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Standardization of Engineering Change Implementation Tasks in Manufacturing

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Abstract

This paper presents an overview of Engineering Change Management (ECM) and its implementation in the manufacturing industry. ECM is a systematic approach to managing all changes made to a product or system throughout its lifecycle. The primary goal is to ensure changes are introduced in a controlled and coordinated manner, minimizing disruption and ensuring the product meets its requirements. Key steps include the identification, evaluation, approval, and implementation of changes. The implementation of task standardization has significantly improved operational processes, with an average time efficiency improvement of 76%. Integrating knowledge and training resources has equipped employees with the necessary tools and information to perform their duties efficiently. Leveraging Visual Factory tools has further enhanced communication, transparency, and efficiency. These initiatives have resulted in substantial benefits, optimizing resource allocation and contributing to overall operational excellence. The findings underscore the importance of standardized processes and comprehensive training programs for continuous improvement.

Keywords: ECM, CO, CI, Change Management, Visual Factory (VF)

1. Introduction - Engineering Change Management

Engineering Change Management (ECM) is a systematic approach to managing all changes made to a product or system throughout its lifecycle in the manufacturing industry. The primary goal of ECM is to ensure that changes are introduced in a controlled and coordinated manner, minimizing disruption and ensuring that the product continues to meet its requirements.It involves four key steps:

1. **Identification of Change**: Recognizing the need for modifications due to design flaws, new requirements, or advancements through engineering change order (CO).
2. **Evaluation of Change**: Assessing the impact of the proposed change on cost, time, and quality.
3. **Approval of Change**: Securing agreement from stakeholders to ensure the change is beneficial and necessary.
4. **Implementation of Change**: Executing the approved changes and updating relevant documentation and processes through engineering change implementation (CI) process.

ECM ensures changes are controlled, coordinated, and beneficial to the overall project.

Figure 1: ECM Process Overview

Problem Statements

There are three main problems often observed in the engineering change implementation and execution which is the most crucial stage of the process.

1. **Lack of Standard**: The absence of a standardized approach in engineering change implementation processes can lead to inconsistencies and inefficiencies. Without clearly defined procedures and guidelines, different teams may handle changes in varying ways, resulting in confusion, errors, and delays. A lack of standardization can also make it challenging to maintain quality control and ensure that all changes align with the overall project objectives.
2. **Knowledge Gap**: A significant knowledge gap among team members regarding engineering change implementation practices can hinder the effective implementation of changes. When individuals are not adequately trained or informed about the processes and tools involved, it can lead to misunderstandings, miscommunications, and mistakes. Bridging this knowledge gap through continuous training and education is crucial for ensuring that all team members are equipped to handle changes efficiently.
3. **Lack of Integrated Solution**: The absence of an integrated solution for managing engineering implementation can complicate the coordination and tracking of modifications. Without a centralized system that consolidates information, tracks progress, and facilitates communication, teams may struggle to stay on the same page and ensure that changes are implemented smoothly. An integrated solution can streamline the process, improve visibility, and enhance collaboration among all stakeholders.

Objectives

1. **Define Change Implementation Work Instructions**: Establishing clear and consistent change implementation standards for key functions within the organization is essential to ensure uniformity and efficiency. These functions may include design, manufacturing, quality control, supply chain, marketing, customer support, and project management. By defining specific procedures and guidelines for each function, the organization can minimize errors, reduce downtime, and ensure that changes are seamlessly integrated across all departments.
2. **Integrate Training & Knowledge Repository**: Developing an integrated training program and knowledge repository is crucial for bridging knowledge gaps and ensuring that all team members are well-versed in engineering change management practices. This repository should include comprehensive training materials, best practices, case studies, and troubleshooting guides. By making this information easily accessible, the organization can enhance team members' skills, promote continuous learning, and improve the overall effectiveness of change management processes.

3. **Integrate Using Visual Factory Tool**: Leveraging a Visual Factory tool to integrate engineering change management processes can significantly enhance communication, transparency, and efficiency. Visual Factory involves using visual tools such as dashboards, flowcharts, and performance metrics to provide real-time updates and insights into the status of changes [1]. This approach helps teams quickly identify issues, track progress, and make informed decisions, ultimately leading to more effective and streamlined change management.

Visual Factory

Work instructions currently based on Microsoft Office documents (such as Word documents or Excel spreadsheets) or PDFs, with part numbers copied and pasted from the ERP system, are un-auditable and prone to error. Similarly, training and competency records, as well as skills certifications, are stored in separate data silos, resulting in no link between the required skills for a task and the individual performing it. Due to the inability to locate or follow proper documentation, operators often make independent decisions, customize processes to their preferences, or rely on memorization, leading to a dependence on "tribal knowledge."

