Success Metrics Driven by PLM
Vaillant Group's Digital Transformation

Vaillant Group - German manufacturer of precision HVAC equipment for over 140 years

Enterprise demands for improving product launches, differentiation, productivity, and quality require an efficient, transparent, and global product development environment. Complexities arise when processes are interrupted and file-based, redundant data is entered manually in different systems over the product lifecycle. For example, when Engineering Change Notifications (ECNs) are handled inefficiently with static applications such as spreadsheets, data can be out of date. The potential for errors, causing loses in time and increasing expenditures, can quickly mount to unwieldy proportions. Such challenges can uncompromisingly hold back engineering teams from delivering better products on time contributing to the top and bottom lines. This is where PLM comes in to not only mitigate these challenges but digitally transform an organization's data management processes into a thriving ecosystem of trusted knowledge.

Vaillant Group is taking a long-term approach to their digital transformation driven by Product Lifecycle Management (PLM). To date, key milestones of the ten-year PLM roadmap have been met, including functionalities to create and to manage parts, Bill of Materials (BOMs) and product documents in Windchill, to track and to manage product compliance and sustainability, to track product maturity over the entire lifecycle, to enrich SAP views using workflows, and to manage phasing out products at the end of their lifecycle.

The release and engineering change management is considered as a key foundational element of their far-reaching PLM strategy.

Mindful of delivering value to the business, every step of the way, they also focused on keenly measuring the impact of PLM on reduction of process runtime, reduction of rework, as well as the improvement of process and product data

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quality as a proof-point for how digital transformation can have huge results driving future innovation for this 140-year-old international organization. The following study details their effective strategy of integrating and balancing PTC Windchill and SAP MDG-M systems as core elements of their End-to-End PLM solution and reaping greater overall efficiency with their workflows.

About the Study

Data collected by Vaillant Group comes in several batches. For development project lead time: 2011–2017 baseline without PLM, and with PLM from January 2019 – December 2019.

For ECM process runtime, master data quality and ECN follow-up documentation: January 2018 – December 2018 without PLM, and with PLM from January 2019 – December 2019.

Metrics also include the start of PLM implementation for Vaillant beginning in May 2015.

This study is built around the following KPIs:

- Release & Engineering change management process run time improvement
- Improvement of process quality of product data and first physical sample before series production
- Reduction of follow-up ECN documentation
- Master data improvement
- Lead time improvement for development projects

Getting the Digital House in Order

The Vaillant Group is a global market and technology leader in the field of heating, ventilation, and air-conditioning (HVAC) technology. For over 140 years, the company has been following a strategy designed to achieve sustainable and profitable growth. Today, the family-owned company conducts its research, development and production activities at 10 sites in 6 European countries and China–and sells high-efficiency and environmentally-friendly products in more than 60 countries worldwide.

Vaillant utilizes several different design and productivity software platforms such as CAD (PTC Creo, AutoCAD, Mentor), PLM (Windchill), and ERP (SAP).

Initially, the Windchill to SAP interface did not exist. Process and data management tasks were manually handled through a combination of spreadsheets and emails. Maturity and approval status of product BOMs, 3D CAD models, 2D CAD drawings, technical specifications and other documents were tracked manually with high effort. Manual search for documents and information within documents was difficult and inefficient. ECNs were managed in Excel, and the ECN data must be transferred to ERP again by manual entry.

System-controlled hard links between release of product data, its first physical sample and necessary workflow did not exist leading to high effort to manage manually.

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There were many drawbacks to this approach: inadequate access-control, lack of concurrent engineering functionality, high efforts for spreadsheet handling, lack of traceability and version control, lack of transparency & status tracking, long waiting times to finish process steps, and a flawed error-prone manual data entry process. The result was slower time to market and higher levels of rework.

These issues were confirmed by an independent consultant (Ernst & Young) after an extensive analysis and evaluation process. The results of which precipitated a digital transformation project for the management of product lifecycle that spans a ten-year phased approach, with deliverables in three phases.

Phase I

This phase, 2015–2017, focused on the core elements of PLM such as workflow-controlled creation of parts and Bill of Materials (BOM), concept and pilot for release and engineering change management and first physical sample release process as well, management of product documents, concept of product maturity status *from cradle to grave*, automatic transfer of product data from Windchill to SAP, workflow-controlled enrichment of SAP views and other product creation related activities after Design Freeze.

