The integration of the supervision in the MES environment within the framework of the Extended Enterprise.

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Abstract: *This paper aims at presenting the integration of structure Command-Monitoring in the logistic chain.. The control and the piloting of any logistic chain require the use of data-processing tools as well on the level of the management of physical flow as informational. Dice the design at the exit of the workshop, a product is dealt with by various systems, most of the time distributed and developing in heterogeneous platform. The sharing of relevant information coming from these various systems is necessary in order to have a better control on the whole of the stages of manufacture of products, to be able to intervene quickly, carry out corrections, or to carry out the validation of the various stages. It is thus necessary to have a link between the various systems taking charges manufacture.By defining the concept MES (Manufacturing Execution System), ERP (Resource Planning Enterprise) and the System of control CONTROLS, the system of information is considered in the point of view of MES and CONTROLS.*
Our model searches to integrate the system of supervision as tool of action and not only a Monitoring System, what has given the idea to search to integrate models Command-Monitoring by using the contribution of the MES. This integration supplies tools of help to the decision to the operator permits a piloting in real time of the production system. By using UML and XML we propose a methodology of definition, and exchange of technical data information of the Extended Enterprise.

I. Introduction

The industrialists of the whole world cope with many challenges trying to answer to worldwide pressures of the market. They constantly endeavor to reduce expenses, to improve efficiencies and to supply a manufactured article of the best quality. Those who have succeeded know that the control of a factory workflow is essential to the performance. If a enterprise does not deliver in the time limit, the whole society suffers from consequences. Manufacturing Execution System is the ideal solution to take up those challenges by supplying information in real time from the workshop to ERP. The implementation of ERP (*Resource Planning Enterprise*) have accentuated the need of information steamed from the ground to refine and/or correct the used referential data, by taking into account the observance of the process real functioning: time of cycles, proportion of operating, cadences, efficiencies, dysfunctions and down time. It procures a better knowledge and a better masters of the process.
The MES system lies in a consolidation and exploitation process of data in real time, with actors and different users on the production sites. To give more flexibility to the Enterprise functioning, it is very interesting to better exploit the information offered bye this new concept, in order to give to the operator tools of help to the decision and information which allow him a Piloting in real time of the industrial proceedings.

We propose to integrate models of command-Monitoring in this new environment. This integration supplies tools of help to the decision to the operator which permits a piloting in real time of the production system. In the following will be presented an idea for the integration of theses models, in particular the diagnosis function.

To better understand the MES and its reports to the other industrial activities, this document supplies the following theoretical basis: a MES definition, the context in which the MES executes its functions and the fundamental interface objects of the MES. Besides this section, the second one supplies a MES definition and different information systems connected to this system. Section three describes a methodology and technology of the information traffic between ERP, MES and CONTROLS. Section four contains the problematic of the Supervision Integration in the Extended Enterprise framework. Section five concludes the paper with an appeal of the continuous development to the Supervision Integration in the MES concept.

II. MES in the architecture of the Extended Enterprise information system

The primary goal of a MES is to provide an information system that can be used for optimizing production activities in a manufacturing facility with the focus on quick response to changing conditions.
Some sub goals of a MES are as follows [1]:

- To improve communication inside a facility; for example, part programs can be electronically downloaded from CAM (Computer Aided Management) systems to machine tools and production activities can be rescheduled to reflect unexpected

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machine down time or production priority changes.

- To improve communication capability between production and other activities in a manufacturing enterprise, such as product design, process planning, resource planning, supply chain management, service and sales, and equipment control.
- To monitor production to control operations within desired performance parameters.
- to better manage production-related data, including resource data, performance data,

Process data, job scheduling data, equipment/device control programs, and so on...

A MES definition can be given as follows: a MES is a system that consists of a set of integrated software and hardware components that provide functions for managing production activities from job order launch to finished products. Using current and accurate data, a MES initiates, guides, responds to, and reports on

These environments need to interchange with a Manufacturing Execution System (MES) environment to help manufacturing meet their needs within certain manufacturing business processes in the production area. A description of these functional groupings is below [2]:

Sales and Service Management (SSM): comprises software for sales force automation, product configurations, order management, service quoting, product returns, and post-sales service.

Supply Chain Management (SCM): includes functions such as forecasting, distribution and logistics, transportation management, electronic commerce, and advanced planning systems.

