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CONTRIBUTIONS TO MONITORING OF THE DESIGN PROCESSES BASED ON THE INTERACTION BETWEEN PARTICIPANTS

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Abstract: *In the design process the designers can work in many manners. Their actions and the interactions between them depend of design process type, of the number of the participants in the design, of the complexity of the design process, of implied resources etc. In this article we present a study on the interactions between the designers during design process. The study was made at the University of Pitești, by a team of three designers, on a design experiment for a drilling device. This study allows us to better understand the behaviour of the designers in the concurrent engineering context, and to propose an indicator to monitoring on-line a design process.*

Keywords: designers' behaviour, design experiment, process monitoring

INTRODUCTION

This paper describes a design experiment used to make observations about the behaviour of the designers in the concurrent engineering context.
The risks of concurrent engineering are presented: specification changes, task interdependence and design errors.
It is presented a typology of interventions of the participants in a design process. Based on this typology was examined design experiment.
It was proposed an indicator constructed on the basis of the interventions between the participants.
Based on the analysis of the design process with the proposed indicator was carried out it interpretation.

RISKS OF CONCURRENT ENGINEERING

Design process is a dynamic and unstable process due to the information exchange between designers [1]. It is almost impossible to have a once through execution of tasks in a design process. One or more repetition of the tasks is necessary to obtain the expected results.
Pahl and Beitz, in their work [6] define iterations as a process by which a solution is approximated step by step. Osborne [5] has observed that iteration is a significant component of the product development cycle time and represent about one third to two thirds of project effort.
The risks of concurrent engineering in design process are the specification changes, task interdependence and the design errors.
Specification changes.
In this case, design objectives and requirements are unstable or new requirements are added. It is particularly the case of tasks using preliminary information supplied by non-finished upstream tasks.
Task interdependence.
It is the case of mutually dependent tasks for which several iterations are necessary to reach an acceptable solution. In this case, the total time of the design process depends on the initial scheduling of the tasks.
Design errors.
Design errors and mistakes that could have a negative impact on the design process. Generally, failures in achieving design tasks are due to human errors, calculation errors, decoding and encoding errors [2], [3] and [4].
Our objective is to observe the designer's behaviour in the two different situations.

THE INTERACTIONS BETWEEN DESIGNERS

In the design process, to obtain certain solutions or information, the designers collaborate in different ways and by different technique.
In our study we used a team of three participants: TL-team leader; DD-device designer; MS-material specialist.
The designers change information, texts, drawings, computer files by different ways.
In figure 1 we are showing the interactions between all the designers and in figure 2 we are showing the interactions between two of them.

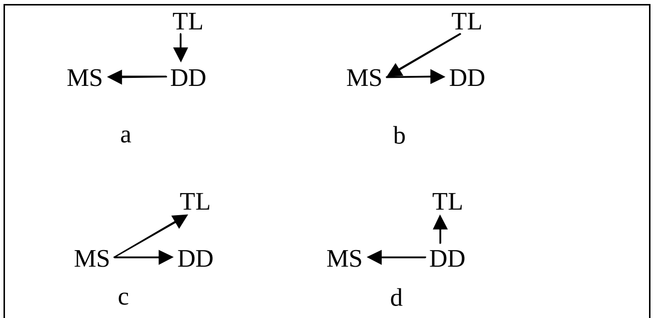

Fig. 1. The interactions between all the designers

In the figure 1, we have 4 situations:
a. MS is requested for its statute of expert in the field of materials (tests, request for councils, figuring etc), to carry out a diagnosis by validating or invalidating the already advanced choices.
b. In this situation, the intervention of MS is shifted upstream of the project compared to the first case and it can thus open the space of the solution thanks to its own knowledge.
c. MS takes the initiative to directly propose an idea of application to the TL and DD.
d. The DD can launch an idea of application to TL and MS.

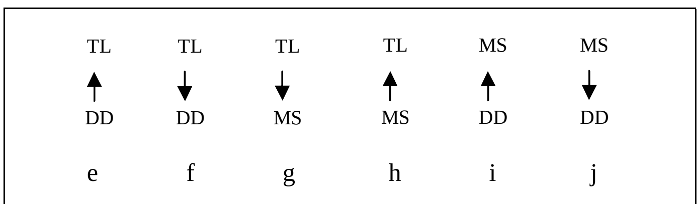

Fig. 2. The interactions between all the designers

In the figure 2, we have 6 different situations:
e. The DD to propose a solution with the TL.
f. The TL to ask a solution the DD.
g. The TL to ask a solution MS.
h. The MS to propose a solution with the TL.
i. the DD to propose a solution with MS and to ask an answer.
j. MS to propose a solution with the DD and to ask an answer.

