Optimizing Workflow with Reduction of Reworks to Models and Drawings

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Abstract

This study delves into aerospace design rework challenges, focusing on Collins Aerospace. Analyzing 280 change notices, it pinpoints notes and Geometric Dimensioning and Tolerancing (GD&T) as key rework origins. Structured communication via pre- and post-task meetings, combined with training and checklists, mitigate confusion and improves attention to detail. Additionally, investing in training programs covering redlines creation and the ASME Y14.5 GD&T standard, along with providing comprehensive checklists, proved instrumental in enhancing the accuracy and completeness of design submissions, ultimately resulting for the reduction of reworks instances.

Introduction

In the aerospace industry, the design phase of a project tends to be a long process due to different factors that can impact the timely completion of deliverables. A typical design process workflow at Collins Aerospace involves collaborating with stakeholders from other disciplines to incorporate changes in model requirements, review standardization procedures, acquire checker verification and feedback, complete a verification review board process to ensure quality and submit change management validations. After completing the review board process, the design will be presented to the client for feedback, and they will inform if the design meets their requirements. If not, the project may be sent back to the designer for rework and pass through the same process as before.

Problem Statement

Reworks are part of the design process and are expected as part of the project. Nevertheless, too many reworks consume additional time, which could impact project deadlines for the design phase and increase costs.

One reason for which a design is sent back for rework is if the manufacturing personnel finds that the drawing does not comply with their requirements. For example, a drawing could be requested if the Geometric Tolerance and Dimensioning (GD&T) used for the model is a previous version or if the drawing is over-defined and this must have less and simpler GD&T due to available resources, such as lack of technical knowledge or machinery limitations.

Effective communication and clear instructions are key factors when working in the design area. When these factors fail, it can be another cause for reworks. For instance, if instructions are not clearly stated in writing, it increases the probability that the designer could have doubts or confusion regarding requirements. Redlines marked to specify the exact location of instructions for a drawing are often created to avoid miscommunications. Outdated or incorrect redlines can also be a cause for additional reworks.

Objectives

The purpose of the project was to determine the causes of reworks occurring during the design phase of a project.

- Minimize the number of reworks that occur for a project.
- Decrease costs due to excessive reworks by minimizing the risk of not complying with established deadlines.

Background

This paper delves into important topics for designers in the aerospace industry, including PTC Windchill Product Lifecycle Management, redlines, Geometric Dimensioning and Tolerancing, Export Control Classification Number, Bill of Materials, and PLM Part Structure. A comprehensive understanding of these subjects is vital for effective performance within the aerospace sector.

Product Lifecycle Management (PLM) is a strategic process that controls a product lifecycle from the initiation, development, and release of the product. PLM software provides a digital thread for delivering the work requested while also making it easier to track and share data throughout the process. This data shows the continuity in which a model and/or drawing went through. PTC Windchill is a specific type of PLM software where work requests, also known as change notices, are acquire and managed. For the design phase of PTC Windchill PLM, a change notice will be created before any new models or changes to existing released designs. A change notice provides important information such as:

- Date Requested
- Work Breakdown Structure (WBS) number
- Deadlines for change
- Change instruction
- Status of change
- Priority of change

After completing the change notice, it will go through the process of change management for the release and completion of the change notice. If the change management team notices that the change is not correctly updated or additional adjustments are needed, then the change will become a rework, having the word rework in the title.

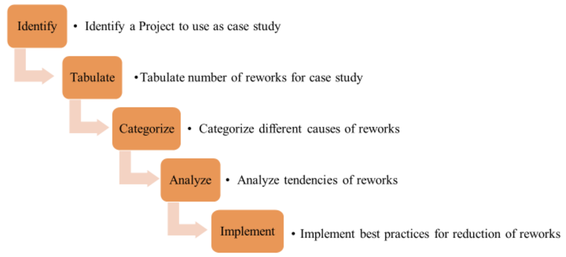
Designers often receive instructions to perform certain tasks, and many times, these instructions arrive as redlines. A redline is a document in which existing models and/or drawings are updated with new instructions in the form of a red line, crossing out the change that needs to be made. This document is given to the designer, and if, during the process, new changes need to be made, the redline is updated, providing the new update using another color to differentiate the original redline from the new instructions.

