

# Make-to-order machining companies: applying project management to production planning

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**Abstract:** At machining factories operating in make-to-order environments, projects play an essential role, since they are the main product of such companies. Therefore, these companies must have an efficient management system, in order to meet their customers' tighter standards for cost, term and quality. This paper presents the implementation of a project management methodology for these companies, mainly for small and medium sized ones, with the purpose of reducing the overall length of its projects. The basic methodology of this work is the one developed by PMI® for general projects, but adapted to manufacturing project management. A practical implementation of the proposed method at a mid-sized company is herein presented. The analysis of the results revealed significant improvement in the company's processes and consequently, in their performance indicators.

**Keywords:** project management, methodology, manufacturing resources planning.

## 1. Introduction

Despite the constant growth in the use of project management tools and practices (VARGAS, 2004), most national companies, mainly the small and medium sized ones, do not have an efficient control of their projects, including the ones that have projects as their major product. This fact is evidenced by a study carried out by the Rio de Janeiro section of PMI® in which 72% of the projects developed by the studied companies had their delivery term extended (PMI, 2003). Therefore, without efficient control of the way these resources are being allocated to the projects, we run the risk of wasting most of these resources in projects that will not bring the expected return, leaving aside other projects which, although less urgent, bring a much higher profitability. Moreover, a system for controlling projects can indicate delays in products delivery before they actually happen, thus improving their speed as well as their on-time delivery index - important competitive factors among service suppliers.

Within the group of companies above mentioned, the ones in the make-to-order manufacturing area usually face serious problems of idleness during their projects' lifecycle (FRANÇA de PAULA, 2001), that is, the productive time spent on the project is much lower than the waiting time, either on queues at production waiting for the resource to be available or for the conclusion of bureaucratic processes. Therefore, the main consequence for the company is the

low efficiency of project deliveries on time, which results in unhappy customers and loss of revenue for the company. (CLELAND; IRELAND, 2002; ELTON; ROE, 1998)

Traditionally, these companies are functionally organized where the organizational chart, despite clearly reflecting its hierarchy, communication channels, authorities and responsibilities, cannot show the organization as a dynamic system. In these cases, there is no clear definition of the added value chain of the company, including clients, products, work processes and collaborators. Such fact impairs the company's internal performance and affects its reliability in the view of customers.

The company studied here is medium-sized, and operates in the mechanical metal sector, rendering make-to-order parts milling and tooling services to world class companies. Therefore, it does not have one particular product and its productive process is structured according to customers' needs. Most of its customers are from the automotive, aeronautics and capital goods industries. The products ordered by these companies are classified as small and medium-sized, ranging from pins and screws to dies and engine shells.

Therefore, preparing to reach the customers' service standard means giving strong emphasis on the organization of internal processes and mainly in project management, so that the scheduled activities, whether manufacturing

tasks or not, meet the project requirements and thus, the customers' needs.

## 2. Theoretical fundamentals

### 2.1. History

Man manages projects since the beginning of our civilization, as evidenced by the pyramids in Egypt or the Great Wall in China (FRAME, 1995). However, project management in its current meaning had its origin just some decades ago. Around half a century ago the companies started to apply system tools and techniques for managing projects in complex undertakings. During the 50, 60 and 70s, the US Department of Defense, NASA and large engineering and building firms used the principles and tools from project management in their large scale projects (VERZUH, 2003). In the 80s manufacturing as well as software development sectors also started to adopt and implement sophisticated project management practices. However, it was just in the 90s that the theories, tools and techniques were widely adopted by several industries and organizations.

This growing demand for project management led to the creation in 1969 in the USA of an institute to deal with this specific issue, called Project Management Institute (PMI®). The PMI® consists in a professional non-profit association dedicated to the promotion and development of the state-of-the-art in project management. With more than 230,000 members in 160 countries (PMI, 2007), the PMI® is today the largest and most respected professional non-profit association for project management in the world (CLELAND; IRELAND, 2002). By gathering and systematizing the knowledge in this area, the PMI® could publish the PMBOK® (Project Management Body of Knowledge), which is currently the most known and used guide for project management worldwide. This manual splits the area of project management in nine knowledge areas: integration management, scope management, time management, costs management, quality management, communication management, risk management, human resources management and acquisition management (PMI, 2004).