A DSM representation of the interactions between the participants to the design process is presented in the figure 3.

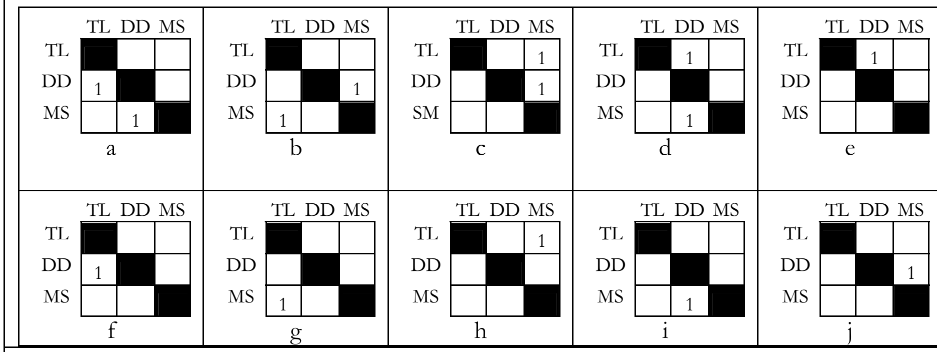

Fig. 3. The matrix representation of the interactions between the participants to the design

We represent in the Gantt chart, in the figure 4, the unfolding of design process of this experiment. The iterations are observed at two levels: between tasks, and for each task, between the participants. In the latter case, a matrix representation of the interactions between participants to the design process can be used.

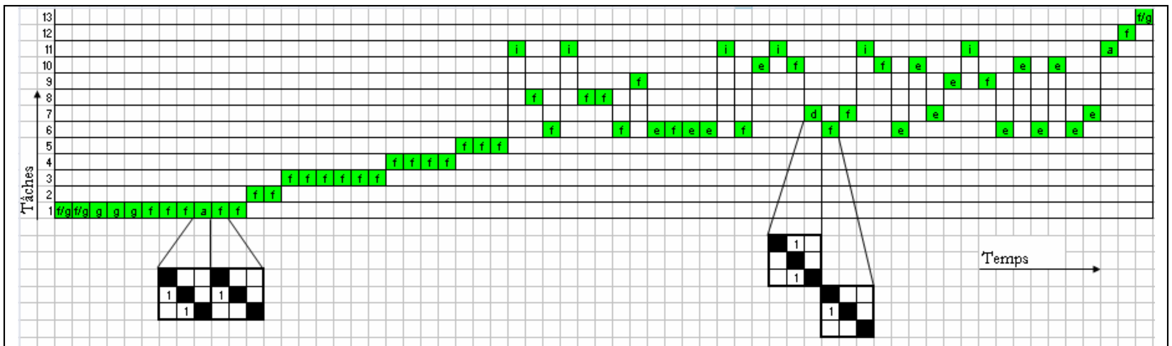

Fig. 4. The type of interactions during the design process

PROPOSAL OF A DASHBOARD TO MONITORING A DESIGN PROCESS

The Dashboard contains a lot of indicators able to show the values of certain parameters, at one time and even their trends.

The indicators must be easily constructed and interpreted. To understand the proposed indicator show the evolution of a process design, figure 5.

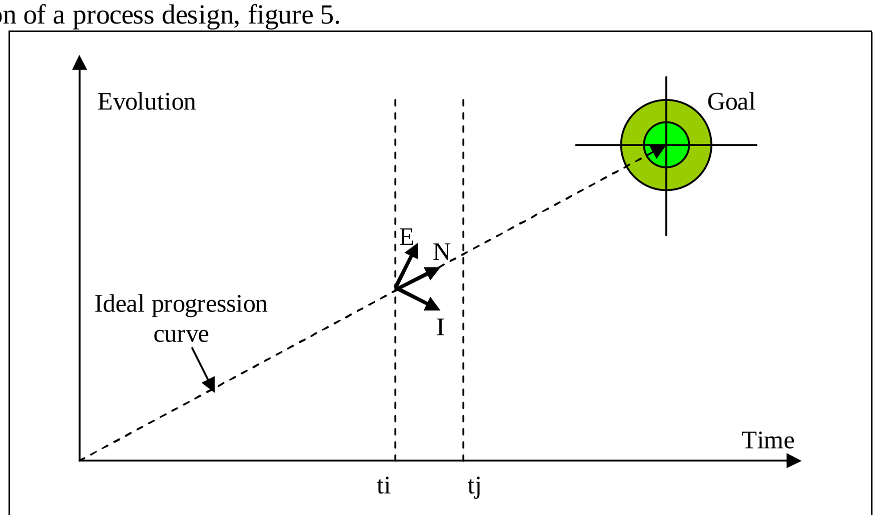

Fig. 5. The evolution of design process

E – Evolutive; N – Normal; I- Involutive.
The proposed indicator consists of three successive interactions, figure 6.

