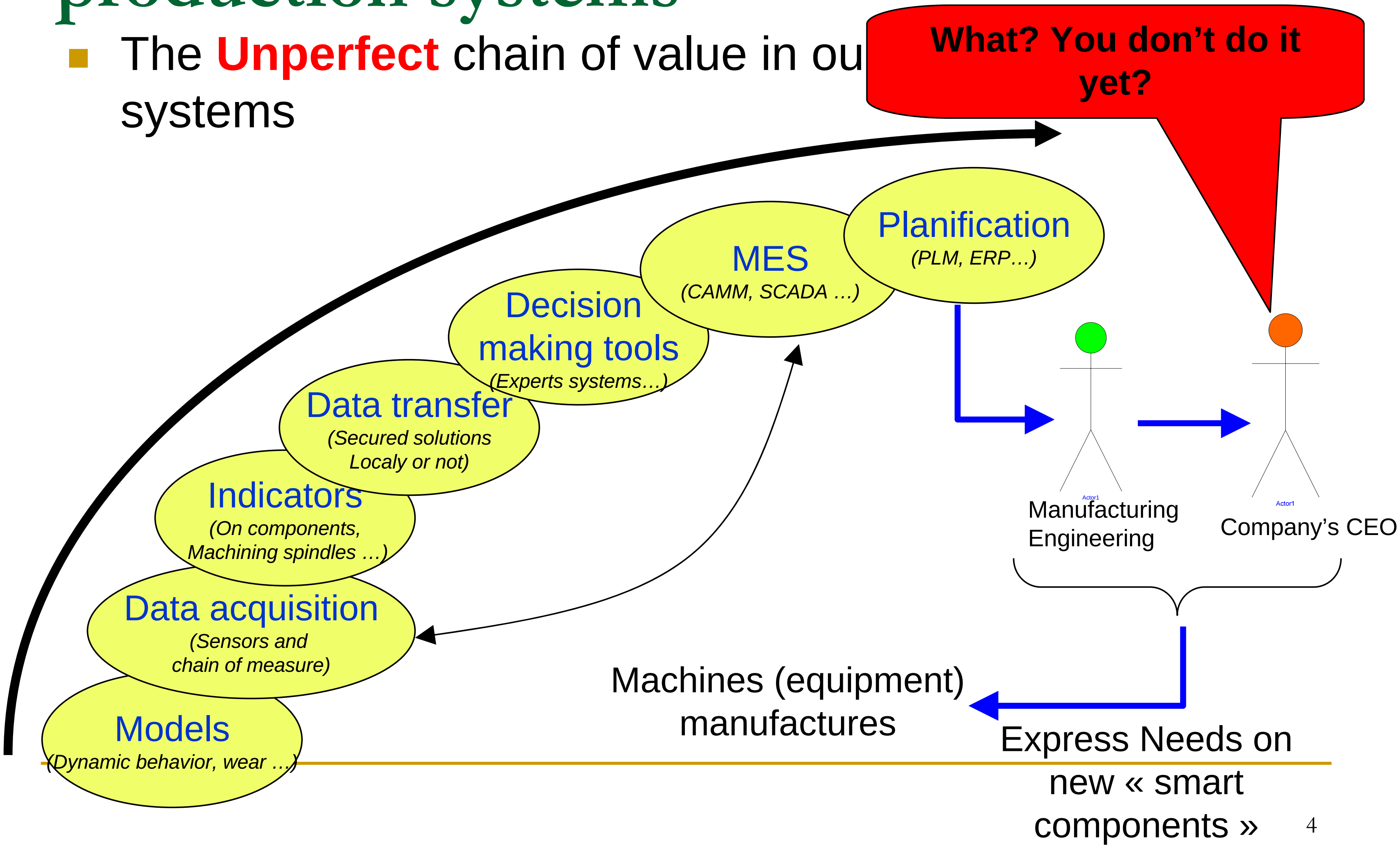
The manufacturing system needs more smart maintenance solutions and standardized / secured data exchange to reduce downtown times and cost

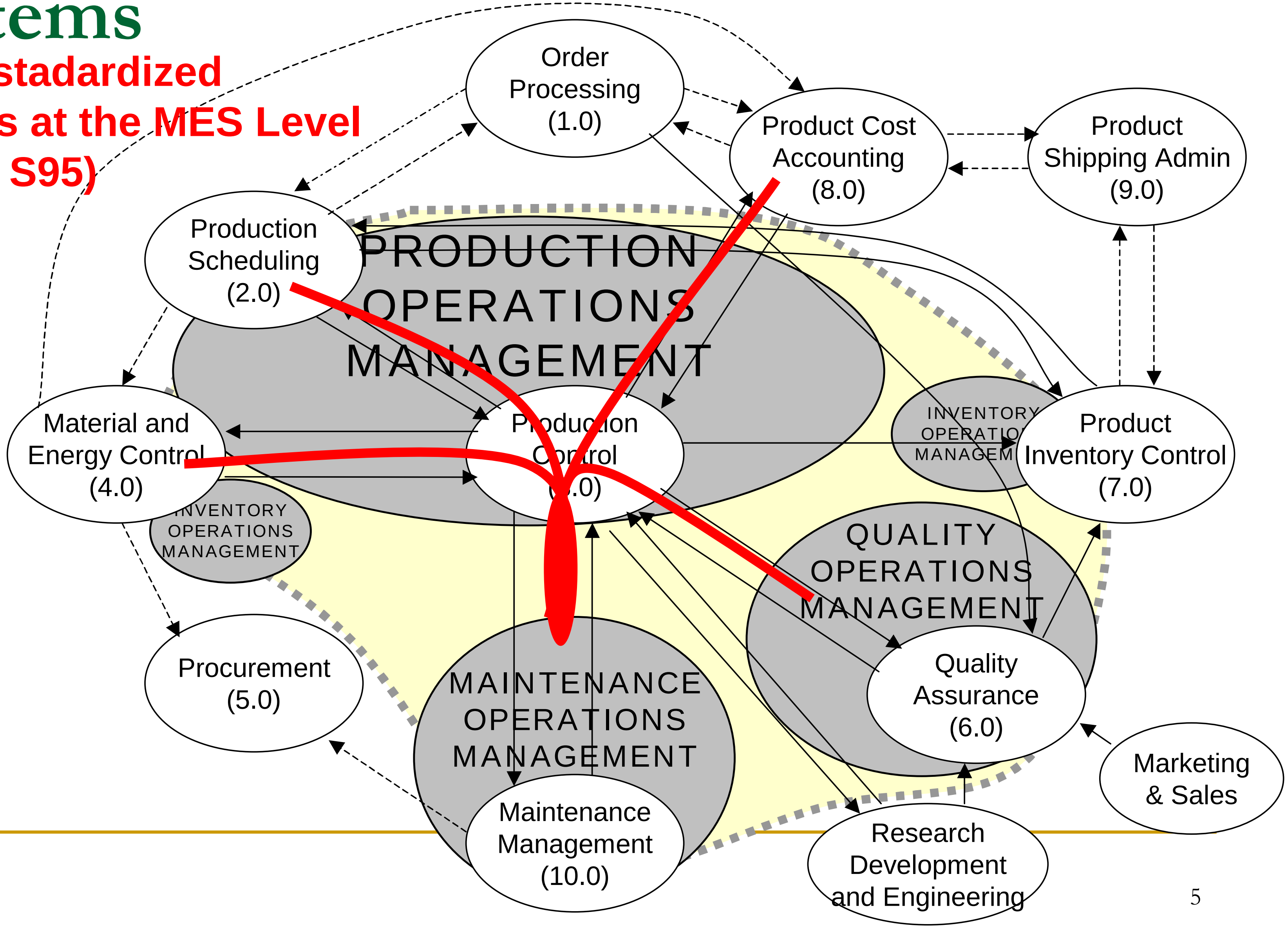
1 Maintenance's role in modern production systems

