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FUNCTIONAL MODELING USING IDEF0 TO DESCRIBE A MANUFACTURING SYSTEM

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Abstract: Integration definition for function modeling (IDEF0) is one of the most popular notations for modeling business processes. In the present article we discuss, evaluate and improve the IDEF0 modeling language. In order to meet end user requirements, we suggest concrete improvements which empower the language to face real world problems such as: human errors, process delays, parallel processes and detail information description. The objective of this paper is to implement a modeling method to represent the control methods, CONWIP, in manufacturing production systems. It is also an example of how a modeling system can simplify the communication of information.

1. INTRODUCTION

In 1983, the Air Force program for Information Support System developed from IDEF1 and created the standard IDEF1X (Extended IDEF1), a technical working model with semantics data.

Now, the IDEF0 and IDEF1X techniques are widely used in governmental, industrial and commercial fields, representing a support for modeling of a great number of enterprises and applied fields.

The standard is mostly recommended in projects that:

- need a technical model analysis, development, technical redesign, integrating or purchasing of software systems;
- Envelop a technical model of a system or of an enterprise for an analysis of the process of production or in a methodology of developing software.

This standard describes the language of the model (syntax and semantics) IDEF0, and the methods and the rules associated for making the graphic representations of a system or an enterprise. Using this standard allows the construction of models, including system functions (activities, actions, processes, and operations), links between functions and data (information and objectives) in order to integrate the system.

Also, it represents a reference, being used by systems programmers that are asked to use IDEF0, for those that develop tools for implementing this technique or by any IT specialist, to understand the exact syntax and the semantic rules of the standard.

IDEF0 models are composed of three types of information: graphic diagrams, text, and glossary. These diagram types are cross-referenced to each other. The graphic diagram is the major component of an IDEF0 model, containing boxes, arrows, box/arrow interconnections and associated relationships as in figure 1. Boxes represent each major function of a subject. These functions are broken down or decomposed into more detailed diagrams, until the subject is described at a level necessary to support the goals of a particular project, figure 2. The top-level diagram in the model provides the most general or abstract description of the subject represented by the model [1,2].

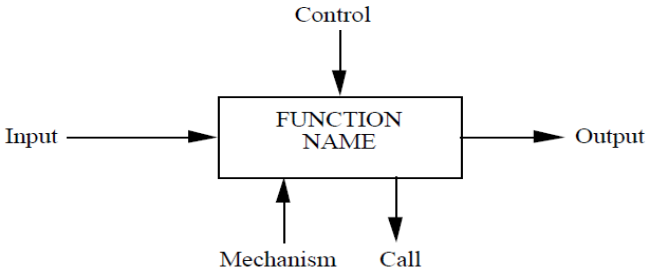

Figure 1. The elements of IDEF0 model

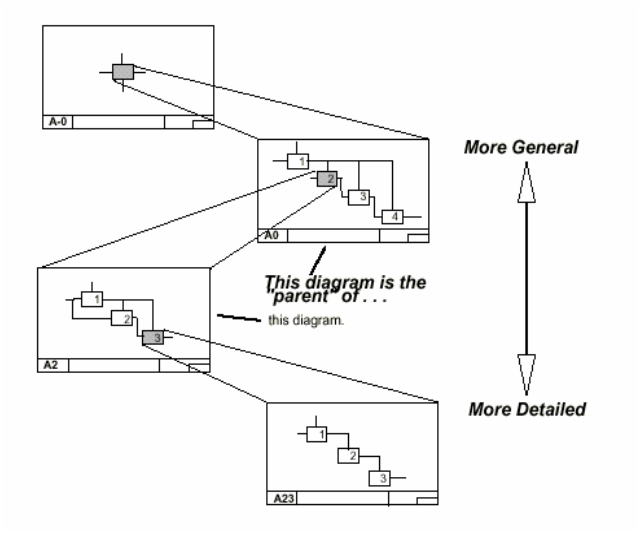

Figure 2 Decomposition Structure

2. PRESENTATION OF THE PRODUCTION LINE

To explain the operating mode of Conwip method will be used a production line, of 4 operations, that manufactures two types of products PA and PB.

