Case Study

Using Rejection Codes in Windchill to Improve Quality of Engineering Design
April 2018

Executive Summary

Industry standards for Quality Management Systems (QMS) such as ISO 9001 and AS9100 necessitate that operational activities be discretely tracked, measured, and trended to provide an informed basis to continually improve quality. Engineering design and development activities included. Measurement of engineering quality is accomplished through a review and validation process, such as a design review. When engineering was performed on drafting tables, reviews were performed by simply redlining or marking up drawings. With the dawn of the digital age, the engineering design review process has become a digitally automated process within a Product LifeCycle Management (PLM) system, such as PTC Windchill, enabling its activities to become easily measurable.

Conducting design reviews digitally offers many benefits, such as parallel review stages instead of serial review when utilizing a physical drawing, but more importantly it allows for better achievement of the principles and requirements of a compliant QMS. The review process of the engineering data can now be better performed, traced, and improved based on objective, quantifiable feedback. With the PLM system, we can automatically track critical information such as timestamps, workflow status, approvals, all while maintaining a full audit trail, including any changes—approved or not. By applying minor configurations to the workflow process, we pave the foundation to capture robust metrics and key performance indicators (KPIs) which empower you with informed decisions, thereby driving an enhanced level of quality in your business.

Elite Engineering Services is an AS9100 certified organization using Windchill PDMLink to manage its engineering data. By managing the data in Windchill, Elite is able to meet the various requirements for AS9100 and IAO 9001, as well as ITAR restrictions. By instituting a digital review process, the engineering design and validation process is accomplished, but Elite wanted to go further than that, and truly gain metrics on its engineering quality in order to drive further improvement.

When trying to improve upon a process, it is prudent to consider the current state as well as the history. In the case of engineering design review, this begins with the concept of redlining. A drafter would make a drawing on the drafting table which would be reviewed by someone else. To make corrections and suggestions more obvious, a different color would be used. Hence, the concept of marking up a drawing is referred to as redlining. Having this other reviewer helps to improve the quality of the drawing. As engineering has gotten more complex it is considered best practice for multiple people to review drawings, each one bringing a different area of expertise. The initial reviewer might be a fellow drafter to make sure that the drawing followed basic drafting standards. Other reviewers would be dependent on the type of product being designed but could include someone with expertise in materials, manufacturing processes, regulatory affairs, or resource planning. Because there is only a single drawing, each person must finish their review before the next person can begin.

The modern world relies on global supply chains and most companies do not have all their resources in a single location. This would make reviewing a physical drawing very challenging if the necessary reviewers are dispersed around the globe. All of this is solved with the digital review and validation process. Multiple reviewers can validate the design concurrently, regardless of their location. For this reason alone, it seems unfathomable why any company would still print out their drawing for review.

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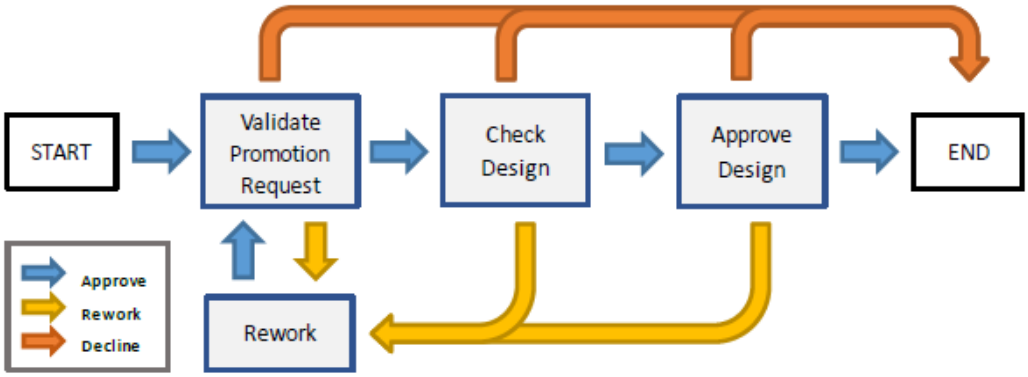
Printing a drawing for design review and relying on the physical copy introduces a potentially serious problem of data integrity. There can only be one source of truth, and now the physical copy and digital copy may or may not align. Performing review like this is risky and inefficient, but also represents a loss of opportunity. Performing the review digitally allows for an easy method to capture metrics, and these metrics can be used to improve the quality and time to market of the product.

Windchill has native workflow capabilities, allowing each company to create their own review processes. An example of a review process in use at Elite Engineering is shown in Figure 1. This is a simple review, requiring only a checker and an approver. Each one is given a chance to review the data and then either approve, decline, or request a rework.

Figure 1: A simple workflow process.



The PLM system can track critical information automatically such as timestamps, process flows, and provide a full audit trail. Applying some minor configuration to the workflow process can allow for robust metrics on the design and development review process, which can then be used to further drive quality enhancements.

These data can be considerations such as the number of rejections, the time elapsed from initiation to completion, or the quantity of rejections. The double-edged sword to metrics is that they create awareness of the condition, or the observer effect. By tracking any given criteria, you risk influencing the behavior of employees and thus the results of the very metric you are attempting to track. For example, tracking the amount of time that a workflow is waiting to be reviewed indicates to an employee that it is important for them to review workflows quickly. This could be a good effect, but it may also come at the cost of them changing their priorities in order to drive desired metrics. Therefore, the metrics that you choose to monitor must be implemented judiciously, and this paper will delve into some of the most valuable ones.

