FarMAS: a MAS for Extended Quality Workflow

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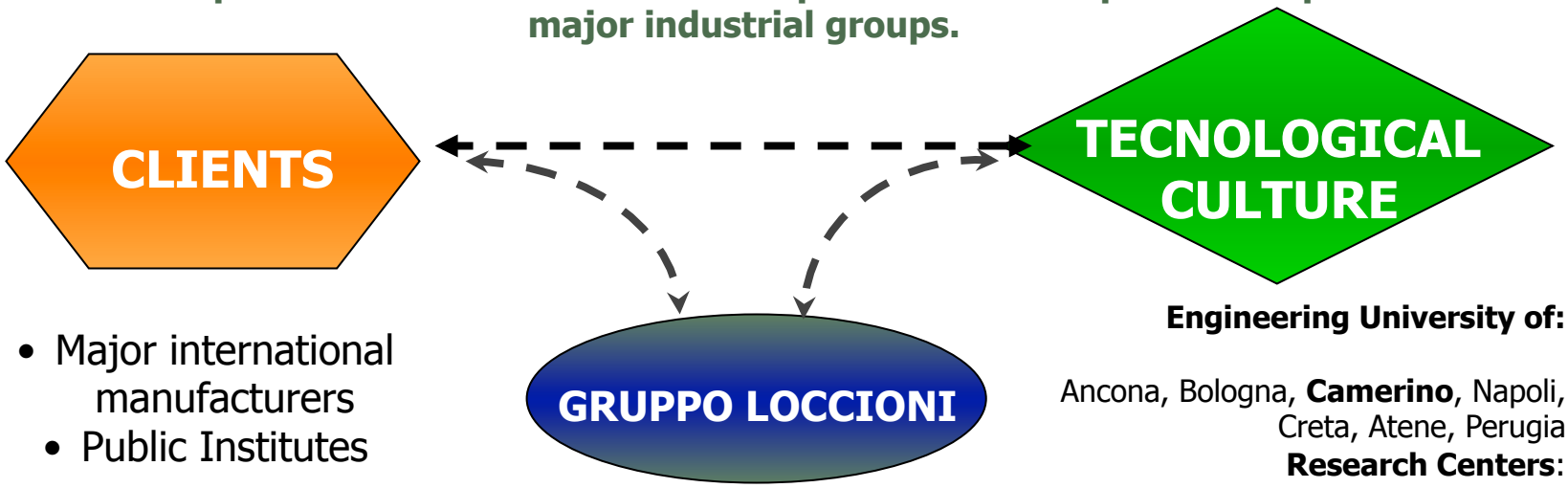
LOCCIONI
imprese integrate

Mission

To improve productive processes and products quality, in order to improve the quality of life.

How we operate

We design and manufacture turn key solutions integrating different technologies, that we acquire thanks to collaborations with Universities, research Centres, etc: We then develop solutions and transfer our competence into the productive process of major industrial groups.



- Major international manufacturers
- Public Institutes

School / enterprise
Decr. Min. 593/2000
Medea
Builtech
Spin.off
Nexus
NetPeople

Engineering University of:

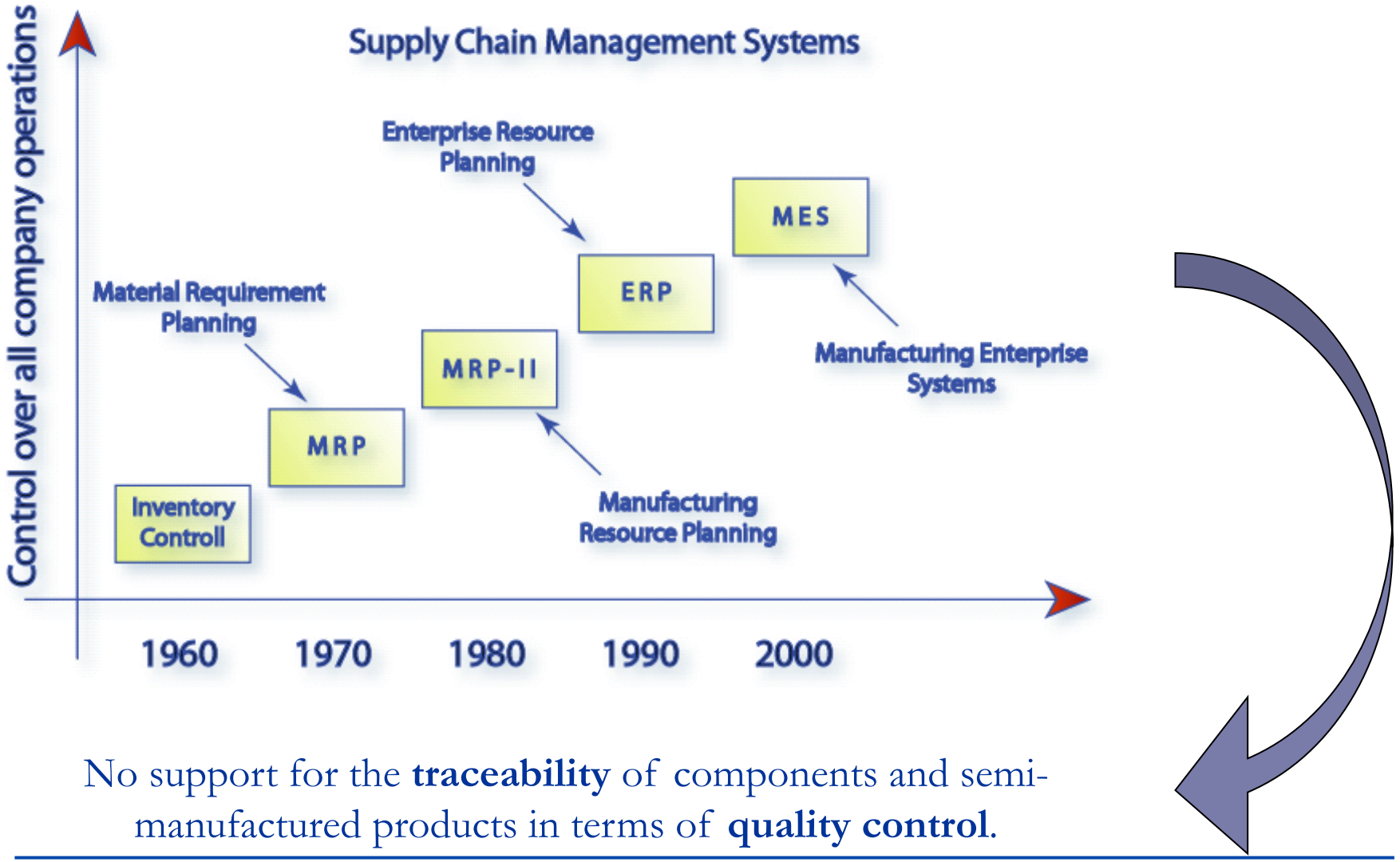
Ancona, Bologna, **Camerino**, Napoli, Creta, Atene, Perugia

Research Centers:
Leti (France), TNO (Olanda), Optoelettronica (S. Pietroburgo)

Technological Poles:
Montpellier, Bari
Israelian Tech Pole

International major suppliers:
Festo, Siemens, National Instrument

Industrial Domain

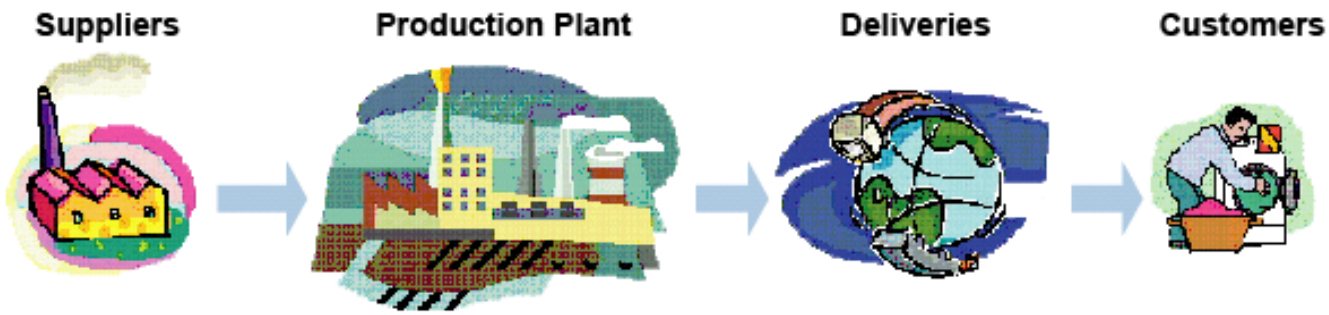


No support for the **traceability** of components and semi-manufactured products in terms of **quality control**.

Outline

- The industrial domain: Extended Supply Chain
  - The developed application: Extended Quality Workflow
- The open computational system: FarMAS infrastructure
  - *Why practical approach for closed systems cannot be applied?*
  - *What kind of openness is considered?*
- A Case Study: Functional Testing Process
  - The organizational model
- Future activities
- *Open problems*

Industrial Domain – the Extended Supply Chain Management



Many actors with different roles

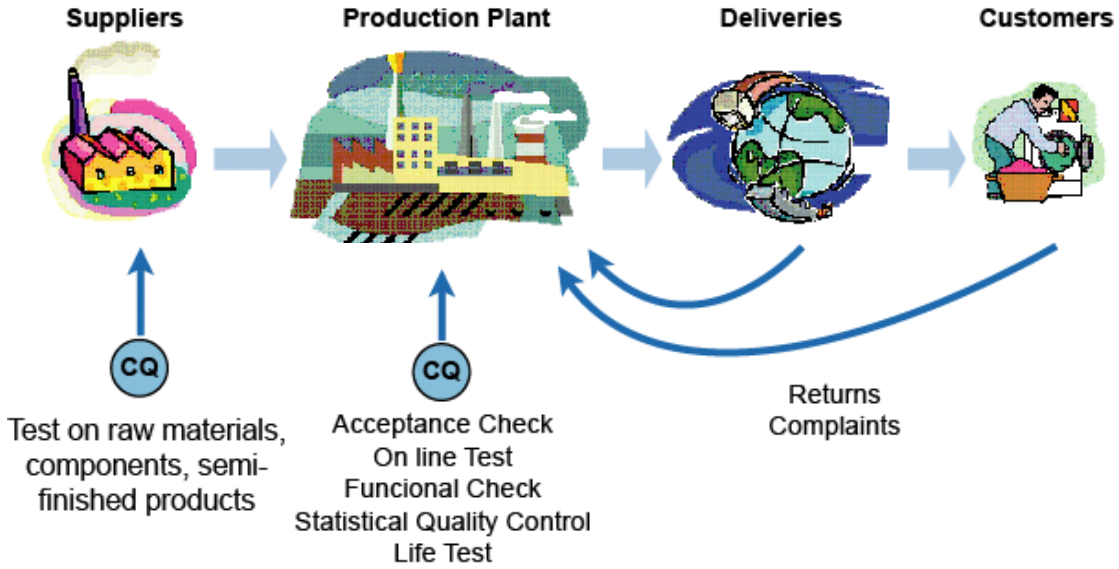
- Suppliers
- Production plants
- Global distribution networks
- Technical assistance centers

Many actors which perform several tasks

- Produce raw materials
- Produce Semi-manufactured products
- Assemble components
- Deliver final products
- Support customers post sale
- …

Application – Extended Quality Workflow (EQuW)

EQuW is a workflow for the evaluation of produtct's quality through tests classification, quality reports integration and data analysis.



During the production process different quality controls are made over the Extended Supply Chain. Each actor of the Extended Supply Chain is characterized by:

- different quality controls mechanisms
- specific equipments
- heterogeneous data format
- heterogeneous solution/strategy

Supply Chain management system = Complex open environment

Quality Data for Quality Control

- Where and why is important to trace all quality data?
  1. At *the production plant*, once a defect is identified in a complex product, **quality data** produced during the life cycle of any single component can provide useful information for further diagnosis.