U.S. Export Control laws establish that any commodities, software, and technology exported must have an Export Control Classification Number (ECCN), which is an example of reworks. The classification number will depend on the item for which the ECCN is being created, which category it will be assigned, and the product group. The aerospace industry falls under a specific category, it may have a different product group. These ECCNs for technical data must be presented in any drawings which are created for any product that is in development and created.

The Bill of Materials (BOM) is a list that should provide information regarding which sub-assemblies and parts are being used for a specific model. It should include the quantities for each part and associate any note which is used for the creation of an assembly model.

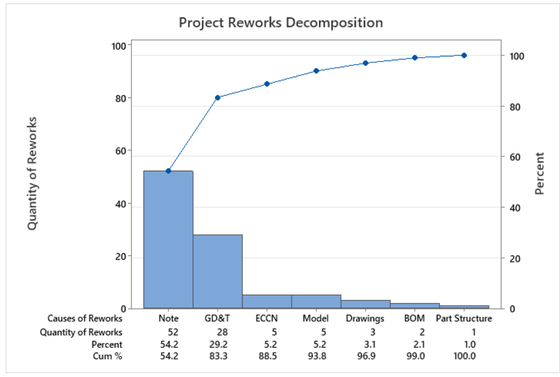
The PLM can provide logistic information for an assembly model and send this to another software such as SAP. For example, in an assembly that is composed of 20 parts, every part number and quantity that compose this assembly should be documented as a BOM, but within the PLM software.

Methodology



Results and Discussion

The case study provided had a total of 280 change notices, of which 63 were reworks. Some reworks had multiple causes. These were counted as multiple, being the case if these reworks applied for two categories or more. The graph below demonstrate the distribution of the total 96 causes.



Seeing as how approximately 83.3% of reworks fell under two categories (Note and GD&T) and analyzing reasons for occurrences, some of the best practices identified were:

- Add a step to the process lifecycle in which the designer and creator of redline met and discussed the changes to implement them before working on the task given. This helped ensure that instructions were clear, doubts were clarified, and if, during the discussion, additional changes arise, then the redline may have been updated to include this.
- Add a step to the process lifecycle in which the designer, checker, and creator of redline met after completing the change to discuss these before sending them to change management for revision. This provided the opportunity to confirm that no additional changes needed to be made and that no details of the task given were missing.
- Provide training in redline creation and ASME Y14.5 GD&T standard to identify best practices when implementing the creation of change notice.
- Create a checklist for the designer and checker to use as a guide when completing a task. This allowed for small details, such as the ECCN, to be verified.

Conclusions

This study delved into the intricate challenges faced during the design phase in the aerospace industry, focusing particularly on the rework processes at Collins Aerospace. After the examination of 280 change notices, it was evident that a significant percentage of reworks stemmed from issues related to Notes and Geometric Dimensioning and Tolerancing. The findings have not only pinpointed the primary culprits but have also proposed practical solutions to mitigate these challenges. Establishing clear lines of communication through structured meetings among designers, checkers, and creators of redlines have emerged as a pivotal strategy. These interactions, both prior to and after task execution, ensured clarity, eliminated doubts, and facilitated thorough discussions, minimizing the likelihood of miscommunication or missed details. Furthermore, investing in training initiatives encompassing redline creation and the ASME Y14.5 GD&T standard, and providing comprehensive checklists for designers and checkers, emerged as valuable tools. These resources serve as guides, ensuring meticulous attention to details such as ECCN verification, ultimately enhancing the accuracy and completeness of the design submissions.

Future Work

In future research, analyzing the impact of implementing best practices on improvement rates is essential. Additionally, investigating changes in existing rework categories and identifying new ones will provide insights into process and project-related factors.

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