Fundamentally, the intent of performing design review and validation is to insure quality. That is why this process is prescribed in a QMS procedure. Therefore, it is prudent to consider quality as the most important metric. When a design is reviewed it should be tracked how often it is accepted or rejected. Tracking the total number of reviews performed and the number of them which are fully approved the first time through gives a quantifiable record for first time quality. Once this metric is established, it should be used to create a trendline and see if the quality of design is improving over time.

The benefits of digital review however are that metrics can be much more granular than just first-time quality. Every action in the database has a timestamp, so metrics are easily tracked for time the review process takes. The total review time can be tracked, as can the review time at each stage. This data can be used to find and eliminate bottlenecks, resulting in a faster review process. This is a good example of benefitting from the observer effect. Once a company is aware of the time review takes and the source for delays, efforts can be taken to address the problem. For example, if the bottleneck is the time for one discipline to perform the review, it may be due to lack of resources

or abundance of review requirements. Better load balancing may result in shorter review processes and thus shorter time to market for the product.

Taking the digital review process one step further, metrics beyond just time can be applied. A metric of the reason for rejection will enable quality improvements. By looking at the most common reasons for rejection, designers and drafters can be better trained. As an example, consider one reason for rejection being drawing tolerances. If this reason is one of the more common reasons for rejection, offering a simple training course on tolerancing would decrease rejections, increase first-time quality, and thus decrease the review process time. Adding a reason for rejection to a PLM system is a relatively simple customization, as Elite Engineering can show. As seen in Figure 2, every company can design their own list of rejection codes. Since PLM is a database, it is also easy to get the data into a report. Regularly reporting out on these metrics brings awareness to the problem and drives the users to improve. As seen in Figure 3, a report allows Elite to categorize the various reasons a workflow was rejected. Graphs allow for simple visualization of the most common sources of error. Elite Engineering created categories (such as design, drafting, modeling, Bill of Materials, Customer, and Manufacturing) for reasons for rejection and assigned rejection codes to these. This allows a reviewer to easily select the reason that a workflow is being rejected. Elite also insured that it is possible to add multiple rejection codes in the Windchill PLM database so that all sources of errors could be tracked.

Figure 2: Sample rejection codes at Elite Engineering.

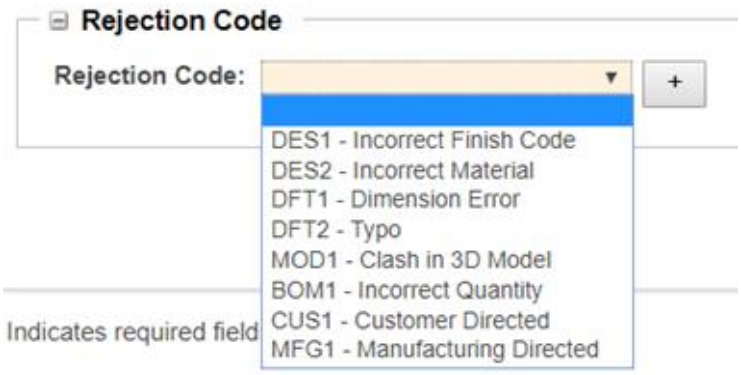
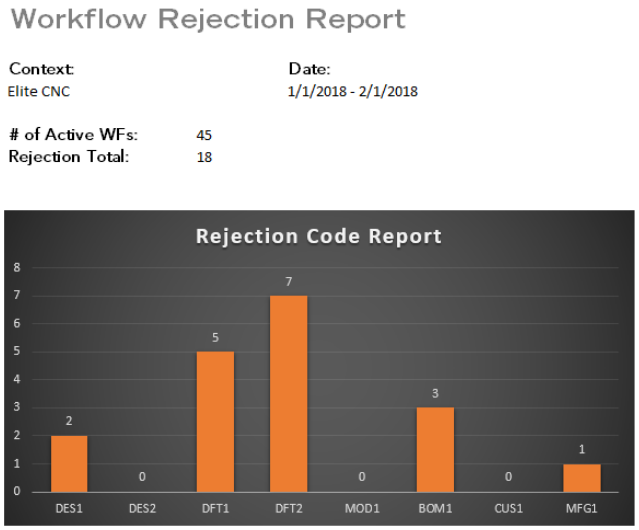


Figure 3: A graph of various rejection code occurrences



Furthermore, an awareness into the reasons for rejection will help you optimize your resources better. Along with providing user training to help reduce the common errors, some systemic improvements can be made as well. For example, if a reason for rejection is that some of the metadata is missing, this can be a very simple fix. Applying a minor configuration change to your PLM database could allow you to prevent data from even being checked in to the database until it contains the minimum criteria. With a guarantee that this information will be present, you've eliminated the chances of human error, and eliminated the need to check for this criteria in the future. This will yield a better-quality product and reduced effort in the design review process. By collecting metrics over time, it is possible to see not only the frequency of each rejection code, but how it trends over time. This allows Elite to track not only if there is improvement in the data quality, but to directly see the effectiveness of efforts to improve the quality of its engineering. As shown in Figure 4, the number of rejections over time allows these metrics to be determined. To understand the quality, it is necessary to consider the number of rejections per workflow initiated, and not the absolute number of rejections. It is however, necessary to first collect the data on what the problem is for you to discover that there is a problem that needs to be fixed.

CAD is an easy example to discuss in terms of performing design review and validation, but the same procedure can be applied to all types of documents. Using basic time metrics and reason for rejection when reviewing data such as BOM, documentation, and reports gives the same value as CAD. Applying reason for rejection to general documents for reasons such as "Typo, Wrong Template, Inaccurate Information" would once again allow a company to make improvements on all future documents.

Figure 4: Sample of rejection code data in a more complete report.