- The **Unperfect** chain of value in ou systems



1 Maintenance role in modern production systems

Needs of stadardized exchanges at the MES Level (ANSI/ISA S95)



1 Maintenance's role in modern production systems

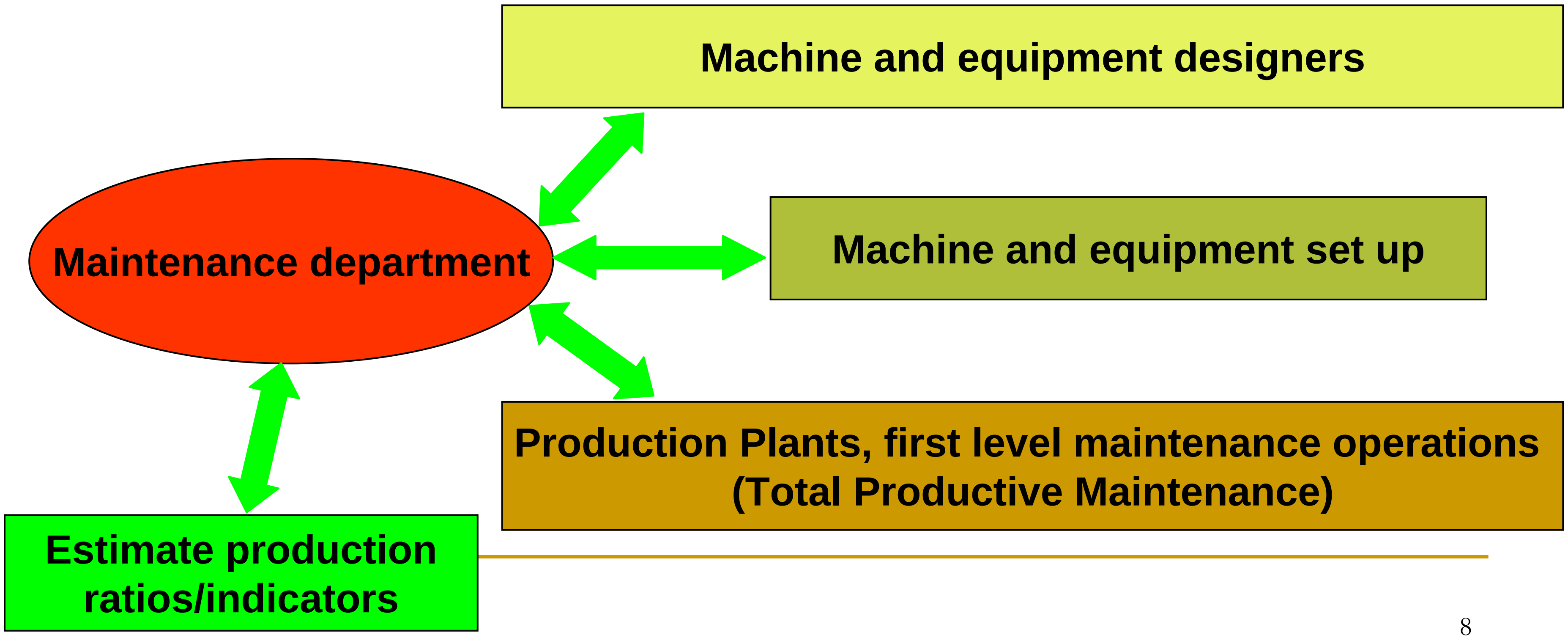
- **optimize workshops** by better **controlling performances** of the execution systems.
- **Industrial maintenance** plays a major part since its role is to **maintain** the execution system at **constant** specification.
- in order to optimize the entire production system need to :
  - use computer aided tools like Computer-Aided Maintenance Management (CAMM) software,
  - **communicate** with the **production** department,
  - and the equipment's **designers**.

1 Maintenance role in modern production systems

- As a consequence, maintenance **optimization** needs:
  - Accurate failure and micro-failure data
  - Semantic analysis to automate reasoning stages
  - Efficient diagnosis methods using Non Destructive Tools and new generation of sensors
- A maintenance oriented application must take into account the human operator.