  2. At the *customer place* when a technical assistance is repairing a product's defect, an early diagnosis could be made analysing all **quality data** of the components.

  3. At a *strategic level*, where decision must be taken also mining the **quality data** of all products.

Quality Data Traceability

The traceability of quality data for an extended quality workflow in a supply chain is a complex process

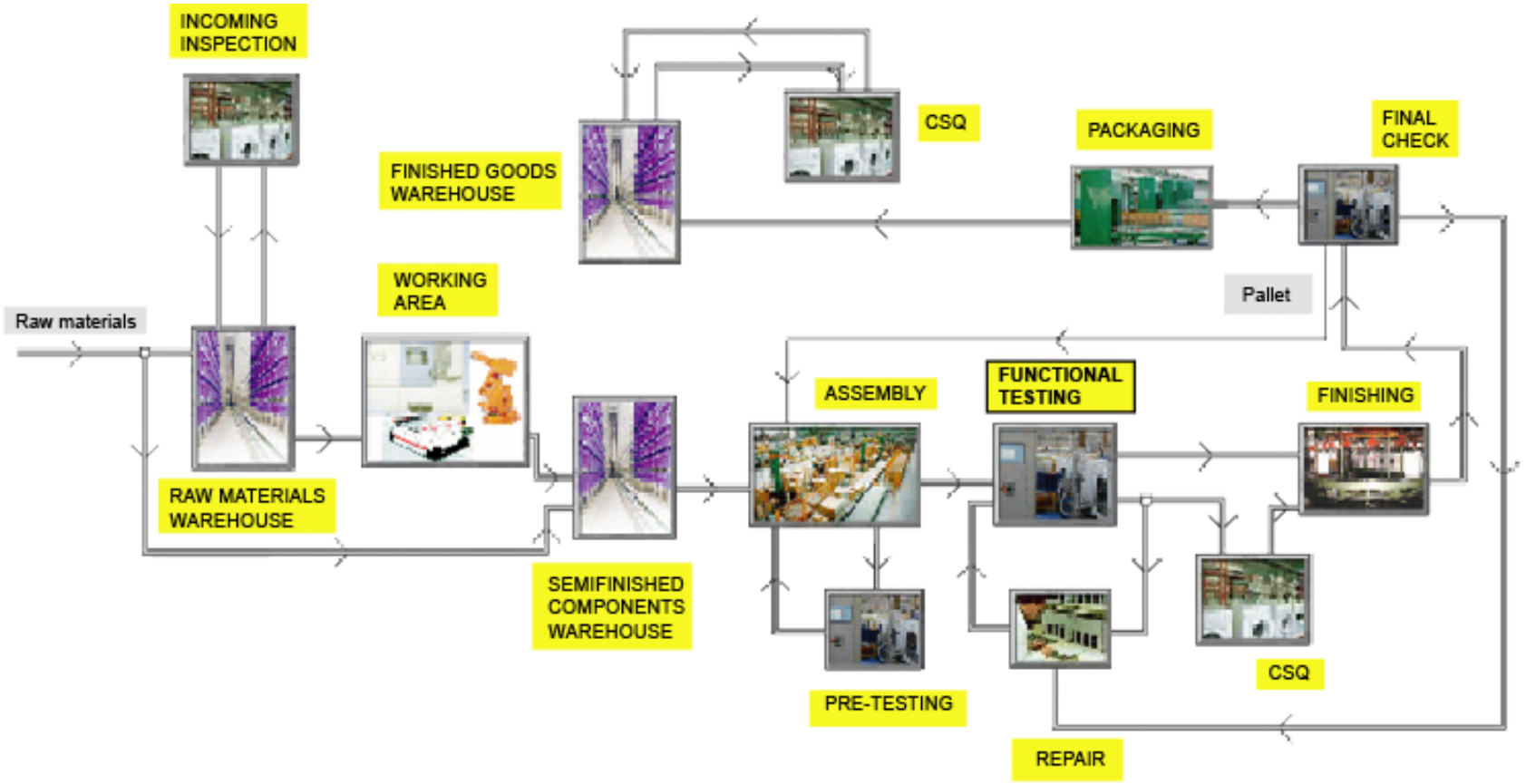
Quality Data

- Identification
- Retrieval
- Wrapping
- Collection
- Integration

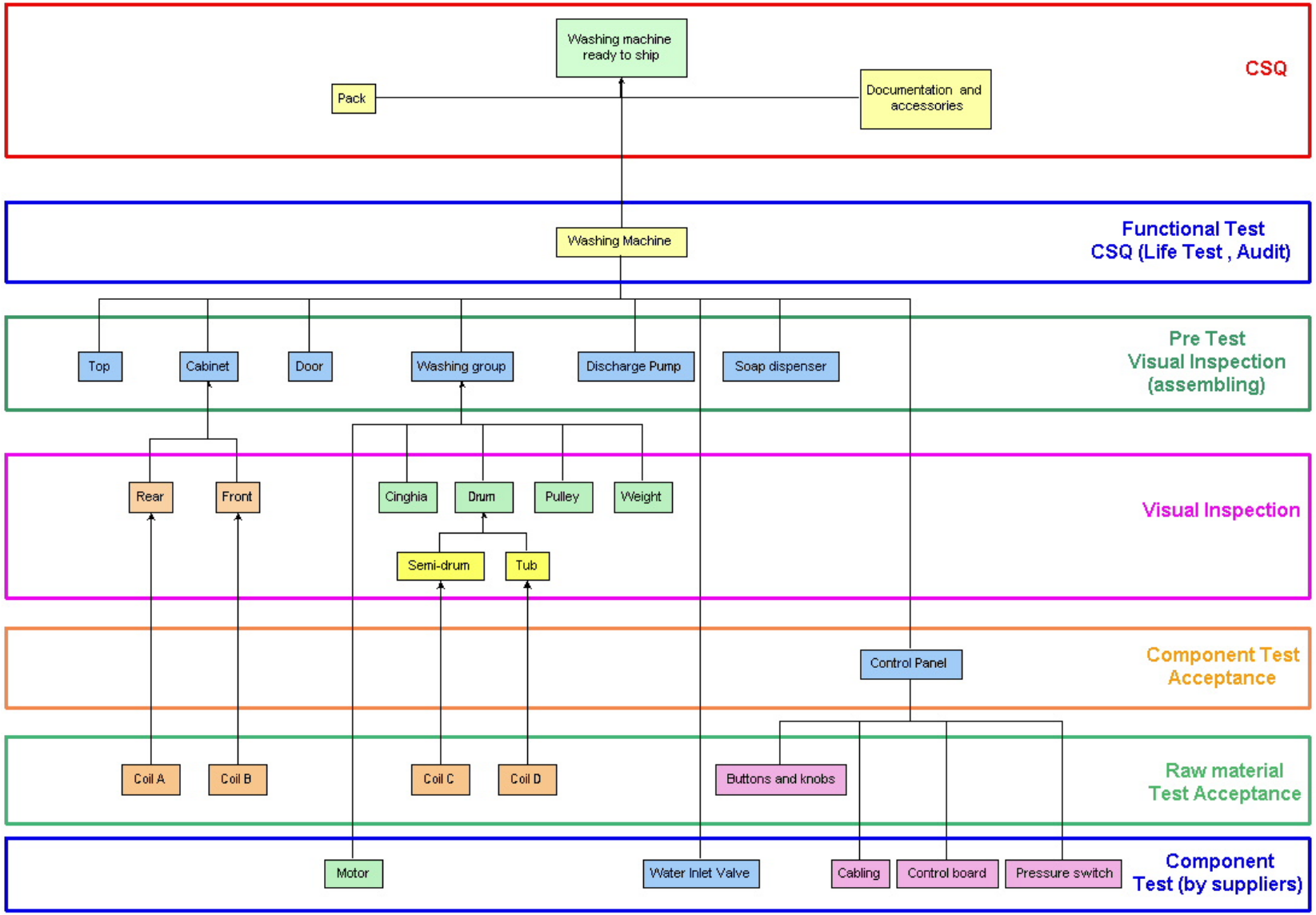
Environment

- Distributed
- Heterogeneous
- Dynamic
- Embedded
- *domotica*

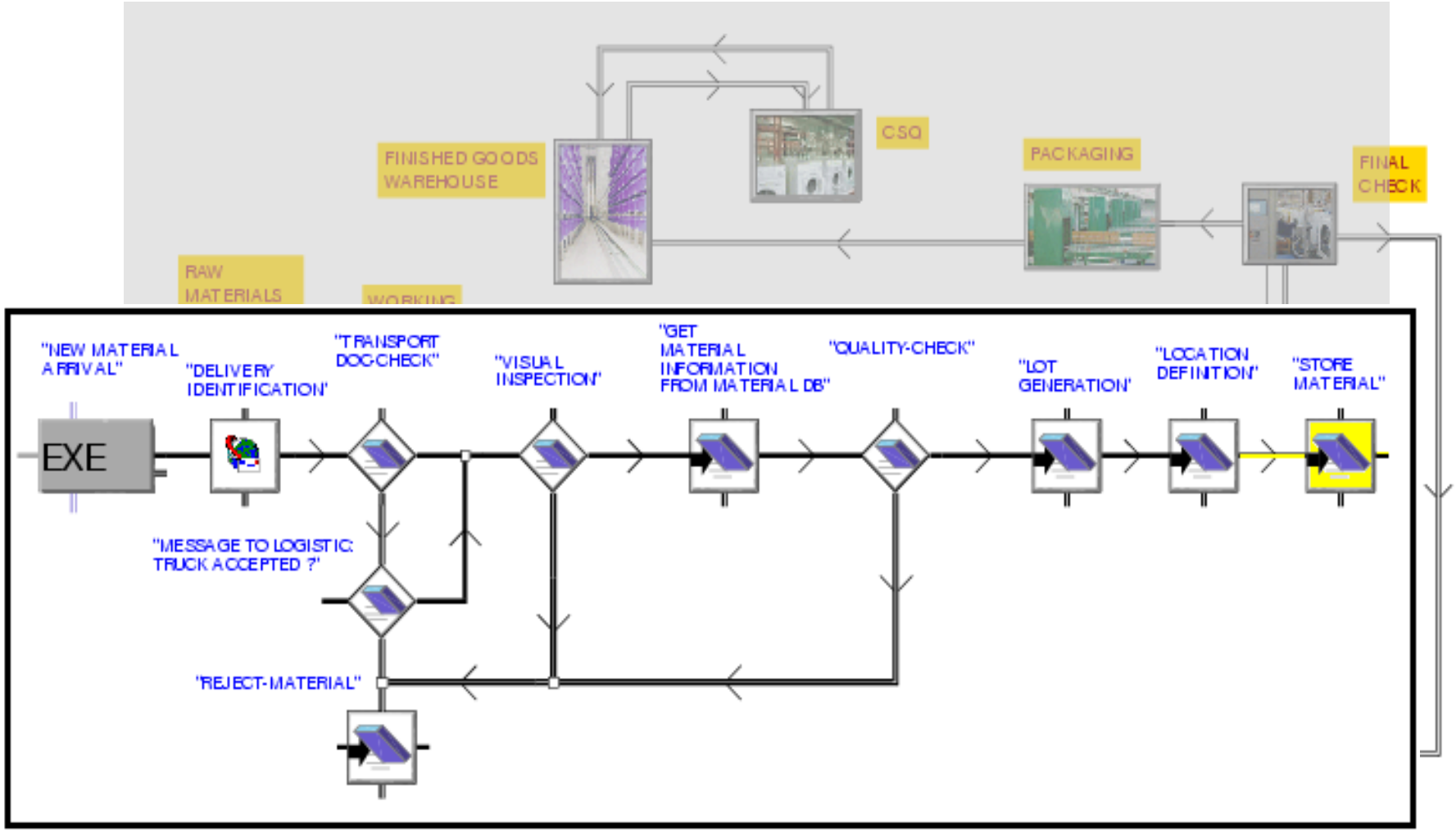
Production Plant architecture



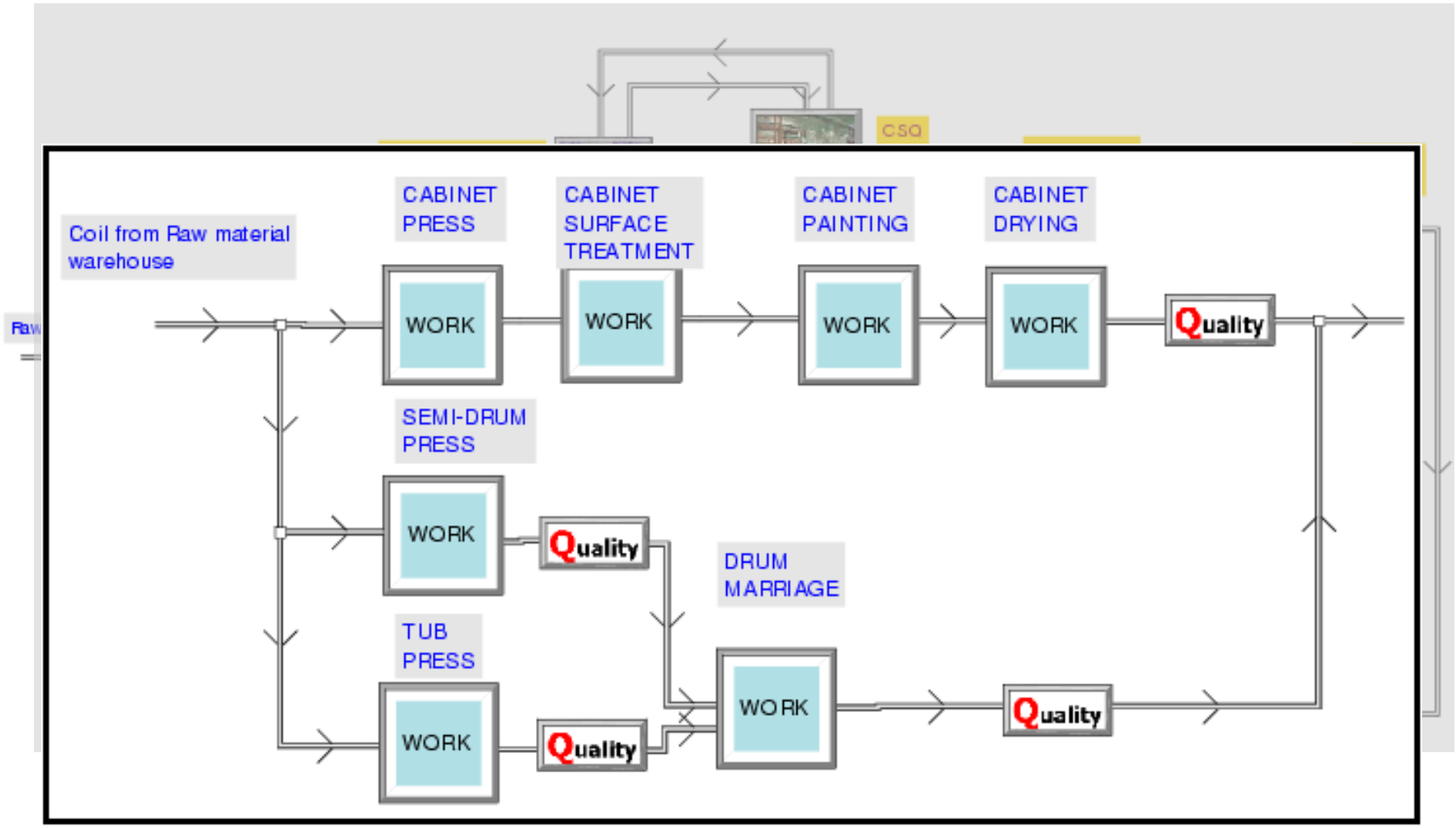
Genealogy


Washing machine ready to ship