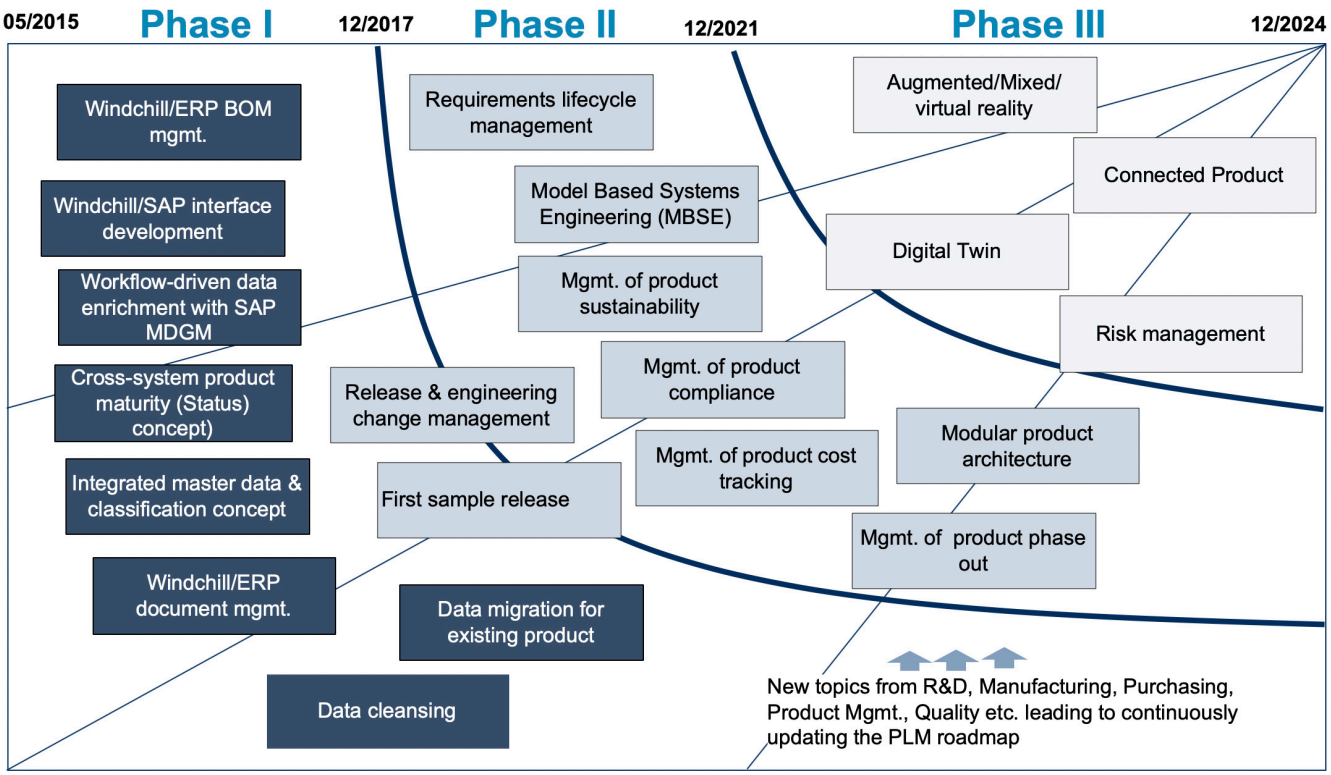

Figure: PLM long-term transformation roadmap

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Phase II

In the second phase, 2018–2021 (planned) of the roadmap, advanced PLM functionalities are added to the PLM roadmap mainly to manage the entire process to collect, consolidate, approve and test product requirements, to manage and track product compliance/sustainability, to manage product costs during developments and to manage a product phase out as well. The world-wide productive use of release and engineering change management and first physical sample release process is a part of this phase as well. In addition, the use for model-based system engineering is drafted..

Phase III

In the final phase, 2022–2024 (estimated), after the delivery of PLM basic and advanced functionalities, Vaillant plans to close the information loop between phases of the product lifecycle by applying digital transformation technologies. For example, they plan on using connected product information acquired from IoT (Internet of Things) sensors to predict failures and optimize new and existing products through fielded product input to design. They also plan to provide service departments with AR (augmented reality) work instructions for improved service delivery, create and apply Digital Twins for different use cases etc. All these use cases need to be described and evaluated together with relevant users and stakeholders in order to ensure the added value.

> "With the introduction of PLM, Vaillant Group has taken an essential step towards Digitalization. We are now able to access, share and connect product information throughout our company and–looking to the future–also with our partners and customers."

Dr. Christian Willmann, Head of Business Application PLM, Vaillant Group

Since Phases II & III are still in process, the remainder of this case study will focus on Phase I a major part of and its KPIs.

- Release & Engineering change management process run time improvement
- Improvement of process quality of product data and first physical sample before series production
- Reduction of follow-up ECN documentation
- Master data improvement
- Lead time improvement for development project

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Products today are growing ever more complex. Changes occur during the product development process daily. Stakeholders up and down the value chain need to keep up with these changes; as well as, optimize their processes to implement these changes. Many assets can change all at once such as 3D CAD models and drawings, specifications, documentation, BOMs, and more. Furthermore, any number of changes from the outside can occur, directly affecting every aspect of the product development lifecycle. For example, changes such as part replacements because of cancellations, product quality issues, new compliance regulations can wreak havoc on a company's New Product Introduction (NPI) process, which can impact time to market.

This already complicated process is made even more difficult when managed by inefficient and archaic means such as spreadsheets and email.

The time to implement changes, the ECN (Engineering Change Notice) process, is their key success metric. The process has a direct impact on time-to-market when combined improved measures such as lack of need for rework for a robust process. For NPIs, this process part starts after creating the product data (e.g. CAD, BOMs, documents, etc.). In the case of product modification, the ECN starts after an analysis phase where an engineering change request (or ECR) is investigated and approved. While the ECR process at Vaillant is significant for modification of series parts, this process is only a formal step with NPI and has no impact on the total lead time.

