Optimizing the Engineering Configuration Control Board Process

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Abstract — *This article provides a detailed review and improvement of a missiles and defense company's Engineering Configuration Control Board (CCB) process. This project was intended to study and explore the main bottlenecks in the CN processing system that slow down engineering processes and may affect contractual delivery dates. Utilizing a business process improvement approach that encompasses process mapping, identification of stakeholders, data gathering, analysis, and the application of corrective actions, the project successfully achieved efficiency enhancements. The derived outcomes include a 39% reduction in check review time, a 67% reduction in CC time, a 37% reduction in Concept Screening Board time, and a 43% reduction in the average time spent on the CCB cycle.*

Key Terms — *change notice, change request, configuration control board, process optimization,*

INTRODUCTION

The company is an international aerospace, defense, and security company. It recently encountered problems in the missiles segment, particularly in the CCB procedure. The CCB process, paramount for controlling engineering changes, has been lagging in processing and releasing documents through Engineering Change Requests (CR) and converted to Change Notices (CN). These delays have been affecting the engineering routines, which may fail to meet contractual deadlines, interruptions in the manufacturing line, and inspection.

The objective of this project was to find out the causes of these delays, whether there are any constraints in the CCB process, and to suggest measures to minimize the time spent processing and releasing CNs. This included assessment of the current process, identification of stakeholders, collection of information, designing better practices, and the process of putting it into practice. [1]

CONFIGURATION DATA MANAGEMENT

Configuration data management (CDM) is a discipline within the Department of Defense projects that addresses the challenges of reducing costs, minimizing risks, and preventing development and operations delays [2]. It is essential for handling project data at every stage of the process. In so doing, CDM ensures that all project components align with one another by bridging the gap between several domains. Such areas include design, production, and product support. Besides, CDM maintains the project on pace by minimizing complexity. This guarantees that data is correct and precise and avoids the need for needless redesign [2]. The key components of CDM are:

- **Configuration Identification (CI):** The first step in all configuration management operations [2]. This function establishes the configuration items that shall be utilized during the lifespan. They are the distinct identifiers for all the parts that went into making the product.
- **Configuration Control Board (CCB):** The official process for overseeing modifications to the project's baselined CIs. Its main objective is to oversee the processing of changes suggested from inception to closure [2]. Besides, it detects modifications to the baseline's configuration.
- **Configuration Status Accounting (CSA):** It allows users to see when modifications are made to CIs and when those changes are released as new baselines [2]. Basically, it keeps track of the current state of the baseline about all approved and suggested modifications.

- **Configuration audits:** Can confirm product conformity with specifications and standards [2]. A functional configuration audit and a physical configuration audit are the two main types of configuration audits.

CDM guarantees the cohesion of all project components, as it integrates several domains and eliminates the gap between them. Such areas are design, production, and product support. Also, it has a role of keeping the project on track by reducing its complexities. This ensures accuracy and precision of data; a way of eliminating unnecessary and costly redesigns. In addition, this has also made sheer change control an important aspect of all the changes. Factual problems like data security, data integrity, and stakeholders' cooperation can be solved with help of effective CDM. In fact, it can be argued that effective CDM is key when it comes to an undertaking being classified as successful, because it works towards preventing issues such as inconsistency, insecurity, and unsteadiness of configuration data.

METHODOLOGY

The project employed a structured, five-step approach to analyze and optimize the CCB process:

- Process mapping and stakeholder identification (weeks 1-3):
    - Develop a comprehensive map of the CCB process from the Engineering CRs to the CNs.
    - Identify key stakeholders involved in the process.
- Data collection and bottleneck analysis (weeks 4-7):
    - Gather quantitative information on time spent waiting at each station in the CCB cycle for six months.
    - Conduct interviews to identify their involvement in the process, difficulties, and possible delay causes.
    - Data analysis done through Excel and Tableau to determine the critical bottlenecks.
- Developing and testing solutions (week 8):
    - Suggest other recommendations to improve the CCB process according to the analysis.
    - Create the first plan to check the effectiveness of the outlined solutions.
- Implementation and standardization (weeks 9-11):
    - Integrate the tested solutions into the overall process of the CCB.
    - Establish a standard operating procedure for the new process.
- Monitoring and continuous improvement (weeks 12-13):
    - Continue to supervise the new CCB process for two weeks to evaluate the process.
    - Seek feedback from other stakeholders and make some changes if necessary.