Each operation is characterized by: processing time, machine failure – down time and up time, changeover time , setup time, the time needed for the operator's lunch and rest, the running time of a tool – it is given by the longevity of a tool and is specific to each type of tool, setup cost and production cost.

The total quantity of containers in the production line is linked to the numbers of Conwip cards. As result, in the line will circulate 4 Conwip cards, CA, for product PA and 4 Conwip cards, CB, for product PB.

If a workstation from the production line has a breakdown, the containers from downstream of this point will be gradually eliminated from the line by the process of demand. Those demands will determine the entry of new raw material in the line. When all the Conwip cards will accumulate upstream the station that is in breakdown and the entry of new tasks in the line is stopped.

3. THE MODELING OF THE PRODUCTION LINE

To describe the operating mode of the line managed with Conwip method it is used the IDEF0 methodology.

In IDEF0 methodology the decomposition of the processes starts with the top level A0.

Departing from the assumption that our production system is an open one that has the characteristics described above, the start mother diagram, IDEF0, will be as shown in figure 3.

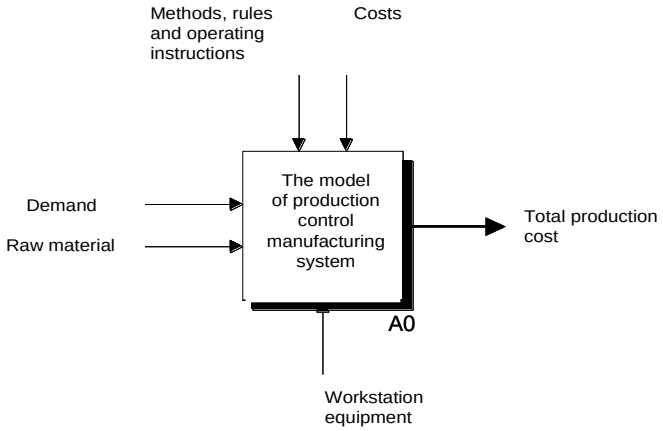

Figure 3. IDEF – A-0

The obtained model, figure 3, has at the top level the following elements: The inputs of the system are: demand and raw material, the mechanism – workstation equipment the control – is formed by costs and methods, rules and operating instruction, the output of the system are total cost.

The first level of decomposition of the production line management system is shown in figure 4.

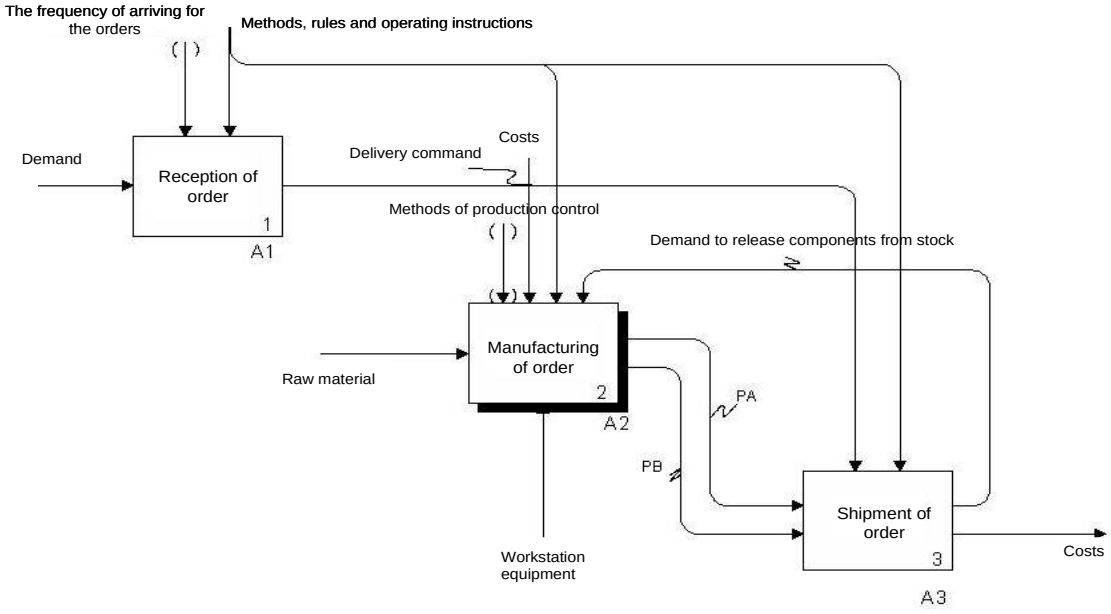

Figure 4. IDEF A0

In figure 4 the model is decomposed in its main processes. These are:

