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The Application of Games in a Model Factory for Education in Manufacturing Integration

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Abstract

This paper describes the development and utilization of enterprises games to improve the ability in the decision taking inside manufacturing integration environment. In order to elaborate the game, it has used the MIE—Enterprises Integration Methodology—that offers a wide range of strategic options in respect to the question of integration. Such methodology has been tested and approved inside the FIM—Model Integrated Factory—which is one of the research lines of the CIM Project of the University of Sao Paulo-Sao Carlos.

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enterprises began to absorb those components as "solutions" for their problems, in a disarranged and isolated way, and so losing the "sense of a whole" of their own organization.

In face of such scenario, the CIM Project of USP - São Carlos (BRA) was created, which searches for ways to help enterprises to put this new manufacture concept into practice, in order to contribute for their survival in the worldwide competition environment.

2. USP - SÃO CARLOS CIM PROJECT

The main objective of the CIM Project is to support human resources formation in all levels, involving graduation courses, post graduation courses and the knowledge extension to the whole community. Commercial CIM components are tested and their integration is tried on prototype solutions, offering references to enterprises in their decision making processes.

Components are developed when a technology needs to be dominated, when human resources must be formed or when there is no commercial offer available for an specific kind of product. Methodologies are also developed for application of Integration technology.

Among all the eighteen research lines developed within Project CIM, the FIM ("Fábrica Integrada Modelo" - Model Integrated Factory) is focused in this paper. FIM represents a complete prototype solution, which applies some results from other research lines and the MIE ("Metodologia de Integração de Empresas" - Enterprises Integration Methodology), which gives support to the integration process (BREMER, 1995).

The basic philosophy of FIM is to demonstrate that the main requirement to obtain the desired competitive advantage is *integration*, not the computer. What is intended within the FIM environment is to simulate enterprises which are bearing an automatization process and so the need to integrate their older facilities. Such philosophy is supported by the MIE methodology, tested and approved inside the FIM integrated environment (RENTES, 1995).

The MIE methodology is divided in three (3) stages and eleven (11) phases (Figure 1). The sequence imposed for the phases does not imply that some of them are not dispensable in certain cases. In spite of that, it is important to emphasize that the accomplishment of certain phases is essential for the success of the integration process.

A deeper description of the phases follows, in order to make clear their relative effects within the integration process (AGUIAR, 1995).

Keywords: games, education, integration, CIM.

1. INTRODUCTION

Manufacturing philosophy has been bearing profound changes within the last years, mainly because of the search for greater production diversification. That has been caused by aspects such as: economy globalization, more intense customer exigency, greater emphasis on quality and lower response times from the enterprises.

Within this context, the industries main feature in the post-industrial society or knowledge society is a new *productivity wave* (ARANHA, 1994). That new wave will only become viable with the introduction of new technologies, which could enable the integration of existent individual systems.

The new technologies required can be subdivided in several technological components (CAD, CAPP, CAE, MRP, etc) and organizational components (TQC, Just-in-Time, etc). The introduction of such components must be faced in a global and strategical manner, according to Skinner, which presumes that all manufacture decisions are linked to an strategical component (ROZENFELD et al, 1992).

The lack of strategical planning within enterprises caused their inability to safely choose the best path in face of so much market offers, that is, which components must be acquired and what priority order to follow in this process. As a result,

- *Stage 1: Requirements and Current Situation Evaluation*, includes the phases:

- **Phase 1 - Organization Stablishing:** the organizational and administrative bases for methodology application are defined, such as necessary resources, choice of a working team and time schedule preparation.
- **Phase 2 - Strategy Definition:** the enterprise's business strategies are identified, besides the manufacturing strategies to support the objectives established.
- **Phase 3 - Metrics Definition:** representative quantitative values are identified in order to measure the enterprise's performance.
- **Phase 4 - Present Situation Diagnosis:** the enterprise's current working procedure is modelled here, in order to offer support for the methodology's second stage phases.
- **Phase 5 - Actions Definition:** in this phase it is decided which phases will need to be applied later, depending upon the enterprise's objectives and priorities, in accordance to the results obtained in the Present Situation Diagnosis phase.

- **Phase 8 - Solutions Selection:** computational solutions are selected which are in accordance and able to give support to the current operation procedure of the enterprise or to the new procedure eventually defined in Phase 6.
- **Phase 9 - Solutions Development:** information systems are developed which support the business processes and/or complement the commercial computational solutions to be adopted.