In addition to these steps, the methodology was expanded to include the following elements:

- **Process mapping:** A flow chart, SIPOC, or value stream map was created to address the visualization of all change management activities from Engineering CRs to Change Notices CNs.
- **Sample size and reliability:** The study sample included all CNs the CDM team did in the previous six months and sought to establish a 95% confidence level in the study.
- **Collaboration with engineering liaison:** Data was collected in collaboration with the Engineering Liaison team to obtain information from the PLM system in relation to the idle time of each of the CCB process stages for the last six months.
- **Interview process:** Stakeholders outlined on step 1 were contacted for an interview to determine their responsibilities, difficulties, and possible causes of delay.

- **Solution testing:** A pilot version of the program was designed to attempt the proposed solutions before the integration of the complete program.

This approach made it possible to gain a holistic view of the existing process, the problems associated with it, and the impact of the suggested interventions.

RESULTS

Process Mapping

The preliminary process mapping unveiled that the company had a rather intricate workflow coordinated through Windchill, a project lifecycle system. Change Management starts with the creation of a CR. It goes through the Engineering Screening Board (ESB), Change Task (CT) Phase, Concept Screening Board (CSB), Internal Work Group (IWG), Configuration Control Board (CCB), and finally, the Audit stage.

Key findings from the process mapping included:

- Multiple review stages (ESB, CSB, IWG, CCB) with the possibility of developmental time loss.
- Approximately 3-4 months for the entire process, excluding the time it takes to acquire the necessary permits.
- Modifications were done in CT or CSB phases because of compliance concerns.

Figure 1 shows the original CCB process flow, and figure 2 shows the CBB timeline.

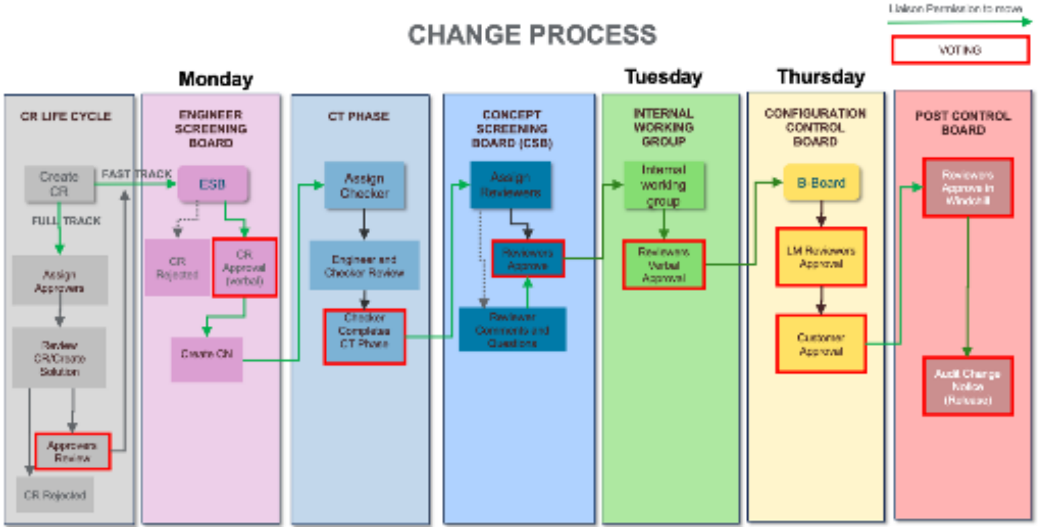


Figure 1
CCB Original Process

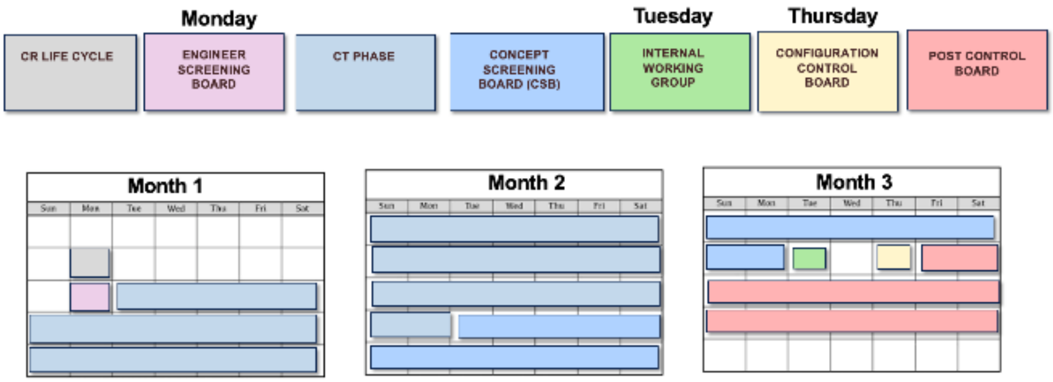


Figure 2
CCB Timeline

Stakeholder Identification

The project identified several key stakeholder groups (table 1).

