WEB BASED ENGINEERING APPLICATION DEVELOPMENT FOR PRODUCTION MANAGEMENT

Traian MAZILU[1], Aurel TARARA[2]

The decision-making actions for the production of customized products in a cost-efficient and fast manner require a comprehensive range of information.

The performance management of production processes can be assisted by new intelligent tools for planning, scheduling and control.

The present paper contributes to the development of a WEB based engineering application to bridge the gap between the existing applications that are expensive and quite difficult configurable and continuously changing of nowadays business environment.

Keywords: customized product, manufacturing, planning, scheduling, control, production process.

1. Introduction

To progress and survive in a globalized and very competitive market of nowadays, because of continuously changing on the attitude of customers in terms of consumption, manufacturing companies have begun to address to modern business strategies as production of personalized products or shifting their current mass production into the mass customization production of goods [1], by approaching methods as make-to-order or engineer-to-order.

Considering the attention that must be given to customers, involving them in the process of co-design, required time for products design increased. Also, to meet a short delivery time as requested by clients, corresponding duration of execution of the products must be as short as possible. Regarding these, some optimized logical models have been developed [2].

Production management concerns specifically in converting inputs into outputs, using the physical resources, to provide the desired customer requirements while organizational objectives are met in terms of effectiveness and efficiency [3]. Information about the inputs, stages of processing and outputs are feedback to the management and the managers have to make control over the conversion process, to see if that info matches their expectations, by measuring the outputs and comparing them with planned data.

[1] PhD Student, University POLITEHNICA of Bucharest, Romania, email: traianarchie@yahoo.co.uk

[2] PhD PhD Student, University POLITEHNICA of Bucharest, Romania, aurel.tarara@gmail.com

Efficient production planning, scheduling and control, PSC, deals with a high number of projects data related to execution orders, which can have a high level of uncertainty and different characteristics.

Most of PSC systems have been developed based on certain methods and algorithms capable of solving problems, such as: simulation, decision tree analysis, linear programming, network flow programming, integer and dynamic programming, stochastic programming [4], etc.

Integrating new tools for PSC systems in case of customized products manufacturing, the production time is significantly reduced.

2. Objective and method of research

To decrease response time from the designing of a new product to execution and up delivery, new applications have to be integrated in the industrial environment, based on modern information and computing technologies.

A special attention should be given to the customized products manufacturing. Taking advantage of existing Intranet Networks, homogeneous connections can be created, from development offices to production location up to every processing equipment involved in the product manufacturing route.

The purpose of this research is to develop a new model application as a heuristic tool for PSC usable both in research and production environment, especially for tracking the customized production of goods.

The method of research was structured in compliance with the main reference elements, as follows: selecting the programming environment and conceptual framework; defining the structural elements of the application; functional design of active commands; unrolling a real case study in industrial conditions; evaluation and interpretation of the application performance.

3. Structure, functionality and operational elements of a web based application for production management

An Electronic Production Survey Application, **EPS.A1**, has been created according with the intelligent PSC tool system logical model, respecting the system diagram [2], to convert the input data into information updated in real time during the conversion process. EPS.A1 is developed in a WEB Editor based on programming languages PHP and Java Script [5]. Collection of data inside EPS.A1 is made by the help of MySQL database software [6]. All EPS.A1 sections are based on CRUD matrix for object oriented data modeling system, using functions witch enable application to CREATE, READ, UPDATE and DELETE data into the MySQL database [7]. EPS.A1 is addressed to users as engineer or supervisor and fulfills several functions related to logical model [1].

General Structure

EPS.A1 is divided into sections of main menu which themselves may be composed of submenus.

In the main section of the menu, as well as in the submenus, distinct commands were drafted, each of them having operational scope.

The operational graph of the considered application is as presented in Fig.1. The application operates in the WEB environment in connection with all units of the production process, PP, through computer networks, which can be accessed online using any browser of operating systems, along network links.