### 2.2. Project

People deal with projects daily; some of them are more complex and some of them are quite simple, such as going to the supermarket or renovating the house. So, everybody manages projects in one way or another. According to Meredith and Mantel Jr. (2002), projects are characterized by some attributes:

- Purpose (or objective): the project is generally carried out only once with very well defined final results. It can be divided in sub-tasks that must be concluded for the project to reach its objectives;

- Life cycle: likewise organic entities, projects have a life cycle with defined dates for their beginning and end (this will be further discussed in item 2.1.3);
- Interdependence: There is a frequent interaction among projects that are being carried out within the same company. However, projects always interact with the continuous operations of the company which hosts it;
- Uniqueness: every project has some elements that are unique, and that is why two projects can be similar but never identical; and
- Conflict: inherent characteristic of a project, this is born from the necessity a project has to compete with the functional departments in order to acquire resources. In multi-project environments (various projects being carried out simultaneously), the projects compete among themselves for the resources they need, what leads to an even more serious problem.

Therefore, a project can be defined as a unique undertaking, characterized by a sequence of temporary activities, aiming at reaching a clear result, defined within the pre-established parameters for resources, time, cost and quality (MENEZES, 2001; PMI, 2004; KERZNER, 2001; WYSOCKI; MCGARY, 2003).

### 2.3. Project management

Starting a project has one basic purpose: to reach a clear and defined objective. Therefore, the reason for organizing this task as a project is to focus the responsibility for meeting the objectives on one person or small group, even if this person or group does not hold the authority that is consistent with its level of responsibility (MEREDITH; MANTEL Jr., 2002). However, laying the responsibility on one person can hardly help the project develop as there is a long way to reach the project objective. The person in charge of the project needs to know the techniques and skills for driving or managing projects efficiently.

Thus, we can define project management as the application of knowledge, skills, tools and techniques during the project life cycle in order to meet the needs and expectations from the project *Stakeholders* (PMI, 2004; HELMAN, 2003).

The project *Stakeholders* are individuals and organizations actively involved in it, or whose interests can be affected, negatively or positively, by the conclusion of the project, being able to influence its results (PMI, 2004; HELMAN, 2003). In a project for urbanizing a square, for instance, the involved parties range from the City Council that is carrying out the works, the neighbors around the place, and even the people who will walk around the renovated square.

## 3. Characterization of the problem

The sponsor of this study, mentioned here as simply the company case, noticed that its strategic customers were

more and more dissatisfied with the time of delivery of their orders. Despite having been certified by ISO 9001: 2000 in the end of 2003, this company, a supplier of made to order parts, could not meet the service requirements from its customers within the planned deadlines.

Through diagnostic questionnaires to the company management and further analysis of the results, which will be more deeply discussed later in this paper, the following assessment was made: 1) the average duration of the projects ranged from three weeks to two months, considering the conception, manufacturing and delivery phases (life cycle). However, the average period for the productive process demanded by the project was only three days, resulting in significant losses of productivity and revenue; 2) there was no specific methodology for the project management, with priority given to the customers that have a heavier influence on the turnover of the company, in detriment to the others; and 3) the tools used for the support to the productive process consisted only in control spreadsheets (static) and a databank with service orders (history). Those tools, however, were not integrated to the orders processes or helpful in the decision of starting/reprogramming the production.

#### 4. Objective

The main objective of this study is the increase in satisfaction levels of customers from the studied company through the improvement of the time of delivery levels of their projects. And to do so, this paper presents the implementation of a project management method that aims at reducing the cycle time or lifecycle of projects in make-to-order companies from the manufacturing sector. Moreover, the developed method is expected to be simple, easy to be understood by the company that is implementing it and with low costs.