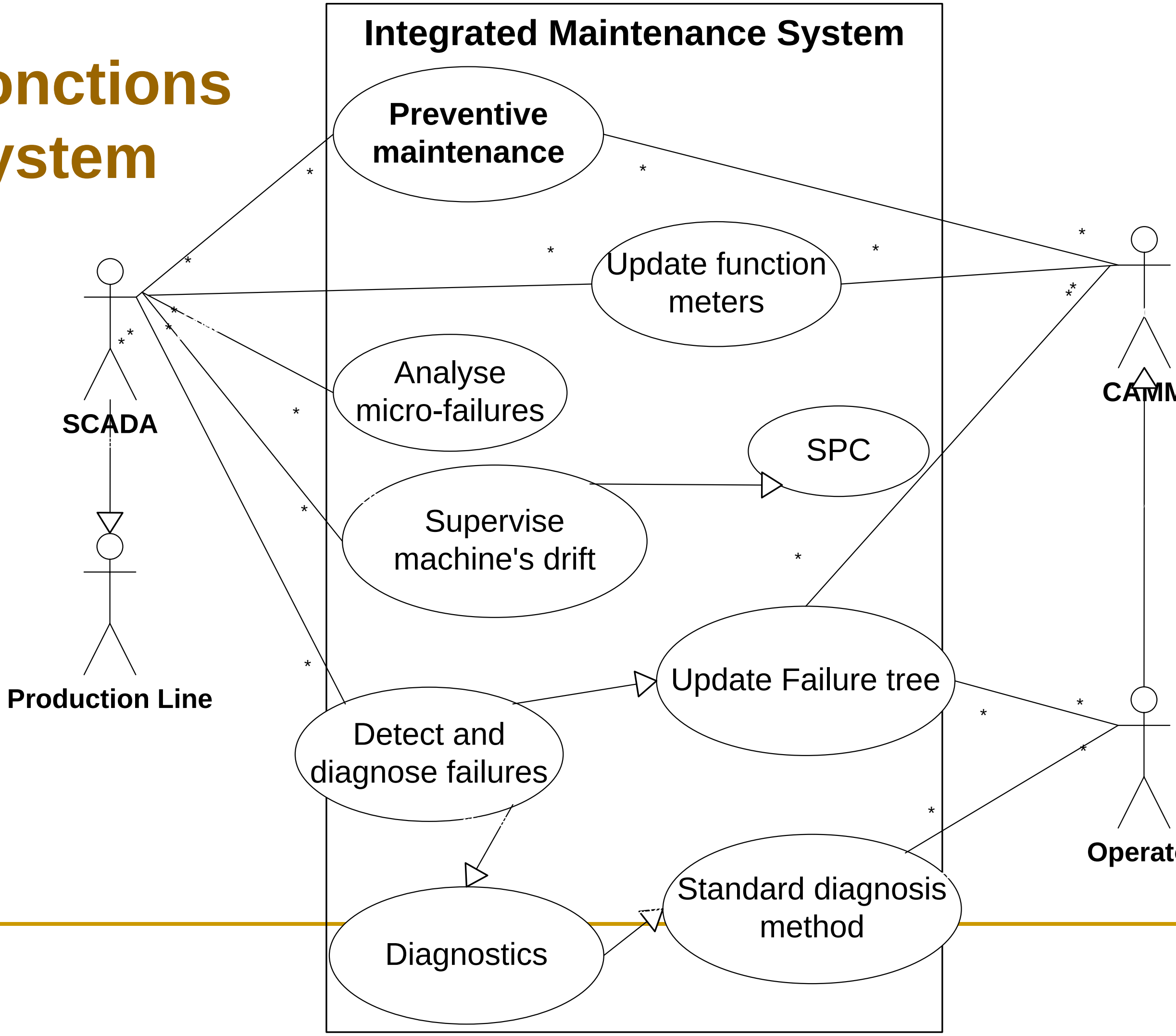
1 Maintenance role in modern production systems

Maintenance is becoming one of the most tactical and strategic function of the company