ECN Before PLM

For Vaillant, managing ECNs before the implementation of a PLM solution was fraught with process issues and inefficiency. They faced a multitude of key challenges: high-setup times (involving manual data collection of changes), non-transparent change statuses, long process execution times, time-consuming manual tracking of actions needed for ECN implementation, and reliant on phone and email.

ECN After PLM

When Windchill's high configurable out-of-the-box PLM capabilities with a multilayer interface to SAP/ MDG-M are applied to this process, a holistic change management solution takes place, and provides the following immediate benefits:

- Lists with interdependent parts, products, documents, etc., are automatically generated
- Critical functions such as pre-defined rules are automatically generated
- Automatic transfer of changed product data, including manufacturing BOM, to ERP SAP (via Enterprise Systems Integration, ESI)
- Enhanced and efficient workflow-controlled approval processes
- Workflow functionalities provided by Windchill and SAP MDG-M
- Automatic and transparent cross-systems status tracking of changes
- And more...

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The following chart illustrates Vaillant's ECN release process layers for NPI, providing a clearer picture of the connection between Windchill and SAP from organization to system to process.

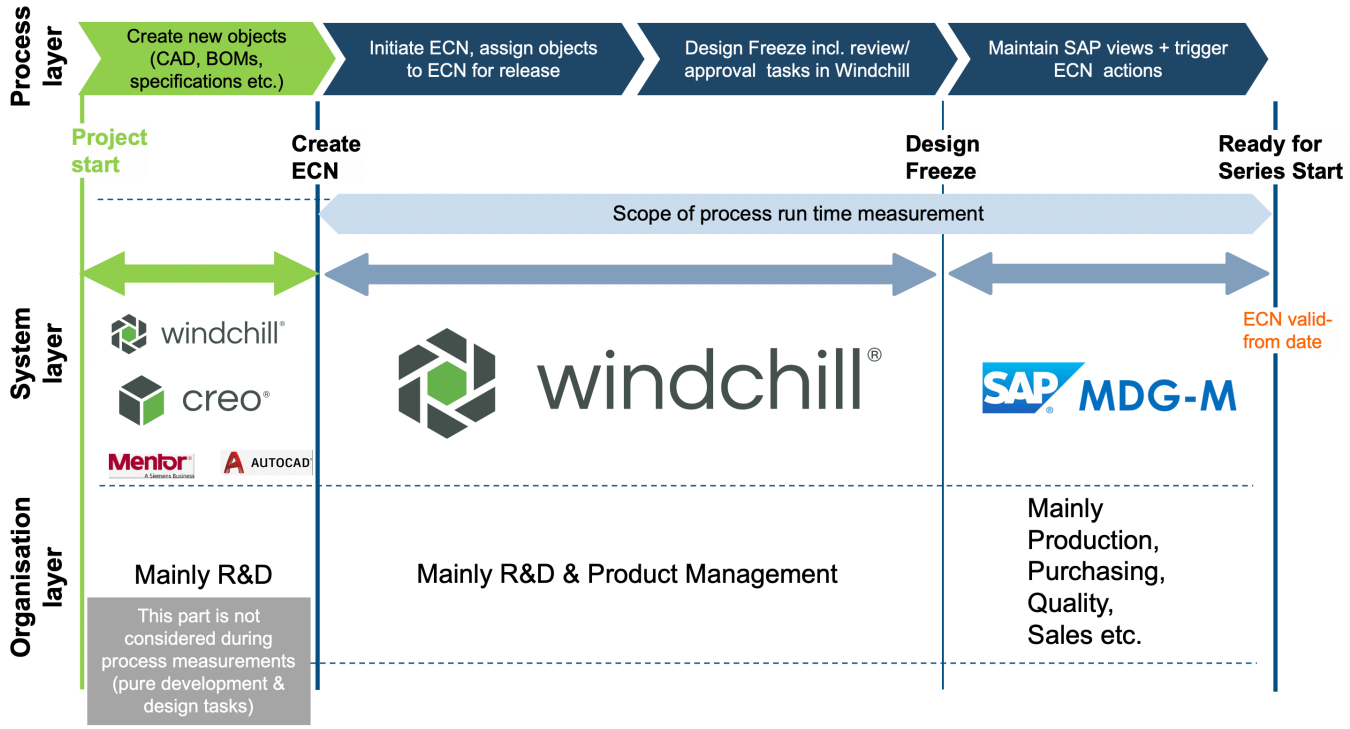

Figure 1: Process, system and organization layers

As you can see from a system standpoint, Windchill is employed to manage core enterprise PLM including ECNs and Product Design data (such as CAD from Creo & AutoCAD) from project start to Design Freeze. After that SAP MDG-M manages the process following steps.

In the next section, we will look directly at the Workflow Management Improvements, the metrics used to test them, and the actual results.

Workflow Management Improvements

Vaillant defined the following three concrete ECN measuring points in the process both before and after PLM:

1. Creation date of ECNs in Windchill with integration to SAP versus the manual process in Excel (before PLM)
2. Date of Design Freeze in Windchill versus manual process in Excel (before PLM)
3. Effectivity dates of engineering changes (ECNs) before and after PLM, meaning that parts/products are ready for series production

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For Engineering Change Request Process (ECR) which is significant for the modification of parts in series, not for NPI, the following three concrete ECR measuring points in the process both before and after PLM.