Pack
Documentation and accessories
CSQ
Washing Machine
Functional Test
CSQ (Life Test , Audit)
Top
Cabinet
Door
Washing group
Discharge Pump
Soap dispenser
Pre Test
Visual Inspection
(assembling)
Rear
Front
Cinghia
Drum
Pulley
Weight
Semi-drum
Tub
Visual Inspection
Control Panel
Component Test
Acceptance
Coil A
Coil B
Coil C
Coil D
Buttons and knobs
Raw material
Test Acceptance
Motor
Water Inlet Valve
Cabling
Control board
Pressure switch
Component
Test (by suppliers)

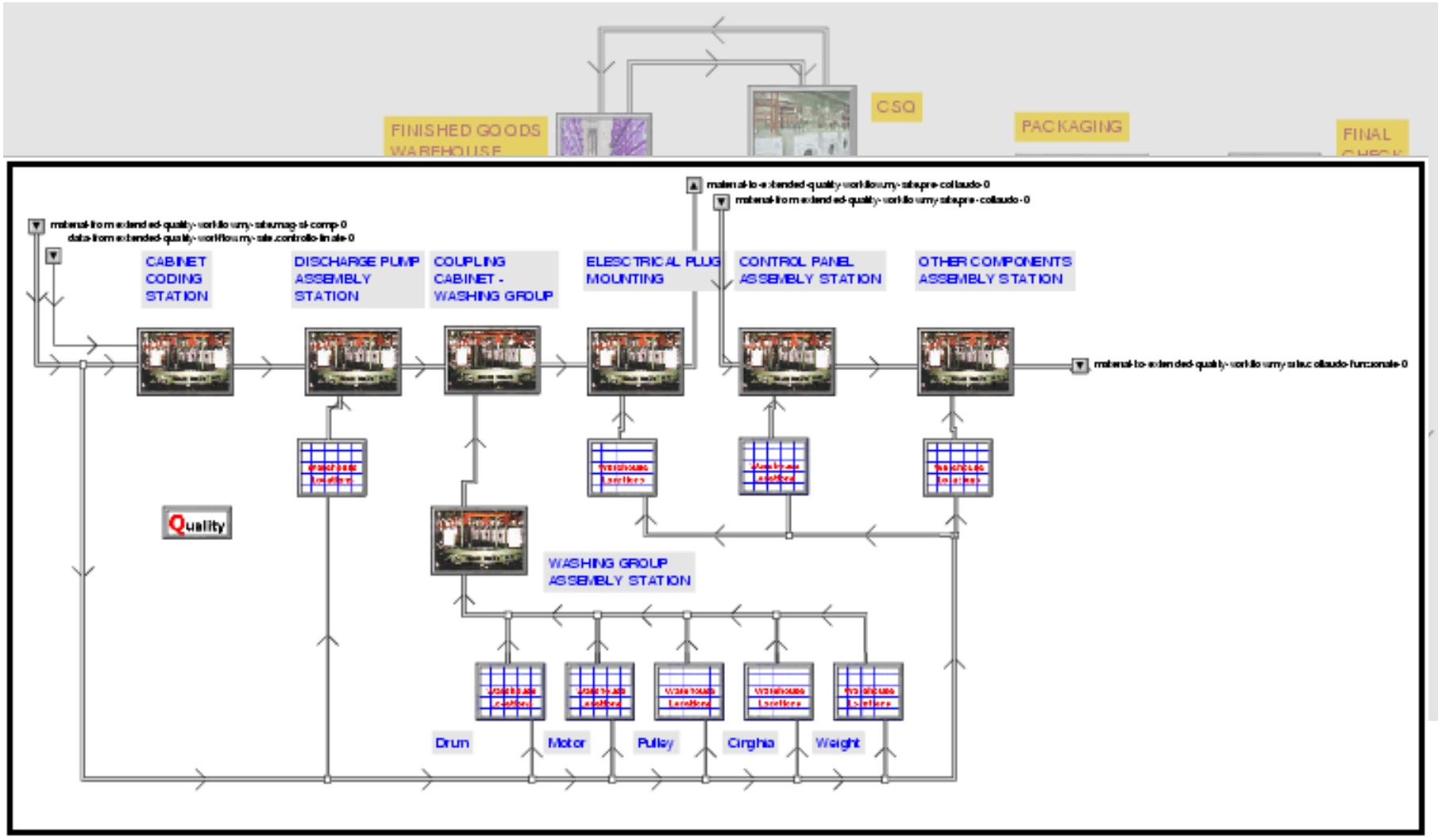
Material Arrival



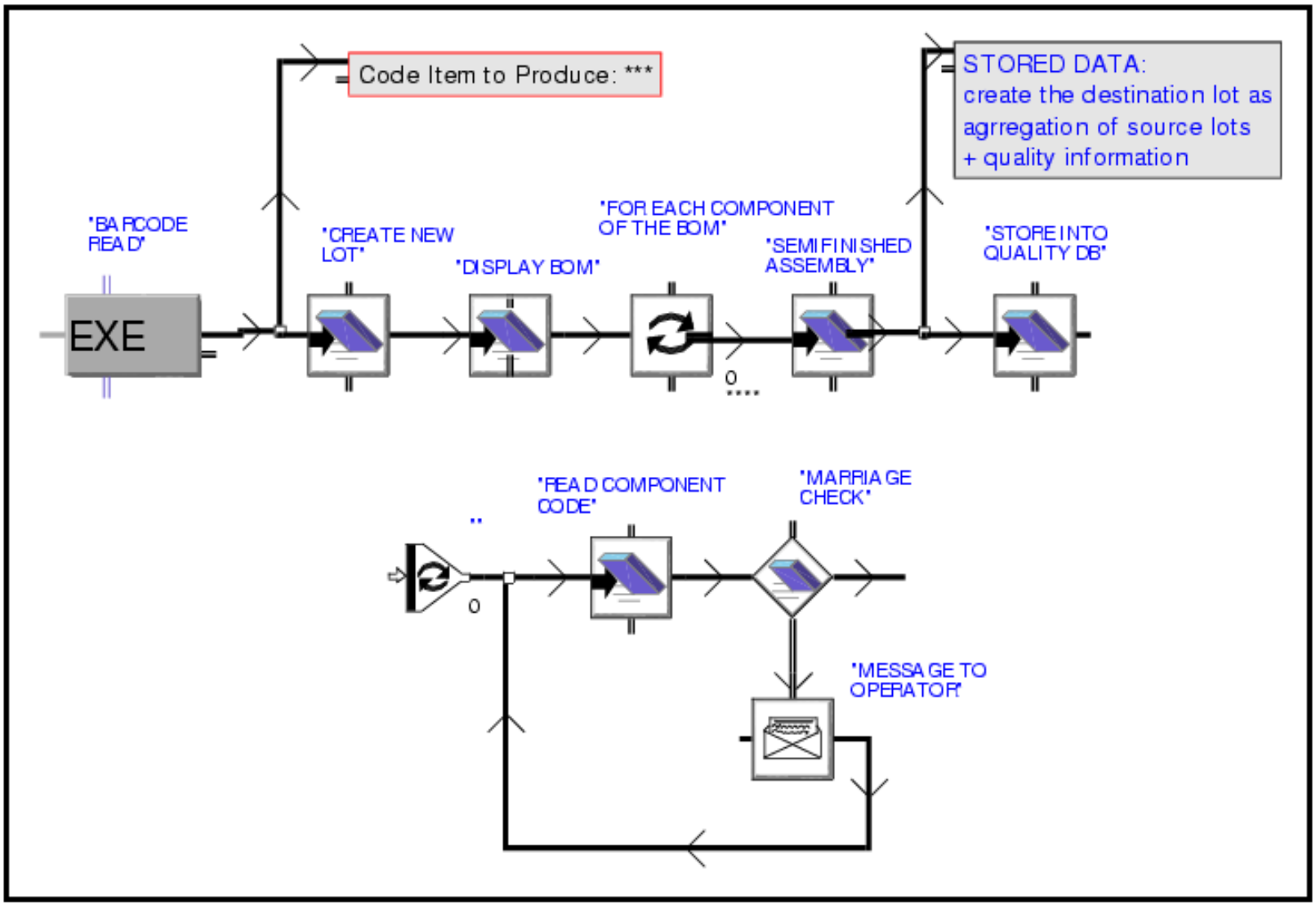
Pre-worked


CSQ
Coil from Raw material warehouse
CABINET PRESS
CABINET SURFACE TREATMENT
CABINET PAINTING
CABINET DRYING
WORK
WORK
WORK
WORK
Quality
SEMI-DRUM PRESS
WORK
Quality
DRUM MARRIAGE
TUB PRESS
WORK
Quality
WORK
Quality