Product and Process Engineering (P&PE): includes computer aided design and manufacturing (CAD/CAM), process modeling, and product data management (PDM). PDM supports information sharing in a distributed environment that can cross company boundaries. The industrial enterprise has a special dependency on its product model information (product data). This product data includes definition of the products that will be manufactured. CAD systems are involved in designing a product or a facility to build a product. At this time CAD systems utilize drawings and specification documents to maintain the design information.

Controls: are usually hybrid hardware/software systems such as distributed control systems (DCS), programmable logic controllers (PLC), distributed numerical control (DNC), supervisory control and data acquisition (SCADA) systems, and other controls designed to automate the way in which the product is being manufactured.

production activities as they occur. A MES provides production activity information to other engineering and business activities in the enterprise and its supply chain via bi-directional communications. This definition is derived from a definition given in the Manufacturing Execution Systems Association (MESA) International White Paper 6 [2]. In the paper, only major functions in a MES are described.

According to MESA's classification the functions of one MES are flowing eleven: Resource allocation and status ,Dispatching production units, Data collection/acquisition, Quality management, Maintenance management, Performance analysis, Operations/detail scheduling, Document control, Labor management , Process management and Product tracking and genealogy

Manufacturing Execution System is one key element of an information system supporting a manufacturing facility. According to MESA International [2], there are five other key functional groupings with which a MES must interface in order to effectively manufacture product.

The following figure (Fig.1) indicates these functional groupings and their interfaces:

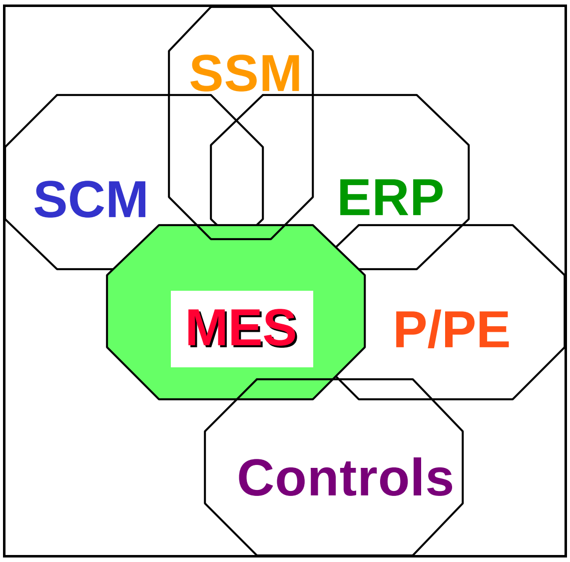

Figure 1. MES Contexte Model [2]

Enterprise Resources Planning (ERP): consists of those systems that provide financial, order management, production and materials planning, and related functions. The modern ERP systems focus on global planning, business processes and execution across the whole enterprise (intra-enterprise systems), with an accrued recent importance of aspects like supply chain planning and the whole supply chain management aspects and extending to include the whole inter-enterprise supply chain.

III. Float of information between ERP-MES-CONTROLS

To better understand the data transfer between ERP-MES-CONTROLS, the following section presents the information stream between MES, ERP and the system of Command CONTROLS.

The ERP systems are mainly concerned by the management of materials float. They have transactional actions as order forms. The transactional character of this control requires the economic planning of these actions. The time balance is for the most precise expressed in terms of hours. The ERP modules systems can be implemented on different platforms, probably even on systems taken away on other sites.

The command system (CONTROLS), on the other hand, is concerned by the management of all sorts of process parameters, as the output the rotary speed and the temperature. The time balance is expressed in milliseconds.

The incompatibility of both worlds (ERP and CONTROLS) is caused by the transactional against the continuous character. The lock of the gap implies the capacity to reconcile process continuous data with transactional status data.

A MES ensures the link between the ERP and CONTROLS by ensuring the data acquisition by interfaces with the command system through SCADA (Supervisor Control and Data Acquisition). The data acquisition is made in a rather direct way. Once these data collected, the MES executes a range of functions.

- It records data of the production process in a data basis in real time (including the history).
- It executes the data reconciliation for the process vague data.
- It converts the process real time data into relational data of group.
- It produces all the kinds of the production reports/ratios
- It maintenance a data basis receipt.
- It manages a production program.

For the presentation of information streams of various functions, several methods are usually used (SADT, SART, MERISE, etc.). Our choice concerned the method SADT [3] because it offers a real «language to communicate» [4] furthermore it is universally known.