- A1 – demand enter – this process contains activities that handle the demand received from the client and has as exit the delivery order send to process A3 – order delivery;
- A2 – order making – this process has activities with witch is made the order of the client and in which the raw material becomes products;
- A3 – order delivery – contains activities that transform the delivery order received from the process A1 in demand release form stock, sent to process A2. When the demand of release from stock reaches process A2, the products are sent to process A3 and are sent to the client.

The model of process A2 – "Order making" when the production line is managed by Conwip method is presented in figure 5. Even if are 4 stages inside the system, the line management with Conwip method assumes that the control of production is made only at the entry in the process, and the stock between operations, Si, don't have any role in control.

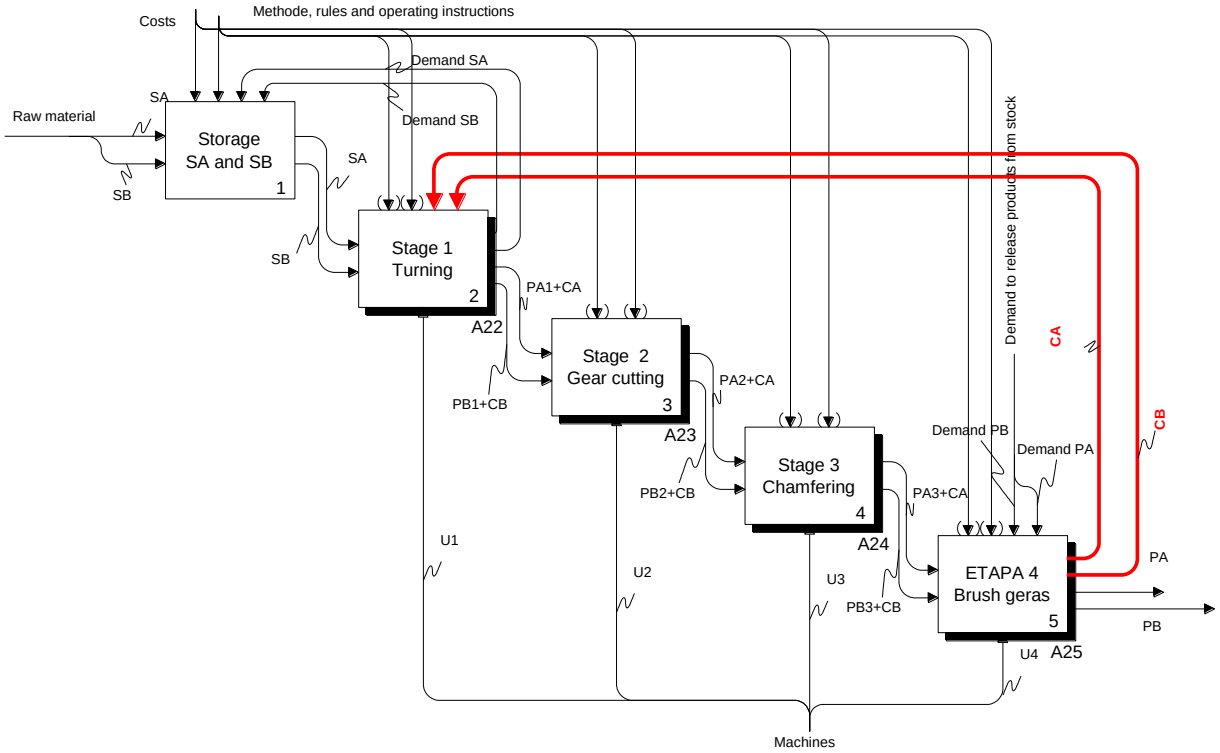

Figure 5. IDEF 0 A2

When the model is at the beginning, before arrival of demands in the system, the work in process stocks, S1, S2, S3 don't have any parts. Only the end stock contains CA and CB, containers with products that have Conwip cards attached.