Table 1
Stakeholder Identification

Stakeholder Type	Role	Area of Interest	Impact Level
Owner	Configuration Data Management	Configuration Control, CSB, IWG, CCB	Medium
Technical Team	Engineering disciplines (Mechanical, Electrical, etc.)	Contractual Obligations, Engineering Standards, Design Fit and Function	High
Functional Team	Safety, Finance, GSC, etc.	Functional Impacts on Respective Areas	High
Customer	DCMA, JPO	Class II Concurrence	Medium
Organizer	Engineering Liaison	ESB	Medium

Understanding these stakeholders' roles and interests was crucial for addressing process inefficiencies effectively.

Data Collection and Bottleneck Analysis

The data collection process was done in consultation with the Engineering Liaisons team and entailed extracting reports from Windchill that encompassed the last six months of 2023. This comprehensive analysis revealed several key insights:

- Checking and CSB phases were established as the most time-consuming steps in the process.
- Another cause was the lack of proper communication between team members; one member would assume that a task had been handed over to another member and thus would do nothing about it.
- Lack of effective communication was observed; SMEs may forget an assigned task or not inform the project team about a change in their roles and responsibilities.
- There were duplicate approvers in both CSB and post-CCB, which caused duplication of efforts.
- Misallocation of workflows led to some of the CNs being idle for a long time.

These observations helped to identify the major sources of delays and suboptimal activities within the CCB process, which served as the starting point for improvement.

Table 2 shows the CN turnover rate for the analyzed period.

Table 2
CN Turnover Rate

Phase	Average Days
Checking	42
CC	30
CSB	30
Audit	7
Total	109

Developing and Testing

During the development and testing phase, efforts were made to solve the discovered pain points, of which communication issues and inefficiencies in the workflow were some of the most significant. Key initiatives included:

- **Automation of reminders:** Take advantage of the Windchill system by setting up automated task notifications after two weeks of inactivity and then every week until the task is completed.
- **Process coordinator role:** Appointment of a coordinator responsible for tracking CNs and engaging stakeholders on time, especially between engineering and functional groups.
- **Elimination of redundant approvals:** Eliminating parallel approval procedures in CSB and post-CCB that cause delays in the CN process and increase idle time.
- **Workflow optimization:** Adoption of better processes to address change requests and perform tasks in a more efficient manner.

These were piloted at the pilot level to determine their viability and feasibility before going to a full scale.

Implementation and Standardization

The implementation phase involved several key changes to the CCB process:

- **SOP amendment:** The standard operating procedure was changed to ensure that post-CCB is done at the same time as the CCB.
- **Chief engineer's role:** CSB approvals were now to be done by the chief engineer at the second stage of the ESB, thus reducing the number of decision points.
- **Process integration:** All the tested solutions were implemented into the general CCB process with the staff being trained in the new process.
- **Standardization:** To maintain the improved process, a new standard operating procedure was developed so that all the departments that require it check on the implementation of the new process.

Some of these changes were meant to maintain continuous improvement and efficient functioning of the CCB process (figure 3).

Monitoring and Continuous Improvement

The new process was observed for six months, with special attention to measurable performance indicators. The result (table 3) showed that there was an improvement in certain areas.

Table 3
CN Results

Phase	2023 Average Days	2024 Average Days	Improvement
Checking	42	25.62	39%
CC	30	9.9	67%
CSB	30	18.9	37%
Audit	7	7.87	-12%
Total	109	62.29	43%

Due to the absence of the original data, the conclusions drawn are somewhat affected. With limited data, the significant variance obscures any observable changes in the averages.

When comparing the averages (figure 4), the average decreases from 25.5 days to 15 days. However, the variance suggests that this reduction may fall within the range of potential outcomes from the original process, leading to the conclusion that no significant changes have occurred. Similarly, in evaluating the consistency of the processes, although the standard deviation decreases from 22.4 to 14.5 days, the high variance in both populations indicates that 14.5 could also represent an outcome of the current process.

Therefore, it is recommended that the original data be obtained to facilitate a more detailed comparison at each stage of the functions, rather than relying solely on the averages.

DISCUSSION

The optimization of the CCB process has achieved significant enhancements in productivity and workflow.