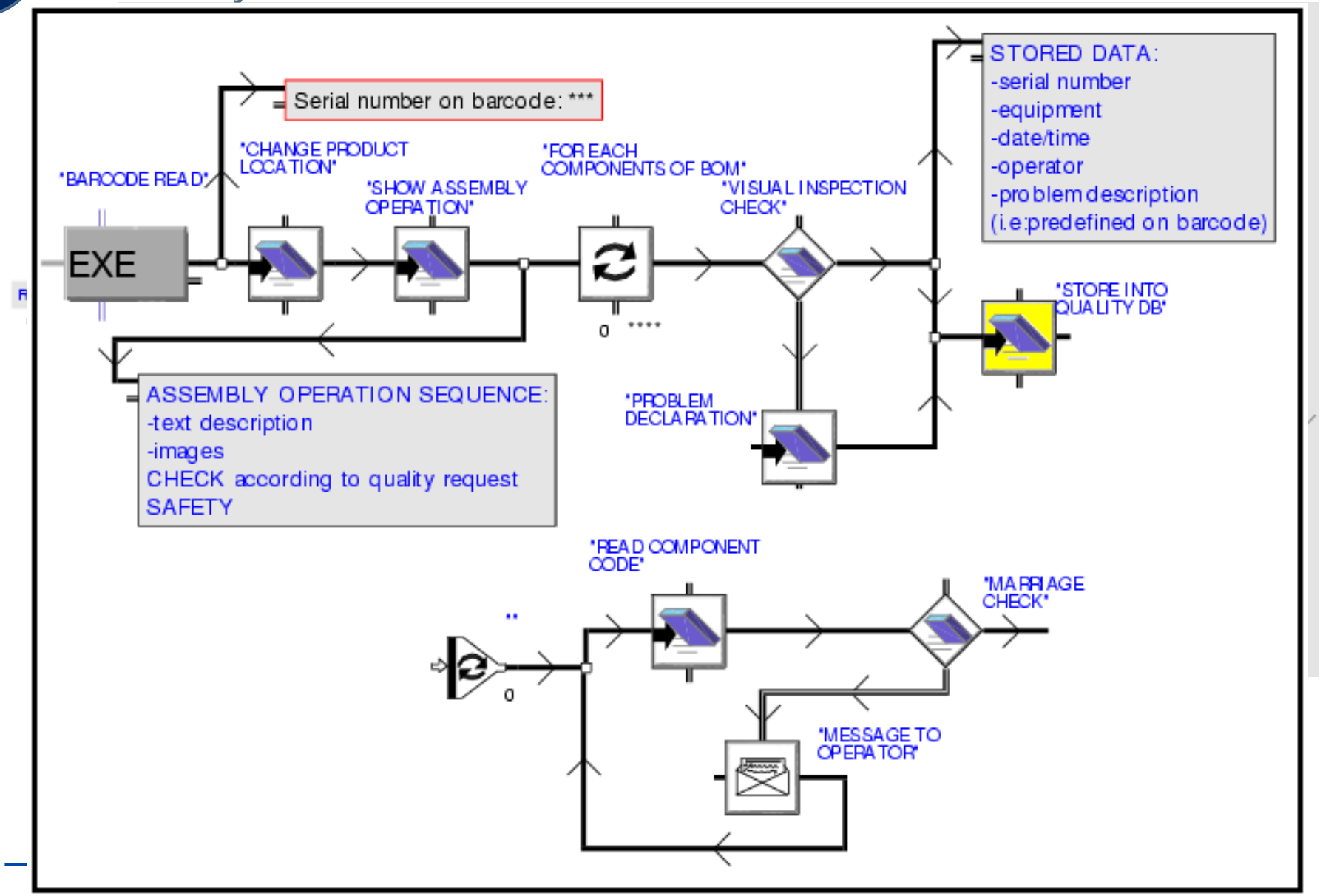
Assembly


FINISHED GOODS WAREHOUSE
CSQ
PACKAGING
FINAL CHECK
CABINET CODING STATION
DISCHARGE PUMP ASSEMBLY STATION
COUPLING CABINET - WASHING GROUP
ELESCTRICAL PLUG MOUNTING
CONTROL PANEL ASSEMBLY STATION
OTHER COMPONENTS ASSEMBLY STATION
Quality
WASHING GROUP ASSEMBLY STATION
Drum
Motor
Pulley
Cirghia
Weight

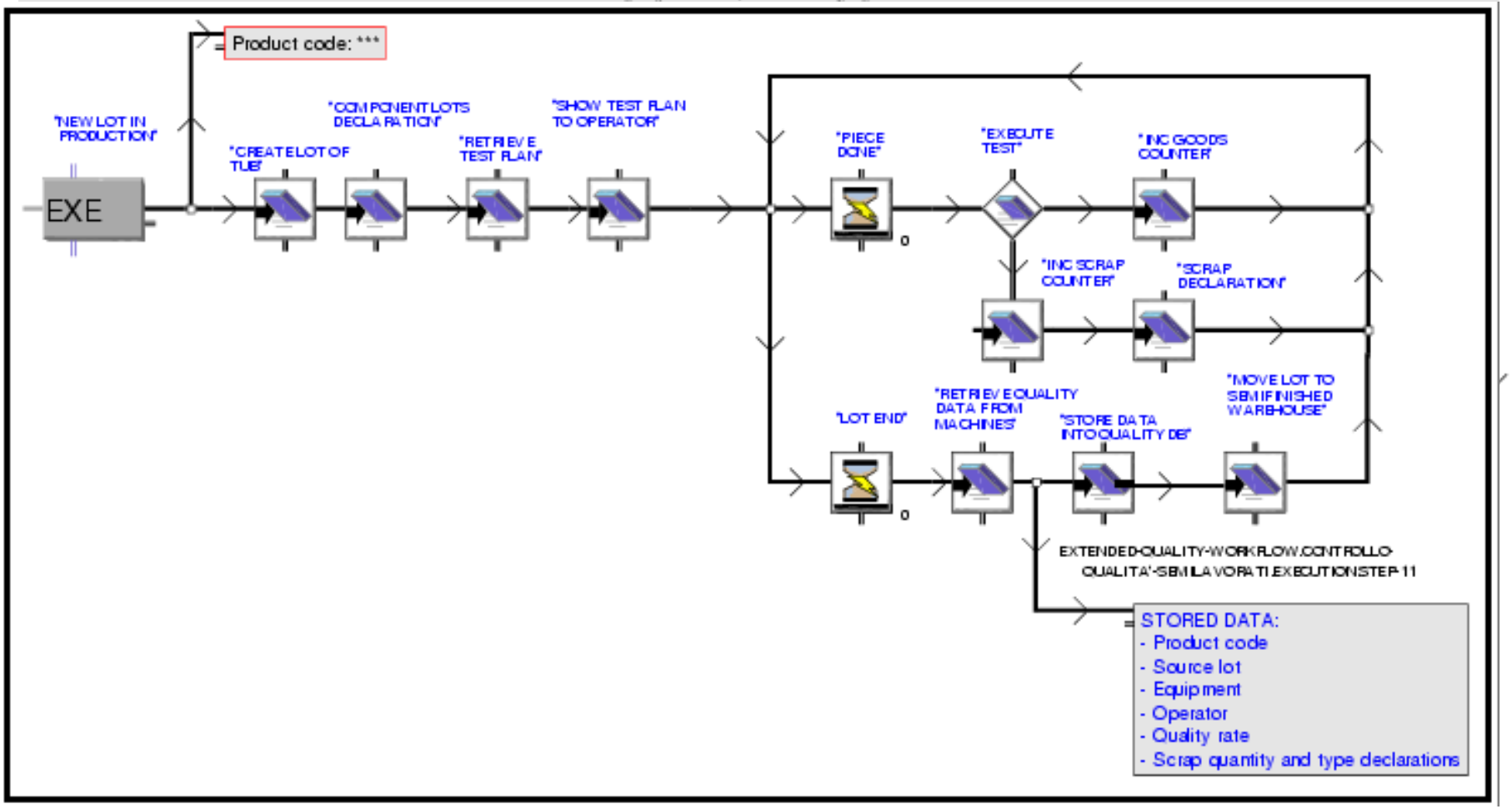
Marriage


Code Item to Produce: ***
STORED DATA:
create the destination lot as
agrregation of source lots
+ quality information
"BARCODE READ"
"CREATE NEW LOT"
"DISPLAY BOM"
"FOR EACH COMPONENT OF THE BOM"
"SEMI FINISHED ASSEMBLY"
"STORE INTO QUALITY DB"
EXE
0
"READ COMPONENT CODE"
"MARRIAGE CHECK"
0
"MESSAGE TO OPERATOR"