Visual Factory aims for "zero ambiguity." It is a web-based software application (operating within your corporate firewall) that has been proven to significantly reduce costs, enhance workforce productivity and efficiency, and ensure Right First-Time quality. Visual Factory provides real-time, dynamic Electronic Work Instructions (EWI) to guarantee that products are built correctly the first time, every time, even in low-volume, high-variety, and configure-to-order environments. The platform is designed to record and track essential manufacturing data, such as the tools used and the duration of specific activities [2].

NoMuda's MES Visual Factory is a comprehensive digital manufacturing software solution designed to assist manufacturing companies in digitizing their shop floor operations. This platform aims to enhance manufacturing efficiency and improve first-time quality [3][4].

Figure 2: Visual Factory Overview [1]

2. Methodology

Visual Factory's work instruction module was used to create and communicate the standard work instructions for conducting the engineering implementation task for changes on a machined part as an example.

Step-by-step explanation and details about using Visual Factory for standardization of change implementation tasks is shared below.

Step 1 – Login

Each user logs in using their own credentials to confirm their identity and validate their authority and skills. Figure 3 below shows a screenshot of Visual Factory's individual login page.

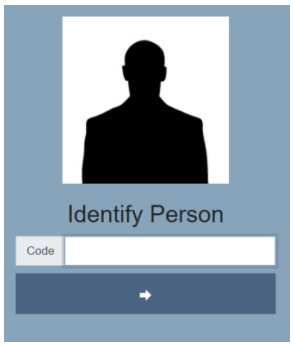


Figure 3: User login

Step 2 – Identify Workstation or Function

Next step is to identify the manufacturing business area and corresponding function in manufacturing. Figure 4 below shows selection of bearings business unit and manufacturing function by the individual.

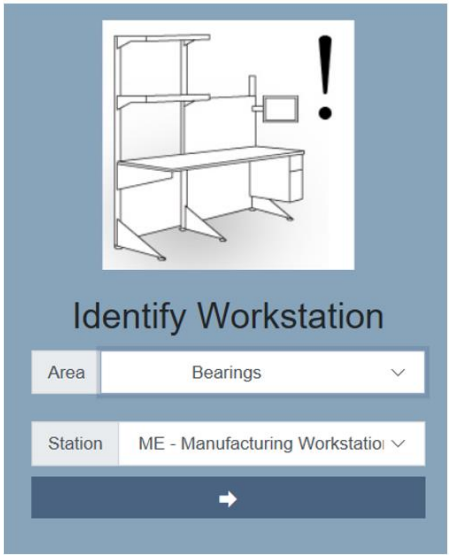


Figure 4: Business and functional fields

Step 3 – Home Page

After logging in, the home page shows all the implementation tasks assigned to the individual user. Figure 5 shows an example of implementation tasks assigned to the user.

Figure 5: Homepage

Step 4 – Start of Implementation Task

Clicking on VL000004 task starts the process to implement the change for bearing product under the manufacturing engineering function. The user is guided through all the required steps to successfully implement this change with help of detailed work instructions as shown in figure 6.

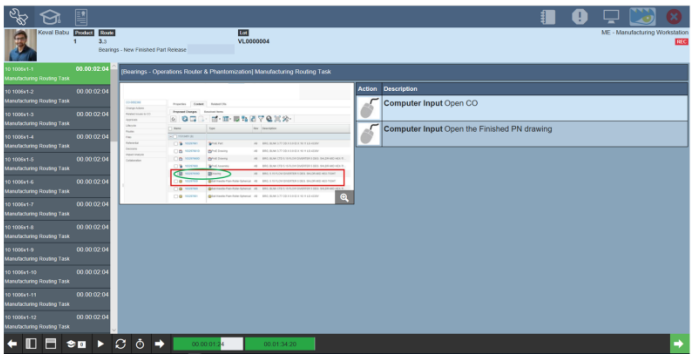


Figure 6: Start of Implementation Task

The figure 7 illustrates various types of actions prompted by the implementation task such as checking type of bearing and recording specific bearing dimensions like diameters and length. Every step has a defined standard time to complete and logs the actual time taken to complete that step by the user. This helps to collect data on standard and actual completion time and analyze it to further improve productivity of implementation tasks.

