



## ■ Safe Maintenance through design

**From machine engineering for safe maintenance to  
maintenance engineering for safe machine**

Workshop Maintenance – Bruxelles – Novembre 2010

## ■ Contents

- ▶ From machine engineering...
  - > Regular and normative framework: main requirements and recommendations
  - > Main issues (accidents analysis)
  - > Is « good » design enough?
  
- ▶ ... to maintenance engineering
  - > More than a « simple intervention »: a complete process
  
- ▶ Conclusion
  - > Designer/ User Dialogue
  - > Training

- ▶ 1.1.2. Principles of safety integration: Machinery must be designed and constructed so that it is fitted for its function, and can be operated, adjusted and **maintained** without putting persons at risk when these operations are carried out
- ▶ 1.6. MAINTENANCE –
  - > Adjustment and maintenance points must be located outside danger zones. It must be possible to carry out adjustment, maintenance, repair, cleaning and servicing operations while machinery is at a standstill
  - > If it cannot be satisfied for technical reasons, measures must be taken to ensure that these operations can be carried out safely (see section 1.2.5)
  - > Machinery must be fitted with means to isolate it from all energy sources.
  - > Machinery must be so designed, constructed and equipped that the need for operator intervention is limited.
  - > 1.6.5. Cleaning of internal parts
- ▶ 1.7. INFORMATION - 1.7.4. *Instructions*

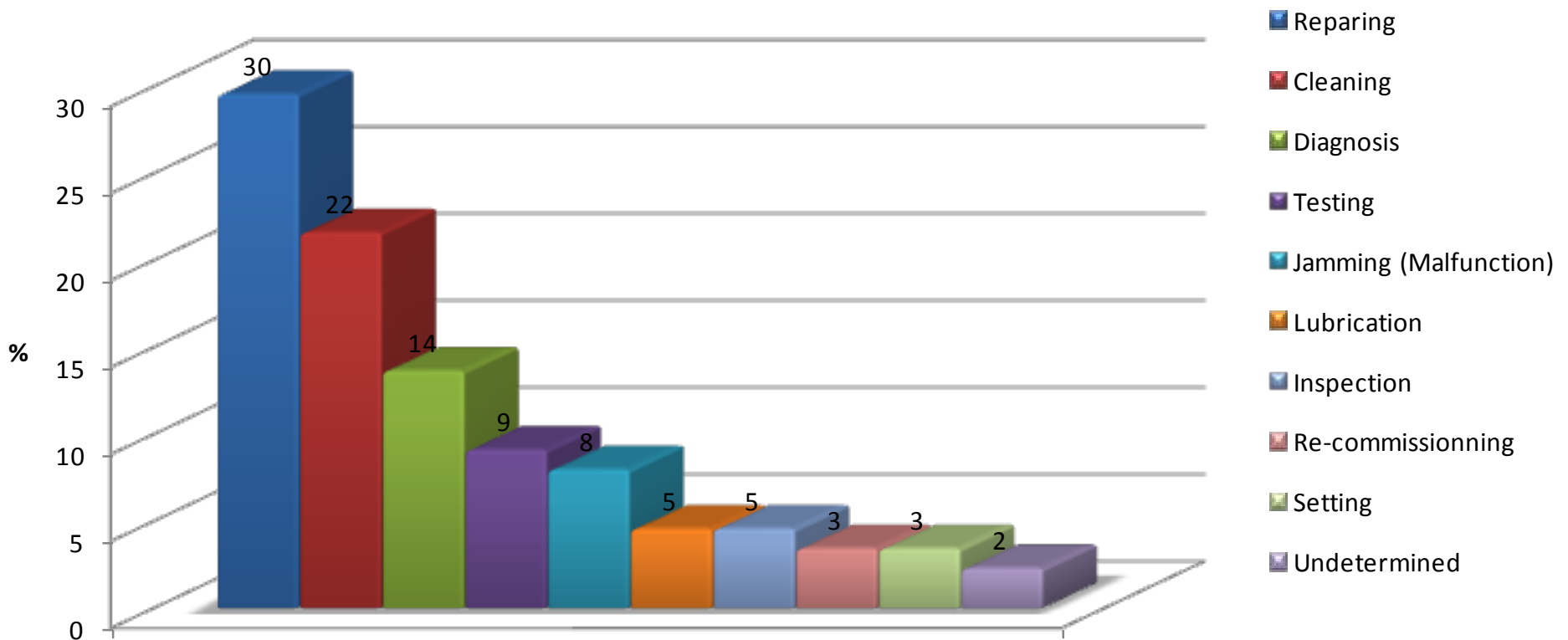
- ▶ 1.7.4.2. Contents of the instructions - Each instruction manual must contain:
  - > (e) the drawings, diagrams, descriptions and explanations necessary for the use, maintenance and repair of the machinery and for checking its correct functioning;
  - > (q) the operating method to be followed in the event of accident or breakdown
  - > (r) the description of the adjustment and maintenance operations that should be carried out by the user and the preventive maintenance measures that should be observed;
  - > (s) instructions designed to enable adjustment and maintenance to be carried out safely, including the protective measures that should be taken during these operations;

