Reduction of Input to Output Process Time for CFD Processes

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Abstract

The Aerodynamics Department of the company Infotech Aerospace Services had been experiencing large time delays in one of the processes due to a lack of resources, in this case trained personnel which could process the amount of client requests. The specific process was the geometry manipulation and mesh generation steps which are the first two processes required in order to proceed to Computational Fluid Dynamics (CFD) process, which would provide internal or external aircraft engine analyses. The process required that improvements would be implemented in order to reduce the amount of delays that the process was experimenting, as clients were expressing their concerns since the delivery of results were taking more time than expected. Data was collected and it was determined that there was a need for multiple employees to be trained in order to perform the defined tasks. Training costs had to be considered when determining to either provide an external or internal training procedure. Once the trainings were provided and the new requests were distributed among the trained employees, a significant reduction in the process start delays, and therefore, a reduction in client costs was observed.

Introduction

In any modern day industry, the reduction of the time that any process takes is a critical aspect that affects positively the cost of any task being performed. The selected process to be analyzed corresponds to one very important part within the aerospace industry, more specifically, related to the engine development stages. The process corresponds to the Aerodynamics Department within the company Infotech Aerospace Services, located in Isabela, Puerto Rico. The company was established in 2003 with the purpose of providing high quality engineering services to the Aerospace Industry at an affordable rate.

The Aerodynamics Department had been experiencing large time delays due to constraints in employee availability for the geometry manipulation and mesh generation processes. These delays had increased the costs associated with waste time, which is equal to wait time. The objective of the analysis was to reduce the process time it takes from the moment the customer sends the geometry, the input, until the moment that the corresponding mesh is completed, the output, and provided to the Computational Fluid Dynamics (CFD) expert which will use that mesh to setup and run the CFD case. It should be noted that due to the nature of the company, real data is restricted, therefore, the used data is not actual process data.

Objective

- Reduce the process time it takes from the moment the customer input, the geometry, until the moment that the output, the generated mesh is provided to the CFD expert.

Process Workflow

The diagram in Figure 1 shows how the process workflow was defined. This project analyzes the Computer-Aided Design (CAD) Process.

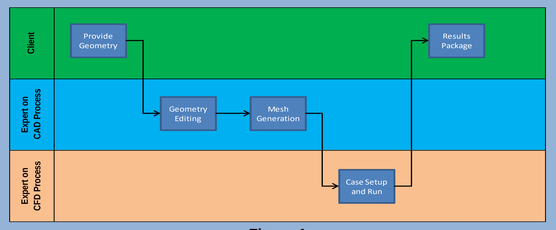

Figure 1
Workflow Diagram

Analysis of Recollected Data

The Aerodynamics Department started with a small group of experts, out of which only one employee was trained to be an expert on geometry modification as well as on the mesh generation process. As the CFD expertise increased, the amount of requests being received also incremented but created a problem in the process since the only CAD/meshing expert available couldn't provide all the necessary support to the projects. Tasks began to encounter large delays due to wait time, which eventually caused delivery delays of results to the clients. These wait times have costs that are not considered when the projects are quoted since the processes are expected to be continuous. In order to calculate the delay costs, the data was recollected for a period of three months. The amount of delayed tasks that were recorded during the selected period of time was twenty-seven tasks. The hourly rate charged to these tasks was $46. Table 1 shows the results for the total time, average delay time per task, and the total cost related to the delayed tasks. These results were obtained when taking the time from the moment the task was assigned until the task was started by the CAD expert. Figure 2 shows a graph of the recorded delay time per task. Figure 3 shows a graph of the costs corresponding to the delay time that were recorded in each task.

When observing and analyzing the data, it was determined that the costs directly associated with the delay in the beginning of each task were too much to be acceptable. The delay times by itself were also too much since those delays caused projects to be delivered later than expected. Mainly because unexpected problems during later stages of the process were causing that the overall delay times would be of a couple of days, if not even a week or more in certain cases. These delays were putting projects at risk because if a customer encountered a delay issue, then he or she would not be confident in sending future work to the department.

Table 1
Delay Time and Cost for Data of Original Process

Total Delay Time (hours)	323
Average Delay Time (hours)	12
Total Delay Time Cost	$14,858