- *Stage 3: Implementation and Monitoring*, includes the phases:

- **Phase 10 - Processes and/or Systems Implementing:** this phase assures the implementation of the processes defined in Phase 6 and/or the computational solutions' integrated implementation, within the time schedule and costs initially established for the integration project.
- **Phase 11 - Evaluation of Accomplishment and Adequation of the Current Strategies:** tracing and observation of previously completed phases, accordingly to the enterprise's strategies.

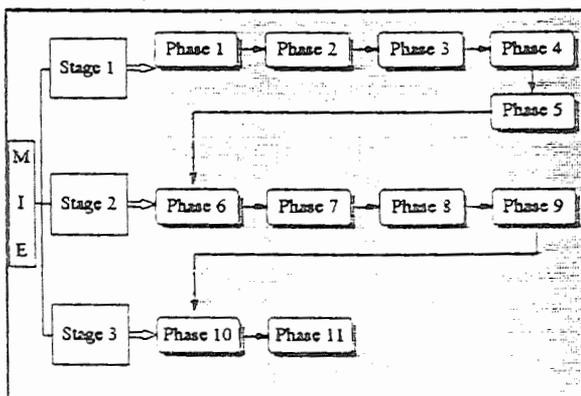


Figure 1: Enterprises Integration Methodology - MIE

- *Stage 2: Projects Specification*, includes the phases:

- **Phase 6 - Business Processes Development:** starting from actions definition, business processes are developed which will be applied in accordance to the embracing level desired. The processes development takes into account the use of Continuous Improvement concepts, Total Quality Control, productivity and rationalization, process perfection, process or business reengineering.
- **Phase 7 - Projects Specification:** this phase aims to make sure that proposed business processes (Phase 6) are implemented in an integrated manner, to eliminate possible effort repetition.

One of the benefits obtained with Project CIM is the knowledge transfer from one of the most important activities within the management function: the decision taking, which embraces the operational, tactical and strategical levels.

In order to develop the strategical level, the user must be qualified for conflict management and must be able to work in situations which involve interdependent decisions. Such situations can be interpreted as a game.

Within this scope, advantages from the use and development of enterprise games to improve management abilities can be noted.

The enterprise game can be seen as a sequential decision taking exercise, structured around a simulation model of an enterprise's situation. As a vital aspect, the person who is being trained must be placed within a situation in which he/she must take decisions without risking his/her post, the enterprise or other people, in this way saving time and money.

The MIE, composed of phases which embrace organizational and technological resources, can undoubtedly make available a very wide range of strategical options for the game players, bringing great benefits to the current situation of the enterprises.

3. THE MIE (ENTERPRISES INTEGRATION METHODOLOGY) GAME

The game is represented by an *option tree* (Figure 2), constructed in accordance to the MIE phases. The game's objective is to make the player trace across the various methodology phases, finally reaching the Evaluation Phase, what will make he/she able to evaluate the consistence of his/her own previous steps.

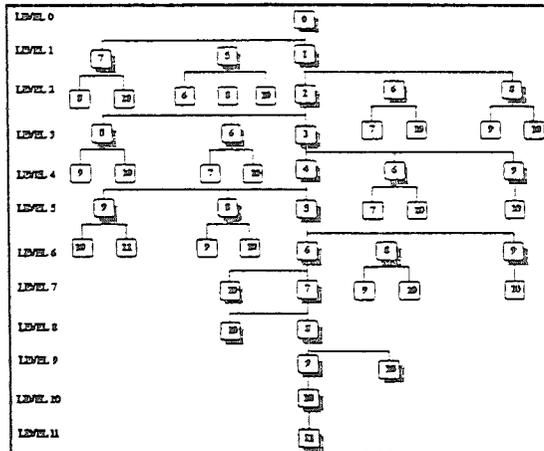


Figure 2: Option Tree

The game presents the following self-structure:

A - Instructions

In order to enhance the player's perception in relation to the effects generated by each phase, the option tree presents ramifications which offer different path options to reach the Evaluation Phase. Every time a player reaches this last phase, an evaluation must be performed, making clear what was left undone along the way, as a consequence of ignored phases.

The MIE game will be available at Internet, making it possible for users all over the world to participate and learn about the development of the integration process.

At Internet, each "box" represented on the option tree opens a window with the necessary information about each phase. The "Box 0" presents an introduction and game instructions.

As the game proceeds and the rounds are ran, the tree is progressively revealed. An example: at a first instant, after the player had read the introduction and the instructions, the first game options that the player can follow are shown, that is, Level 0 and Level 1 on the options tree (Figure 3).

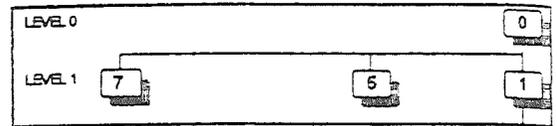


Figure 3 - First Round

In the second round, the tree will be unveiled until Level 2. For example: if the player chooses Phase 7, Level 2 will be "opened" below it (Figure 4).

