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MULTIPOLAR SIMULATION REVISITED IN MANUFACTURING NETWORKS MANAGEMENT

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Abstract: *As a result of our industrial partners demands in our researches meant to increase the productivity by optimizing the manufacturing architectures we focused during the past years on two main axes. The first one is synchronizing process and material flow simulation. The second one is synchronizing different simulations of interconnected manufacturing systems acting like nodes in a virtual enterprise oriented network. In this paper we will focus on extending our solution by implementing a multipolar project planner integrated system able to simulate the costs evolution during the entire project for different optimizing material flow solutions.*

Key words: *manufacturing architectures, material flow, multipolar simulation, project management.*

1. INTRODUCTION

We agree here that virtual enterprises (VE) could be defined as a network of enterprises collaborating to produce a single product during a project cycle time (Cotet et al., 2009). In figure 1 a three nodes virtual enterprise model is presented. The three nodes are representing manufacturing systems placed on different geographical locations.

We are modelling information and material flow using a total contact theoretical model. In this model every node of the network is connected for the material as well as for the informational flow with all the other nodes. We choose to represent in figure 1 and to discuss the total contact principles a 3 nodes manufacturing network in order to obtain a clear image of the internal relationships.

Even if the behaviour is similar for more than 3 partners the nodes relationship representation is more difficult and less intuitive.

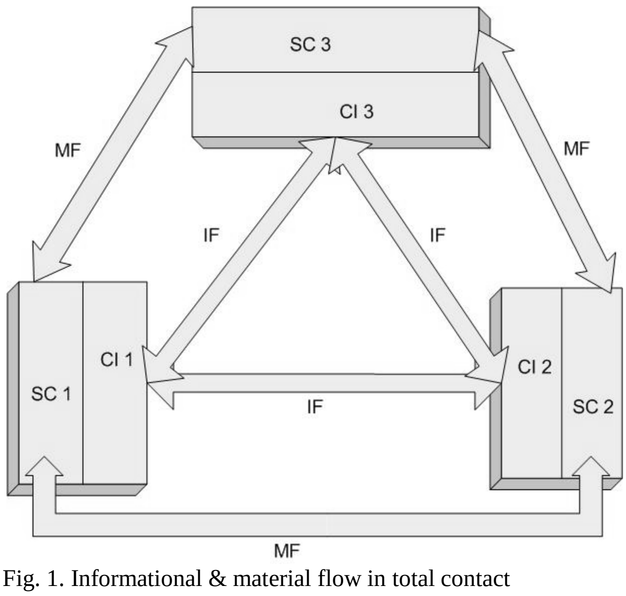

Fig. 1. Informational & material flow in total contact manufacturing networks

We define as multipolar distributed simulation the integrated digital monitoring system of more than two material flow simulations interconnected in an enterprise network architecture. In multipolar simulation for total contact manufacturing networks the nodes could be diffused as well as concentrated systems.

We define diffused manufacturing systems as architectures with more than two work points connected by transport & transfer systems and using deposits at local or system level. We define then concentrate manufacturing systems as architectures based on a single work point surrounded & assisted by transport, transfer & deposit facilities (Cotet et al., 2008). Diffused as well as concentrated manufacturing systems could be mass production, batch production and job shops (Dhouib et al., 2009). In order to illustrate our multipolar algorithm using the 3 nodes network model presented in figure 1 we used the APMOSTVC Algorithm for Concurrent Part families and Machine groups formation with Operation Sequence, operation Time, production Volume and machine Capacity (Lokesh & Jain, 2010).

We consider a material flow and process synchronous simulation the simulation of a model where at the level at the work point the process simulation is concomitant with the material flow simulation. For a designed manufacturing architecture it is always useful to simulate the process & material flow conduct before applying our design into practice in order to avoid potential flow concentrators (bottlenecks) generating low productivity or even blockage (fig. 2). Flow concentrators also generate under utilization of the structural elements of the manufacturing system leading to financial loss (Gill, 2008).