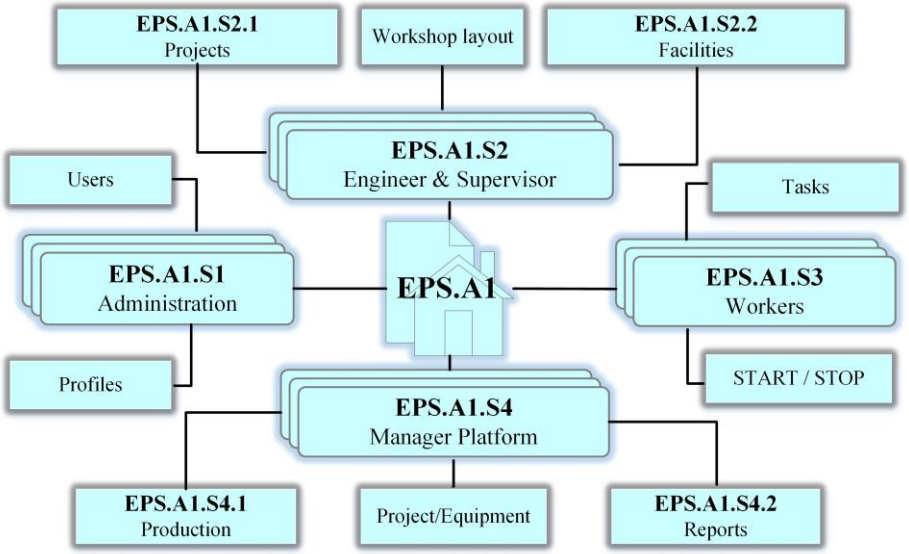


Fig. 1. Operational Graph of EPS.A1

EPS.A1 Main Interface

EPS.A1 can be accessed through an active default icon, which automatically loads the system, or manually introducing the address of application in the URL command of any WEB browser. In both cases, EPS.A1 interface is instantly launched and it is common to all types of users designated by the application administrator. Logging in of any user is made by stringent redirecting to each user assigned section.

EPS.A1.S1 Administration Section

EPS.A1.S1 is purely administrative section and it can be used only by the persons appointed to manage the application.

The main interface contains a section type *User accounts window* and some active buttons such as *Add user*, *Modify* and *Delete*. The admin can

introduce into the system a new user by filling required fields: *Username, Password, First* & *Last Name* and the proper *Rank*.

According to the role in the PP, the user's *rank* may be of the type: *System admin, Supervisor, Engineer, Worker/end user* or *Manager*.

EPS.A1.S2 Engineer & Supervisor Section

The main fulfilled features in this section are: insertion and saving the input data, related to project based products, project planning based on experience/ predetermined completion deadlines, scheduling for the execution of all the product components, insertion of the facilities that are found in the PP.

EPS.A1.S2.1 is for introduction of individual projects corresponding to custom orders associated to products that could contain multiple subassemblies, and EPS.A1.S2.2 - for introduction of resources such as manufacturing facilities, processing equipment, to which may be assigned resources of human resources type, as presented in Fig. 2.

This section is one of the most important of EPS.A1, because by filling the attributes *Subassembly start date*, *Shift* and *Running Time*, the scheduling function for execution of subassembly is effectively made by the programmed algorithm.

In the *Running time* field, it is necessary to introduce the effective duration of the execution, which is determined based on: calculation formula, CAM simulation processing, or experience.