1. Creation date of ECRs in Windchill versus the manual process in Excel (before PLM)
2. Date of ECR Approval in Windchill versus manual process in Excel (before PLM)

The key metric here is the reduction in processing time to implement an engineering change owing to the benefit of PLM. From January 2018 – December 2018, Vaillant was measuring the average time to process engineering changes having a valid-from date within this time window. When that same metric was tested after they implemented PLM consequently for the ECN process from January 2019 – December 2019, the average process run time reduction was ~ 25% by the end of 2019. The measurement includes Windchill and SAP MDG-M as well.

The performed run time measurements have been cumulated in order to gain realistic and actual results. This means that, the arithmetic average of process run time was calculated for all ECNs during the first Quarter 2018 (without PLM) and compared with all ECNs during first Quarter 2019 (with PLM). The following measurement step considered all ECNs in Quarter 1 and Quarter 2 in 2018 (without PLM) compared to all ECNs in Quarter 1, and Quarter 2 in 2019 (with PLM), and so on.

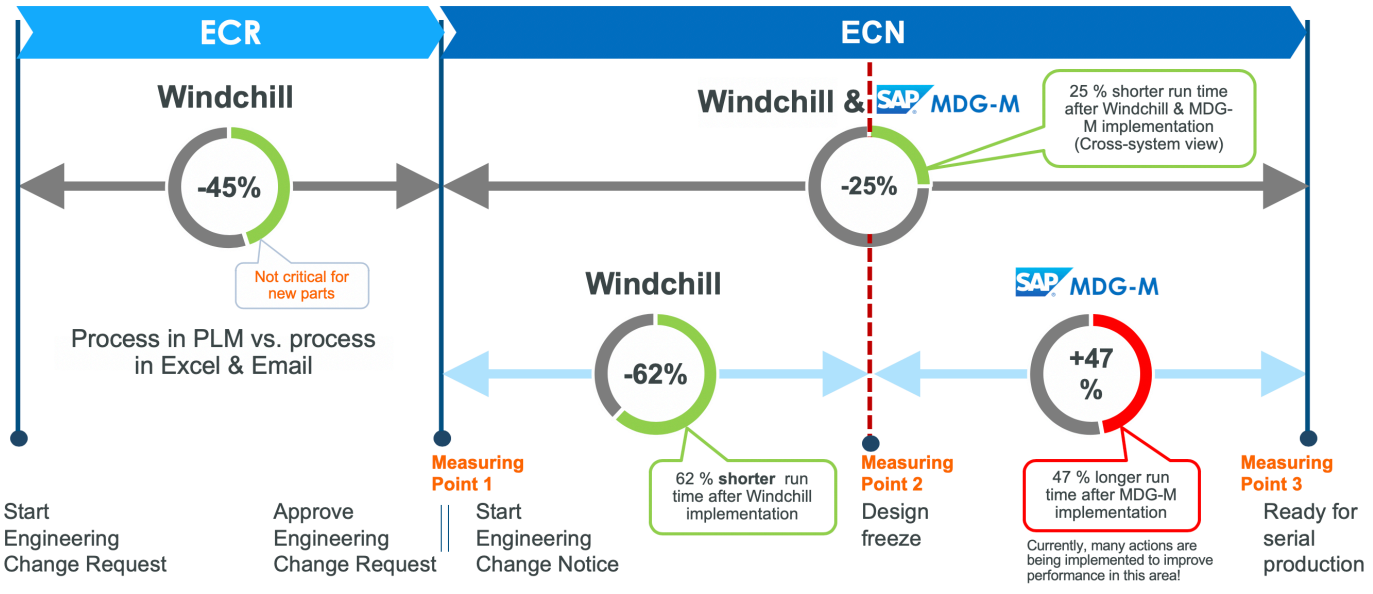

Figure 2: ECN for NPI (Release/Launch of new parts)