The Conwip model works as following: when the release demand from the stock arrives in stage A25 – "Gear finishing" this is linked to activity A253 asking the release of one container with finished products from the stock to the client, figure 6.

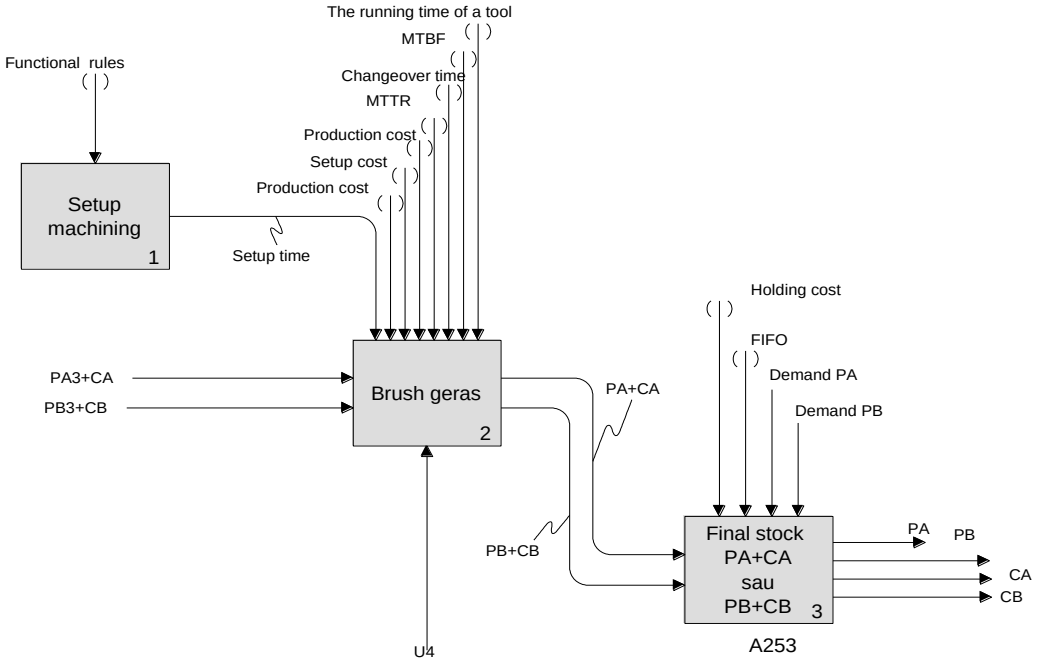

Figure 6. Stage 4 – Brush gears

In this moment there are two possibilities:

- if a container is available in the end stock (initial situation), this is send immediately ti the client, and the Conwip card, CA or CB, is detached from the container and sent to the Conwip board, figure 7;