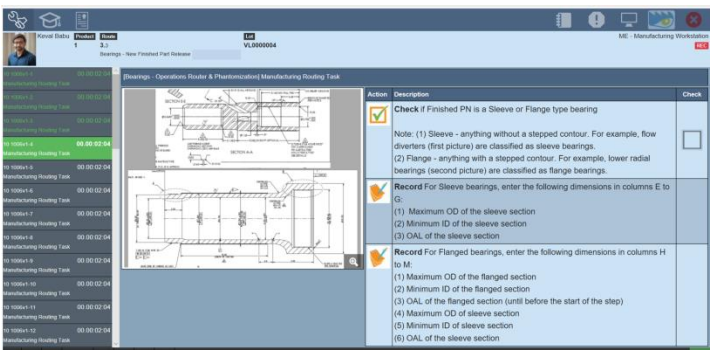


Figure 7: Types of actions

One of the key features of Work instruction module is the operations summary at the end of every work instruction [3][4]. The operations summary verifies and ensures that all the steps within the task are completed before marking the task as complete. Any steps skipped or missed are flagged on the operations summary page as shown in figure 8 below. This is a full-proof mechanism to ensure nothing is missed or overlooked by the user carrying out the task. This features assists in upholding quality, productivity, and implementing change right-first-time.

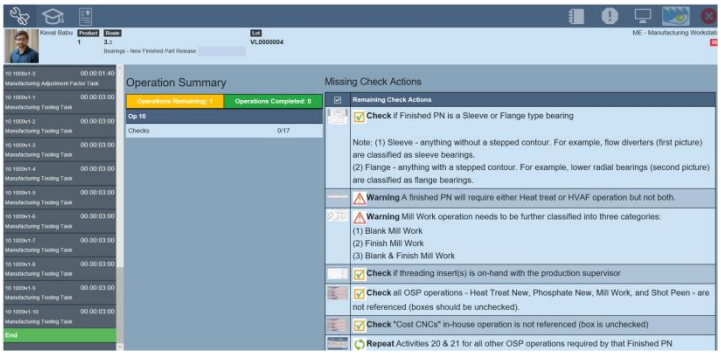


Figure 8: Missing check actions flagged

Step 5 – Completion of Implementation Task

After the user has completed all the required steps to implement the change, the operations summary page shows a green thumbs up icon to signal successful completion as shown in figure 9 below.

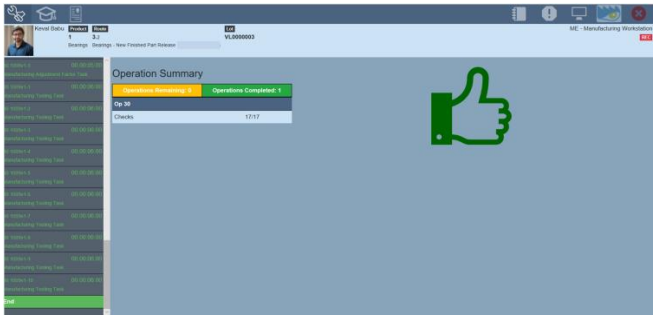


Figure 9: Completion of task

Step 6 – Optional History

Visual Factory also records and provides history of every step within the implementation task as shown in figure 10. For every step, it logs the date, time, and user who completed those steps. This ensures comprehensive traceability of managing and implementing change.

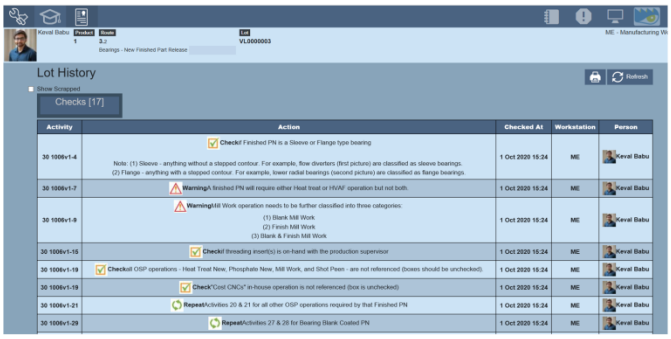


Figure 10: History of steps

The user can also view a summary of end-to-end change implementation progress across various users and functions on the overview page. The figure 11 below shows that implementation tasks of supply chain, manufacturing and customer service are currently active and in progress whereas rest of the functions are yet to start on their tasks.

