# AGENT-BASED OBJECT ORIENTED CONTROL APPLICATION FOR FLEXIBLE MANUFACTURING SYSTEMS

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**Abstract:** In this paper we propose an agent-based object oriented control application for a flexible manufacturing cell composed from the TMA 55 five axis milling machine, two robots, one T shaped conveyor, storage system and a quality control system.

## 1. Introduction

In this paper an object-oriented rule-based specification framework is proposed to incorporate a rule system model into an object-oriented specification, to analyze and design the global processes and operational strategies of a Flexible Manufacturing Cell.

Our FMC consists of :

- two ABB robots with IRC5 controller
- T shape conveyor with S7-300 Siemens PLC
- TMA 55 5 axis milling machine with GE Fanuc 310i CNC control
- storage system
- quality control
- server

## 2. Objects and agents

These physical objects can be found in our object-oriented framework as virtual objects with specific properties, which can interact with each other. The purpose of the interaction between objects is to get information about the processing and the status of the real world object involved in the manufacturing.

All the data about the properties and the possibilities of interaction between the physical objects are included in the FMC control application database. The goal is to represent the information related to real world objects in the defined virtual objects.

Below we present a sample virtual object.

```
Object_Name

{

        State setOf{Information}

        Roles setOf{Role_Class_Name}

        Behavior setOf{Operation}

        Relationships setOf{Relationship_Name}

        Events setOf{Event_Name} }
```

The virtual objects can be used with agents. These agents are complex objects with an attitude. They extend the objects with structured state and behavioral properties. An agent can be defined as interactive, autonomous and adaptive element, properties such as rationality and learning ability are additional characteristics that are not necessary for

operation. An agent have additional set of components such as belief, goal, plan and action.

An agent would look like this in our FMC control software.

```
Agent_Name
{
        Beliefs setOf{Belief_Name}
        Goals setOf{Goal_Name}
        Plans setOf{Plan_Name}
        Actions setOf{Action_Name}
        Events setOf{Event_Name},
        Roles setOf{Role_Class_Name}
        Relationships setOf{Relationship_Name}
}
```

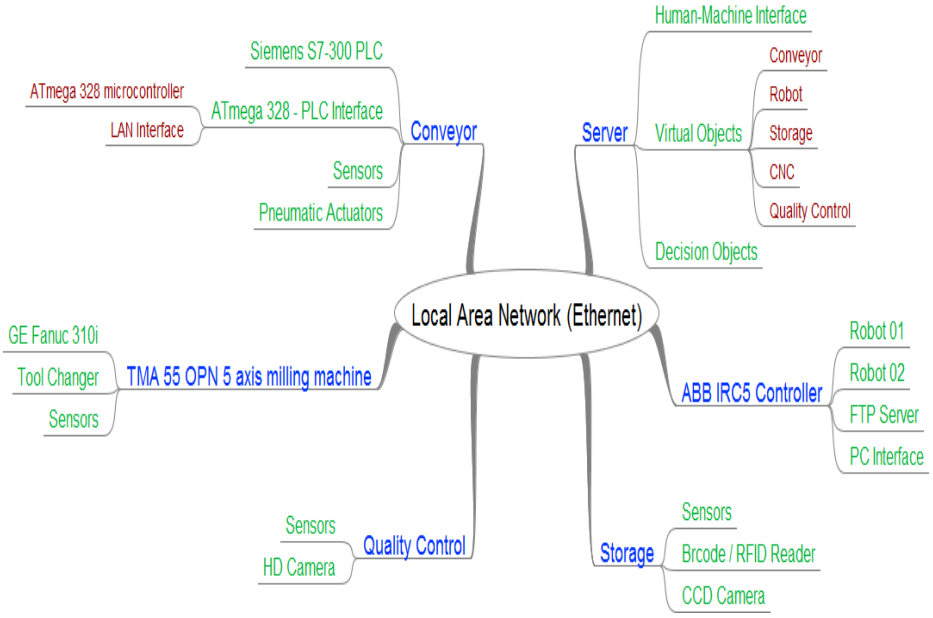
The behavior of the agent is manifested through its plans and actions which are based on characteristics like autonomy and adaptation. The relationship property of an agent describes how the agent is linked to another object and interact with them.

The behavior of the agent extends the object behavior:

- agents are autonomous without the need of external intervention
- an agent have full control over the behavior, agents can deny the requests of other agents
- they can change their behavior changing the list of actions

The FMC software initiates interactions between virtual objects that results in the interactions between real world objects of the FMC, and the results of the interactions of the physical objects is reflected in the virtual world.

The figure below shows the connections between the elements of the FMC. To control the objects of the cell we will use an ethernet network. On the top of the network is the server which will run the control application.




## 3. Conclusions

The use of the objects and agents in the control software will increase the autonomy, productivity and flexibility of the manufacturing cell. For example adding another virtual object (like a robot) to the manufacturing cell, will not be necessary to make radical modifications to the control software, only to add another virtual robot object with the corresponding agent and with their properties.

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