The following diagram(Fig.2) presents the main streams of information between ERP, MES and CONTROLS:

A1-Development of the production plan: The Development of the production plan (A1) activity relates to Enterprise Resource Planning functions. Based on the production needs, generates production orders and jobs schedules . This activity needs the status of quality, the status of production orders and the work in process.

A2-Manage equipment, employee and material:The Manage equipment, employee and material (A2) activity relates to the manufacturing execution System functions. Based on the production orders and master schedule, guides, responds to, and reports on production activities as they occur.

A3- Control Equipment: The Control Equipment (A) activity executes the fabrication, assembles and inspects operations and/or controls the equipment which performs them. It controls and monitors the process parameters. All the more it identifies problems and anomalous behavior.

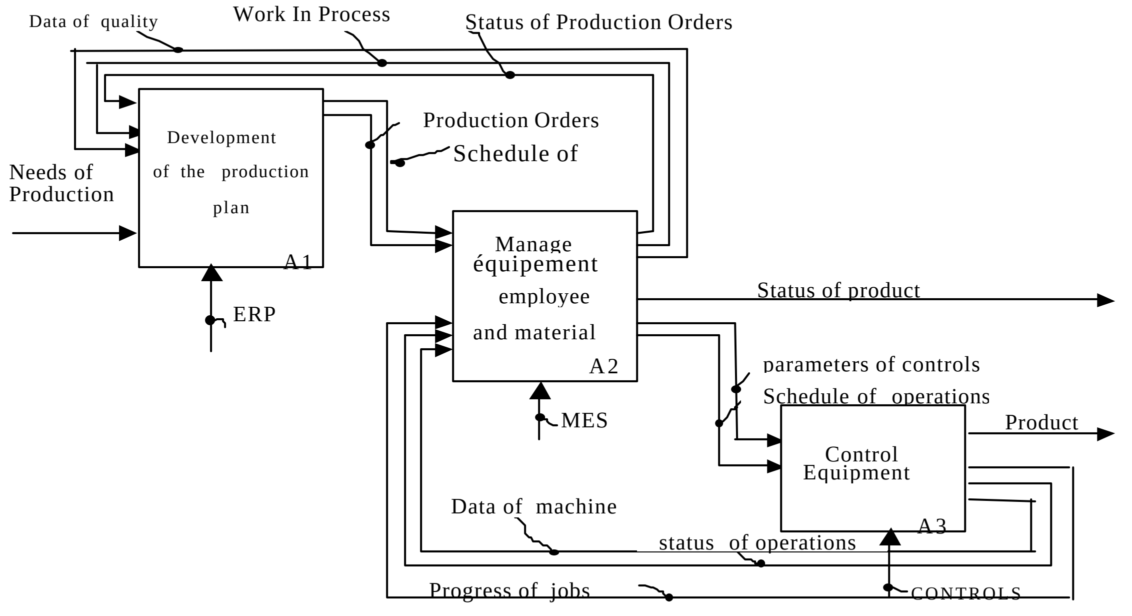

Fig.2 float of information MES-ERP-CONTROLS

IV. Integration of supervision in the MES concept

With the interfacing of the controls systems of equipment, MES can capture the process data of for filing as well as to pass the instructions of the execution and product information through this system. The type of information transferred from SCADA for example towards MES relates to the state of machine (example 0: machine off; 1: machine on), reasons of down time and the consumption of materials.

SCADA allows a monitoring of process operation e by transferring all the activities data from the machines to MES, this last records them, then it produces reports on line and putting the level highest of the Enterprise in runs with all that occurs in the workshop. MES supervises the data exchanges and pilot the production thanks to the commands transferred by the planning system ERP(Fig.3).