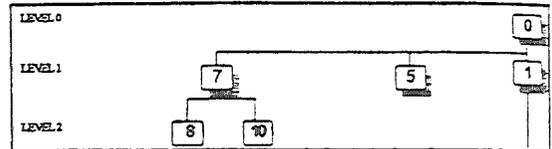


Figure 4 - Second Round

Following that sequence, the third round will enable the levels beneath the phase chosen by the player to be shown. In the example below, the levels are shown considering Phase 8 to be the player's choice (Figure 5).

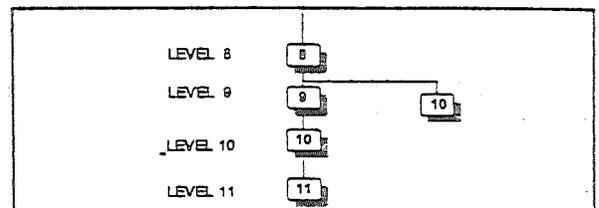


Figure 5 - Third Round

As the player reaches Phase 11, the evaluation is presented. Logically, the number of phases will not be presented, but the correspondent action instead.

The choice between one or other path occurs until the game is over. The player will not have any external influences anytime during the game, making his/her own decisions based only on self "good sense".

B - Arbitrator

This game's only arbitrator will be the computer itself, which will conduct the player throughout the windows sequence in accordance to his/her first rounds.

C - Evaluation

The evaluation will be presented as soon as Phase 11 is reached, when a screen will be shown presenting the player's rounds evaluation. Positive and negative points will be considered after each round results. If the sequence is the one defined by MIE, the player will not receive any warning.

Following the previously presented examples, an evaluation will be presented for the path adopted. The chosen path went through Phases 7, 8 and 10. For such path, shown in dotted lines on Figure 6, the following evaluation is presented:

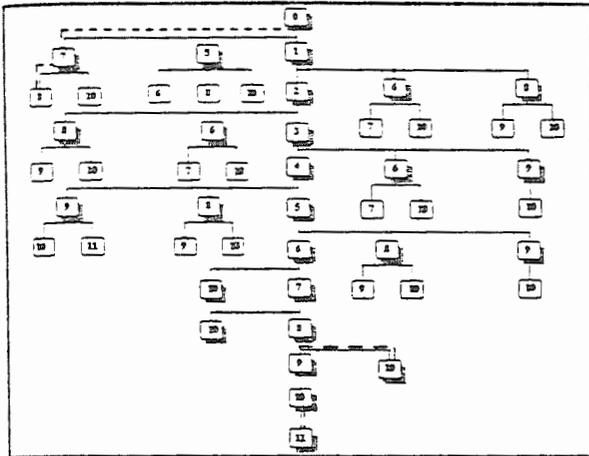


Figure 6: Path chosen on the Options Tree (0-7-8-10-11)

1. With the avoidance of Phase 1, there is no high management compromise, so there is no guarantee that any technical and organizational resources will be available. Another important point to be considered is lack of a time schedule organization procedure, compromising the activities' development.
2. Without passing through Phases 2 and 3, there will be no knowledge about how the enterprise works. That will make impossible to accomplish Phase 4. Current Situation Diagnosis.
3. Without Phase 4 completed, the enterprise will not have any reference to define its future actions.
4. Without actions definition (Phase 5) there is not how to follow any way. Any path followed without this phase's accomplishment will not be a safe choice.
5. Without new business process development (Phase 6), the enterprise will continue without a defined "better" path. That means no sure decision about what to do, neither how to do anything.
6. At last, there will be cases in which solutions development (Phase 9) will be essential to assure workability for the selected solutions.

D - The End of the Game

The end of the game will be defined by the player himself/herself. This will occur when the player feels to be informed enough about the MIE functioning.

4. CONCLUSIONS

In face of the nowadays world scenario, enterprises must update themselves in order to assure competitive advantage. Such updating needs reference standards, hence the Project CIM role grows important within the community.

The use of enterprise games for knowledge transference provides the participation of people in situations otherwise only available in real life, thus involving high costs and long periods.

The greatest advantage of games utilization is their contribution to higher capacity professionals formation and in recycling professionals already in the market, offering them a global vision of the enterprise environment functioning and of its operational dynamics.

It is intended to further extend the limits of this game in the future, as well as the ways to play it, by introduction of external influences, decision taking limited time and by taking into account specific features of the player's enterprise.

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