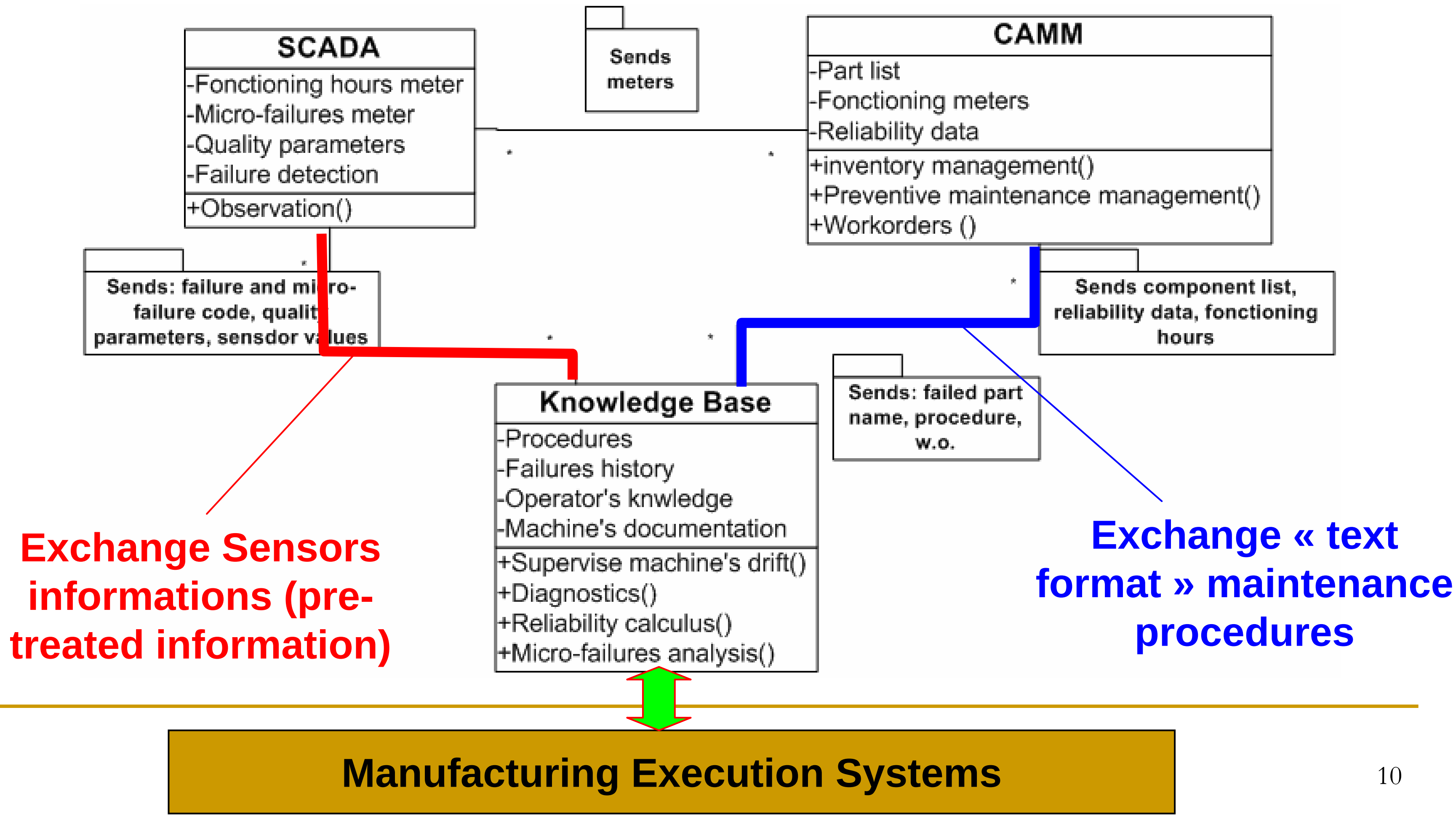


2 Proposed Integrated maintenance system's architecture

Initial Fonctions of the system



Integrated maintenance system's architecture



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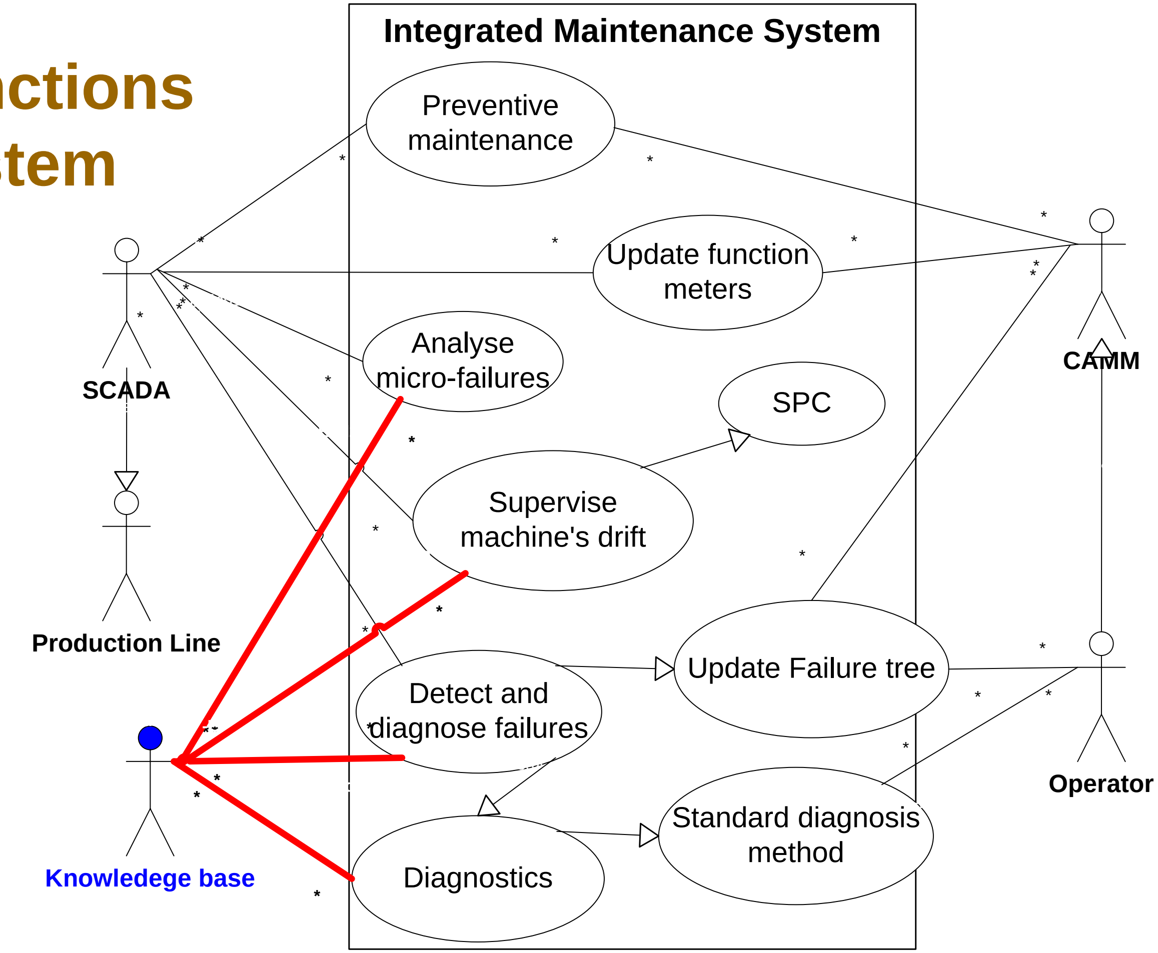
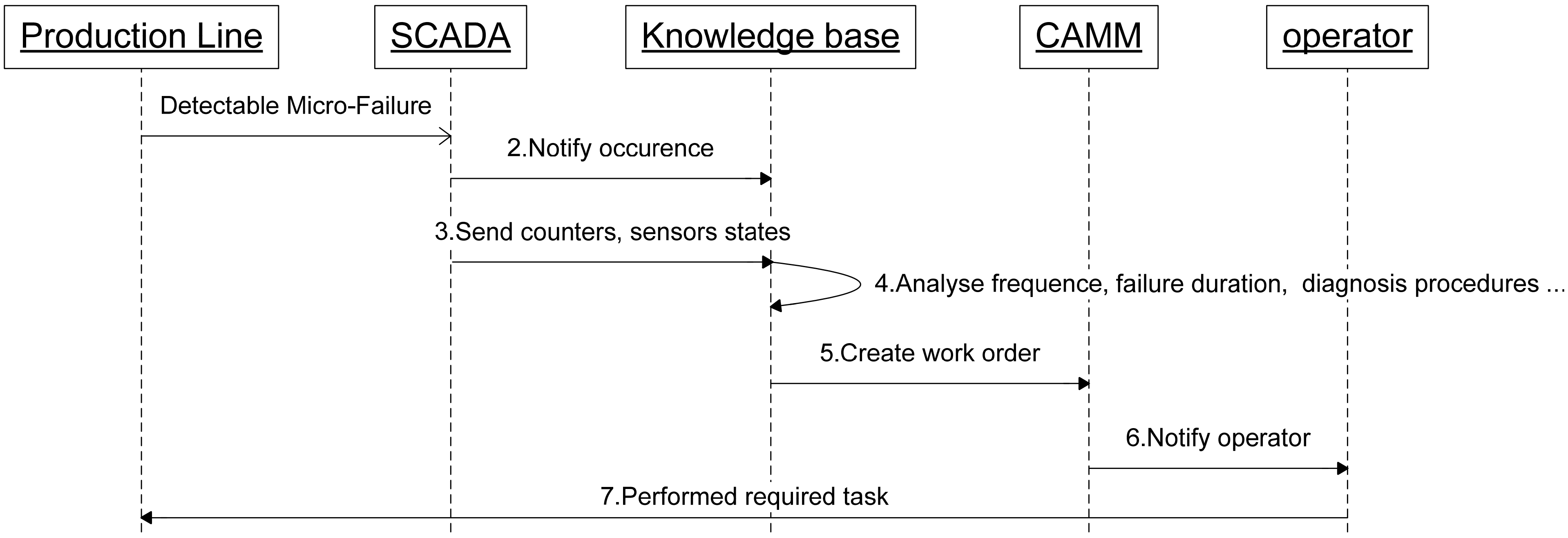