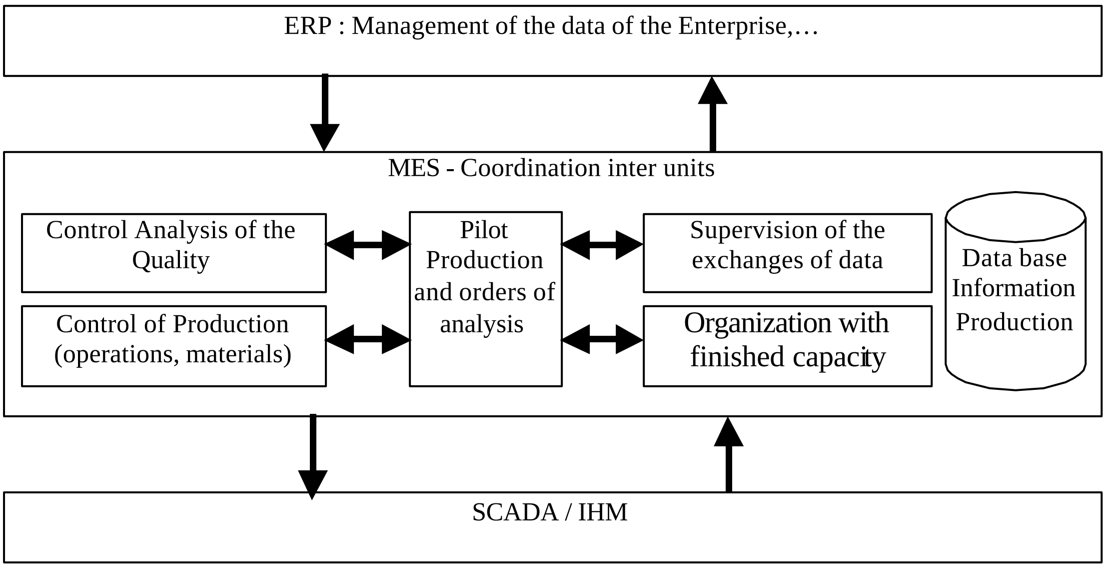

Fig.3 The position of the industrial supervision in the concept MES[5]

The main problem is that the supervision system is only a monitoring system. To resolve this problem we proposed an idea based on integration of command-monitoring models, this permits to exploit the contribution of the MES concept. This integration provides tools of help decision to the operator what allows a piloting in real time of the production system.

The main functions of the command-monitoring structure are Detection, the Diagnosis and the Recovery:

Detection : this function describes as normal all the situations rising from the execution of the command in absence of failure and abnormal all the others. The detection of a failure operation is then carried by the control device which compares the signals emitted by the process with those that the model provides. When a deviation is noted, the detection system interpret this like a symptom of failure. The models of detection are three. One defines the filter model [6], the emulation model[7] and reference model[8].

Diagnosis [9]: generally the goal of the system of diagnosis is to seek the causes having involved a particular observation. In the production systems, the diagnosis relates to the abnormal situations: it is a question of determining which is the element which by its failure led to the detection of a symptom of abnormal operation. For stage the problems which appear during the diagnosis, one distinguishes two techniques from diagnosis, the first are based on the systems with training and the second is based on a formal model of the process ordered.

Whatever the method of diagnosis used one must obtain required information essential to know the identity of the failing component. The recovery constitutes the last stage of the supervision. It is the realization of the two following functions:

The function of decision [9]: The stage of the decision is completely different from the decision-making process arranged hierarchically inherent in normal operation of the automatic control device. The decisions to be taken must make it possible to solve the problems involved in the occurrence of a failure of a component of the process

- The level of the process, it is initially necessary "to repair the defective hardware" in way, to find the normal operation of the system. That can be carried out manually or automatically. Then it is necessary to decide state to which the process must evolve to find a situation belonging to a sequence of normal command. This state called not of recovery, depends well on action which failed

- The level of the system of the command, the detection of an anomaly translates made that the noted evolution of process does not correspond to that which had been specified. There is thus a shift between the real state of the process and the image that the system of the command has some. It is thus necessary to readjust the models of the command system on the real Contracting State of ordered, in order to be able to act again on the process. From, it is still necessary to establish the link and to guarantee coherence between these models and the new actions engaged on the process.

The Recovery function [9]: consist in applying all the actions previously decided, it is carried out in two times. Firstly, the models used by the control device must be modified to be able to represent the real state of the process (addition of the sequences, relaxation of the constraints or change of model). Secondly, the process must undergo the sequences of recovery which bring back it in the state corresponding to the selected point of recovery. It should be noted that the emergency actions are a particular form of the recovery. In all the evolution of the production system it is necessary to ensure a follow-up of process and an update of the process model to ensure a faithful image of the real system.

Our model is based on three principal elements: a structure of command monitoring hierarchical and modular, an information system MES and a center of management which ensures the communication between the two preceding elements. The following figure (Fig.4) show the exchange data structure.