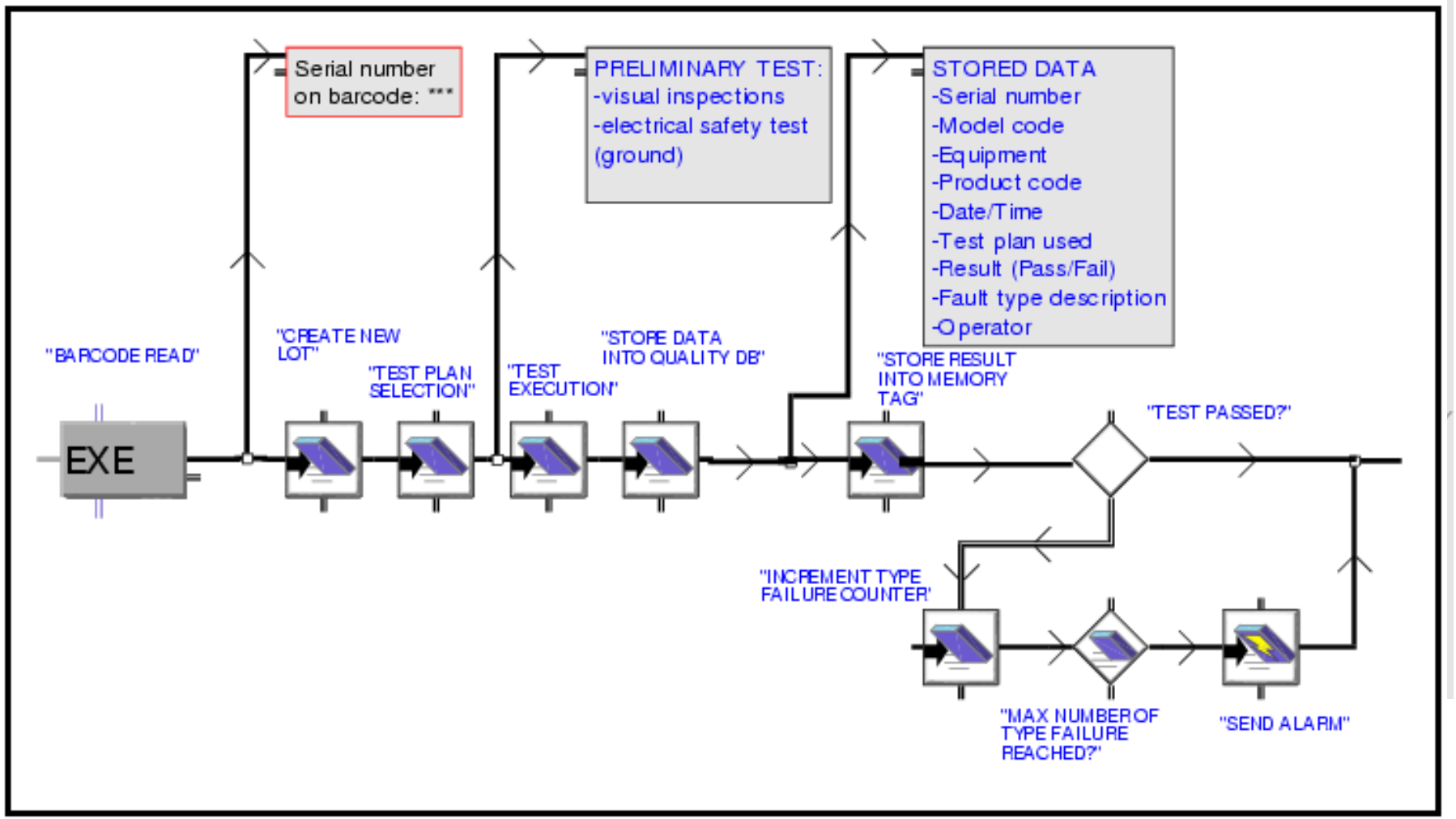
Assembly station check



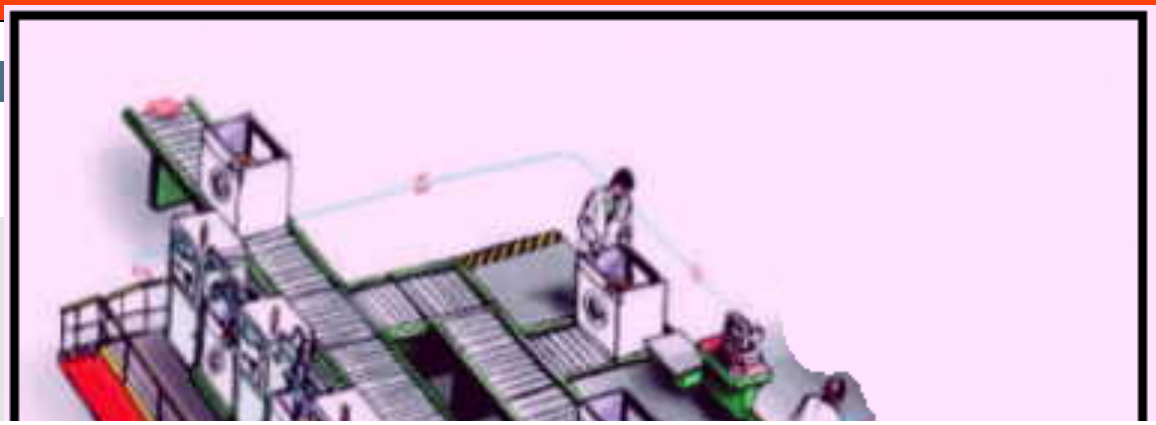
Semi-Worked Warehouse

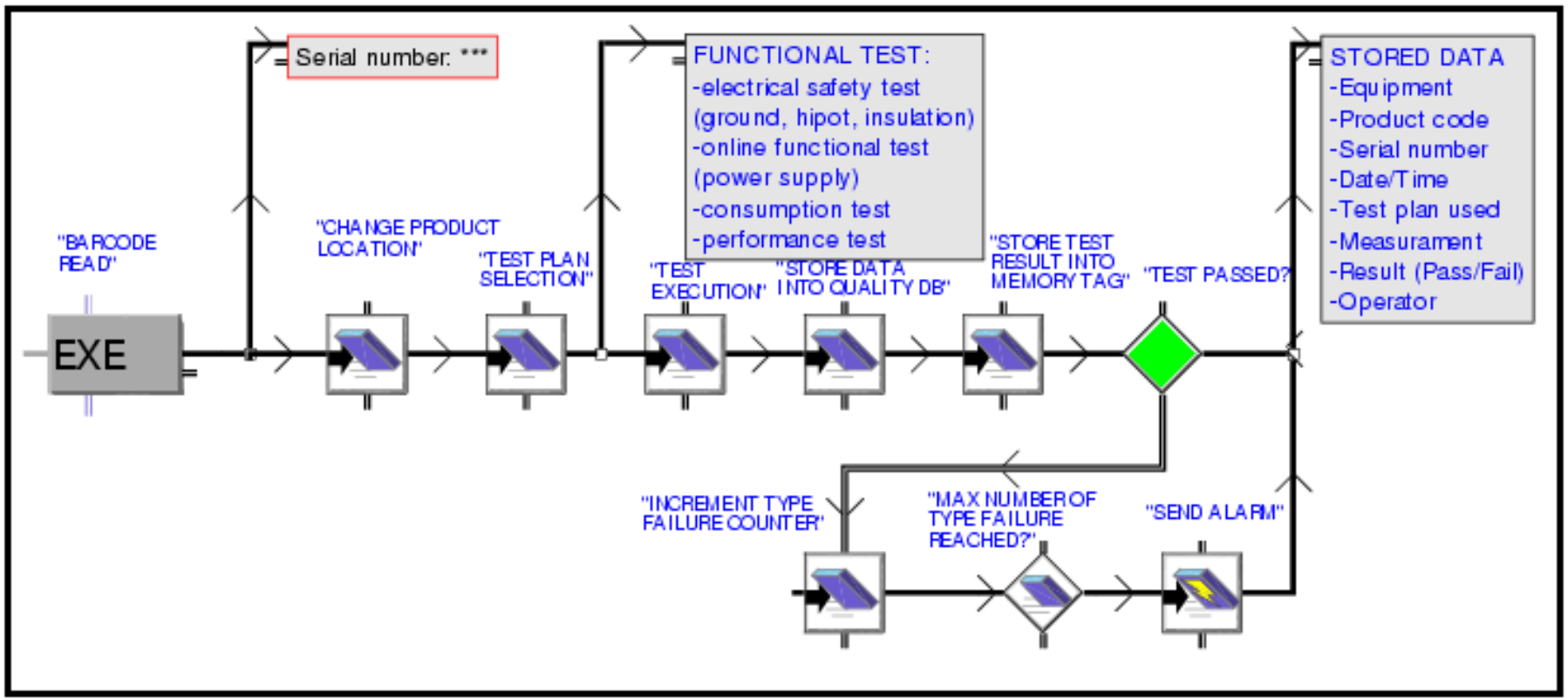


Pre-testing

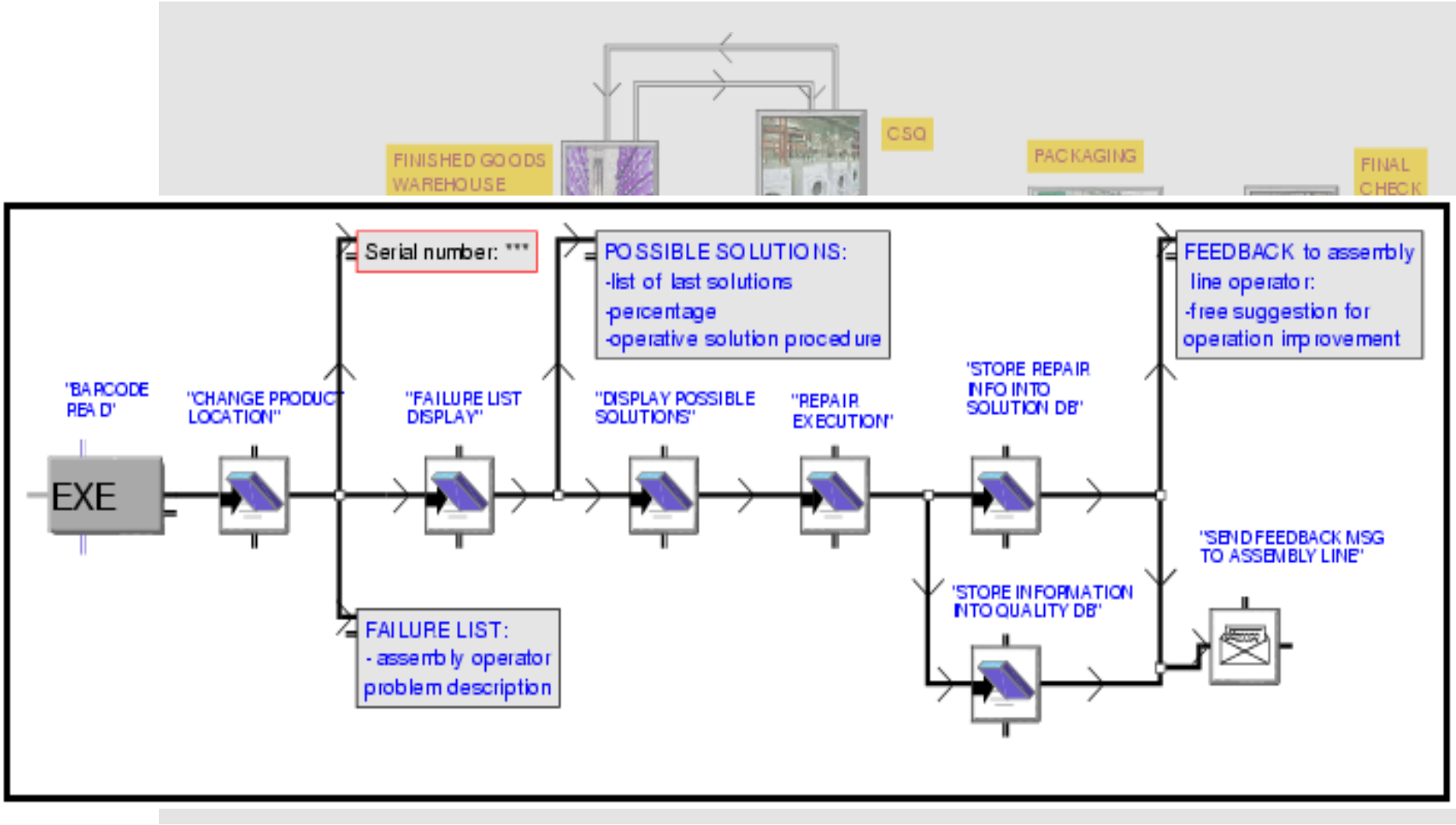

Serial number on barcode: ***
PRELIMINARY TEST:
-visual inspections
-electrical safety test (ground)
STORED DATA
-Serial number
-Model code
-Equipment
-Product code
-Date/Time
-Test plan used
-Result (Pass/Fail)
-Fault type description
-Operator
"BARCODE READ"
"CREATE NEW LOT"
"TEST PLAN SELECTION"
"TEST EXECUTION"
"STORE DATA INTO QUALITY DB"
"STORE RESULT INTO MEMORY TAG"
"TEST PASSED?"
EXE
"INCREMENT TYPE FAILURE COUNTER"
"MAX NUMBER OF TYPE FAILURE REACHED?"
"SEND ALARM"