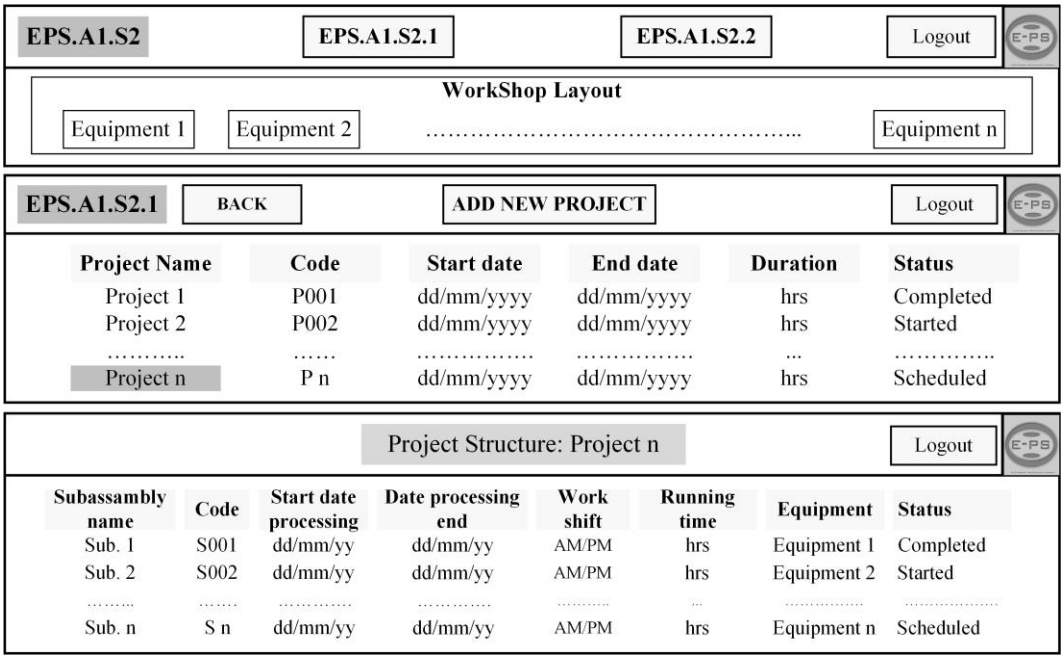


Fig. 2. EPS.A1.S2.1 Project Management submenu

EPS.A1.S2.2 *Facilities management* submenu is for inserting resources type of *equipment* and *assigned worker* into the system, as presented in Fig. 3.

An equipment can be programmed to perform inside of PP when a new subassembly is introduced into the system.

Activating one of the equipment tab, essential information about the status is displayed, such as info about the workpiece being processed and the next workpiece scheduled to be processed on the same equipment, as presented in Fig. 4.

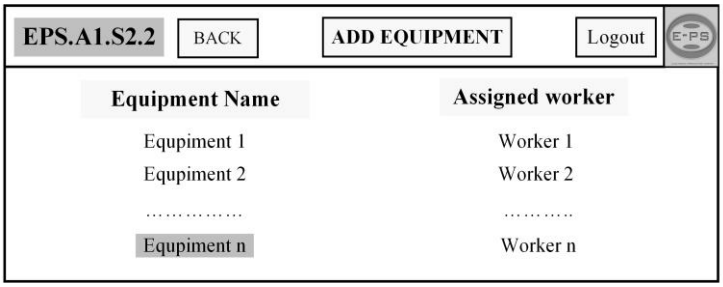


Fig. 3. EPS.A1.S2.2 Facilities Management submenu

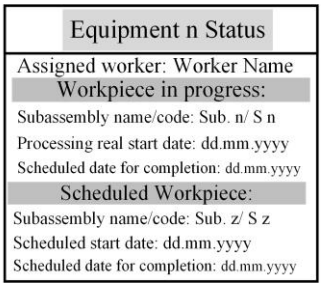


Fig. 4. Equipment Status

The EPS.A1 features for project planning, and also those for scheduling of the subassemblies inside the projects, are based on the FIFO method (First-in First-out). For EPS.A1, FIFO method is adapted as follows: the first project planned is first executed, and the first subassembly scheduled on equipment is the first started. For EPS.A1.S2 section, besides the basic functions, customized functions were created in order to check the manufacturing program to be lack of interferences between the subassemblies in execution and those scheduled.