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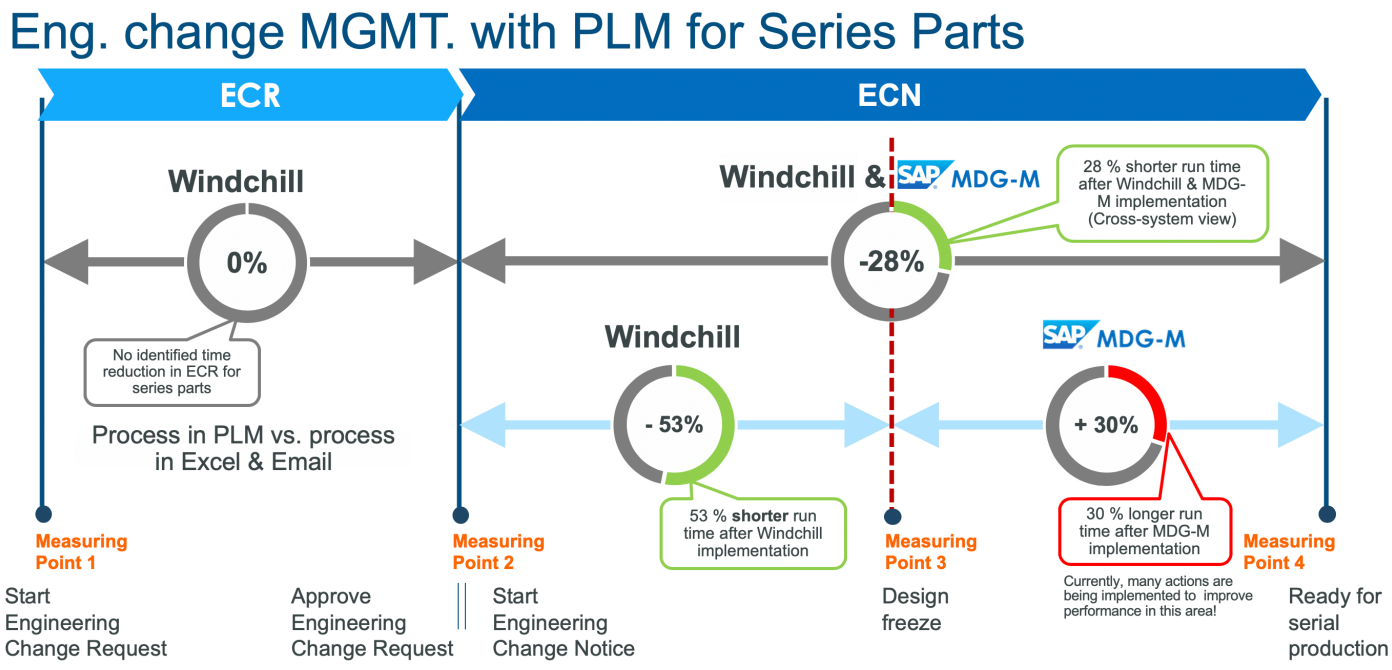
A deep dive into the active workflow systems applied for the ECN process shows a significant run time reduction where Windchill is applied. On the other hand, the process part running in SAP MDG-M indicates a gap between expected and real process run time reduction. Many promising activities have been defined and either launched or currently being implemented to improve the situation.

Looking at the process for modification of series parts, we can summarize following remarks:

- For the ECR process, which is a significant part of the process, we could not see any run time improvement so far. Currently, the process and the system set up are being investigated with close collaboration with key users in order to achieve maximum possible efficiency
- The ECN process shows a cross system (WINDCHILL and SAP MDG-M) run time reduction of ~ 28%. The numbers for Windchill and SAP MDG-M are like ECN for NPI.



Baseline: Big number of ECOs without PLM in year 2018 versus ECNs with PLM in year 2019

Figure 3: ECN for modification of series parts

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Besides PLM workflow benefits, there is another significant aspect which could be noticed before and after PLM. While big ECNs containing a lot of BOMs, drawings, and other documents have been often used before PLM to release new products; the situation after PLM has changed. The people use now smaller ECNs and start the process on the right time leading to shorter process run times and a better planning.

Process to approve 1st physical samples

Before parts or products flow into series production, two important approvals–besides others–must be carried and should be aligned with each other:

- Approval of product data and documents: This process is managed with the ECN process (Engineering Change Notice) ensuring that all data and documents are ready for series production. The process ensures also that all necessary tasks have been carried out by production, quality, purchasing etc.
- Approval of 1st samples of parts/products: Based on product documents and data, the first physical samples of products are delivered, for example by supplier. Now, it should be ensured that the delivered physical samples of parts or products fulfil the requirements described in product data, drawing, technical specification etc. This control is carried out by, above all, Quality, Development, Production and Purchasing.

> "The workflow functionalities in the End-to-End PLM solution made up of Windchill and SAP MDG-M makes communication faster, transparency much better and reduces manual work to a minimum. Windchill and SAP MDG-M have all the assets for the groups to view. Essentially, the way we are working and creating Engineering Change Notices (ECNs) has vastly improved with our End-to-End PLM solution. PLM has changed the way the people at Vaillant work, our workflows, and transfer of our most valued objects."
>
> **Dr. Gamal Lashin, Strategy & Performance Manager, Vaillant Group**