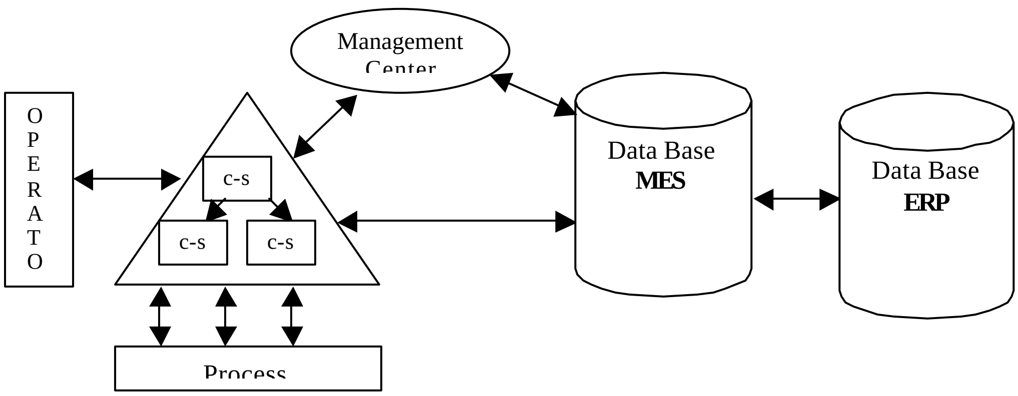

Fig.4 Data exchange Structure [10]

To better understand the integration mechanism of the command-monitoring structure in the MES environment, we firstly present an object model which highlights the management of the intervening events all the production chain long (Fig.5) within the MES system. This model is represented by Class Diagram in the format of a Unified Modeling Language UML [11].

We find the modeling of the incidents, the symptoms and other events like their recovery plans. The events come from the production workshops and more particularly of the equipment, it its taken charges some by the Manager of event Event Manager. Also an Event is identifiable by its source (or origin), a date, a priority as well as symptoms. A Symptom is identifiable by a number, a name and a description. A Symptom Manager is also present in order to allow a simpler handling of the symptoms. Moreover, in order to make an event recoverable, the plans of recovery are associated the type of event; these plans can be broken up into stages. A Plan must at the same time be interpretable by a machine (or the system of control) and a human being (operator). A Manager Recuperation Manager allows the handling of the plans of recovery.

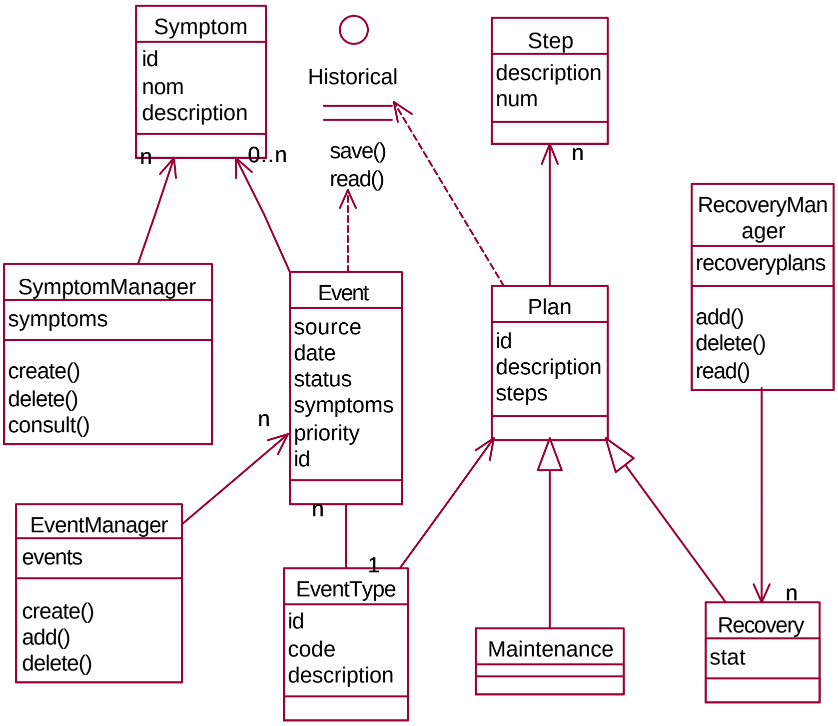

Fig. 5 - Modeling of the management of the events

Secondly, we present the model which highlights the modeling of the various equipment of the enterprise. Each equipment has all the properties of a resource. It also requires to be prepared before being in activity, and has also a specificity which enables it to deal with only one certain category of tasks or its production capacity. Moreover a machine must be able to be located, in case of the management of several workshops. An Equipment has a Module which is composed of a whole of under modules. These modules make it possible to establish a diagnostic equipment and to identify a breakdown in a more precise way, also a module informs us about its state and the code of the symptom related to the possible breakdowns. The manager makes possible the equipment configuration.