- ▶ No specific safety of machinery standard relative to maintenance (maintainability)
- ▶ EN ISO 14122: Permanent means of access to machinery
- ▶ EN 547-1: Human body measurements
- ▶ French standard: NF X 60-301 : Guide for taking into account criteria for maintainability of durables for industrial and professional use
- ▶ EN 1037 – safety of machinery Prevention of unexpected start-up
- ▶ Reference standard on safety on machinery: EN ISO 12100
  - > Same recommendations than directive requirements

- ▶ **3.3 maintainability (of a machine)**
  - > ability of a machine to be maintained in a state which enables it to fulfill its function under conditions of intended use, or restored into such a state, the necessary actions (maintenance) being carried out according to specified practices and using specified means
- ▶ **4.11.9: Control mode for setting, teaching, process changeover, fault-finding, cleaning or maintenance**
- ▶ **4.11.12 Provision of diagnostic systems to aid fault-finding**
  - > Diagnostic systems to aid fault finding should be included in the control system so that there is no need to disable any protective measure. NOTE Such systems not only improve availability and maintainability of machinery; they also reduce the exposure of maintenance staff to hazards.
- ▶ **4.15 Limiting exposure to hazards through location of the setting and maintenance points outside of danger zones**

- ▶ Analysis of 93 accidents of « repair » - Main « direct » risk-factors
  - > Intervention when machine powered on: 76 % of accidents
    - machine fully operated : 40 %
    - machine automatically started up : 25 %
    - machine intentionally switched on : 25 %
  - > Statutory safety devices missing: 41 % of accidents
  - > Release of energy: 14 %
  - > Deactivation of safety devices: 11%