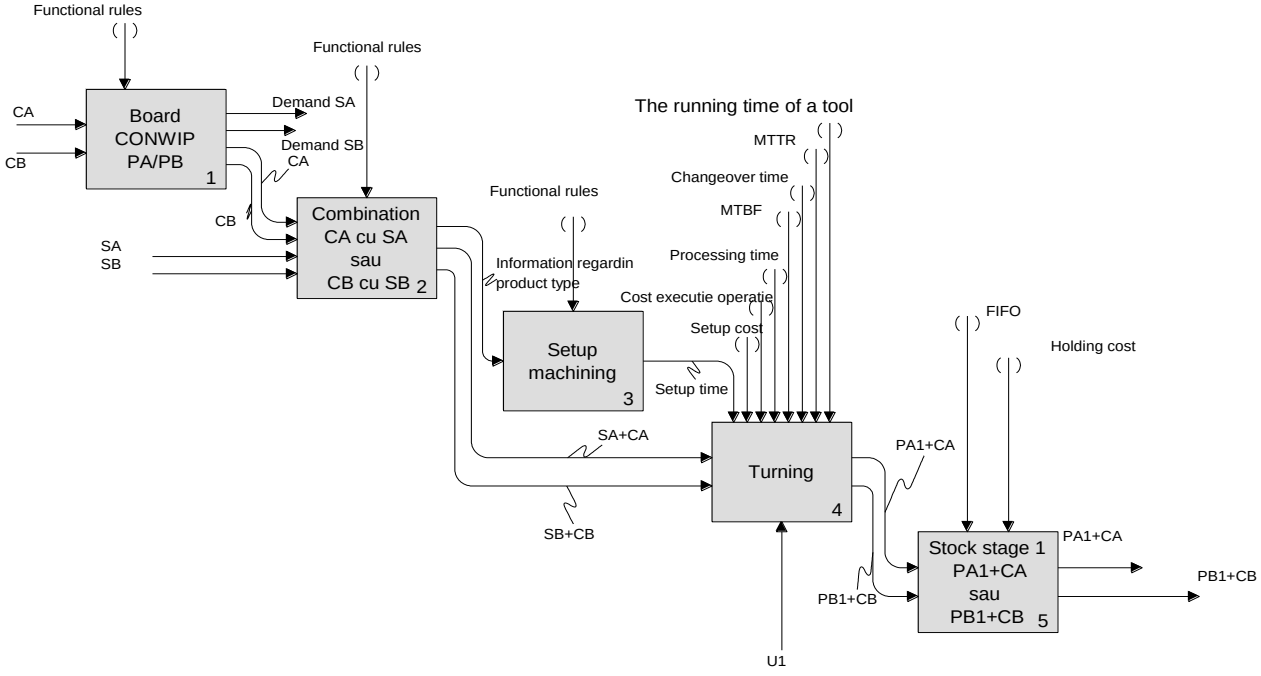

Figure 7. Stage 1 – Turning

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- otherwise, the demand is delayed and waits until a full container arrives from the previous stages. For the others stages, excepting the last, are the same operating

mode as for a push system, the containers moving through the system with no constrains, figure 8, figure 9.