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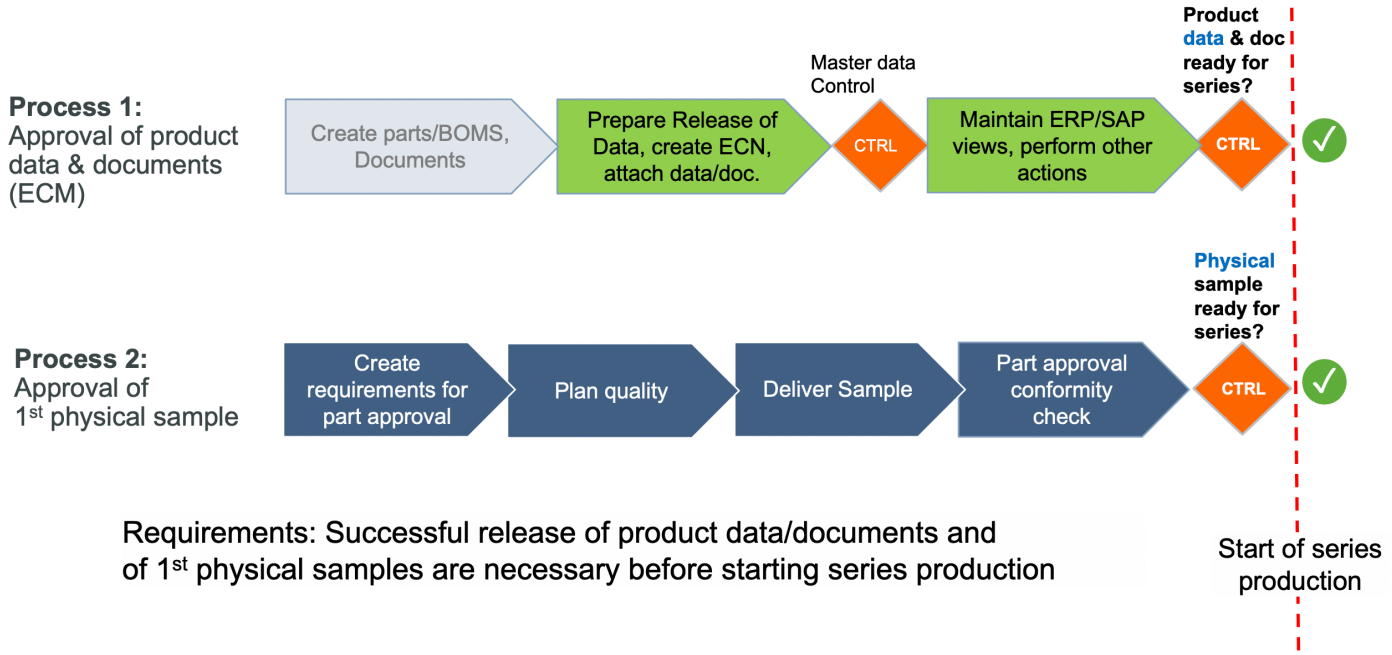

Figure 4: Necessary approvals before starting series production

Situation before PLM:

Before PLM implementation the approval of product data and documents as well as the approval of 1st physical samples and the alignment between both approvals were managed manually and with spreadsheets with typical complexities. An analysis of two significant Bill of Materials (BOMs) which were carried before PLM shows that about 50% of physical samples approvals were not done or were done but not consistent (approval protocol vs. ERP data) at the start of series production. As this is not allowed, a re-work was necessary.

After the implementation of PLM, both approvals are fully controlled by PTC Windchill and SAP. There is a hard link between both approvals in PLM allowing no deviation at the start of series production.

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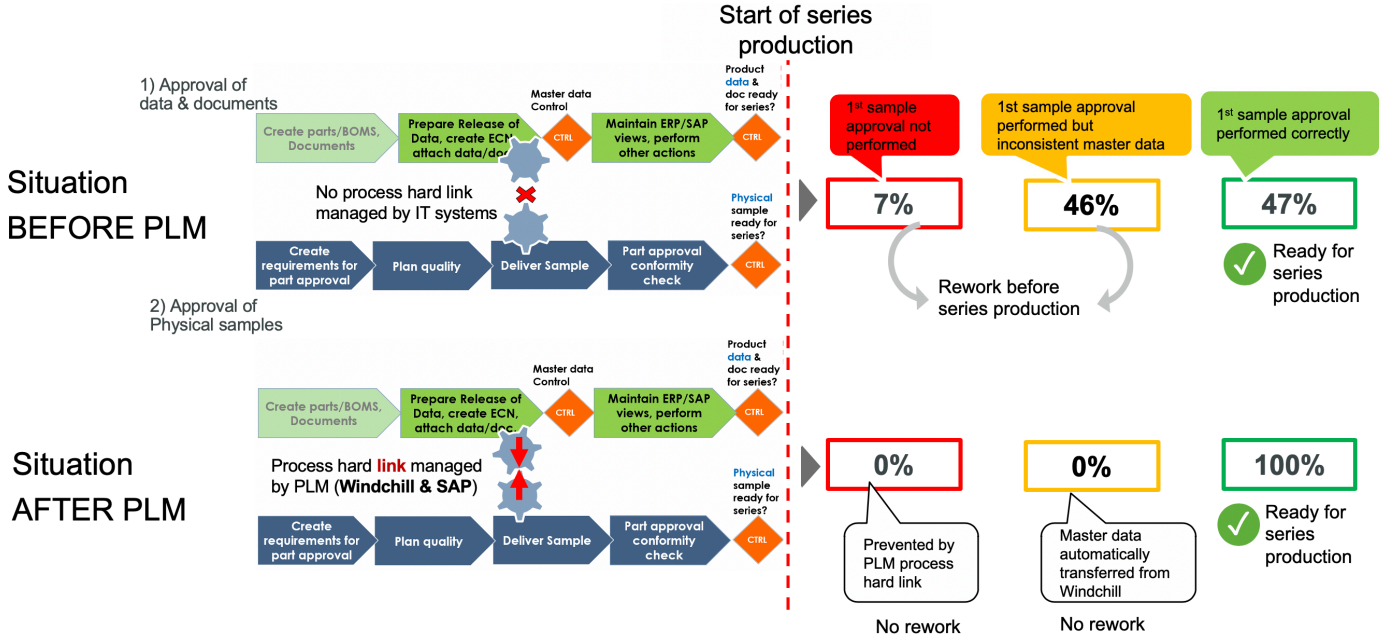

Figure 5: Improved process quality of 1st physical sample approval after PLM mplementation

Improving follow-up documentation of ECN

The documentation of Engineering Change Notices (ECNs) follows a formal and regular approach as explained in figure 6.