Functional

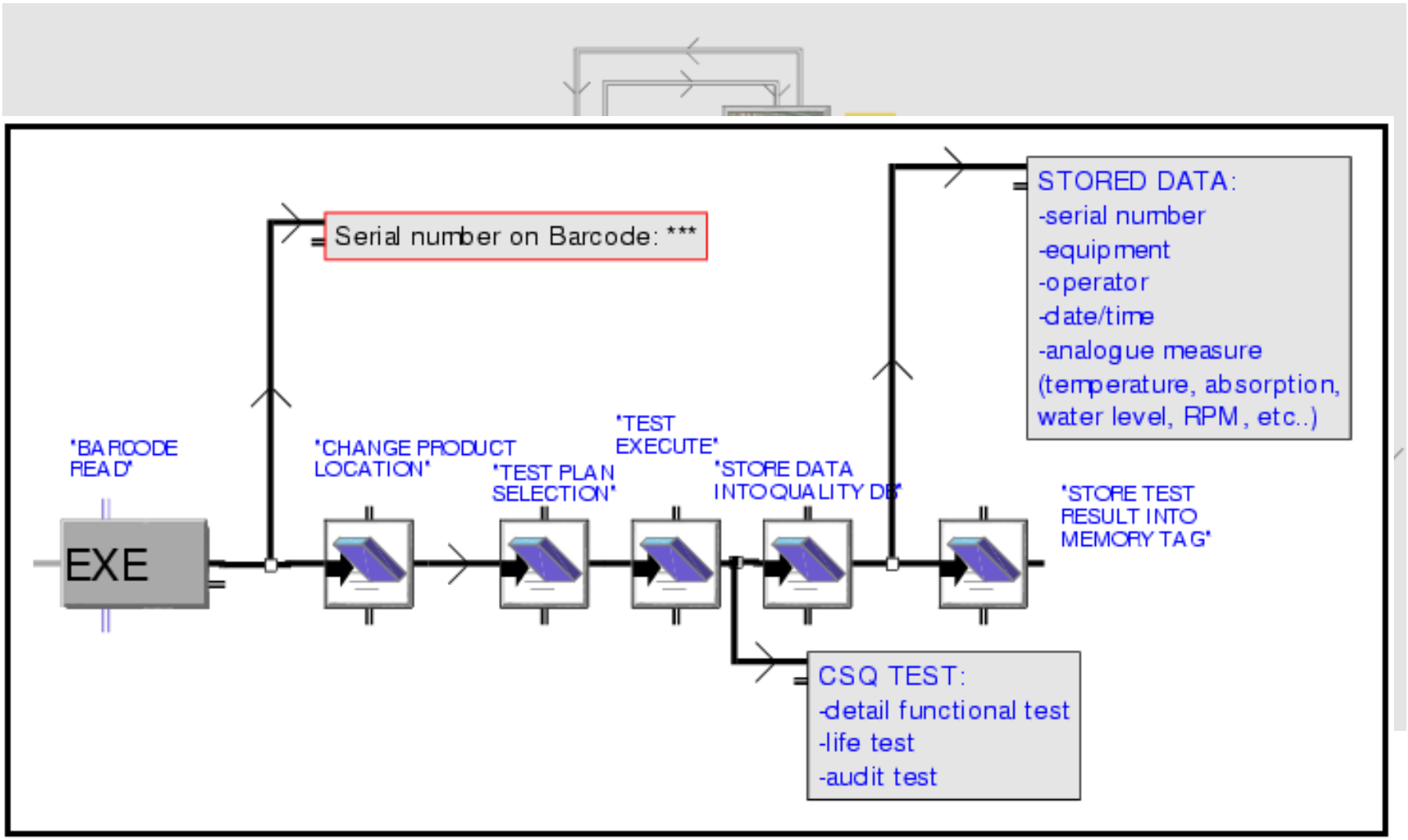



Serial number: ***
FUNCTIONAL TEST:
-electrical safety test (ground, hipot, insulation)
-online functional test (power supply)
-consumption test
-performance test
STORED DATA
-Equipment
-Product code
-Serial number
-Date/Time
-Test plan used
-Measurament
-Result (Pass/Fail)
-Operator
"BARCODE READ"
"CHANGE PRODUCT LOCATION"
"TEST PLAN SELECTION"
"TEST EXECUTION"
"STORE DATA INTO QUALITY DB"
"STORE TEST RESULT INTO MEMORY TAG"
"TEST PASSED?
EXE
"INCREMENT TYPE FAILURE COUNTER"
"MAX NUMBER OF TYPE FAILURE REACHED?"
"SEND ALARM"

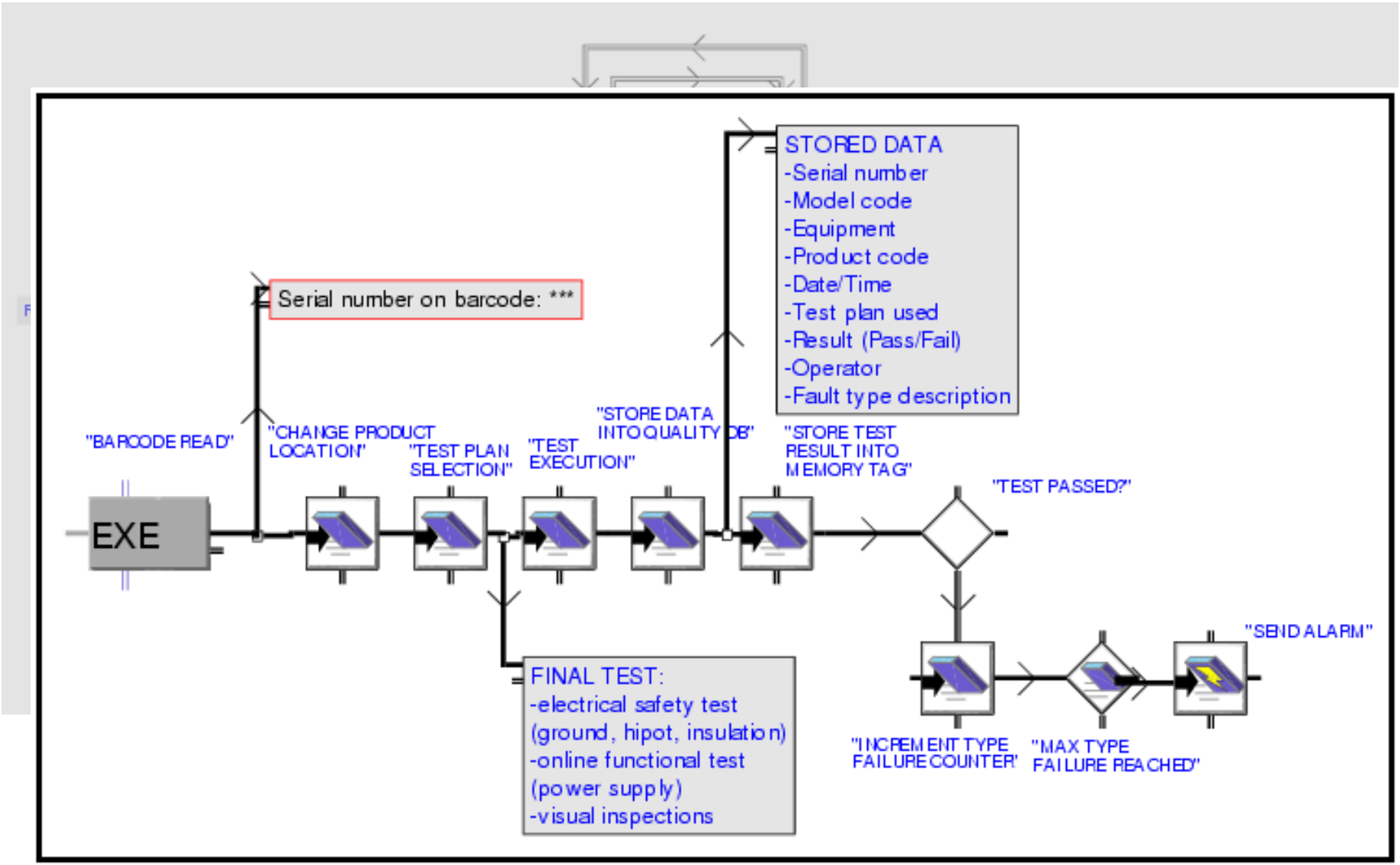
Repair


FINISHED GOODS WAREHOUSE
CSO
PACKAGING
FINAL CHECK
Serial number: ***
POSSIBLE SOLUTIONS:
-list of last solutions
-percentage
-operative solution procedure
FEEDBACK to assembly line operator:
-free suggestion for operation improvement
'BARCODE READ'
'CHANGE PRODUCT LOCATION'
"FAILURE LIST DISPLAY"
"DISPLAY POSSIBLE SOLUTIONS"
"REPAIR EXECUTION"
'STORE REPAIR INFO INTO SOLUTION DB'
EXE
'SEND FEEDBACK MSG TO ASSEMBLY LINE'
'STORE INFORMATION INTO QUALITY DB'
FAILURE LIST:
- assembly operator problem description

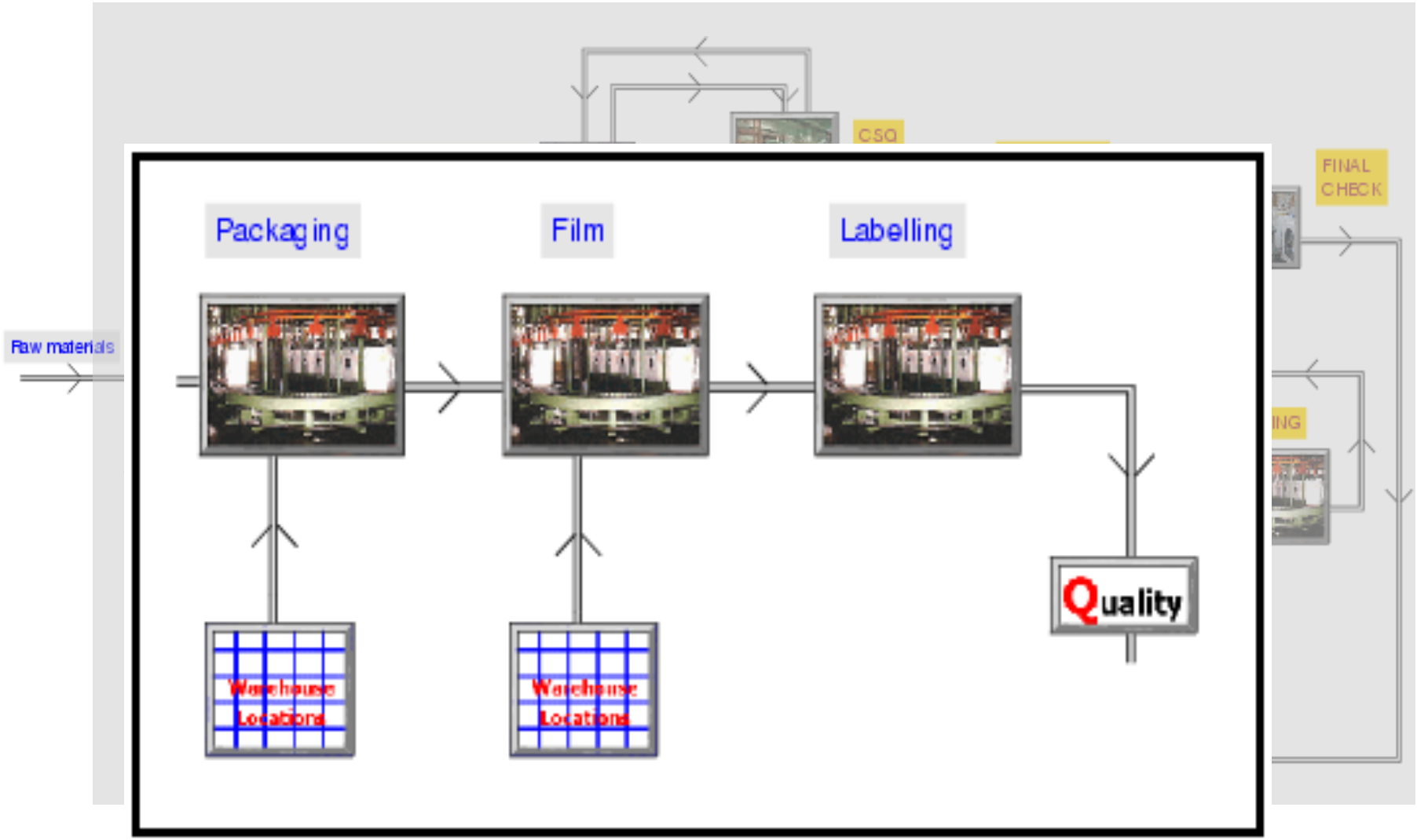
CSQ


Serial number on Barcode: ***
STORED DATA:
-serial number
-equipment
-operator
-date/time
-analogue measure
(temperature, absorption, water level, RPM, etc..)
"BARCODE READ"
"CHANGE PRODUCT LOCATION"
"TEST PLAN SELECTION"
"TEST EXECUTE"
"STORE DATA INTO QUALITY DB"
"STORE TEST RESULT INTO MEMORY TAG"
EXE
CSQ TEST:
-detail functional test
-life test
-audit test