- **Comprehensive process analysis:** The description of each phase of the CCB process also helped identify areas of congestion and low efficiency. This thorough understanding was crucial to the formulation of viable solutions.
- **Stakeholder engagement:** The involvement of key stakeholders in the project helped address the problem from different angles. Therefore, the suggested solutions were more viable than one individual would have provided.
- **Data-driven decision making:** Applying quantitative methods to analyze data and pinpoint bottlenecks and changes was useful, as it offered a more structured approach to process changes.
- **Technological integration:** Integrating Windchill in the design process for setting automated reminders and managing the workflow was a major factor in avoiding delays and enhancing communications.
- **Continuous improvement approach:** The cyclic approach of the project in terms of control and monitoring also provided for the fine-tuning of solutions and effectively managed new problems as they arose.

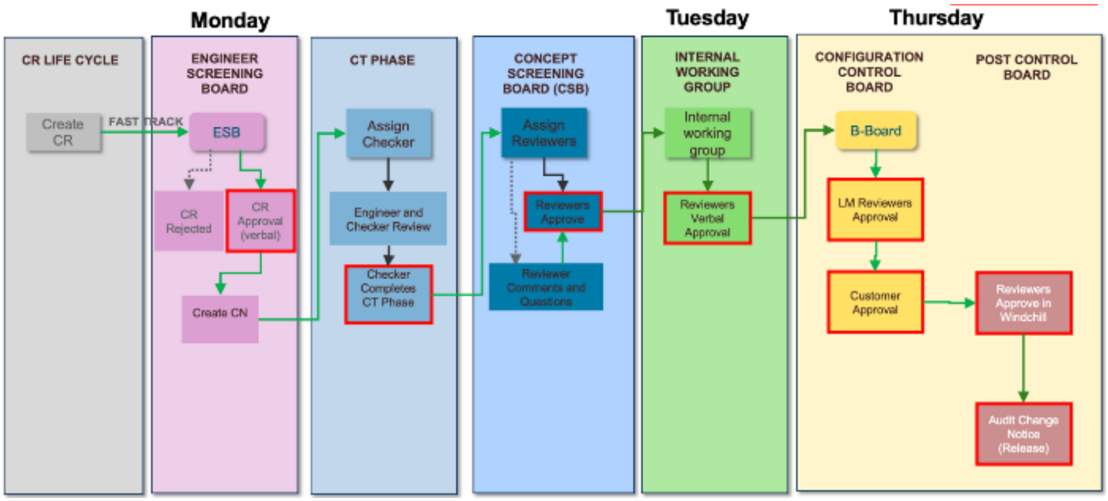
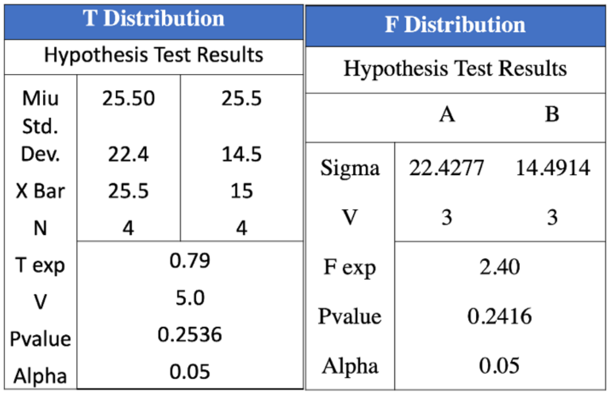


Figure 3
New CCB Process



T Distribution		
Hypothesis Test Results		
Miu	25.50	25.5
Std. Dev.	22.4	14.5
X Bar	25.5	15
N	4	4
T exp	0.79	
V	5.0	
Pvalue	0.2536	
Alpha	0.05	

F Distribution		
Hypothesis Test Results		
	A	B
Sigma	22.4277	14.4914
V	3	3
F exp	2.40	
Pvalue	0.2416	
Alpha	0.05	

