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.*

Key Terms *—Client; Geometry; Mesh; Waste.*

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.

LITERATURE

In the aerospace industry, product development and the transition of new technologies through design and testing to production involve numerous processes and practices. All follow a very strict process of analysis and many are dependent on sophisticated equipment and facilities [1]. During the design and part of the testing phases of development, these analyses are performed, primarily, through the use of computer software. The multiple software used provide tools that drastically reduce the costs associated with these stages of development and testing of every part of the aircraft. Quality controls are defined and maintained using quality management systems like Six Sigma and AS9100 [2]. The industry has invested extensively in these systems in order to comply with Federal Aviation regulations.

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. At first, many of the clients provided the geometries that had already been modified in order to pass directly to the mesh generation. However, with the increase of CFD expertise, many new clients suggested and/or requested that the entire process, starting with the geometry modifications, were to be performed locally. Figure 1 shows a diagram of how the process workflow was defined.

This request created a problem in the process since a single person 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 mainly 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, only taking in consideration the tasks that had a wait time, or delay, for the geometry or mesh generation process. The amount of 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.

Table 1
Delay Time and Cost for Total Data of Original Process

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

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 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.

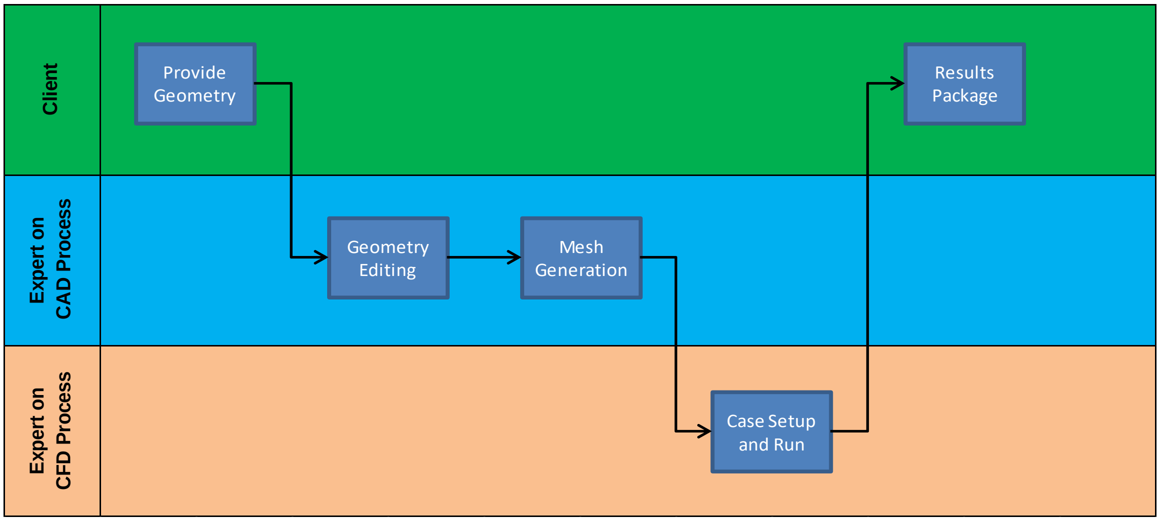

Figure 1
Workflow Diagram

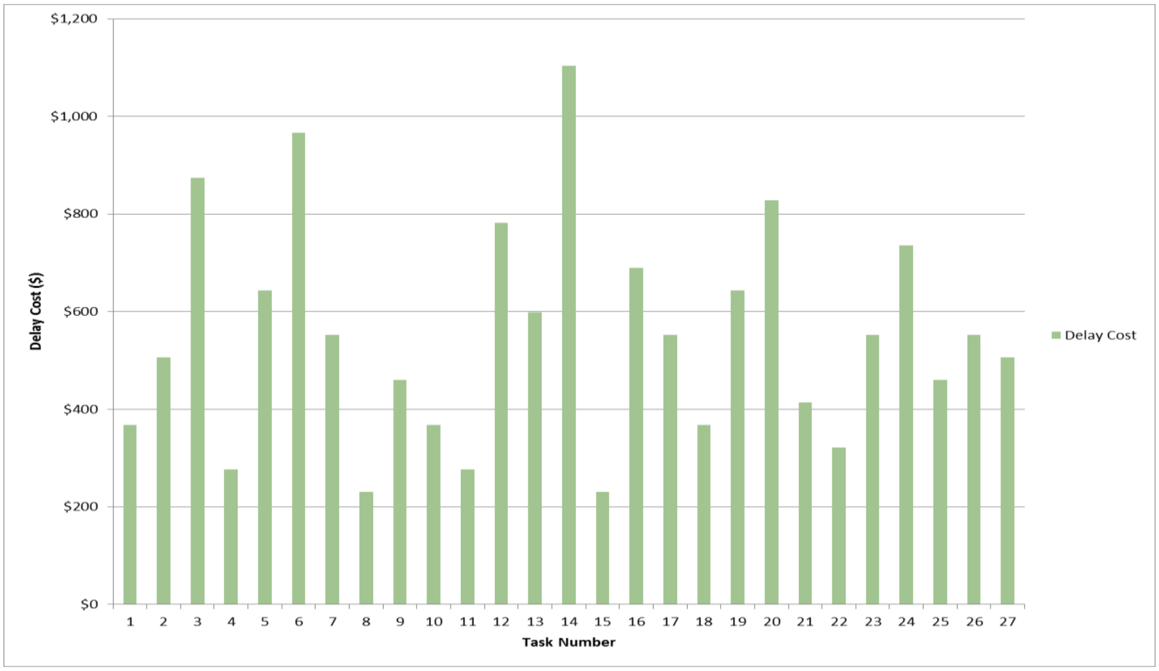

Figure 2
Delay Cost per Task for Original Process

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RESULTS

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. The solution to the problem was not difficult. 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. Once the quantity of new resources was established, the decision to make was how these employees would be trained. 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. However, this option presented several costs issues since first, the cost of training was estimated at $3,000 per employee. Another unfavorable situation was that each employee would be unavailable to work on any of their current tasks since the trainings would take approximately eight hours per day. This would mean that the current projects being worked by those employees would encounter a delay of three days which wouldn’t be seen as necessary by the clients since they expect current projects to be worked on daily and as necessary. 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. At first the projects would have some delay since the work wouldn't be completed as fast but on the other hand there would be a person working the tasks since the moment they arrived and not just waiting to be worked on.

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.

Table 2
Delay Time and Cost for Total Data of Improved Process

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

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

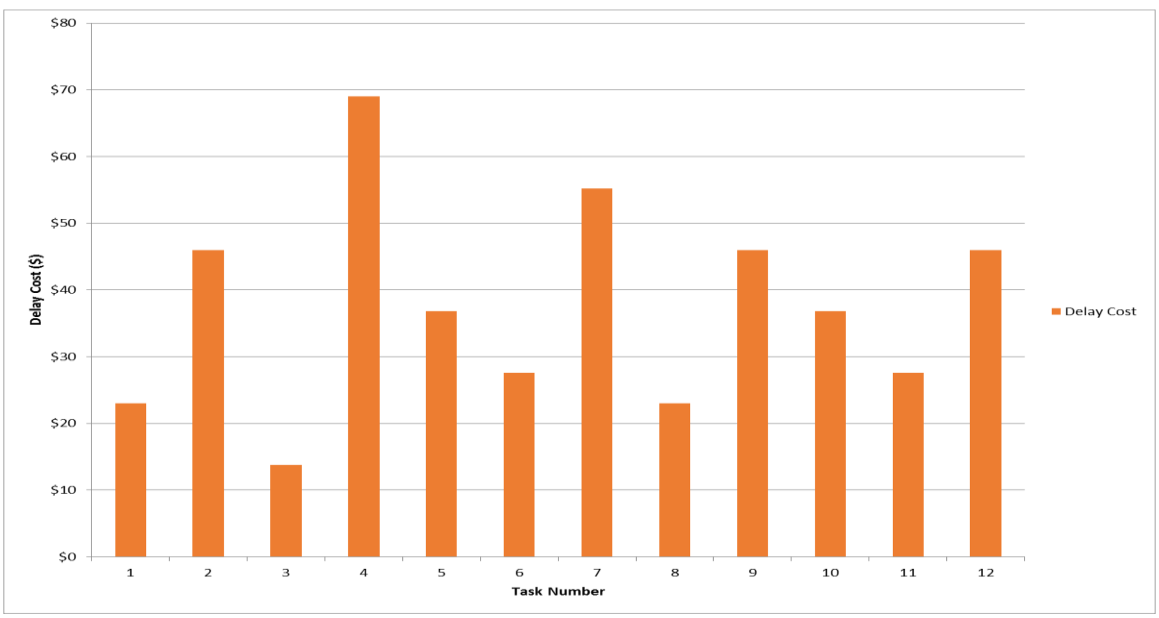

Figure 3
Delay Cost per Task for New Process

CONCLUSIONS

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.

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