3 Examples of sequence diagrams

Treatment of microfailures

- Two categories: **detectable** by SCADA and **non-detectable**
- SCADA does not differentiate a failure from a micro-failure
- For non-detectable micro-failures the system relies on the human operator



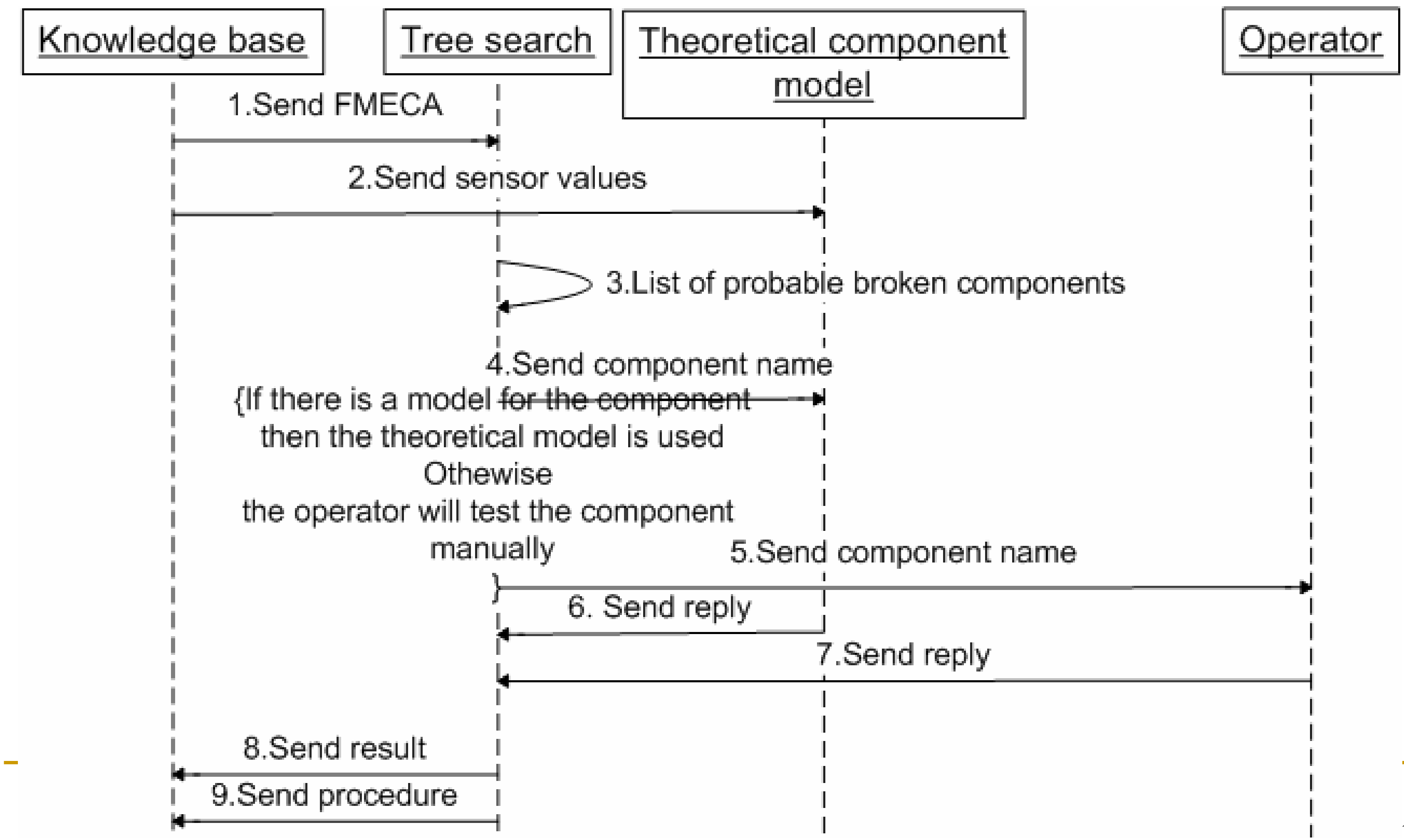
3 Examples of sequence diagrams

Diagnosis

- Diagnosis tools are mostly needed in the beginning and the end of the equipment life cycle
- During the maturity of the machine usually failures repeat themselves, or are “well known”
- For failures **already treated** in the past “IF…THEN” rules are used
- For new failures:
  - The **failure tree** is used to compile a list with components that have a high failure probability
  - Components are tested
  - When the faulty component is identified a new rule is added to the knowledge base