After deciding on Engineering Change in Step 1, an ECN is created in Windchill (Before PLM this was called ECO in SAP) to manage the implementation of the change. After creating the ECN, the relevant data and documents which are planned to be changed must be assigned to the ECN (Step 2). In Step 3, the data and documents are changed by the user before the ECN approved in Step 4. including all attachments (data & documents). Based on the modified data/ documents, the production and other departments prepare the implementation of the change in Step 5. In steps 6 the series production can start.

Generally, a manual process allows unwanted deviations. This was the case with ECN documentation before PLM. This situation leads to re-work before starting series production causing efficiency drop.

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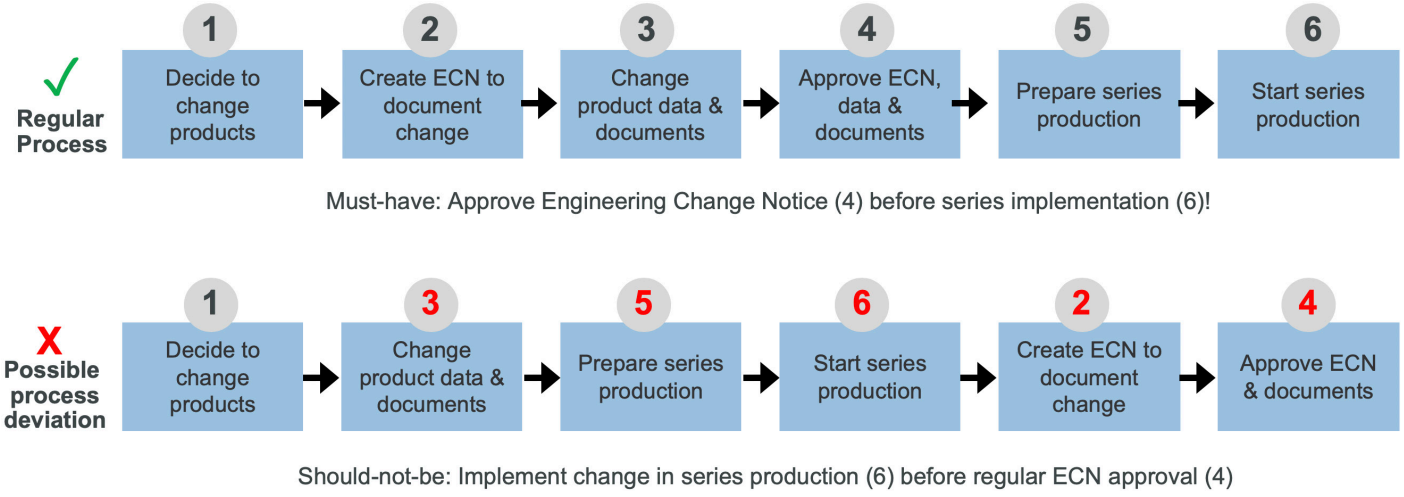

Figure 6: Regular process and possible deviation with ECN documentation

Now, this process is fully supported by PLM at the Vaillant group. The share of ECN follow-up documentation in 2018, where PLM was not yet applied for ECN process, was compared with 2019 where all ECNs run in PLM (Windchill and SAP MDG-M). Thousands of ECNs and ECOs have been investigated before and after PLM and the picture is worth 1000 words. With PLM the share of ECN follow-up documentation was going down from ~ 50% to 2% within 12 months. This is a clear message for the ability of PLM to get processes under control and enable your engineers to have more value-added time.