#### 5. Proposed method

The companies that are the object of this study have as their main product make-to-order manufacturing projects. These projects have very specific characteristics which are similar to each other. Among them, we can mention the most relevant ones for the development of the method proposed herein:

- Several projects being carried out simultaneously;
- Relatively short projects with similarities among them;
- Projects involving manufacturing activities mainly;
- The cost of each project is not high;
- Quality is controlled mainly for the product (tolerances, etc...);
- The project team is often formed by machine operators, technicians and engineers who control the production;
- The main acquisitions consist in raw material and

tools for the manufacturing of products; and

- Projects competing for limited resources.

The characteristics of these types of projects make their management more difficult than conventional projects, mainly due to the fact that there are several short projects running simultaneously. However, the similarity among them is an advantage that enables the development of standards for their management.

The proposed model tries to cover all the areas of knowledge in project management, but it eliminates items that are not useful for the type of project that is the focus of this paper. The developed method in this study is structured in the following way:

- Proposal: processes related to the receipt of proposals and projects initiation, including feasibility analysis;
- Planning: processes that configure the best ways to carry out the project with maximum efficiency;
- Execution: processes related to product manufacturing and delivery;
- Control: processes that accomplish the project progress monitoring; and
- Closing: dealing with the projection completion.

The model construction was based on the project management methodology from PMI®. Therefore, it takes into consideration the steps proposed by the PMBOK® for general project management. However, changes were made in order to adjust the processes to the management of projects in a manufacturing environment. The flowchart of the proposed model can be seen in Figure 1 below.

#### 6. Implementation

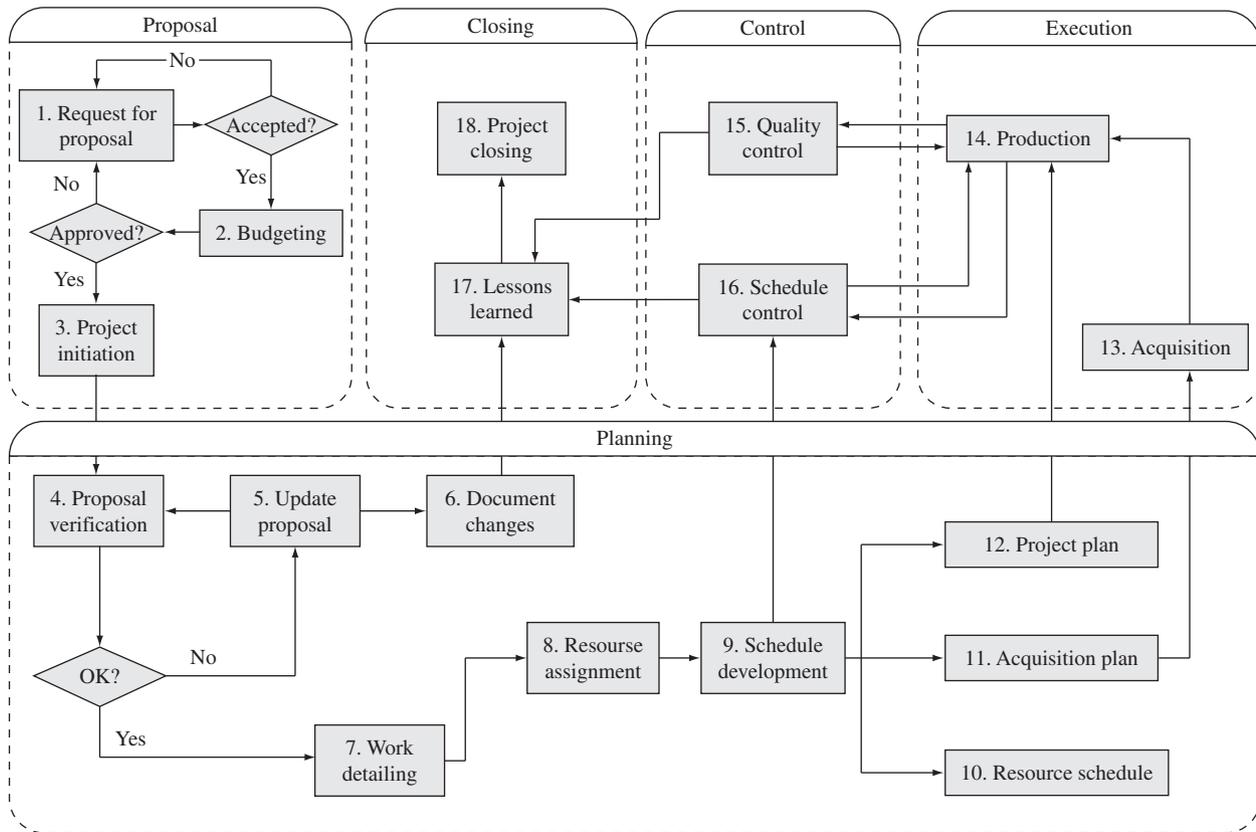
For a successful implementation of the method presented in the previous section, some steps had to be taken, as we can see in the flowchart in Figure 2. The details of each step are described in the following items.

