COMPLEX MODELLING SCHEME OF AN ADDITIVE MANUFACTURING CENTRE**POPESCU Liliana Georgeta***associate professor, Faculty of Engineering/Department "Industrial Engineering and Management"
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Abstract: *This paper presents a modelling scheme sustaining the development of an additive manufacturing research centre model and its processes. This modelling is performed using IDEF0, the resulting model process representing the basic processes required in developing such a centre in any university. While the activities presented in this study are those recommended in general, changes may occur in specific existing situations in a research centre.*

Key words: IDEF, modelling, virtual research centre

1. Introduction

The globalization phenomenon, technological and communicational development, the demands of a competitive market, the development dynamic of the economic and social environment, the complexity of the organizational tasks and the speed of the transformations at the microeconomic level focus the attention of practitioners and researchers to management concepts used by organizations – state institutions and enterprises, concerns, companies and private firms, centres and research institutes. Flexible organizational structures are necessary, that allow organizations to react rapidly to the environment, orient towards the market, fulfil client needs, assimilate and process information in a timely manner, be innovative and find new solutions.

Today experts and consultants in creativity management put forth a huge variety of methods, procedures, models, etc., usable in almost all fields. It should be noted that these modern techniques and methods tend to balance more and more the emphasis placed on the three important sides of creativity in an organization: the product of creativity, the creative person and the creative process.[1]

The efforts to improve performances in an additive manufacturing centre depend mostly on process models created for analysis and re-designing. The purpose of this paper is to present/In this paper a modelling scheme which supports the development of a complex model of an additive manufacturing centre and its processes is presented. The work presents an overview of the efforts such as rethinking the business process, integration of the additive manufacturing centre, and engineering the research-design centre using process models, and also, a modelling scheme that uses the IDEF series (Integration DEFinition) of the modelling methods to integrate the business rule, activity, resources, business process and organizational vision of the additive manufacturing centre. In the professional literature [2], [3] several improvement methodologies are presented for the performance of an enterprise through project processing. Examples of these are related researches regarding subjects such as business process reengineering, enterprise integration and enterprise engineering. Business process reengineering has become a subject accepted in the professional and academic literature [3].

The enterprise engineering paradigm regards the enterprise as a complex system of processes which can be projected to attain specific organizational objectives. The comprehensive approach that begins with an explicit consideration of the goals and objectives of additive manufacturing centres and an evaluation of the manner in which each process of the additive manufacturing centre should be designed to support the goals and objectives. This involves the need of an approach which takes into consideration all the aspects of an additive manufacturing centre, including its processes, resources, functions and control structures. Most of the modelling methods available focus on one or several aspects at the same

time. Even in a series of methods like the IDEF methods the integration over the methods is ad-hoc. Current modelling methods do not adequately support the necessities of enterprise engineering. Between these necessities is the ability to:

- Represent multiple visions of the additive manufacturing centres;
- Support multiple means of analysis;
- Support a projection of business processes;
- Integrate in the currently accepted and available methods.

Modelling of research and design centre from multiple angles (current activity, business process, organization. Business rule and resource vision) would require, in turn, the following:

- The business vision defines the functions fulfilled by the additive manufacturing centre;
- The business process vision highlights the chronological steps series which form the process that the centre uses to attain its objectives;
- The management vision details the manner in which the additive manufacturing centre organises itself;
- The business rule vision defines the entities administrated by the additive manufacturing centre and the rules that govern the relationships between said entities;
- The resource vision models the resources administrated by the research centre.

Multiple visions are necessary to model multiple perspectives from which an additive manufacturing centre can be viewed. This does not mean that all of these visions have to be present in all models. A model is an abstract representation of reality which excludes uninteresting details for the stakeholders. The model has to be developed to answer some of the questions about the additive manufacturing centre. If the model answers the questions for which it was created for, one or several of these visions can be sufficient.

2. Modelling scheme of a additive manufacturing centre

The modelling scheme has to meet the needs of the modelling process for the design of the additive manufacturing centre. The model is developed through progressive specification of the five visions, starting with the business rule vision and ending with the management vision. This is accompanied by feedback and the perfecting of the visions defined previously to ensure consistency of the visions.