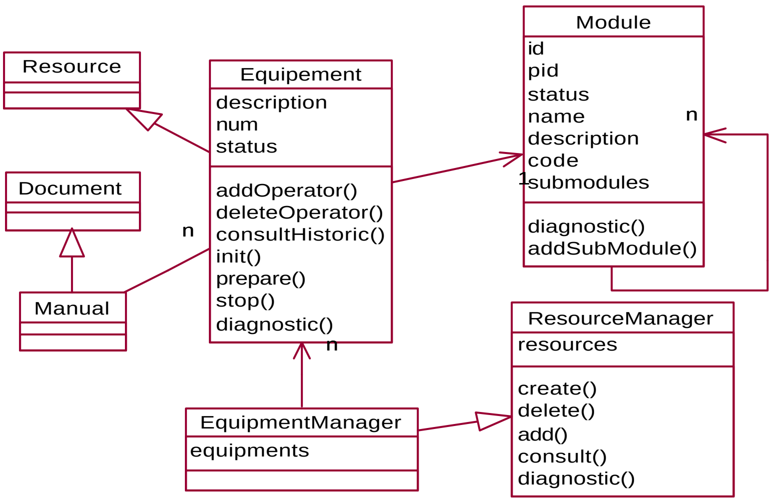

Figure 6 - Modeling of the Equipment

Thirdly, we present the model of ManagementCenter(Fig.7) which allows the activation of the requests coming from the messages sent by the command-monitoring structure. The principal function of the ManagementCenter is to collect a maximum of information on the resources, the symptoms, the plans of recovery and the history of the activities of the system to answer the requests which are addressed to him.

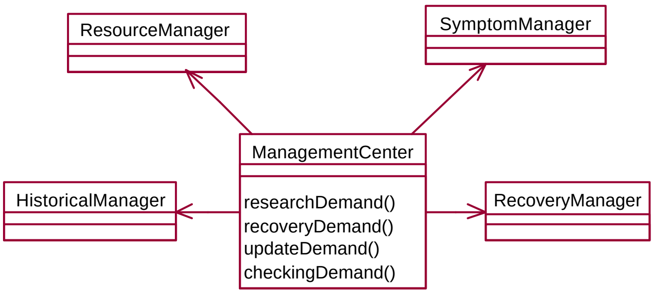

Figure 7 - Modeling of the center of management

The ManagementCenter receives a request coming from the monitoring orders structure for each operation that must be carried, these requests are: Research Demand, Recovery Demand, Checking Demand and Update Demand. The request of the ManagementCenter contains the activity identifier responsible for the failure and the resource identifier of the type weakening. The diagram of sequence (Fig.8) shows the link between the various functions of the ManagementCenter.