Figure 4
Variance Test

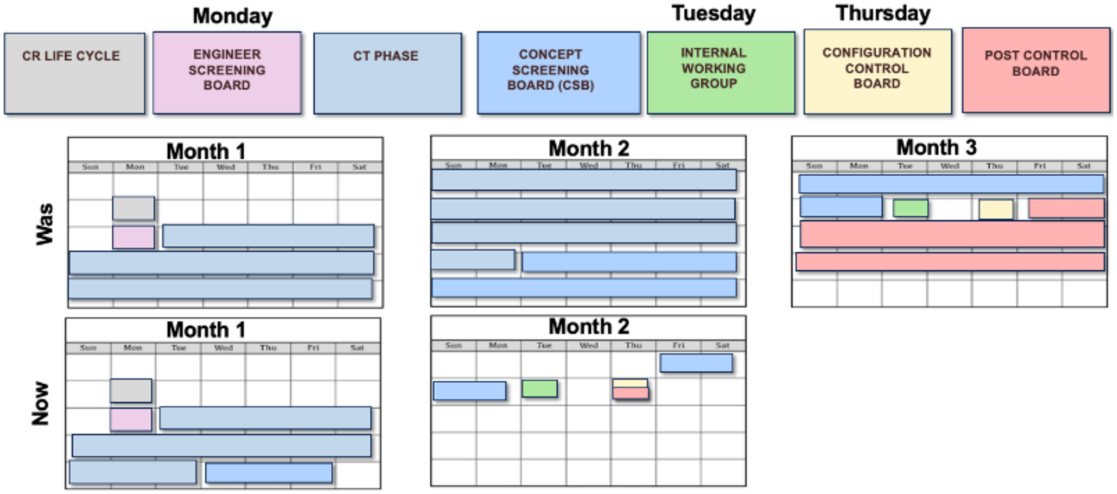


Figure 5
CCB Timeline Comparison Variance Analysis

The reduced time to complete the review process and the extended general CCB cycle indicate that the changes worked. These enhancements improve the company's internal processes and impact the company's strategic position in the aerospace and defense market environment.

IMPLICATIONS AND FUTURE DIRECTIONS

- **Enhanced operational efficiency:** The integration of CCB ensures that engineering changes are implemented faster, which may result in a better product development cycle and shorter time to market [2].
- **Cost reduction:** This way, the project may help save costs through better utilization of resources as well as avoiding contractual consequences for delays.
- **Improved customer satisfaction:** Quicker responses to the changes can also result in the improvement of products and faster problem-solving, which will improve customer satisfaction.
- **Competitive advantage:** This optimized process enhances the company's competitive advantage in the aerospace and defense market, increasing its capacity to adapt to dynamic market requirements and emerging technologies.
- **Cultural shift:** The successful implementation of the project may lead to the creation of a culture of business improvement within the organization, leading to the adoption of similar initiatives in other parts of the business.

For future directions, the following areas could be explored:

- **Expansion to other divisions:** The successful methodology and solutions could be applied to the other divisions with similar problems.
- **Advanced analytics integration:** Predictive analytics could also complement the CCB process by identifying areas that may likely be constrained before they are.
- **Cross-functional integration:** It is also possible to expand the application of the optimized CCB process to other business processes, bringing even more efficiency to the organization.
- **Supplier integration:** Applying changes implemented in the enhanced CCB process to the key suppliers may improve the supply chain's responsiveness and effectiveness [2].
- **AI and machine learning applications:** Exploring the possibility of implementing artificial intelligence and machine learning to support automated decision-making in some of the tasks of the CCB process can also help reduce the time taken and enhance efficiency.

CONCLUSION

Enhancing the engineering configuration control board process at the company can be a success in furthering organizational performance and ensuring the company's continued dominance in the aerospace and defense markets. By following a structured approach that included detailed process mapping, consultation with relevant parties, and data analysis, the project was able to determine and solve major pain points in the Change Notice processing system.

This was achieved through the implemented solutions such as automated reminders, the enhancement of the approval process, and better communication channels, which reduced processing time in several phases of CCB. The optimization has been effective, as indicated by the overall 43% reduction in the cycle time of the CCB. It is recommended that the original data be obtained to facilitate a more detailed comparison at each stage of the functions, rather than relying solely on the averages to further access if the implementations to the process created a significant change.

Nevertheless, these improvements, have benefit the company by increasing a faster turnover on documents to customers and reducing costs, hence the benefit of increasing its adaptability in responding to new customer demands and technologies. The success of this project establishes best practices for the continuous improvement agenda within the organization. It provides insight that may be transferable to other divisions and potentially even the wider supply chain.

Since the aerospace and defense industries are rapidly growing, configuration management has become a significant factor in managing change. This project clearly shows how the company is determined to improve its processes to be a role model in the industry.

In the future, the sustained assessment of the CCB process, alongside the pursuit of enhanced technologies such as AI and predictive analytics, will be pivotal in maintaining and improving the progress made. It demonstrates how successful process improvement can be accomplished in working environments within engineering. It answers the question of how rapid and effective change management can deliver organizational success in industries with high stakes.

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