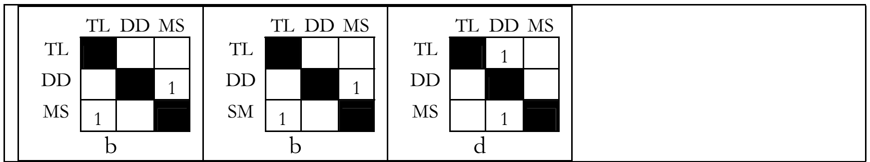

Fig. 6.

Its role is to show the trend of the design process development. To find the various combinations of successions and their type we analyze a design process.

RESEARCH METHOD

Design Experiments

Design is a complex activity in which the information's change and the designer's behavior are essential. To understand the design process, it is useful to use experimentations.
The design experiments are used to understand the designer's behavior during the design process.
Examining the work of designers, who work jointly or separately, provide understanding of the design process in certain conditions.

Experimental environment

The experiment described in this paper has been made at the University of Pitești, by a team of three designers, on a design experiment for a drilling device used to simulate the manufacturing process in CATIA V5, figure 7.

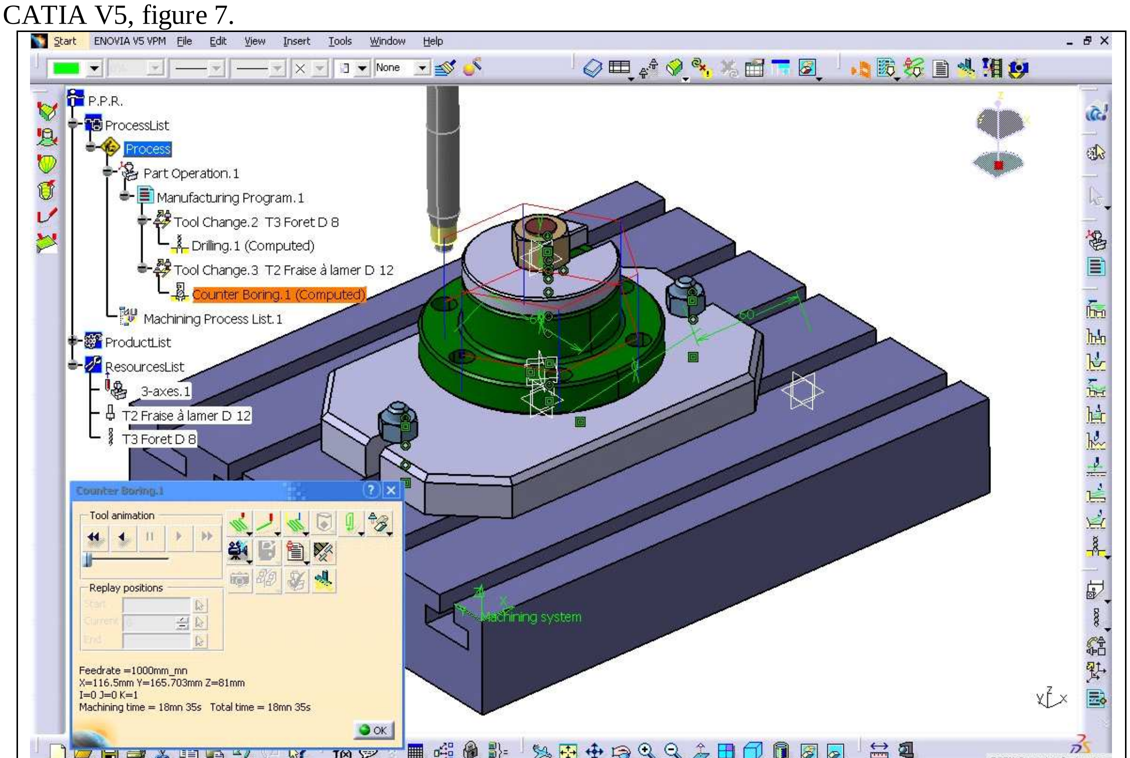

Fig. 7. The drilling device

During the separately reunion, the designers used a chat program and speaker-phones for personal communication, and ftp (file transfer protocol) for computer files exchange, figure 8. CATIA V5 was chosen as the application to be used to create part and assembly drawings, to develop and to simulate the manufacturing process. Also, a shared whiteboard was used to allow real time sharing of notes, drawings, and sketches.