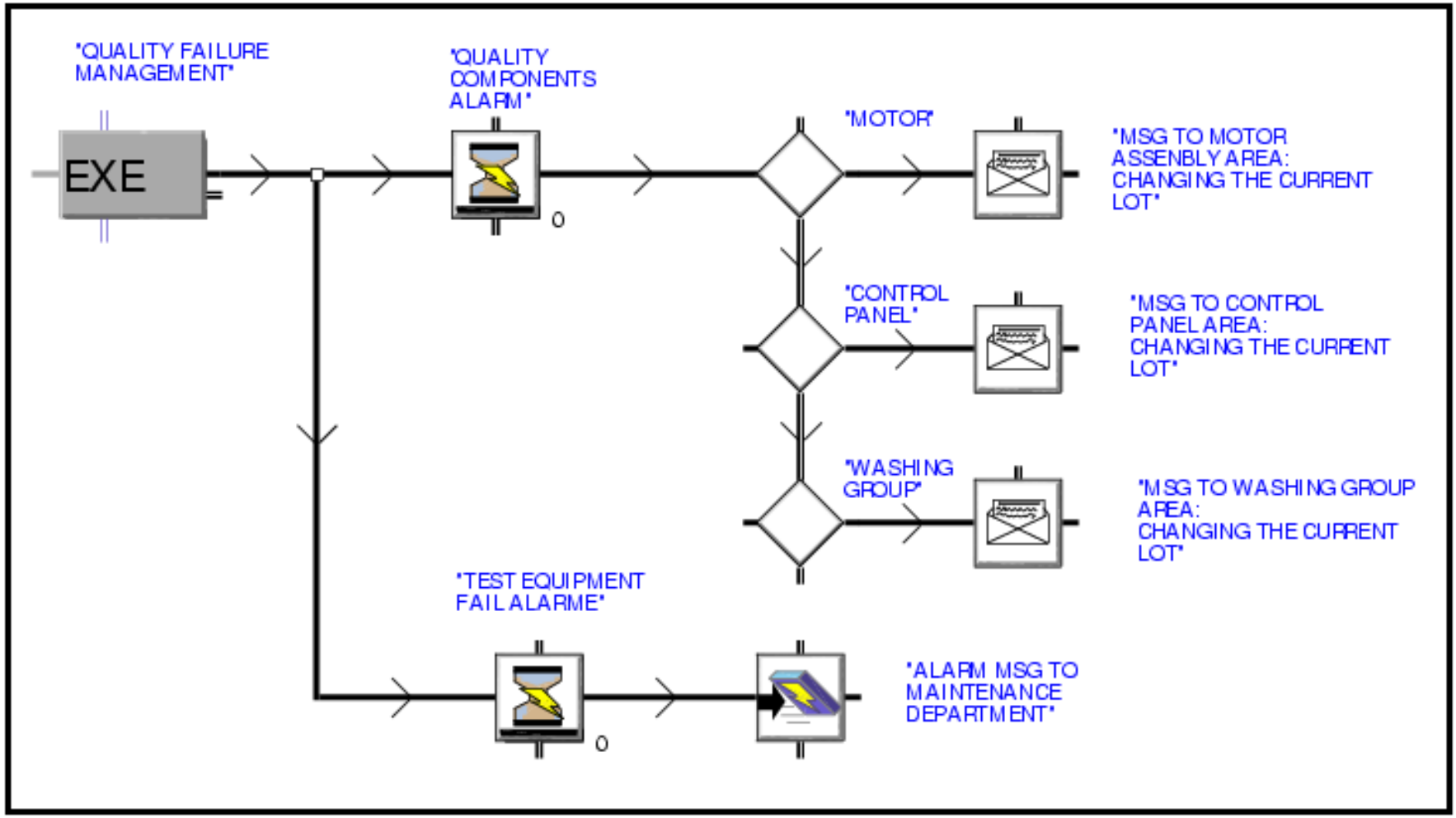
Final Test


STORED DATA
-Serial number
-Model code
-Equipment
-Product code
-Date/Time
-Test plan used
-Result (Pass/Fail)
-Operator
-Fault type description
Serial number on barcode: ***
"BARCODE READ"
"CHANGE PRODUCT LOCATION"
"TEST PLAN SELECTION"
"TEST EXECUTION"
"STORE DATA INTO QUALITY DB"
"STORE TEST RESULT INTO MEMORY TAG"
"TEST PASSED?"
EXE
FINAL TEST:
-electrical safety test (ground, hipot, insulation)
-online functional test (power supply)
-visual inspections
"INCREMENT TYPE FAILURE COUNTER"
"MAX TYPE FAILURE REACHED"
"SEND ALARM"

Packaging


CSQ
FINAL CHECK
Packaging
Film
Labelling
Raw materials
Quality
Warehouse Locations
Warehouse Locations

Failure Management



Test system for Quality Control

- Sample of a single quality test:

Testing equipment

Testing Report Generated (WashingMachine)

		Ohm	Mohm	mA	Volts
	MIN.	109,6	10	1,5	1980
	MAX.	121,2	100	8	2200
	COD. PROVA	50	20	10	11
	COD. POST.	4	4	4	4

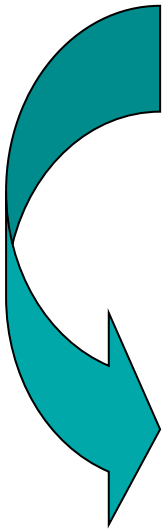
Data	Ora	Matricola	Esito	Resistenza	Resist. Isol	Rigidita di	Contr. V
27/09/2003	14.25.04	2018964	OK	113,2	100	3,3	2126
27/09/2003	14.25.38	2018965	OK	113,2	100	3,3	2126
27/09/2003	14.26.15	2018988	KO	108,8	100	3,3	2124
27/09/2003	14.26.24	2018967	OK	112,7	100	3,2	2125

Quality Data Traceability

The traceability of quality data is a complex process in an open environment

- Identification
- Retrieval
- Wrapping
- Collection
- Integration

- Distributed
- Heterogeneous
- Dynamic
- Embedded
- *domotica*



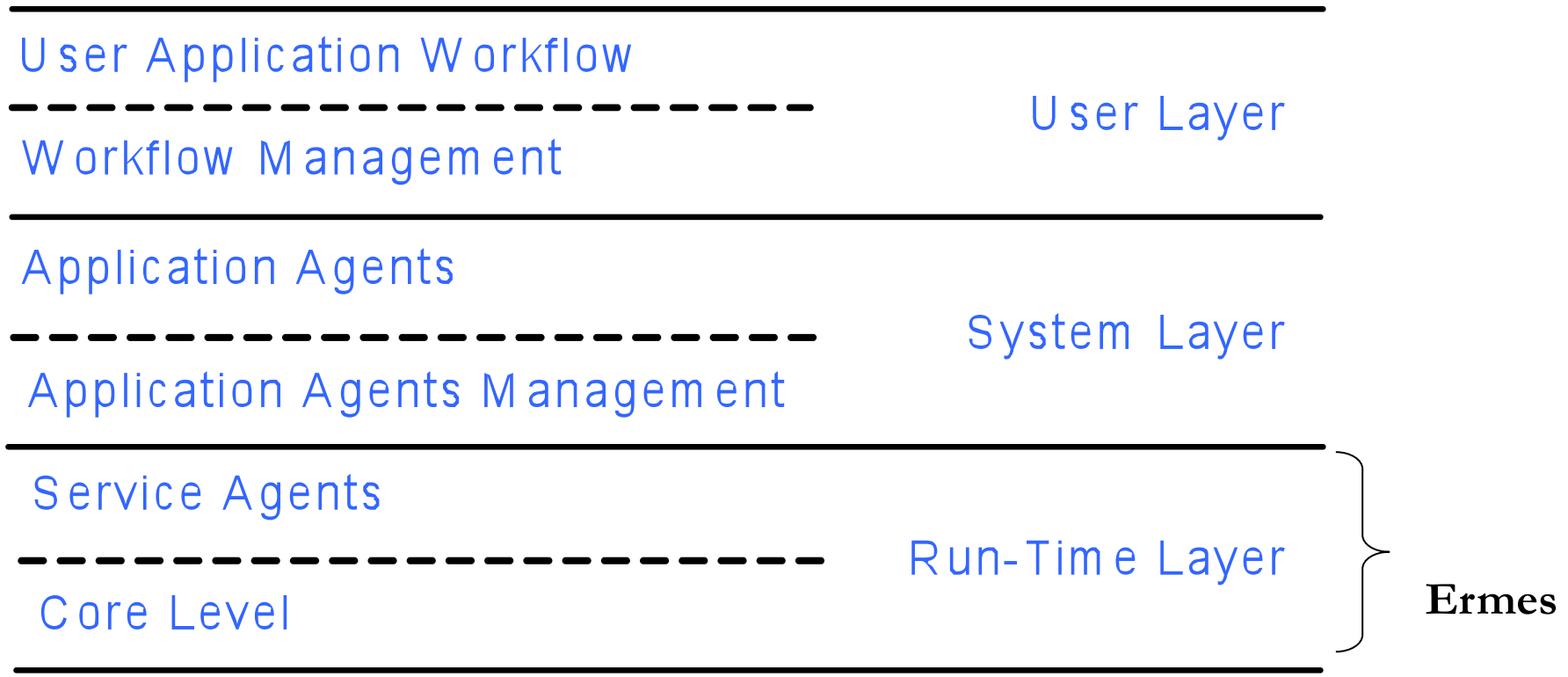
FarMas

[F.Corradini, L.Mariani and E. Merelli
"Agent-based approach for Tool Integration
Journal on STTS special issue on tool Integartion, to appear.]

a multi-agent system for quality data traceability

FarMAS – infrastructure

FarMas has been developed following a 3 layered software architecture



FarMAS – infrastructure (2)

- User layer is an environment to specify *quality-oriented workflow*
  - The visual editor is *SIMATIC IT Modeler* from SIEMENS
  - The visual editor can be replaced with one open source (Jawe)