The way of planning and scheduling can be customized by applying different prioritization strategies, e.g.: components of the project with the longest duration of execution, or elements that are necessary in the early stages for the assembly of finished product may be scheduled to be executed at first; if multiple element of the project must be executed on single equipment, the scheduling will be so that to avoid bottlenecks in the production flow.

EPS.A1.S3 Workers Section

This section addresses to users with the rank of workers, called also *end users*, as human resource in PP, representing operating personnel.

EPS.A1 is designed to run on a terminal near the workplace of *end users*, being networked in the intranet system of workshop. When they are login into the application, **EPS.A1.S3** section is instantly launched. The main display window consists of two parts, between these two active buttons are found, START and STOP, as depicted in Fig. 5. If the worker finds a scheduled subassembly, by pressing *START*, execution will begin.

By activating *STOP* button when the execution is finished, the present running subassembly is being updated in the database and its place is taken automatically by the next scheduled subassembly.

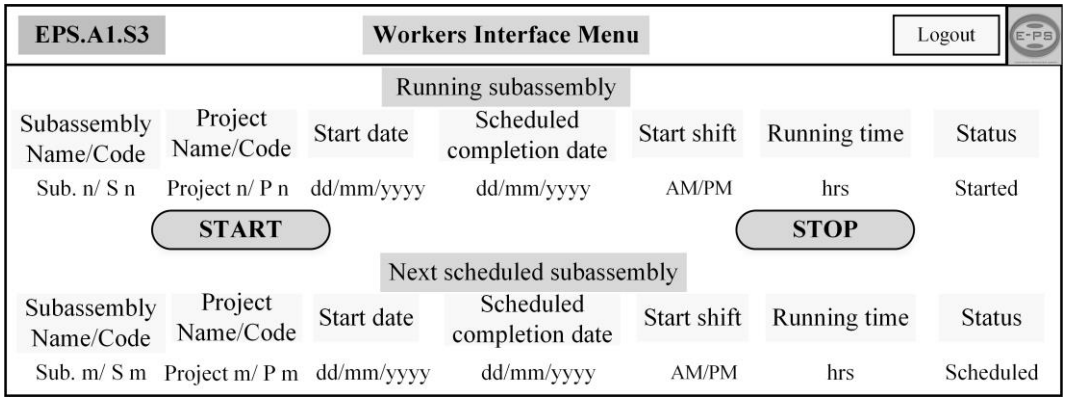


Fig. 5. EPS.A1.S3 Workers Section

EPS.A1.S4 Manager Section

This section is addressed to users with the rank of manager. The main function of the section is to verify, interrogate, update and generate all the information entered and processed in the system, related to the planned projects, in the form of reports, which are continuously updated.

EPS.A1.S4 is designed for: exposing the Workshop Layout with all equipment involved in PP, as in the case of EPS.A1.S2, to check the status of the production, etc. (Fig. 6).