A business model usually identifies the objects of interest in a certain field and their relationships. Each of the other visions is built through exaggerating the entities and the relationships regarding the vision. The proprieties and relationships for each vision are defined progressively while the visions are developed. While these new proprieties and relationships are defined, there will be just one case and one definition of the resource. This contrast with the traditional techniques, in which the resource is defined in the activity vision and redefined in the information vision.

The scheme is built on the IDEF [4] modelling methods. IDEF – Integration DEFinition are a series of modelling methods that have developed from the ICAM project of the Air Force (ICAM – Integrated Computer Aided Manufacturing) from the '80. Each of the IDEF methods offers a set of syntaxes and modelling steps that describe a particular perspective of the additive manufacturing centre. The modelling system presented in the following figures develop from the start the model of a possible additive manufacturing centre, regardless of it being independent or functioning in a university or enterprise. Through understanding of the capabilities of current technologies, the needs of the beneficiary or consumer, the steps that have to be taken have already been decided.

Figure 1: Performance improvement of an additive manufacturing centre

In the purpose of reengineering an additive manufacturing centre, the interest is initially focused on the activity vision ('what is being done'). When this is determined, the interest shifts on the behaviour that allows carrying out the activity. In other words, knowing 'what has to be done' for an additive manufacturing centre, one must determine 'what can be done' when the resources are selected.

Figure 2: Improvement of the additive manufacturing centre

Figure 3: Development of the business strategy

The environment in which the additive manufacturing centre is integrated is analysed, the next step being the integration and improvement of the centre through understanding the client and the product. Then the next steps consisted of modelling the product improvement, designing and implementing the adequate means of control, developing the technological solutions, understanding the needs, designing the system/solution, building the system/solution modules, implementing the system/solution.

As a result a new model of additive manufacturing centre can be obtained. Putting into practice these activities, a centre can 'set' its development direction and main objectives. Overall directions of improvement can also be visualized.

This model is the general one, because at the moment there is an impressive diversity of additive manufacturing technology applications in various fields: machine construction, automotive, aviation, medicine, dentistry, marketing, architecture and art, the entertainment industry, archaeology etc., being fabricated different functional objects, models for testing of the assembly, objects for viewing/presentation of concepts, market studies, models, casting models, prototypes of medical devices, toys, etc. Each of the above areas have particular needs and constraints, which means that the object must be manufactured to meet specific requirements of material, size, shape and dimensional accuracy, surface quality, mechanical resistance, colour, texture, cost, etc. [5] Nowadays, there are on the market, many additive manufacturing techniques such as: 3D printing (3DP) systems, selective laser sintering (SLS), stereolithography (SLA), fused deposition modelling (FDM). Use of these techniques is particularly advantageous in situations where customer requirements are related to complicated geometric structure, unique pieces and relatively short time production.

3. Conclusions

Application of system engineering methods and techniques advertise the widespread usage of informational and communication technologies, which allow an efficient resource management, long distance communication in real time, decision making in the informational economy context. The economic and social impact expected is significant, in the sense that a consistent and rigorous approach is offered, in regard with the standards used in traditional market economies. The operational demand, of restructuring the Romanian economy and, in particular, the industrial sector, can transform into and architecture optimized by the system, with the integration of manufacturing and logistic support.

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5. References

1. Moraru, G.M., *Methodological levels in creativity management*, in Proceeding of INTED2015 Conference, 2nd-4th March, pp.4362, Madrid, (2015).
2. Davenport, T., Short, J., *The New Industrial Engineering: Information Technology and Business Process Redesign*, Sloan Management Review 32 (5), (1990).
3. Liles, D., Johnson, M., Meade, L., Underdown, D., *Entreprise Engineering: A Discipline?*, Society for Enterprise Engineering, Orlando, (1995).
4. Mayer, R., *IDEF Family of Methods for Concurrent Engineering and Business Re-engineering Application*, Knowledge Bases Systems, Inc., (1995).
5. Popescu, L. G., *Tendinte in activitatea de cercetare*, Editura Universitatii “Lucian Blaga” din Sibiu, pp. 141–148, Sibiu, (2014).
6. Popescu, L.G., Zerbis, M.V., Bucur, A., *Strategic Analysis Model for a Virtual Research Centre*, in International Multidisciplinary Scientific Conference on Social Science and Arts - SGEM 2014, pp. 43-50, Albena, (2014).