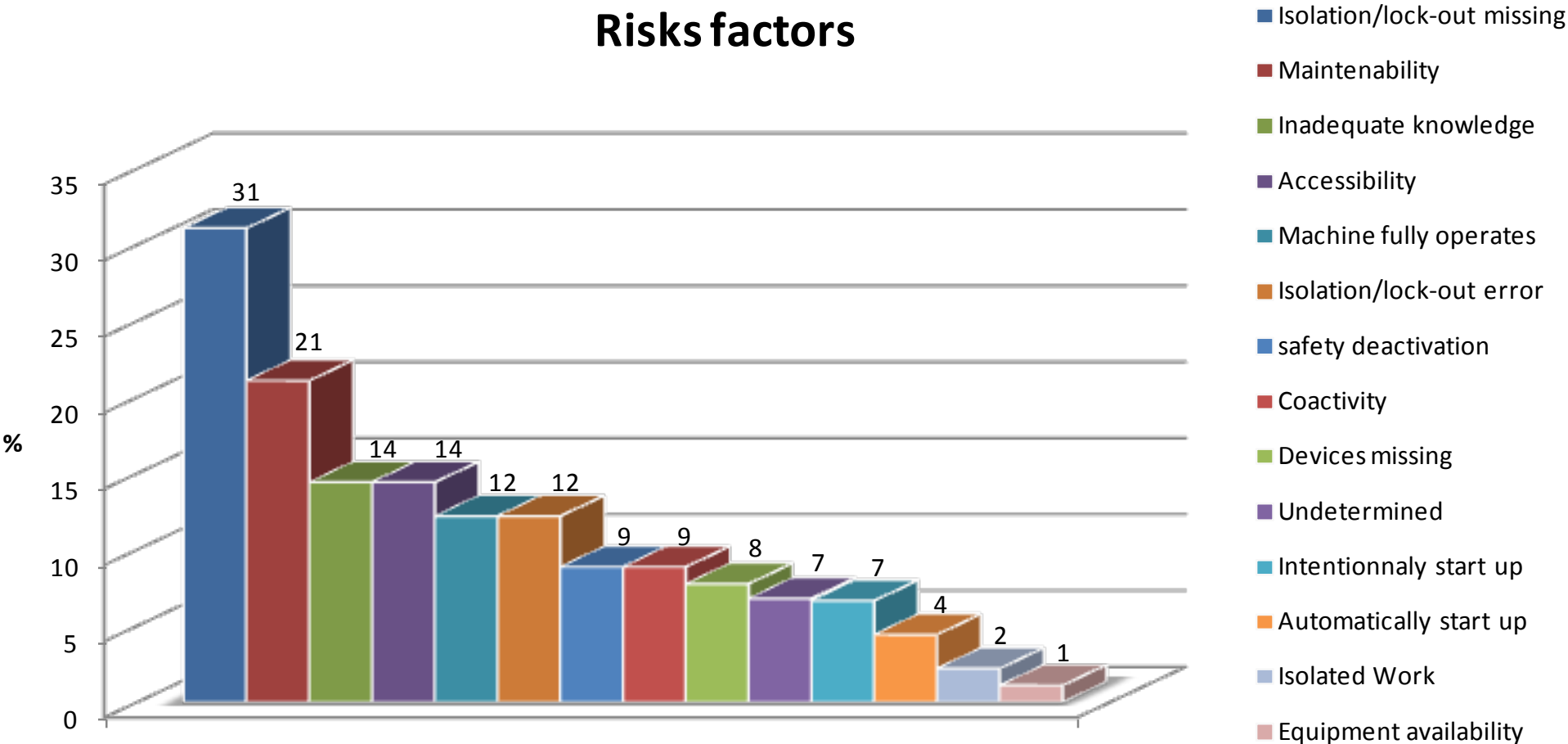
## OA Distribution/ EPICEA working phase





## OA Distribution/ risks factors

### Risks factors



## ■ Conclusion of OA analysis

- ▶ Intervention under energy
- ▶ Maintainability has to be improved
- ▶ Safety measures must be adapted to the intervention
- ▶ Integration at design stage to be prioritized
- ▶ It's essential to identify intervention needs

■ Maintenance : high-risk activity?



**Ensure  
safety on  
energies**

■ Maintenance : high-risk activity?