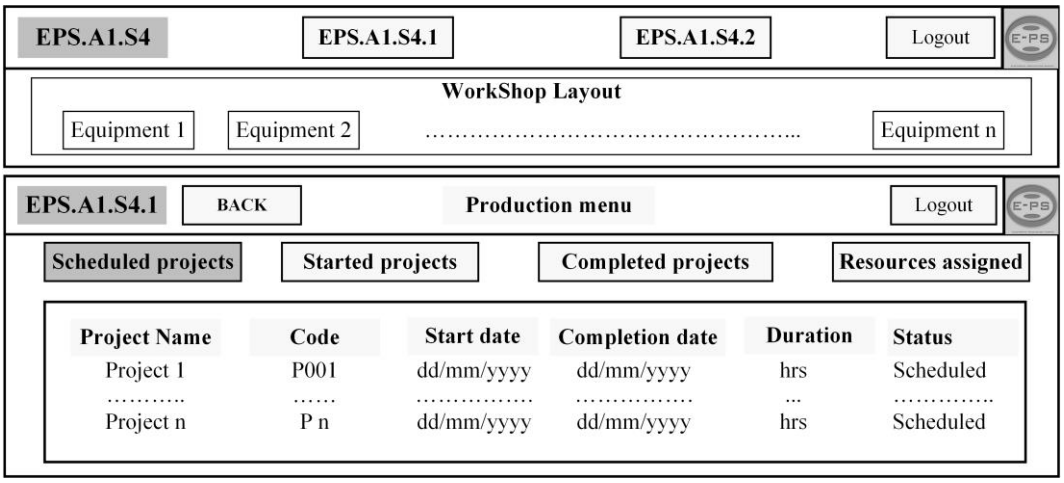


Fig. 6. EPS.S4 Manager Section

Special Remarks

In order to generate customized reports, the time terms must be introduced in the system.

All important production units are networked in an Intranet system.

For evaluating the system performance when PSC actions are performed with the help of EPS.A1, some of the most important performance indicators are considered: project planning and scheduling time (PST), daily program preparing time (DPT), manufacturing data collection time (MCT), reports elaboration time (RET), production rescheduling time (PRT), decision making time (DMT).

4. Case study

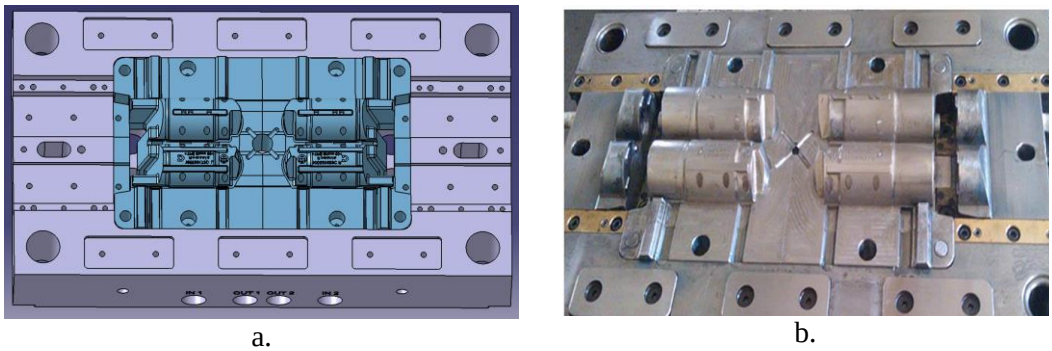
The case study was developed in real industrial conditions, in the framework of a Romanian tooling factory, based on data associated to a plastic injection mould and complex tool.

The input data are referring to the parts to be manufactured, as presented in Table 1.

Table 1

Project 1. Engine body shield RP200100				
Mould parts list			Manufacturing	
No.	Name	Code	Technological operation	Estimated duration, hrs
1	Core back plate	RP200100-5	CNC M-D/ R, F	24
2	Core side	RP200100-6	CNC M/ R, S, F	56
3	Slider core left	RP200100-8	EDM	24
4	Slider core right	RP200100-9	EDM	24
5	Cavity side	RP200100-10	CNC M/ R, S, F	48
Legend. CNC: Computerized Numerical Control, M: Milling, D: Drilling, EDM: Electrical Discharge Machining, R: Roughing, S: Semi-finishing, F: Finishing				

During the mould production, EPS.A1 was launched to track the technological operation for all 3D developed components. For exemplification, two parts from the project are presented in Fig. 7. a, b.



a. b.

Fig. 7. Core back plate and Core side parts: a - 3D models, b - machined parts

Project data registration

A new layout was created in EPS.A1.S2.2 based on the description of equipment from the workshop.

RP200100 project was added in EPS.A1.S2.1, and its components were inserted according to the data from Table 1, as presented in Fig. 8. *Subassembly start date* considers the global production planning and the equipment availability.