##### 6.1. Current situation analysis

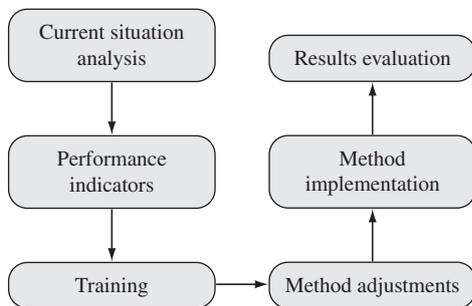
The current situation analysis or diagnosis must be carried out so as to check the real needs of the company that is implementing the method. A map must be drawn showing the way the company is operating in order for the problems and areas for improvement to be detected. In this phase the following activities were developed: visits to the company case, preparation of the evaluation questionnaire, interviews and data collection as well as collected data analysis. Table 1 below summarizes the data collected in this phase.

##### 6.2. Performance indicators

Attributing performance indicators is very important for a future analysis of the benefits brought by the method implementation. Table 2 shows the used indicators, their calculation method and a brief description of their purpose.



**Figure 1.** Flowchart of the proposed project management method.



**Figure 2.** Flowchart for the implementation of the presented method.

Some of these indicators were already being used by the company case but some had to be adopted.

### 6.3. Training

The training aims at leveling knowledge both for the ones who participate directly in the method implementation project and the ones who will suffer the consequences of this implementation. The objective is to reduce the resistance against changes through the promotion of awareness of the

company's needs and the benefits brought by the changes to people's work.

At the company case two training modules were given, the first to the board of directors and people who would not work directly with project management, aiming at highlighting the importance of a work methodology. The topics covered in this training module were: projects general features, project management processes, importance and methodologies for project management. The second training was given to the people directly involved in the projects. Besides the topics covered in the first training module they also had more advanced issues related to project management as well as tools used in the projects.

### 6.4. Method adjustment

The objective of the method adjustment is to structure it based on the company's needs as there are differences among make-to-order manufacturing companies, mainly in what concerns the number and length of the projects. Therefore, the method needs to be adjusted to the company reality, as this can increase the chances of success in its implementation.

At the company case, the method adjustment was highly important, as some aspects were specific to their projects.

**Table 1.** Summary of the analysis carried out with the data from the data collection and interviews phase.

Projects average length	• Product manufacturing only: 30 days;
Procedure or system for project management	• Procedure adapted in each item
Tools currently used for the project development or follow-up	• Database in Microsoft Access
Success indexes in the projects	• Cost: 90%; • Term: 50%; • Quality: 95%; • Scope: 75%; and • Customers' satisfaction: 80%.
Person in charge of the project	• Manufacturing manager
Learnt lessons recording	• No recording in any phase of the project
Major products	• Make-to-order machining of parts generally composed of one single piece

**Table 2.** Performance indicators of the company case.

Indicator	Description	Calculation
Fulfillment of project cost	Percentage of projects that were within the estimated cost	Projects within cost/total number of projects
Fulfillment of project deadline	Percentage of projects that met the initial deadline	Projects within deadline/ total number of projects
Fulfillment of planned scope	Percentage of projects that could fulfill the agreed scope	Projects within scope/total number of projects
Customers' satisfaction	Percentage of projects that received positive assessment from the customers	Customer's good or excellent assessment/total number of projects
Product quality	Percentage of projects that met the product quality requirements	(total number of projects – projects with complaints)/total number of projects

One of the most important aspects is related to the products manufactured by the company, usually made of just one piece without the need of further assembly. Another aspect is concerned with the length of the projects, as they usually do not exceed two months, from closing the agreement to the customer's final acceptance.