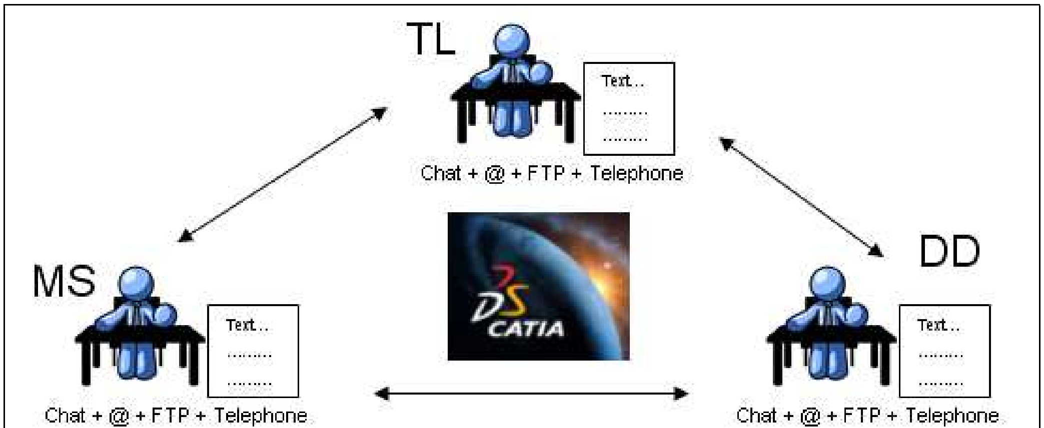

Fig. 8. Separately design team

FINDINGS

In order to identify designer’s behaviour in the design process, we have first identified the design tasks performed by the designers:
1. Establishing the initial data; 2. Establishing the dimensions and the quotation system; 3. Establishing the orientation system and the orientation elements; 4. Design the orientation elements for the part; 5. Braking system for drilling; 6. Design the device body; 7. Design elements for the braking system; 8. Design auxiliary elements; 9. Choosing the materials; 10. Establishing the functional dimensions for the device; 11. Technical advices.
After analyzing the experiment I noticed the following types of interventions:

Designer	The intervention types										
	a	b	c	d	e	f	g	h	i	j	alone
TL	8	11	9	-	18	42	2	3	-	-	-
DD	8	11	9	7	18	42	-	-	5	1	26
MS	8	11	9	7	-	-	2	3	5	1	2

Fig. 9. The intervention type

Were identified:
- interventions of involutive type : iff, showing in figure 10.

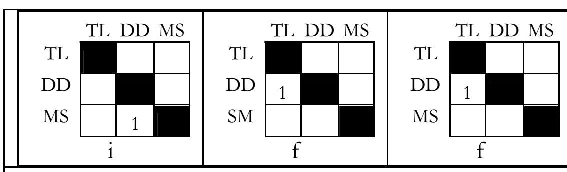

Fig. 10.

- interventions of evolutive type : aai; aaa; acd, showing in figure 11.

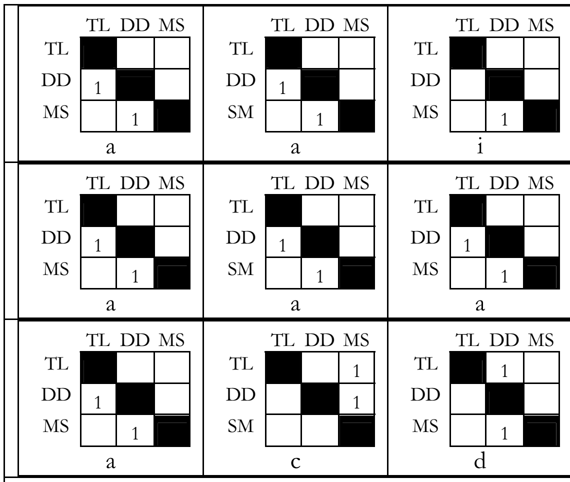

Fig. 11.

Other interventions are normal or haven't significant influence on the course of the design process.

CONCLUSIONS

In this study we tried to understand how the designers make the contact. For this reason, we adopted an experimental approach. Experiments are a useful way to get relevant information and reach records about the design process.

We proposed an indicator based on the sequence of the interventions between the participants able to provide information's as to potential developments in the design process.

This indicator is easily to built and used; a big advantage of them is the opportunity to monitoring the design process in real-time.

If the design team get numerous, the construction of the matrices may become more difficult.

Another disadvantage is the relatively high degree of subjectivism.

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