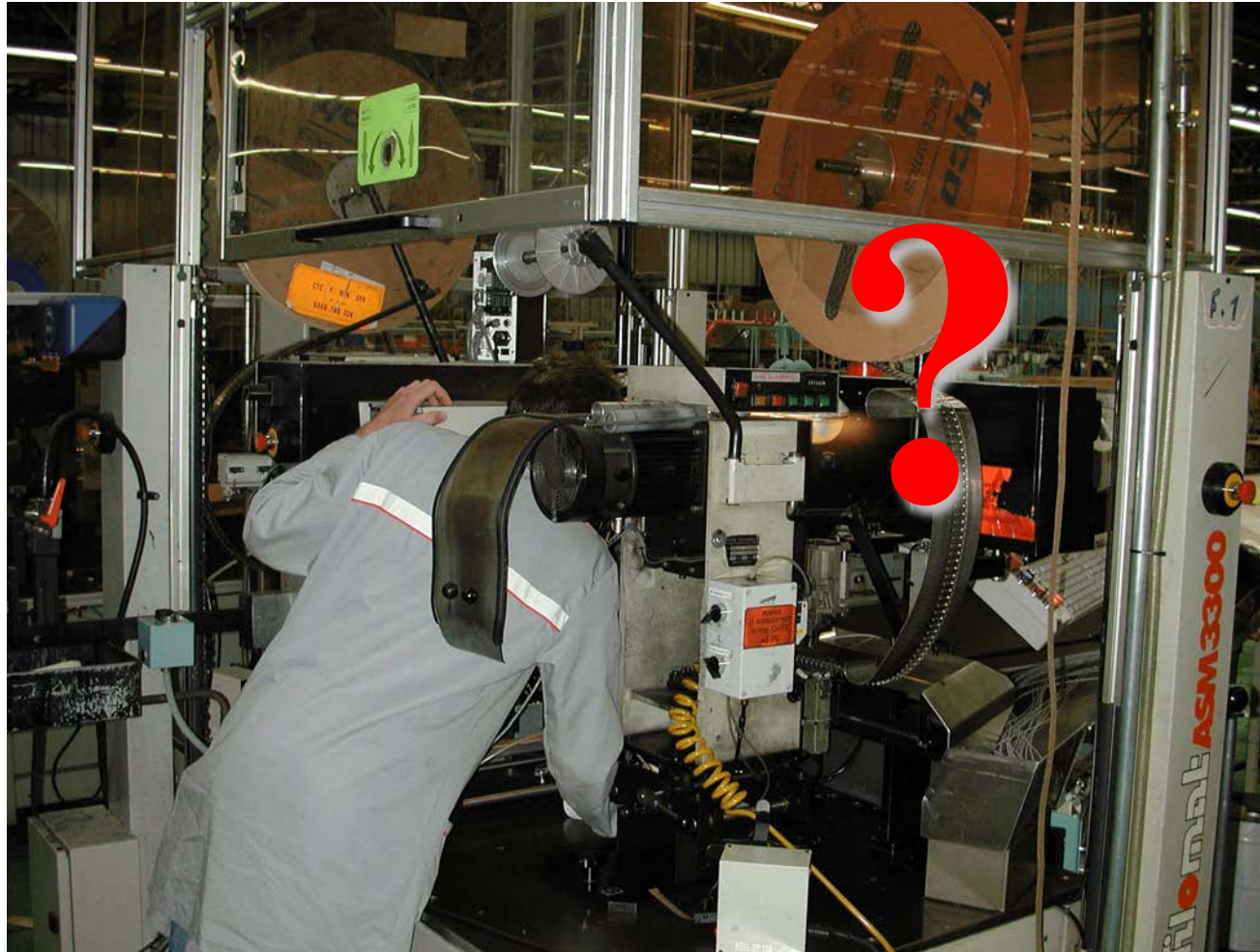
**Organize  
the activity**

■ Maintenance : high-risk activity?



# Train operators

■ Maintenance : In reality !



**Analyze,  
Estimate,  
Prevent  
Risks**

- ▶ Not only consider the intervention on machinery
- ▶ Before intervening
- ▶ After intervening
- ▶ Each maintenance stage contributes to safe operation performance on work equipment