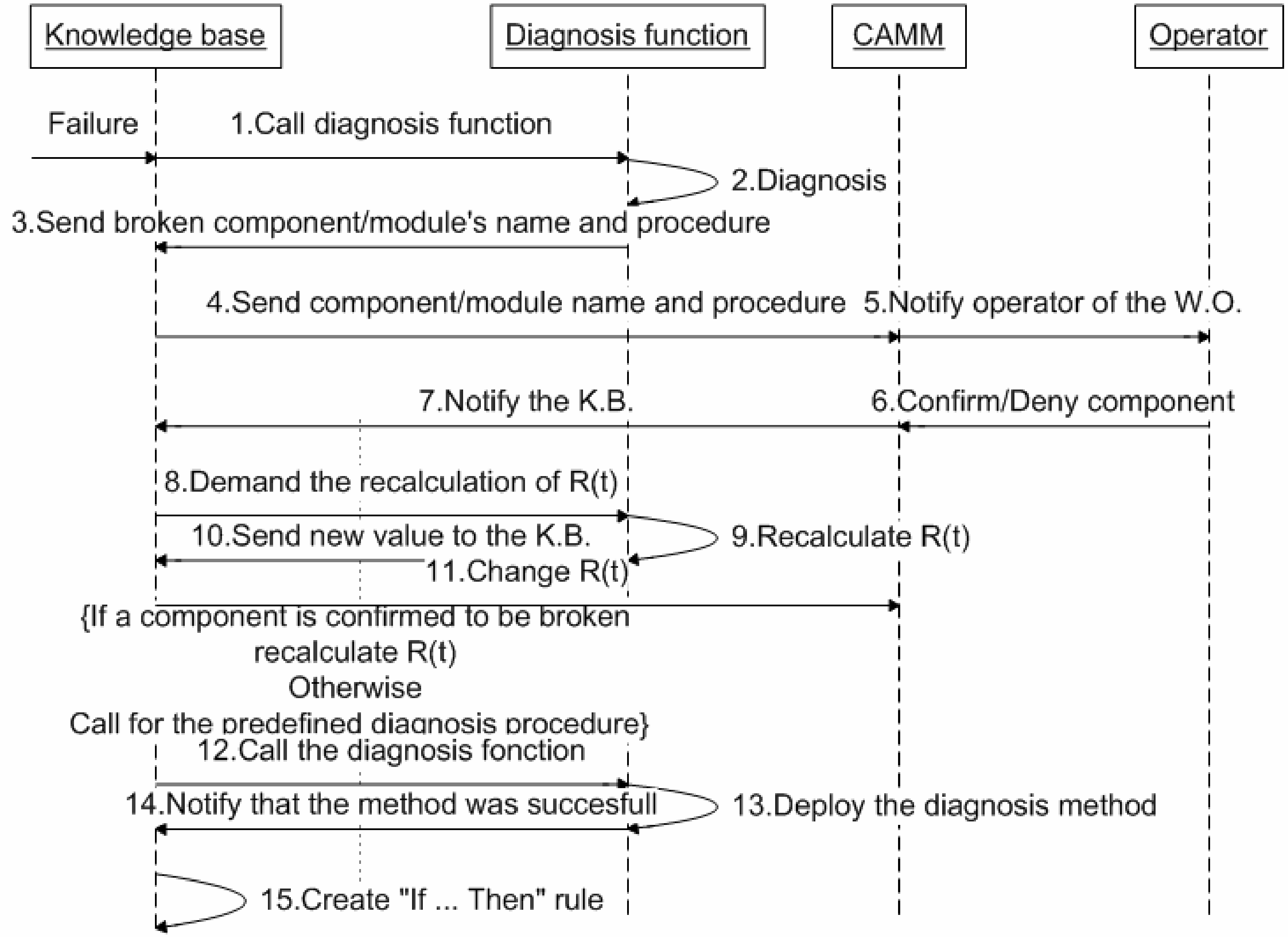
3 Examples of sequence diagrams

Diagnosis



3 Examples of sequence diagrams

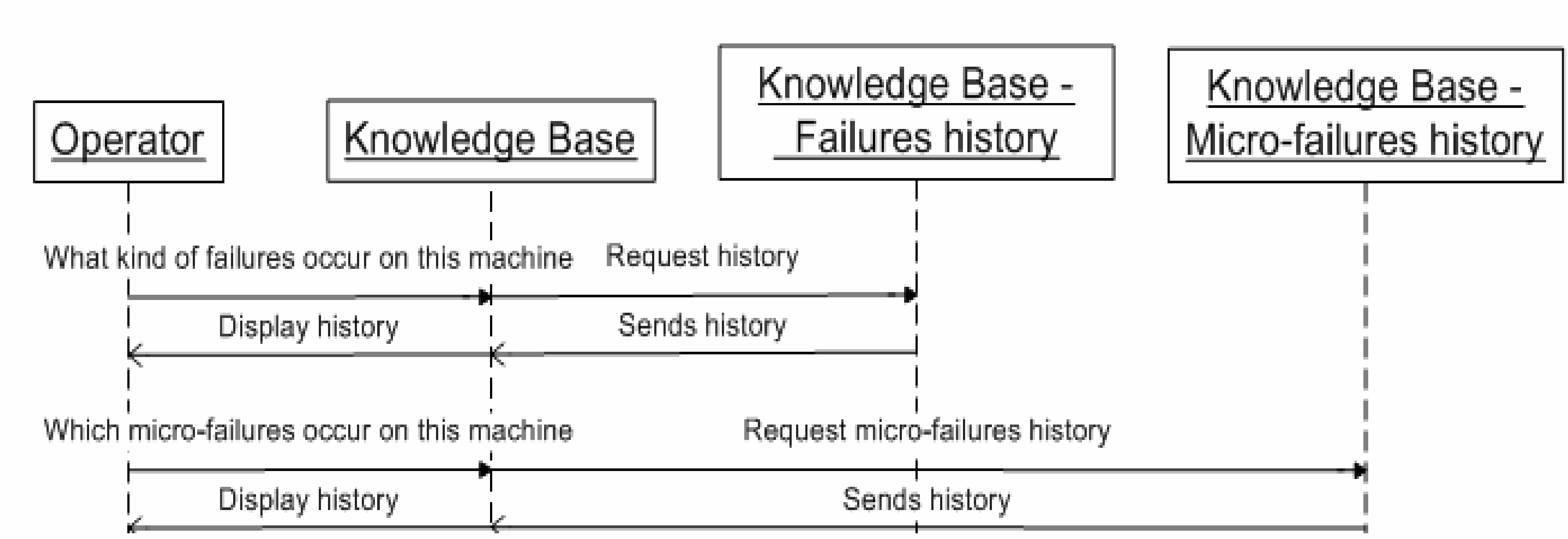
Reliability function update



3 Examples of sequence diagrams

Learning tool

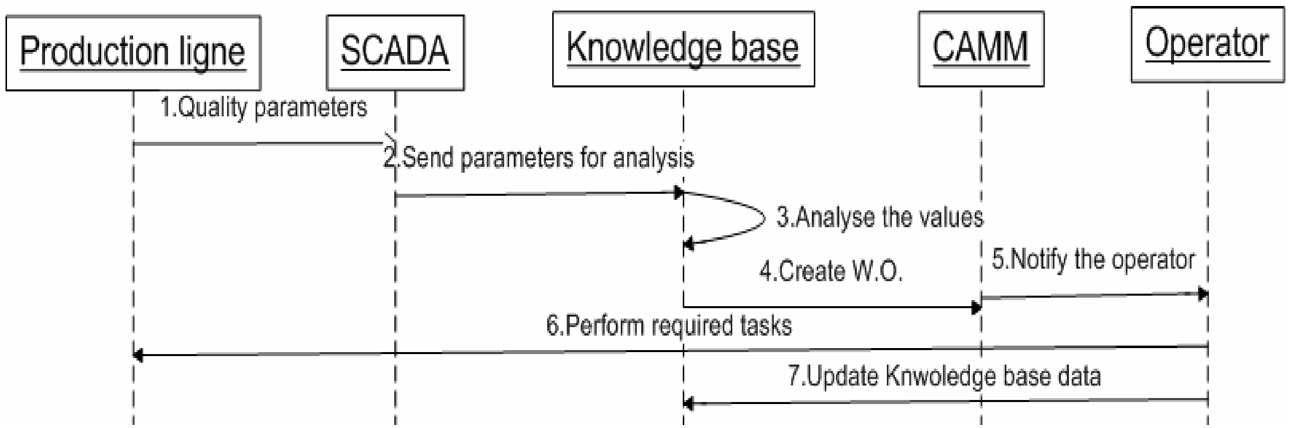
- The **knowledge base** stores all the procedures and machine history
- This knowledge can be easily shared within the enterprise
- Here are two examples of retrieving history data:



3 Examples of sequence diagrams

Supervising machine's drift