### 6.5. Method implementation

After the preparation described in the previous steps, the implementation of the method proposed in Figure 1 was initiated and the best way to implement it was to apply the phases according to the company's needs.

In the proposal phase the budget calculation was restructured. Some projects were "forgotten" or not duly prioritized, having the purchase of raw material or tools, for instance, been carried out just when the project became critical, with less than one week for the product delivery. Based on that, a process for project opening was adopted in order to work as a "bridge" between the commercial department and the beginning of production (process preparation and request of raw material, tools, devices, etc...).

By doing so the necessary tools were gradually implemented to better control the company's projects, such as the production management through queues for the resources; schedules for the projects; tables with daily allocation of resources used in the products manufacturing;

techniques for the schedule control and recording of the lessons learnt during the project.

### 6.6. Results evaluation

The results of the proposed method were analyzed based on two aspects: adjustments and benefits to the company. The first item is more related to the application of the proposed method in an organizational perspective whereas the second studies the performance of the company after its implementation.

In order to analyze the adjustments made to the company, interviews were carried out with the ones more directly involved in the method implementation. The result of this inquiry is presented in Table 3, with answers that range from 'very low' to 'very high' levels. We can notice that the answers related to the method comprehension were in general "reasonable" due to the short period available for training, mainly for the ones who worked at CAD/CAM, what prevented them from a better understanding of the method. However, according to the employees of the company there was a significant improvement at the level of projects control, as this control was previously carried out through a daily report of the projects that should be delivered in the current and following week, without any specific methodology.

The indicators described earlier were used for the analysis of the company's results. Table 4 lists these indicators comparing the indexes before and after the method implementation. The indexes before applying the method are approximate values, as they were collected from the questionnaire answered by the company's board of directors, due to lack of data records. The most significant improvement happened in the index related to the fulfillment of project deadlines, which rose from 50% to 76.6%, mainly due to the better planning and control of the projects promoted by the employed analytical methods. We also have the index for customers' satisfaction, which rose by 15.5% due to the increase in the index for the fulfillment of project deadline.

## 7. Conclusions

The manufacturing projects discussed in this paper require a management methodology that can meet the needs of the companies that sponsor it. Such needs include a tighter control of the projects, the structuring of the orders management process and the development of standards that make the management easier and more agile.

Therefore, by meeting the requirements mentioned above, it was possible to achieve the main objective, which is to adapt an existing methodology and propose a project management method for the reduction of the project lifecycle in make-to-order companies from the manufacturing sector. The performance indicators of the company case monitored

**Table 3.** Interviews results.

Aspect	Answer
Easy comprehension	Reasonable
Employees' acceptance	High
Implementation costs	Low
Significant improvements in the company	High
Improvement in the projects' level of control	Very high

**Table 4.** Company's quantified results.

Indicator	Index before method implementation	Index after method implementation
Fulfillment of project cost	90%	88.3%
Fulfillment of project deadline	50%	76.6%
Fulfillment of planned scope	75%	86.8%
Customers' satisfaction	80%	92.1%
Product quality	95%	94.6%

in this study, in order to show the results obtained, revealed significant improvement when compared to the figures collected before the method implementation. The indicator related to the fulfillment of project deadline rose from 50% to 76.6% of projects without delays, due to the creation of a system for project management activities and to the definition of a clear and standardized information flow system. It is believed that this fact is the main reason for the increase in customers' satisfaction index, from around 80% to 92.1%, a difference of more than 15%.

It is important to highlight that the implementation of a method alone, without adequate training and adjustments, may lead the company to the opposite direction than the objective proposed in this paper. It is also worth to mention that, for the implementation of this method, there is very little need of computing resources. This is convenient for small and medium-sized companies that do not have a large amount of resources.

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