# Maintenance generic Chart

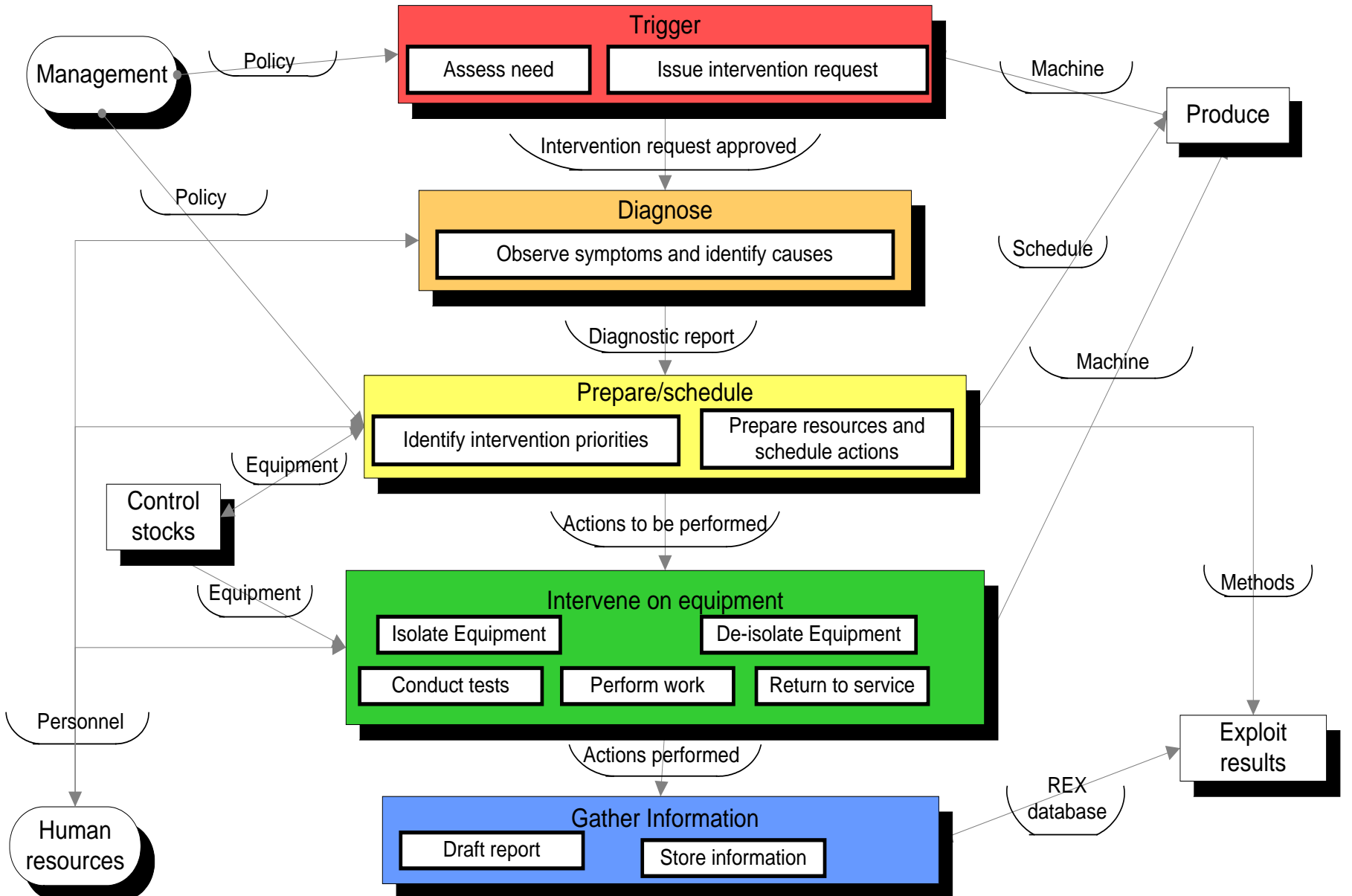
Process

Sub-process

25/10/2007

information

External entity





## ■ Thinking aimed at designers

- ▶ A machine must be designed such that it can be safely maintained without necessarily resorting to a maintenance operation under isolated conditions
- ▶ To optimize conditions under which a maintenance operation is performed
  - > eliminate or limit it whenever possible through appropriate equipment design choices
  - > integrate maintainability
  - > analyze operating modes in relation to this maintenance operation based on zones, durations and the work to be performed
  - > analyze and assess risks for each operating mode,
  - > derive safety measures appropriate to this operating mode,
  - > knowing that each technical solution has its limits, derive compensatory measures, if necessary,
- ▶ it is important to consider the consistency of adopted safety measures, depending on the type of operation: a solution retained for a maintenance operation can be incompatible with another operation.

# Conclusion

- ▶ Concerning designers: difficulties to foresee some « specific » modes: process observation
- ▶ Concerning users: difficulties to anticipate some intervention: breakdown, spare parts...
- ▶ Information have to be shared : dialogue - specification formalisation
- ▶ Operators training
  - > Before putting machine into service
  - > During the life of the machine (changes)
  - > drawings and diagrams available and up to date !.

# Safe maintenance is making progress

