FarMAS: a MAS for Extended Quality Workflow

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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.

CLIENTS
- Major international manufacturers
- Public Institutes

TECNOLOGICAL CULTURE
Engineering University of:
- Ancona, Bologna, Camerino, Napoli, Creta, Atene, Perugia

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

Technological Poles:
- Montpellier, Bari
- Israeli Tech Pole

International major suppliers:
- Festo, Siemens, National Instrument

GRUPPO LOCCIONI
School / enterprise
- Decr. Min. 593/2000
- Medea
- Builtech
- Spin.off
- Nexus
- NetPeople
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 product’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
Material Arrival

[Diagram showing the process of material arrival with various stages including NEW MATERIAL ARRIVAL, DELIVERY IDENTIFICATION, TRANSPORT DOCK CHECK, VISUAL INSPECTION, GET MATERIAL INFORMATION FROM MATERIAL DB, QUALITY CHECK, LOT GENERATION, LOCATION DEFINITION, STORE MATERIAL, REJECT MATERIAL, and FINAL CHECK.]
Pre-worked
Assembly
Marriage

**STORED DATA:**
create the destination lot as aggregation of source lots + quality information

- BAPCODE READ
- CREATE NEW LOT
- DISPLAY BOM
- FOR EACH COMPONENT OF THE BOM
- SEMIFINISHED ASSEMBLY
- STORE INTO QUALITY DB
- READ COMPONENT CODE
- MARRIAGE CHECK
- MESSAGE TO OPERATOR

Code Item to Produce: ***
Assembly station check

ASSEMBLY OPERATION SEQUENCE:
- text description
- images
CHECK according to quality request
SAFETY

STORED DATA:
- serial number
- equipment
- date/time
- operator
- problem description
(i.e. predefined on barcode)

*PROBLEM DECLARATION*
Semi-Worked Warehouse
Pre-testing
Functional Testing

- Electrical safety test (ground, hipot, insulation)
- Online functional test (power supply)
- Consumption test
- Performance test

Serial number: ***

FUNCTIONAL TEST:

STORED DATA
- Equipment
- Product code
- Date/Time
- Test plan used
- Measurement
- Result (Pass/Fail)
- Operator
Repair
CSQ

STORED DATA:
- serial number
- equipment
- operator
- date/time
- analogue measure (temperature, absorption, water level, RPM, etc.)

CSQ TEST:
- detail functional test
- life test
- audit test
Final Test

- Serial number
- Model code
- Equipment
- Product code
- Date/Time
- Test plan used
- Result (Pass/Fail)
- Operator
- Fault type description

FINAL TEST:
- Electrical safety test (ground, hipot, insulation)
- Online functional test (power supply)
- Visual inspections

"SBND ALARM"
"INCREMENT TYPE FAILURE COUNTER" "MAX TYPE FAILURE REACHED"
Failure Management
Test system for Quality Control

• Sample of a single quality test:

Testing equipment

Testing Report
Generated
(Washing Machine)

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Quality Data Traceability

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

- Identification
- Retrieval
- Wrapping
- Collection
- Integration

FarMas

a multi-agent system for quality data traceability

[Distributed
- Heterogeneous
- Dynamic
- Embedded
- domotica]

[Corradini, L.Mariani and E. Merelli
“Agent-based approach for Tool Integration
Journal on STTS special issue on tool Integration, to appear.]
FarMAS – infrastructure

FarMas has been developed following a 3 layered software architecture

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User Application Workflow

Workflow Management

Application Agents

Application Agents Management

Service Agents

Core Level

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User Layer

System Layer

Run-Time Layer

Ermes
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

Many Suppliers -> A Production Plant -> A Distribution Network -> A Technical Assistance Center

Environments

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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 Wrapper Service Agents)

**Fragmenter Agent:**
- Decomposes a complex domestic device into a list of components
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

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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 artifacts)?
  • 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?