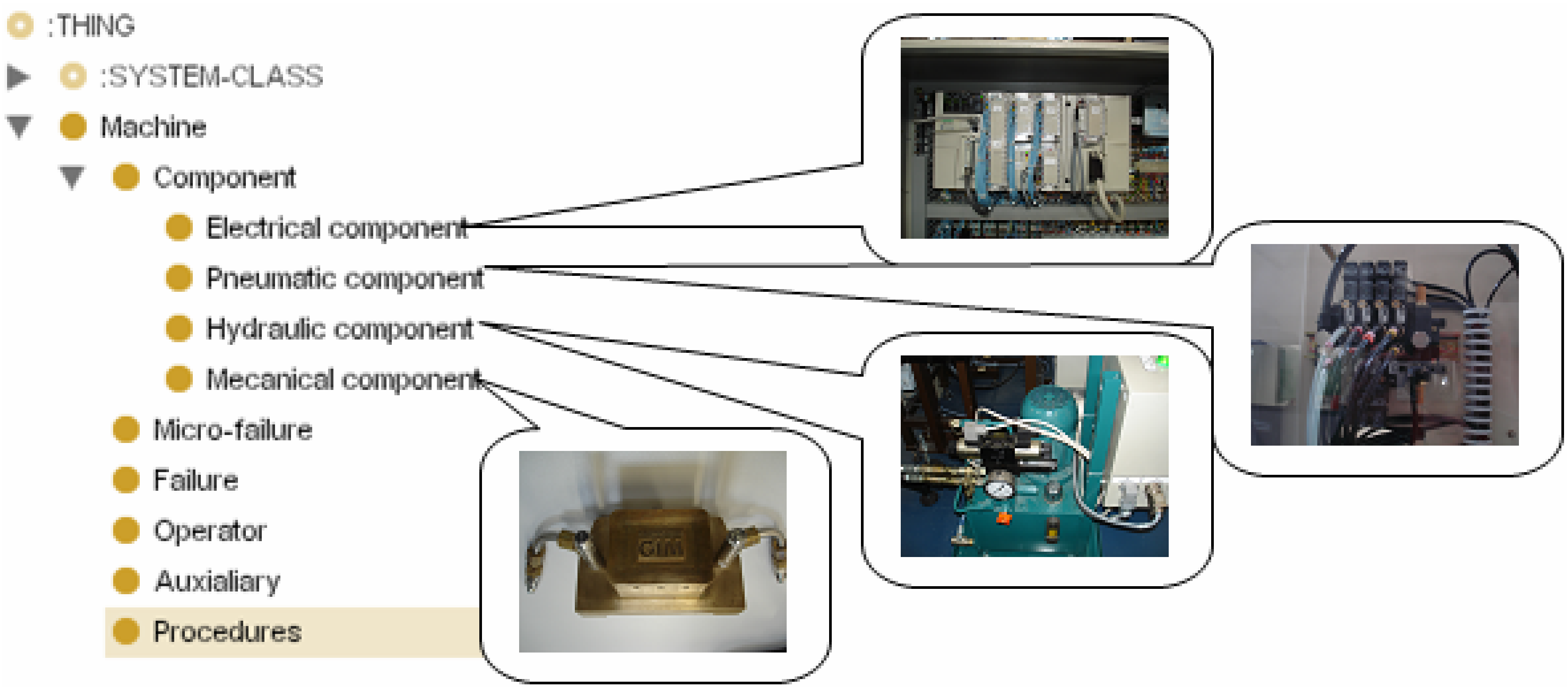
- Most workshops use Synthetic Efficiency Rates (SER) to picture workshop's **performance** in terms of **quality**, **availability** and **machine performance**
- Failures are generally well taken into account, however the **impact** of micro-failures is rarely correctly quantified
- The **knowledge base** has access to all the information required to calculate the correct values of SER
- The same data is used to **improve** the performance parameters