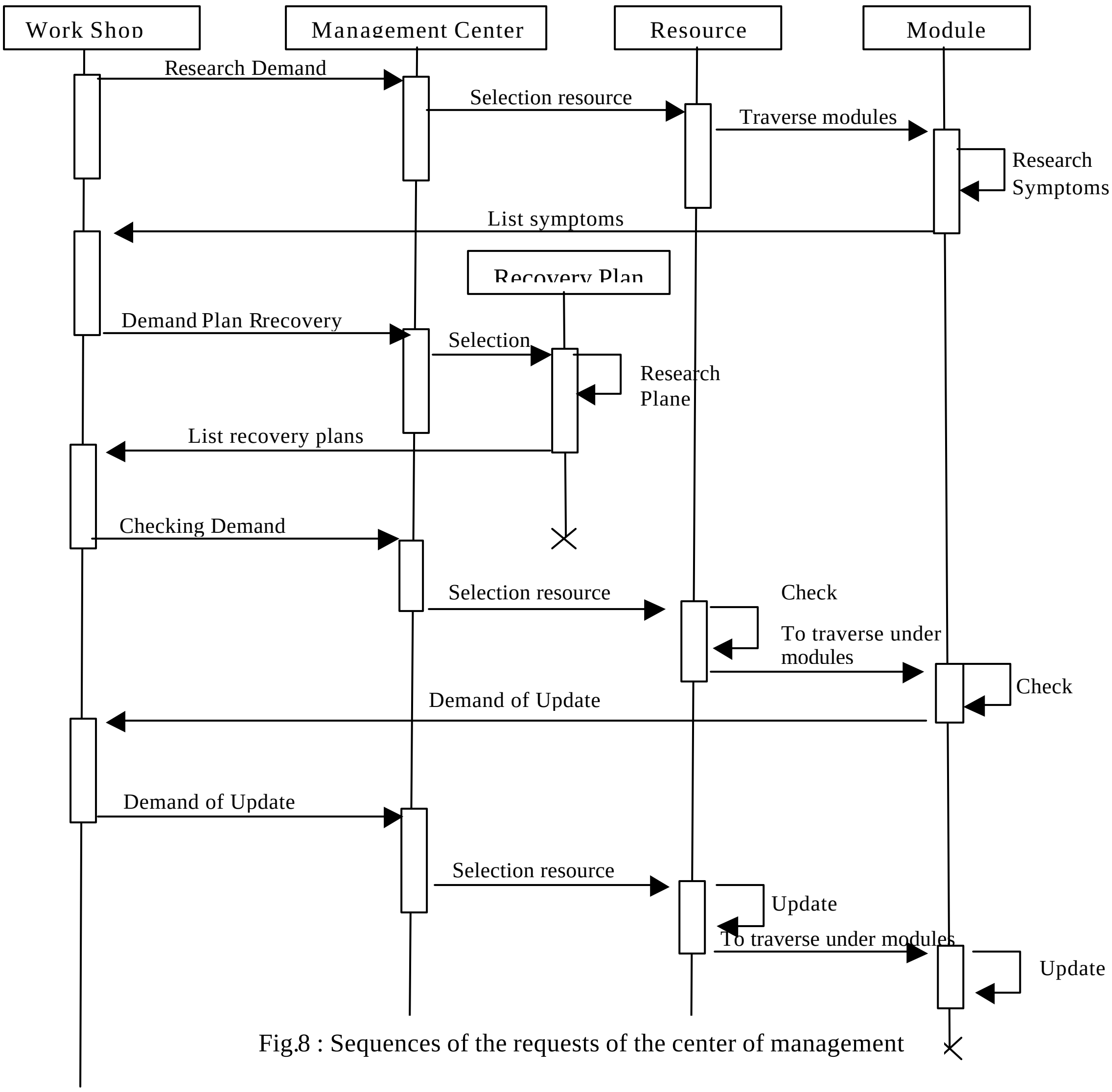

Fig.8 : Sequences of the requests of the center of management

In the continuation, we present the formalism of each operation, thus after having received one of Research Demand, a request for recovery is activated. The checking and the update are carried out after reception and application of the plans of recovery to the level of the workshop.

Research Demand: The procedure of Research started by a module of the structure command-monitoring. It focuses on the localization of information in the MES system.

Demand recovery: After the localization of information in the MES system, a demand of recovery is activated , the result is a List recovery plans.

checking Demand: The checking procedure permits the identification of failing Resource.

Demand of Update: The update is done in normal evolution or after recovery in order to keep a Real image of process in the MES system and the workshop.

Conclusion

For the interchange of the data several technical solutions are foreseeable, the first is CORBA, she can be applied as well for exchanges requiring the intervention of a human being that in the automated exchanges. The second is the RMI solution of Java, it possesses the same properties that CORBA but can communicate solely with applications java.

The third is to establish a format of exchange in XML can be interpreted by the different systems and this whatever is the environment in which functions systems.

we propose extensible XML (*extensible Markup Language*). One can thus have communicating applications with XML on sockets Internet in place, for example, IIOP for ORBs of the CORBA type. Moreover, XML offers advantages in term of transport of data on the networks. These data can indeed pass avoid-fires (or firewalls), and all the places where the security authorizes only the passage of data, but not of communication of programs. It is thus within the framework of very significant constraints of security that XML can play a role in a distributed architecture. Metalanguage XML is perfect for the communication between systems evolving/moving in different mediums and is here the best choice for exchange not requiring intervention of a human being. Thus, data exchanges to format XML with an architecture of the Client/Server type for the exchanges not requiring the operator action. This type of integration permits a good industrial process restraint and permits the exploitation of the new contributions of the technology in term of software package to integrate, several improvements are foreseeable as the use of tools of Data Mining for the prediction of down time cases.

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