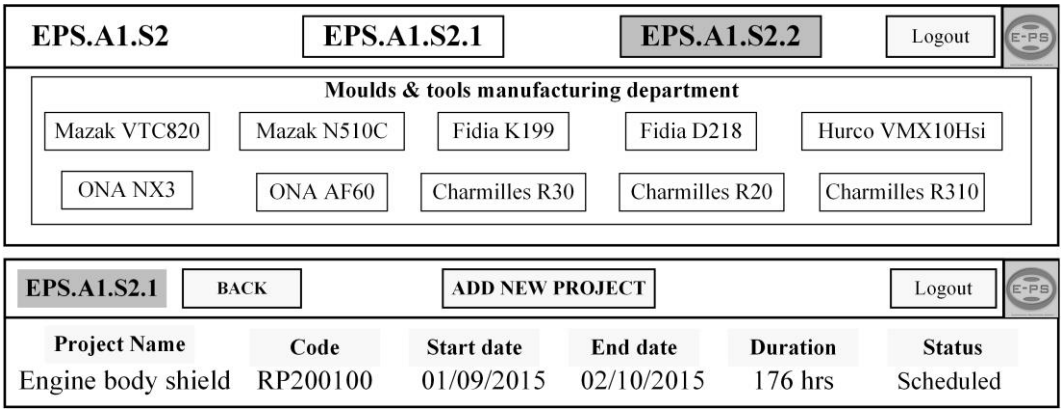


Fig. 8. Project data recording

Manufacturing data collection

Manufacturing data was automatically collected in real time, in EPS.A1.S3, after users with rank of workers pressed *START* at the beginning of a technological operation, and *STOP* at the end of the same operation.

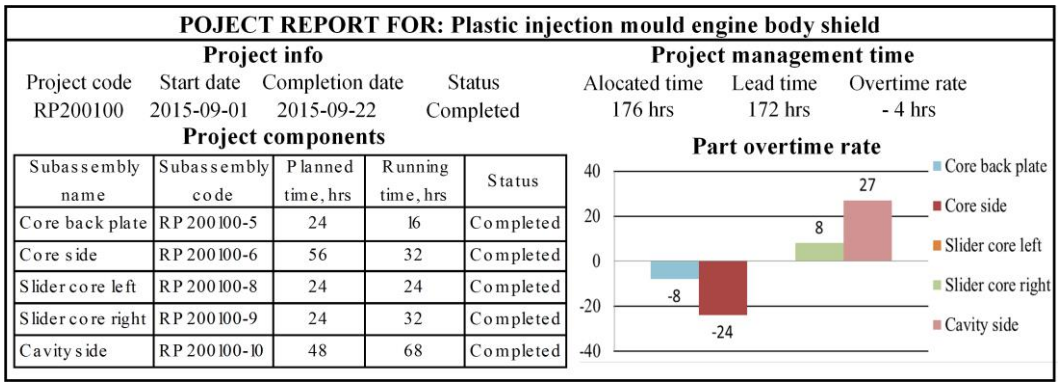
MySQL database of EPS.A1 was updated and saved the new info, as presented in Table 2.

Table2

Excerpt with updated info from EPS.A1 MySQL database				
Part Code	Status	Estimated duration, hrs	Lead time, hrs	Equipment
RP200100-5	Completed	24	16	FIDIA D218
RP200100-6	Completed	56	32	Mazak VTC820
RP200100-8	Completed	24	24	ONA NX3
RP200100-9	Scheduled	24	0	Charmilles R30
RP200100-10	Started	48	16	FIDIA K199

Reports generation

In order to track the subassemblies execution and project status, production running was checked several times in EPS.A1.S2.1, by users with the rank of supervisor and manager, manufacturing reports being generated in EPS.A1.S4 on completion of the last part, as presented in Fig. 9.