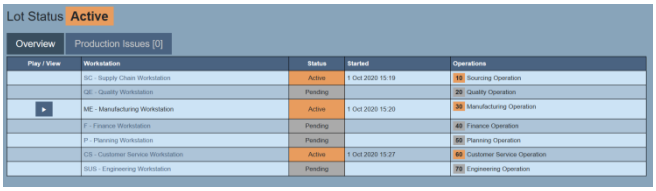


Figure 11: Overall implementation progress

Integration of Training & Skills Matrix

Visual Factory's Skills module allows seamless integration of training management and skills matrix [1]. A user could be assigned a specific implementation task to get trained and certified in those tasks. Once the user completes the training, the skills matrix is automatically updated to reflect the appropriate competency levels as shown in figure 12 below. The user "Keval Babu" below is certified to execute two implementation tasks in manufacturing and quality respectively. Whereas remaining users are either only certified to complete manufacturing implementation tasks or yet to be training in any task.

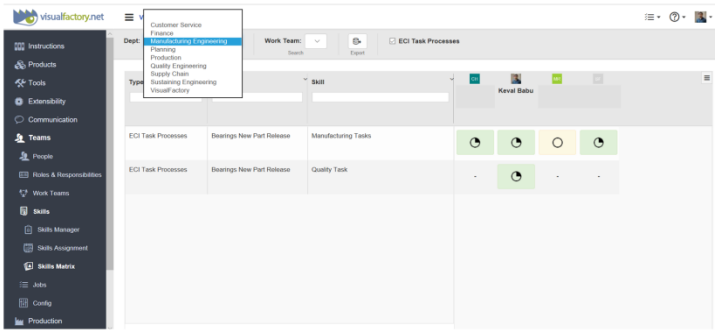


Figure 12: Skills Matrix

A user not competent and certified to complete an implementation task would be prompted with a blocker message in any attempt to open the task as shown in figure 13 below. This ensures proper access and control when it comes to executing the change.

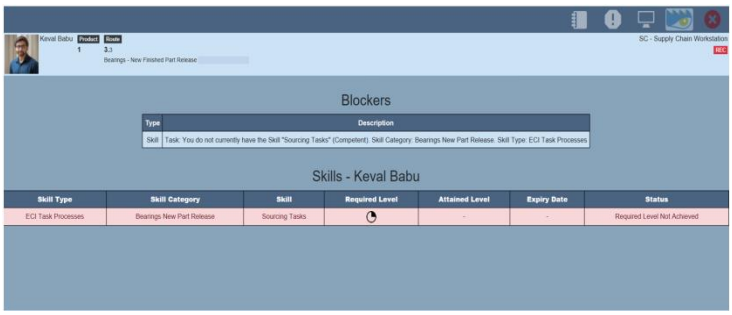
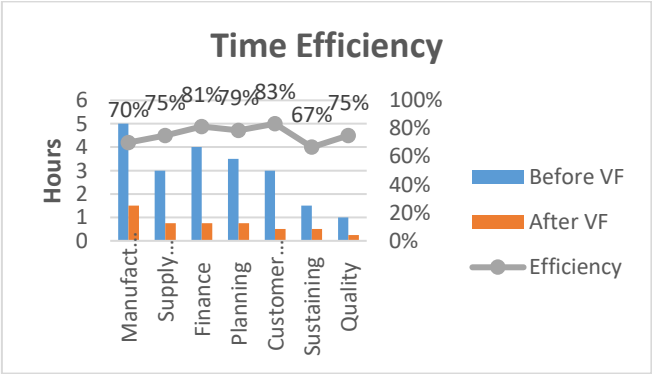


Figure 13: Sourcing task access blocked

3. Conclusions

The implementation of task standardization has proven to be a game-changer in operational processes. By integrating knowledge and training resources, it equipped employees with the necessary tools and information to perform their duties efficiently. This approach has resulted in a marked improvement in the efficiency of learning and completing implementation tasks.

The data presented in the chart (figure 14) highlights this significant enhancement in time efficiency across various tasks, such as Manufacturing, Supply Chain, Finance, Planning, Customer Service, Sustaining, and Quality. The efficiency improvements range from 67% to 83%, with an impressive average time efficiency improvement of 76%.



This remarkable improvement underscores the value of standardized processes and comprehensive training programs. By reducing the time required to complete tasks, we have not only increased productivity but also optimized resource allocation, ultimately contributing to overall operational excellence. The successful integration of these elements has demonstrated the potential for continuous improvement and the importance of investing in such initiatives.

In conclusion, the Visual Factory (VF) implementation has yielded substantial benefits, evidenced by the significant time savings and efficiency improvements across all areas. This achievement serves as a

testament to the effectiveness of the approach and the dedication to strive for excellence in all aspects of operations.

REFERENCES

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[4] NoMuda Visual Factory. (n.d.). Hypertherm.