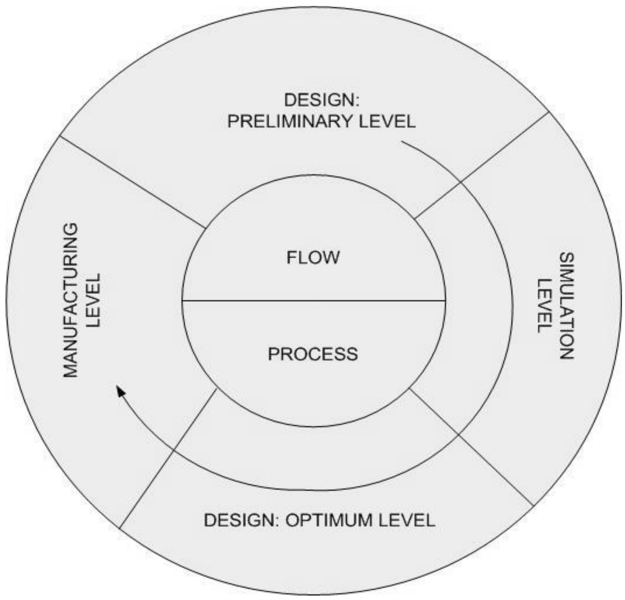

Fig. 2. A process & material flow road map from design to manufacturing

2. MULTIPOLAR SIMULATION REVISITED

In our previous researches related to multipolar simulation we focused on optimizing the manufacturing design not only for isolated manufacturing systems but for manufacturing networks acting in VE architecture. In this model random search algorithms have been attempted for scheduling. (Udhayakumar & Kumanan, 2010). We considered that the flow concentrators for the network manufacturing are not always the bottlenecks identified for each of the manufacturing systems of the network acting isolated. In the multipolar synchronous simulation the elements of the model are simulating the behaviour of manufacturing systems and the transfer and transport systems are simulating the links between the manufacturing systems acting like nodes of the network.

In this paper we propose a new complementary algorithm meant to validate in financial terms this optimization. In our classic approach the main goal in optimizing manufacturing architectures was increasing productivity. Our complementary algorithm, based on net present value analysis meant to check if the increasing productivity obtained in our previous researches covers in financial terms the investment necessary in optimizing the manufacturing architecture. The algorithm has the main following steps.

Step 0. In the multipolar synchronous module (MSM) developed by us in our previous researches the project of a preliminary manufacturing network architecture is designed and transferred using Intranet as data entry for the financial analysis project planning simulation module (PPSM).

Step 1. An activity flow for the manufacturing network architecture is designed using PPSM in order to estimate the costs implied by the preliminary architecture (fig 3).

Step 2. The preliminary architecture model is transferred as data entry for the multipolar material flow and process simulator MSM.

Step 3. In MSM the process and material flow simulation of the activity flow is performed to identify the flow concentrators.

Step 4. The activity flow MSM simulation results are transferred as data entry for PPSM. The results of the PPSM simulation give the possibility to identify the supplementary costs generated by the architecture optimization meant to eliminate the flow concentrators. It is possible now to recognize the elements from the preliminary architecture that must be changed and the costs implied by those changes as they are in the model cost database used for simulation. If we decide that the results are satisfactory and validate the investment the PPSM is updating task activities and reviewing resources assigning to activities.

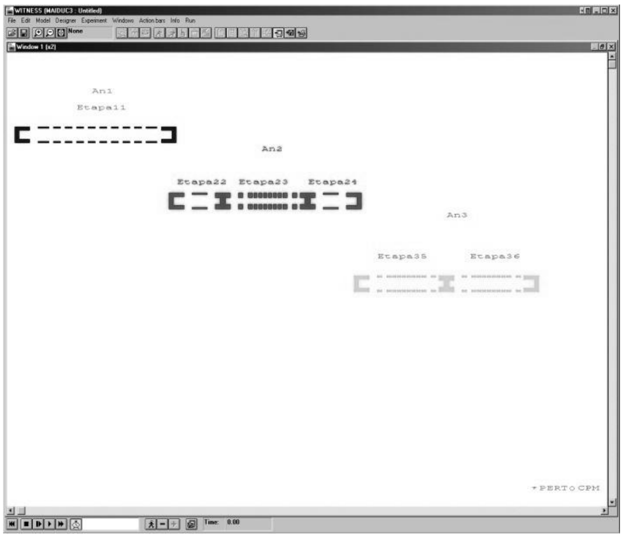

Fig. 3. Informational & material flow in manufacturing networks

Step 5. The results of the PPSM simulation are transferred to MSM. The result of the new simulation is generating the new productivity rates generated by the optimized manufacturing architecture.

Step 6. The new results are transferred as data entry for PPSM activity flow in order to see if the financial gain generated by the increased productivity covers the investment value.

Final Step . If so the optimized architecture is validated.

3. CONCLUSION

Based on the algorithm presented in this paper according with our previous research results in material flow simulation one can analyze the material flow, identify the flow concentrator for the manufacturing architecture and propose an architecture modification as a solution for this problem. The new element introduced by this algorithm is an additional simulator used to validate in financial terms the optimized architecture and the obtained increase of productivity based on a NPV financial analysis that must confirm the profitability of such a solution.

The main innovative character of our new multipolar simulation algorithm is given by three kinds of synchronic simulation identified and used by us in building our model.

First of all at the level of each manufacturing system the financial analysis simulation for each work point is synchronic with the financial flow simulation describing the isolated system activity.

Secondly the simulation of the financial flow for the multipolar model and the simulation of the financial flow for each manufacturing system model are synchronous. Last but not least the integrated multipolar model is synchronizing the results of financial flow for all the nodes of the virtual enterprise architecture, the isolated manufacturing systems financial flow simulators acting like elements of the multipolar model (work point, buffers, etc.).

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