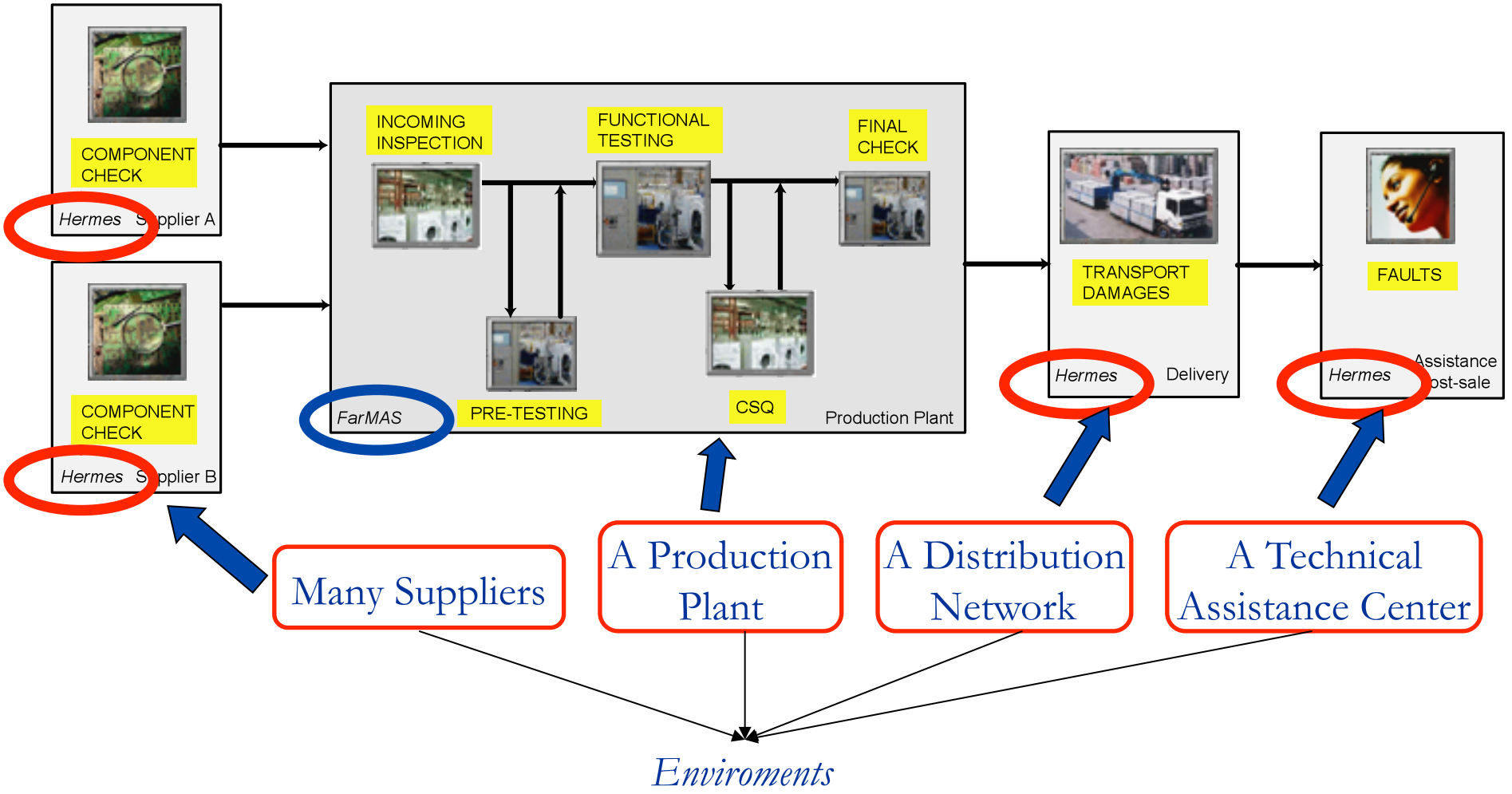
FarMAS – infrastructure (3)

- System layer performs the mapping from a *quality oriented workflows* to an *agent oriented workflow* and it generates an agent society (workflow executors) from a given *agent oriented workflow*

FarMAS – infrastructure (4)

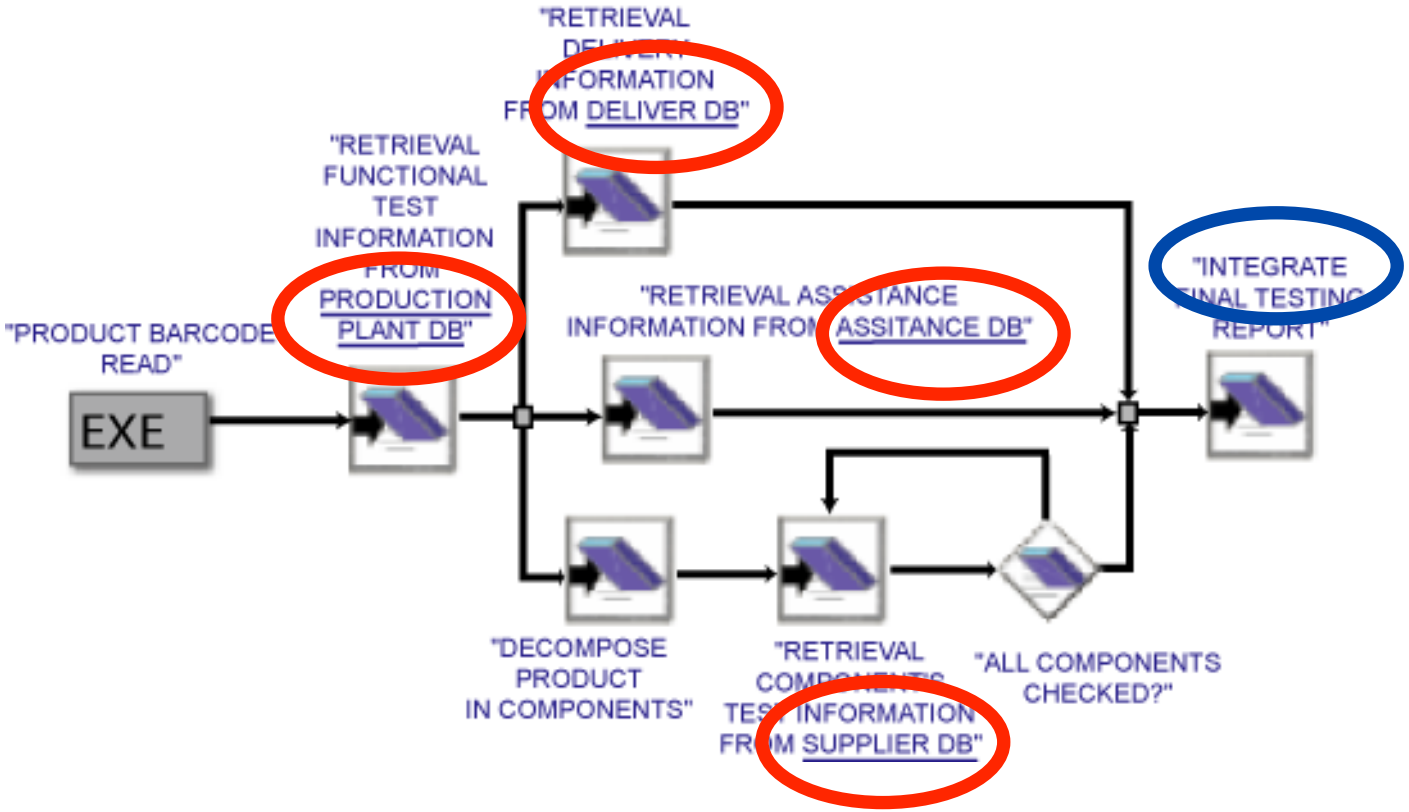
- Run-Time layer provides the needed support for the execution of workflow executors
  - The core is Hermes (agent-based middleware)
  - The service agents are AIXO agents (a component-based wrapper agent)

Case Study: a simple supply chain



Case Study: Functional testing

- The quality-oriented workflow → *Preliminary Roles and Interactions*



Case Study: Functional testing (2)

- The agent-oriented workflow → *Roles and interactions*

Test Agent:

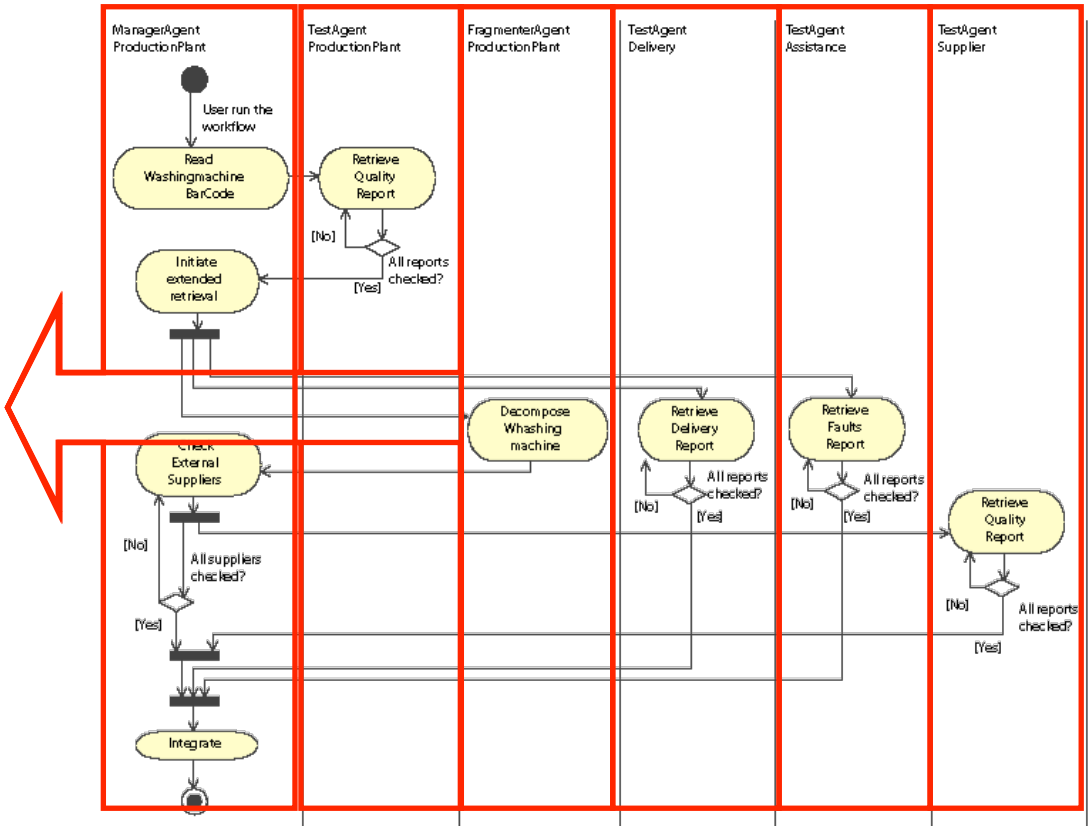
Retrieves quality data for a single component (it interacts with the Repair Agents)

Fragmenter Agent:

Decomposes a complex domestic device into a list of Wrapper Service components

Manager Agent:

Interacts with other agents and integrates the final report



On-going Activities

We are

- moving from the SIMATIC Modeler to one Open Source (Jawe, Taverna..)
- developing the first prototype of the compiler to allow the automatic generation of user-agents
- implementing new service agents for new test equipments
- defining a domain specific ontology for the quality control
- designing a test reports repository
- extending the propose approach as self-healing environment (automatic computing systems will detect, diagnose, and repair localized problems resulting from bugs or failures in software and hardware)

… for technical aspects the contact is

Diego Bonura

diego.bonura@unicam.it

Open problems

- Do we agree to classify this application as an open computational system?
- Has, in our opinion, the GAIA methodology been applied in this example?
  - What are the organizational abstractions?
- Is the workflow a coordination model suitable to describe the agent behaviour in a multiagent system?
- Do we need a formal methods to specify and verify consistency (integrity constraints) among roles, activities and rules?
- Do we need to specify a domain-specific ontology for any application domain as Quality Control of electrical domestic appliances?
  - What is the ontology of the environment (services and artfacts)?
  - What is the ontology of roles?
  - What is the ontology of the communication protocol (roles and interaction)?
  - What is the ontology of the organizational rules?
- Do we need to introduce code mobility?