Manufacturing Process Modeling

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***Abstract*-This paper describes the development of a visual environment prototype that allows the manufacturing processes design and modeling using LAB (Besançon Automatics Laboratory) modeling. LAB models are used to perform design and modeling in four levels of detail, from abstract to concrete. To validate the relations within the model in a formal way, relations visual grammars are used. Finally, this paper describes an example of a manufacturing process.**

I. INTRODUCTION

In manufacturing processes, one of the stages that has been neglected and without a doubt is very important is the planning and design of the processes required to elaborate a product as well as the required equipment. In the following sections of this paper, LAB models are described, giving the definition of each model and the description of each level of detail. Once all models are defined, relations visual grammars are used to formalize the relations between models. Finally, a modeling example is presented.

II. LAB MODELING

The LAB (Laboratoire d'Automatique de Besançon) in France developed LAB modeling [1]; with the purpose of contribute to the complete and integrated conceptualization of manufacturing processes in four levels of abstraction, specifying in a progressive manner the product, the process tools and the necessary equipment. This systematic analysis approach allows complexity reduction in the generated process descriptions, helping in their comprehension by different people involved in the manufacturing process.

In this work context, the fabrication universe is composed by three base sets of elements that are involved in a manufacturing process. The three sets are:

1) A set named P, and its elements are the basic components of a product.

2) A set named H, which consists of the tools necessary for the transformation of P components. These tools can be a *palett* (for containing or transporting a product component), a *gripper* (for holding and manipulating), or cutting tools (such as grinders, drills, saws, etc.), among other tools.

3) A set named M, which consists of the means to generate mechanical energy or otherwise and transformation or process tool (H elements) bearers. This set can contain the following elements: robot arms, CNC machines, motors, conveyor belts, and other equipment.

The tasks performed in the manufacturing of a product are described by [2] in four levels of abstraction:

Level 1: Functional Scheme. With the use of functions, it describes the integration of components with the purpose of obtaining a product.

Level 2: Operational Scheme. It describes the operations performed on product components in a given location and with a given orientation on the installation space. It considers only product components without the equipment and the means to elaborate them.

Level 3: Execution Scheme. The operation describes product components and transformation tools (H set) involved in the processes required for manufacturing a product.

Level 4: Action Scheme. The actions are sets of product components, transformation tools and bearers of these transformation tools (M set). Actions include tasks represented in the previous three levels plus the means necessary (e.g. a robot arm, a conveyor belt, etc.) for the manufacturing of a product.

An example is shown in Fig. 1.

Note: The difference between the elements of sets H and M is that elements in H act directly upon the product components and elements in M act using an element in H.

T. Sobh (ed.), Innovations and Advanced Techniques in Computer and Information Sciences and Engineering, 237–242.

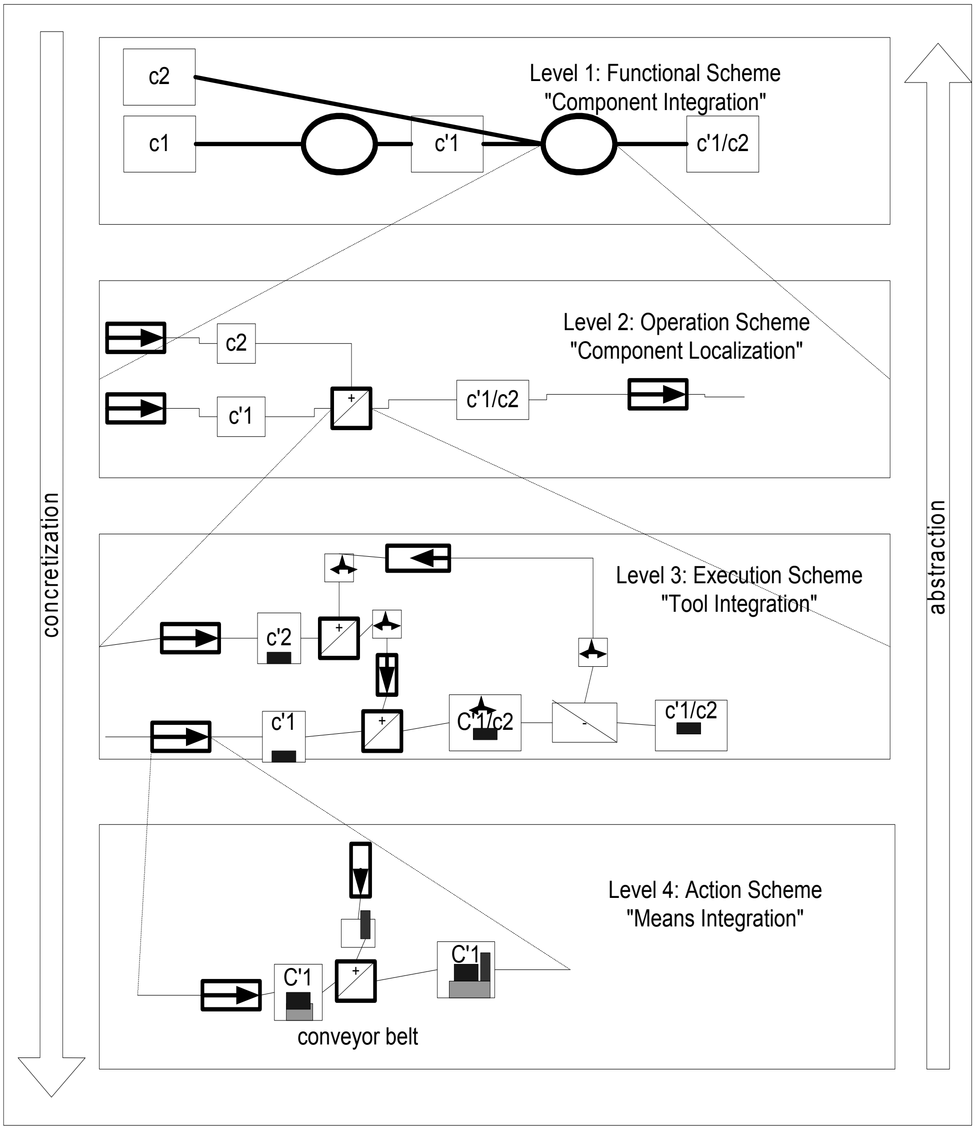

Fig. 1. Detail description of a task using four levels of detail.

III. Symbolic Relations Grammar

Once the model is defined, a formal Symbolic Relations Grammar (GRS) is applied to generate a visual language as is specified by [3] and [4]. In a GRS a sentence is seen as a set of consecutive symbols.

Definition: A GRS is part of the visual grammars and these are part of the Context Free Grammars. Is a sextuple G = (N, T, I, R, Atr., P) where:
N: Is a finite set of non-terminal symbols.
T: Is a finite set of terminal symbols.
I: Begin symbol.
R: Is a finite set of relations symbols.
Atr.: Is a finite set of attributes symbols.