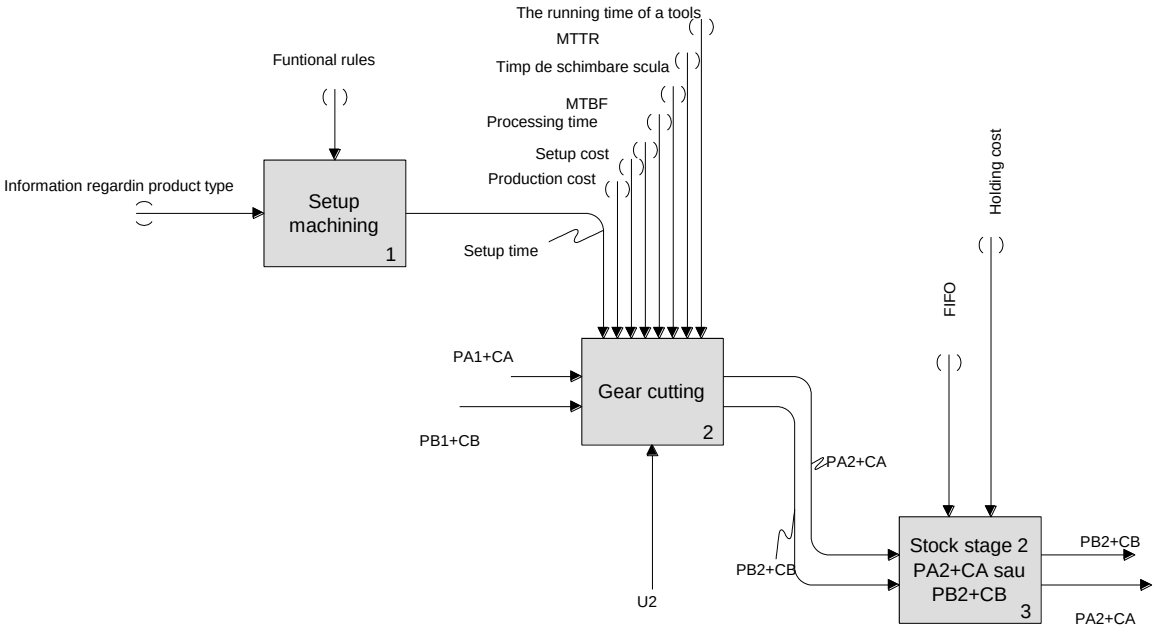

Figure 8 Stage 2 – Gear cutting

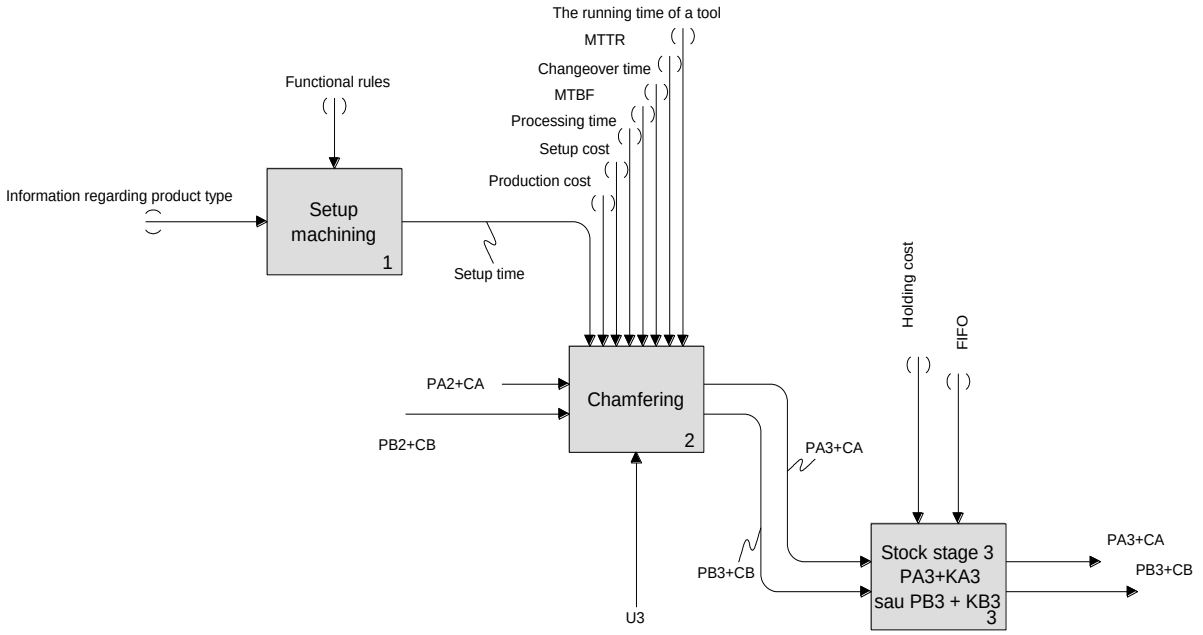

Figure 9 Satge 3 – Chamfering

The Conwip method is implemented by associating each card to a container, doing so allowing its entry in the system. Anytime a container exits the end stock, its card is detached and sent to the first stage allowing the entry of a new container in the model. All the other stages of manufacturing of the system are always let to work any container sent in the model, therefore the passing of the Conwip cards by this stages is not needed.

4. CONCLUSIONS

The operating mode of Conwip model is simple because it depends of only one parameter, the number of Conwip cards, CA/CB. These cards control the flow of containers in the model and also the transfer of information of the client demand. Inside a model like this, there is no transfer of information between the manufacturing stages, excepting the first and the last stage.

IDEF0 can be used to structure a big variety of systems, autonomous or dependent. For the new systems, IDEF0 is used first to define the needs and to specify the functions and after to describe an implementation that must meet the needs and to attend some functions. For the existing systems, IDEF0 can be used to analyze the system functions and to record the mechanisms that make this functions work.

The results of using IDEF0 on a system are a model that contains a hierarchical series of diagrams and texts and a glossary with references. The two primary components of the model are the functions (represented in diagrams by boxes) and the data or objectives that interact with these functions (represented by arrows).

One of the most important characteristic of IDEF0, from the model concept point of view, is that of introducing gradually levels, increasing in details on the structure of diagram. In this way, the level of communication is increased by offering to the reader a high content of details in a structural form.

Besides defining IDEF0 modeling language, the methodology describes, also, procedures and techniques to develop and to read a model, to gather data, to build the diagrams, the review cycles and how to make the documenting stage.

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