POJECT REPORT FOR: Plastic injection mould engine body shield

Project info

Project code	Start date	Completion date	Status
RP200100	2015-09-01	2015-09-22	Completed

Project management time

Alocated time	Lead time	Overtime rate
176 hrs	172 hrs	- 4 hrs

Project components

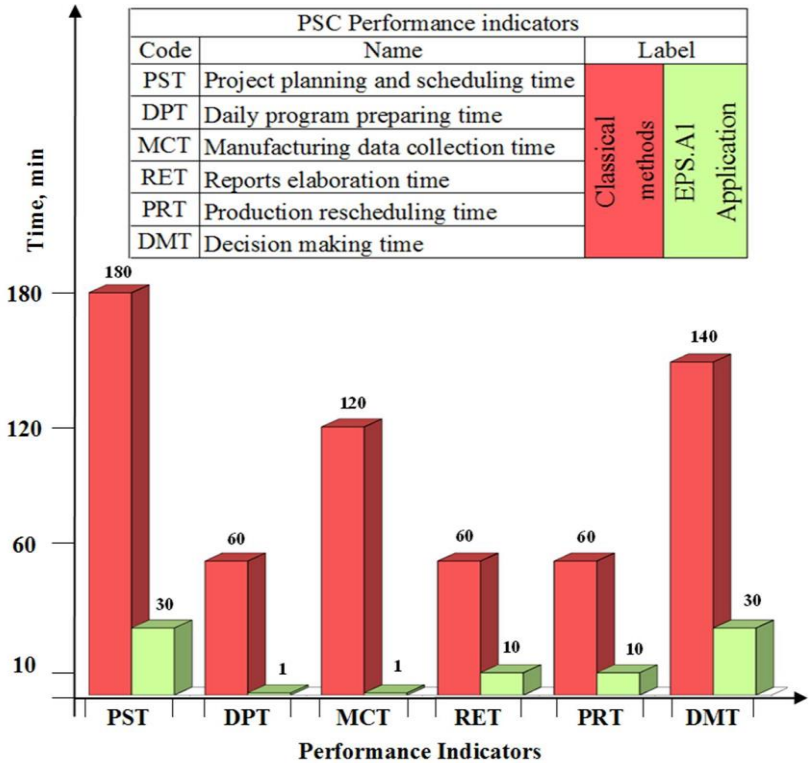
Subassembly name	Subassembly code	Planned time, hrs	Running time, hrs	Status
Core back plate	RP 200100-5	24	16	Completed
Core side	RP 200100-6	56	32	Completed
Slider core left	RP 200100-8	24	24	Completed
Slider core right	RP 200100-9	24	32	Completed
Cavity side	RP 200100-10	48	68	Completed

Fig. 9. Custom Report Generated by EPS.A1

EPS.A1 performance evaluation

Regarding the effective duration for PSC, following the completion of the project, relevant results were recorded and compared with others obtained in parallel with EPS.A1 by using classical methods, Gantt charts and surveillance sheets, as presented in Fig.10.

The results demonstrate the application utility of EPS.A1, as a powerful tool, in complex production processes management and overcapacity periods.



PSC Performance indicators		
Code	Name	Label
PST	Project planning and scheduling time	Classical methods / EPS.A1 Application
DPT	Daily program preparing time	
MCT	Manufacturing data collection time	
RET	Reports elaboration time	
PRT	Production rescheduling time	
DMT	Decision making time	

Fig. 10. PSC Performance indicators by classical methods and by EPS.A1

5. Conclusions

With the main goal to reduce the response time inside the production processes and to have a real time control for a better management of the manufacturing environment, a new web based application, Electronic Production Survey Application/ **EPS.A1,** has been developed and tested.

A case study is reported to demonstrate the feasibility and potential of the proposed method for PSC using EPS.A1, in real industrial conditions.

The new EPS.A1 application platform is a powerful tool for decision-making actions, in the customized products environment.

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R E F E R E N C E S

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