GENERAL FRAMEWORK

THE CO-EVOLUTION MODEL

Outline of the presentation

- The role of processes
- Co-evolution model: integration
  - Constraints caused by the market
  - Constraints caused by the organization
- Conclusions
The co-evolution framework: integration level

A first framework has been introduced in Kobe in order to formalize the concept of integration of products, processes and production systems.

Role of the Process

Need of motivating the existence of the process, independently from the system, was highlighted.

An approach to formalize the manufacturing context of interest is the analysis of real cases...
The FMS configuration in the case of sub-contractors.

The FMS configuration is realized on the basis of:
- the type of processes which the sub-contractor decides to acquire;
- the capability the sub-contractor decides to meet.

The system is configured on the basis of the processes the system must be able to perform. The product are normally not known in the system configuration phase.

Part mix change: introduction of a new code

Hydraulic chain tensionator components
Are there cases in which the process evolves independently from the product and system evolution?

**TECHNOLOGICAL CONTEXT CHANGES** → **PROCESS CHANGES**

Evolution of tool materials guarantee higher process performance.

- The product does not change
- The system may change (Structural changes for supporting higher performance)

The process changes cause the evolution

Several examples can be found considering:

- Continuous improvement

**PROCESS CHANGES**

- Process modifications for environmental regulation:

**REGULATION CHANGES** → **PROCESS CHANGES**

- Limit on vapor emissions of tool coolant used in machining

- Alternative process plans to address changing contexts

**ECONOMICAL CONTEXT CHANGES** → **PROCESS CHANGES**
Integration is needed

The examples show the importance of considering the co-evolution and integration of products, processes and production systems in the configuration process, while acting in a frequently changing environment.

Evolution and Integration

The Co-Evolution MODEL

- Level of Integration: the capability of a methodology to provide configuration solutions or guidelines taking into account product, process and production system aspects.

- Level of Evolution: the capability of a methodology to provide configuration solutions or guidelines considering the influence of possible changes in the future.
The Co-Evolution MODEL

- Contributions in improving and sharing the model are needed

http://www.species.polimi.it
The logic we propose to follow for mapping the methods is that of ternary diagrams.

To position the point characterized by (0.2, 0.2, 0.6):

Configuration methods map

Procedure for Mapping Methodologies

Experience based evaluation

Normalized weights \((w^p, w^o, w^m)\)

Ternary Diagram Logic

Methodology Positioning

Conclusions

The Role of Processes
Integration
Co-evolution model
Market Constraints
Organization Constraints

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The configuration approach

DEF: A configuration approach is a procedure that allows to configure the product, the process and the production system.

Example:
- Product (0.75, 0.25, 0)
- Process (0.1, 0.9, 0)
- System (0.1, 0.3, 0.6)

Integration Map - Sequential configuration

Outputs:
- (red=product)
- (blue=process)
- (green=system)

Conf. constr. \rightarrow Conf. goals

To Configure the Product

Search Algorithms

Evaluation Tools

Product Know/ Data

Conf. constr. \rightarrow Conf. goals

To Configure the Process

Search Algorithms

Evaluation Tools

Process Know/Data

Conf. constr. \rightarrow Conf. goals

To Configure the System

Search Algorithms

Evaluation Tools

System Know/ Data
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Integration Map - Design For Assembly

Integration Map: the Metric

Outputs:
- (red=product)
- (blue=process)
- (green=system)

Approach Mapped

The perimeter of the region is a metric for the level of integration of the approach. The larger is the perimeter the lower is the level of integration of the approach.

$$LoI_i = 1 - \frac{P_i}{P_{Triangle}}$$

$$0 \leq LoI_i \leq 1$$
Constrained Configuration Problems

Is it always possible to aim at managing configuration tools and methodologies which are highly integrated in considering the products, the processes and the systems?

It depends on:
- the market condition: Sub-contractor case
- the organization: Departmental organization case

If the decision maker can use all the degrees of freedom:

[Diagram showing the ADMISSIBILITY REGION for configuration methodologies]

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Constraints imposed by the Market

Is it always possible to aim at managing configuration tools and methodologies which are highly integrated in considering the products, the processes and the systems?

It depends on the market condition: Sub-contractor case
- product: less relevant in the configuration phase, configured by different actors
- process: are relevant and can be configured with an integrated methodology

External degrees of freedom the decision maker can use

Constraints imposed by the Organization

Is it always possible to aim at managing configuration tools and methodologies which are highly integrated in considering the products, the processes and the systems?

It depends on the organization: Strictly departmental organization
- product
- process
- system

Internal degrees of freedom the decision maker can use
The Role of the Manufacturing Strategy

The Manufacturing Strategy decides the target level of evolution and integration to be considered in the configuration phase and how changes impact on the product, process or production system.

TARGET MANUFACTURING STRATEGY

PRESENT MANUFACTURING STRATEGY

The Role of the Company Strategy

The Manufacturing Strategy is part of the Company Strategy that defines the level of evolution to be considered at each company function.
Conclusions

Both the internal and external degrees of freedom define a limited region in the global configuration problems space. Which are the existing methods and tools that can better support while addressing a particular configuration problem?

The CO-EVOLUTION MODEL provides:
- A topology for the configuration problem space
- A metrics for measuring the best level of integration required to face the specific problem

Future meetings: Evolution level

The turbulence of the market and frequent changes of the environment lead to the need of considering the configuration problem in an evolutionary way (vertical axis).

In the new evolutionary vision of the problem all the three basic objects are involved. Goal: co-evolutionary configuration and management of production system-product-process.
Thank you