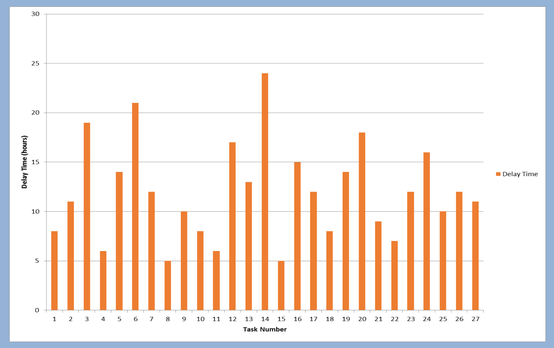

Figure 2
Delay Time per Task for Original Process

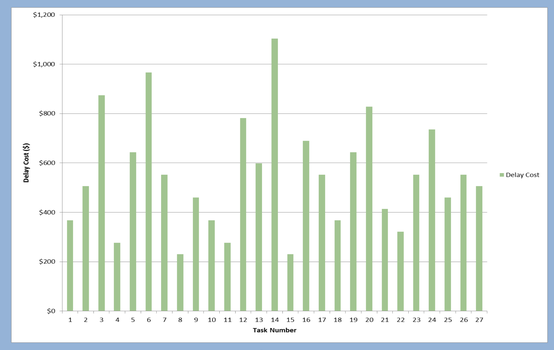

Figure 3
Delay Time per Task for Original Process

Results for Original Process

Utilizing the Root Cause Analysis (RCA) process, the results concluded that the principal cause of the delay issue was the lack of specialists available within the department that could tackle the geometry modifications and mesh generation processes as soon as the client provided the inputs. It was determined that in order to assess the delay issues, the best course of action would be to train several other employees to become CAD experts and therefore, expanding the available resources that could work with the geometries and meshes that the clients requested.

Due to the amount of work being received, it was determined that the necessary amount of employees to be trained would have to be five. In order to provide training, two options were selected to be analyzed. The first option was to have an external expert be brought to the company in order to provide a three days training course. The second option would be to perform an on the job training, which would mean to have the current CAD expert in the department to teach the employees as they worked on the new tasks.

After careful consideration, it was determined that the option of on the job training would be the best option on how to teach the employees since it reduced significantly the direct and indirect costs and possible issues with several clients.

Results After New Process Implementation

Once the employees were trained and they were working on the geometry modification and mesh generation process, data was collected for an equal period of three months in order to have a good comparison. The amount of tasks that were documented as having a process delay where twelve. The results for the data collected after the implementation of the new process can be observed in Table 2.

When comparing the data that was recollected when there was only one CAD expert versus the data recollected after the employees were trained and became experts, which now summed a total of six employees, it can be observed that the total delay time was reduced from 323 to 9.8 hours. The average delay time was of just 0.8 hour versus 12 hours for the first set of data. The total delay time costs were largely reduced from nearly $15,000 to just $451.

Figure 4 shows the reduction in tasks as well as the reduction in delay time per task. Figure 5 shows the reduction in the costs due to waste (delay) time after the new process was implemented. This reduction in the quantity of delays, delay time, and costs are evidence that the analysis and implementation of the process improvement worked as intended.

Table 2
Delay Time and Cost for Data of Improved Process

Total Delay Time (hours)	9.8
Average Delay Time (hours)	0.8
Total Delay Time Cost	$451

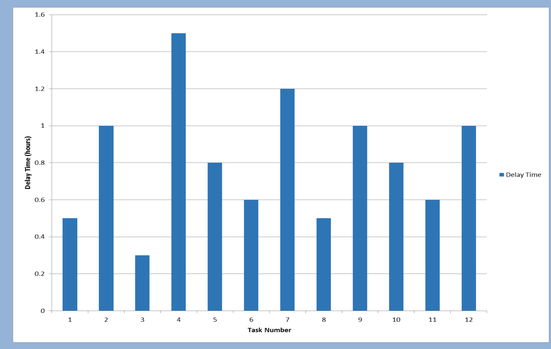

Figure 4
Delay Time per Task for New Process

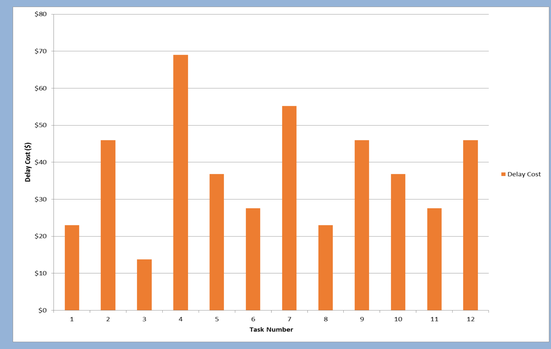

Figure 5
Delay Time per Task for New Process

Conclusion

In every process, whether it's design, testing or manufacturing, the reduction in waste, meaning, the reduction in the time that the process takes to be completed, is extremely important. This reduction has the effect of optimizing the process by shortening the time it takes to be completed which simultaneously helps reduce costs associated either with manpower, electricity, or others. Each process is different and in order to reduce time and costs, a process may require either a different program, possibly a different machine, or, like in the analyzed process, an increase in the amount of trained employees necessary to complete similar processes simultaneously. In every situation, there may be several methods to be considered since in most cases there must be costs to be taken into consideration. The process that was selected, analyzed and finally improved, required training to be provided to multiple employees and the costs associated with it had a large weight when determining how to perform the training. Improving process efficiency requires that multiple steps are implemented in order to achieve the desired results and this process results showed that the correct steps were performed.