4 Knowledge base architecture

- The integrated maintenance system must respond to every change on the equipments of the production system
- A **knowledge base** must be able to give that flexibility
- Need of developing an **ontology** in order to use the knowledge base for multitude of applications and **tailored** it to the particular needs of a workshop

5 Knowledge base architecture

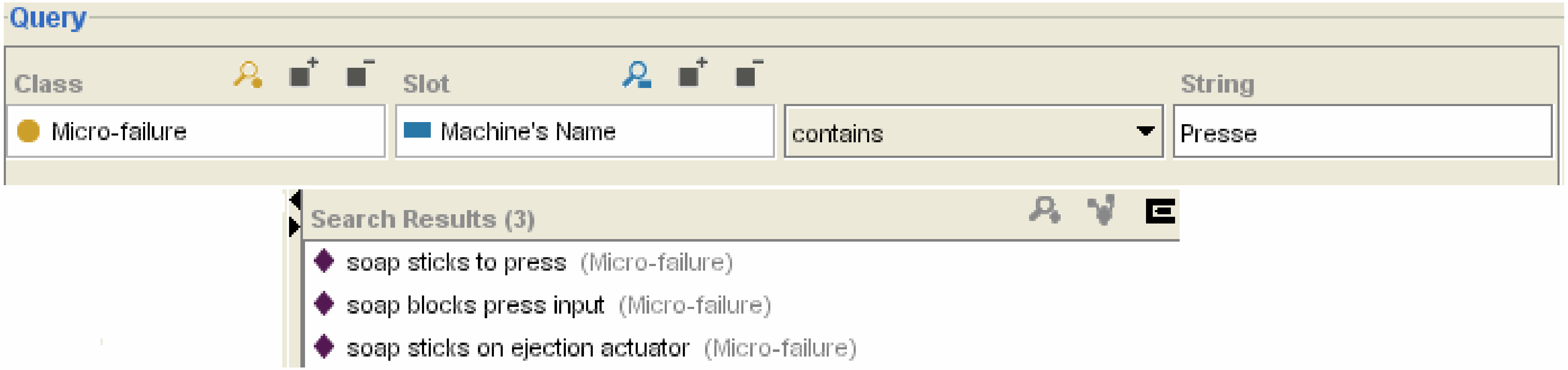


The procedure class contains all the procedures not related to a failure (startup and shutdown procedures for instance)

The “auxiliary” class for consumables like filters, cooling liquid, oil, and so on, for which there is a programmed maintenance and no reliability variables are related to them

6 Knowledge base architecture

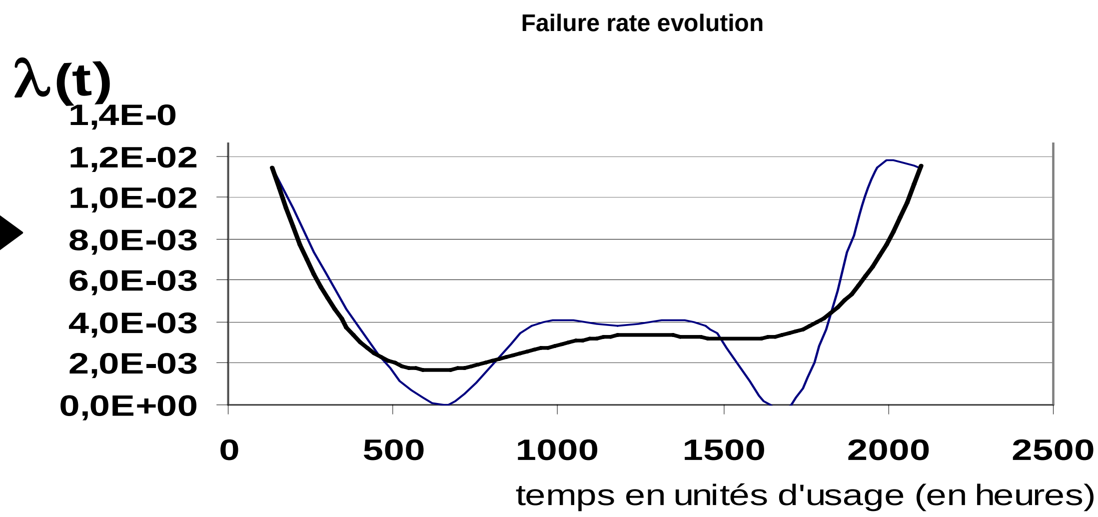
Implemented using Protégé and making some queries



6 Knowledge base architecture

	Régime	Lignes & Opérations	3 x 8	1 x 8	2 x 8	VSDj	VSDn	Total
A	1	Tour L2 PM5/PM6	250					
	1	Tour L6 PM5/PM6	250					
C	2	Tour L7 PM6		480				
D	1	Laser 4	120					
E	1	OP 30 PM5 Essence ML6	80					
F	2	Tour L1 R5/R6		130				
G	2	Tour L5 R5/R6		586				
H	2	Tour LP R5/5						
J								
K								

N° Machine	1
	1
Σ TA/mach	685,00
Nb de pannes / mach	14,00
M T T A / mach	48,93
panne 1	120,00
panne 2	75,00
panne 3	10,00
panne 4	45,00
panne 5	30,00
panne 6	80,00
panne 7	50,00
panne 8	30,00
panne 9	10,00
panne 10	45,00
panne 11	30,00
panne 12	80,00
panne 13	50,00
panne 14	30,00



Precise and accurate production ratios/Indicators

Conclusion and perspectives

- Maintenance of machining systems includes the use of many Smart Machine tools components
- A knowledge base is necessary to incorporate knowledge into maintenance optimisation
- Still need to be fully integrated to the manufacturing systems at the design levels
- Need of standardized data exchange at the MES level
- The knowledge base have also to be able to provide information for reliability based maintenance of manufacturing systems