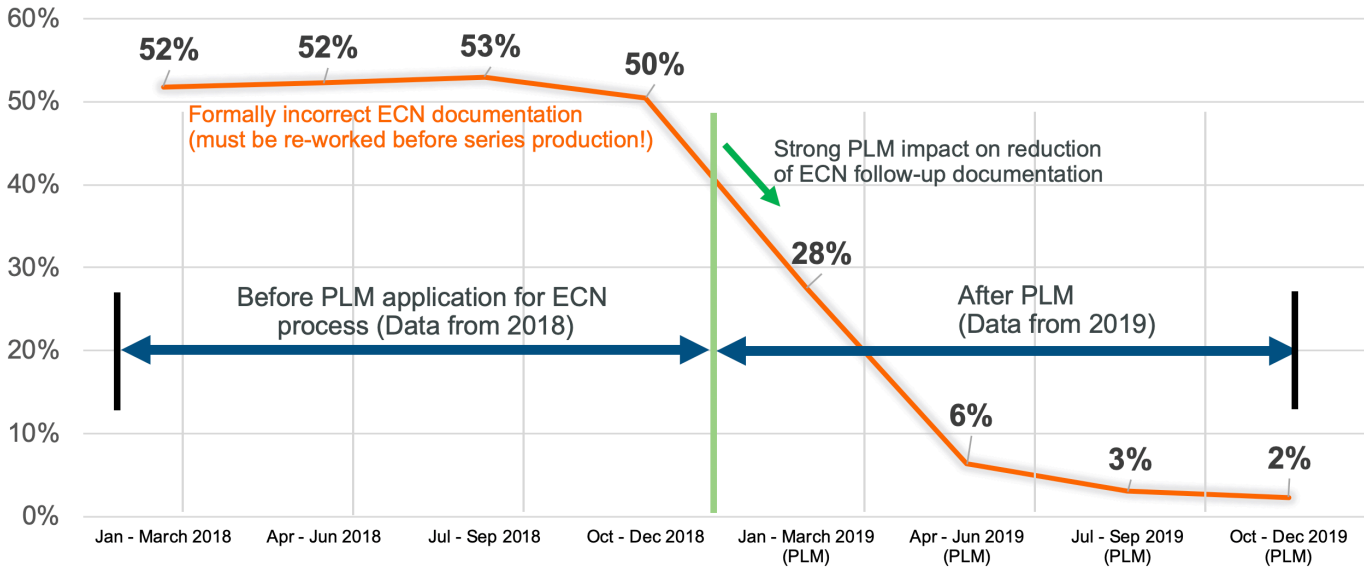

Figure 7: Significant reduction of ECN follow-up documentation due to PLM

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Improving master data quality

Master data are key data assets within an organization and are the entities that describe products and drive business processes. They need to be evaluated, for instance, to measure performance. In order to achieve high quality of master data to ensure smooth business operation, they must be controlled by governance processes.

Before PLM, master data of products at the Vaillant Group have been created and maintained by R&D in different systems: 3D CAD system, PDM system, spreadsheets, Text processing systems etc. This led to duplicated data, multiple data inputs, incomplete data etc. Examples of products master data created during product developments are: part designation (Nomenclature), part number, part revision, material, division, weight, basic unit of measure etc. Before design freeze, a master data quality check must be performed. Incorrect or incomplete master data must be reworked before passing Design Freeze. This rework caused additional effort.

After PLM, data sources where master data are maintained are connected and duplicated data have been minimized. The share of rework due to master data quality issues is decreasing after PLM and free resources can focus on innovative tasks (Figure 8). By the end of 2019, the share of rework has been reduced by 16% compared to 2018. As practice makes perfect, it is expected that the situation will be continuously improving in the future.

Project lead time

The project lead time is the latency between the start and the completion of a project.

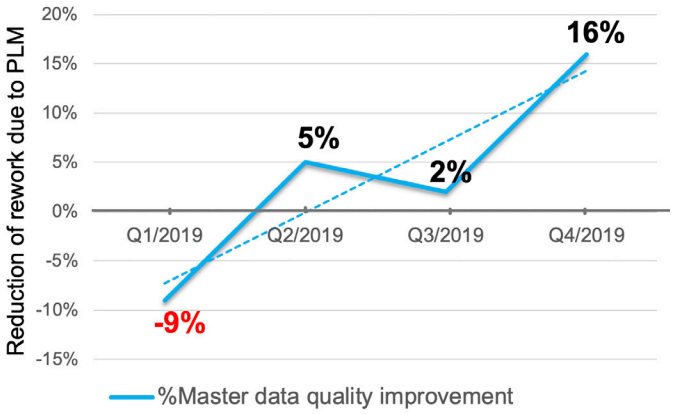

Figure 8: Improved master data quality due to PLM

Reducing project lead would also lead to reduce time to market increasing the completive advantage of a company. For product development and product management, the time to market is often a key KPI to measure work performance. The right PLM solution will help to reduce time to market.

At the Vaillant Group, development projects are maintained and tracked in MS Project before and after PLM. Before PLM project work was characterized by several complexities:

- Maturity of parts and product were maintained manually in Spreadsheets with links to relevant data of systems.
- Many processes during product development were based on paper, email, and spreadsheets
- Product data distributed in many systems without effective connection
- Duplicated data were entered manually in different systems
- The maturity status of all drawings and all technical specification within a project was extremely difficult to track

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PLM could really help through following functionalities:

- Workflow control for key processes and approvals
- Central database for engineering data (consistent & up to date) and loading other systems with up-to-date information
- Visible status concept for parts, products, documents etc. over the complete lifecycle. The status is available in Windchill and in SAP as well.
- Automatic data transfer from Windchill to SAP
- Reduction of data entries
- Provides excellent search mechanisms for product documents and information
- Enables cross-enterprise collaboration and communication during product development, also with third-party,
- ….and more

The project lead time was measured before and after PLM. The following measuring points have been selected:

- Date of project start
- Date of product design Freeze (developed within the project)
- Date, where the product is available in the market.

A huge number of projects before and after PLM have been analyzed to measure the effect of PLM on the lead time. The most significant lead time which can be affected by PLM is between *Start* and *Market Availability*. Projects run in PLM show an average reduction in the lead time *Start-to-Market Availability* of about 8% compared to projects run before PLM. Further reduction in the lead time is expected due to increasing experience with PLM in the future.

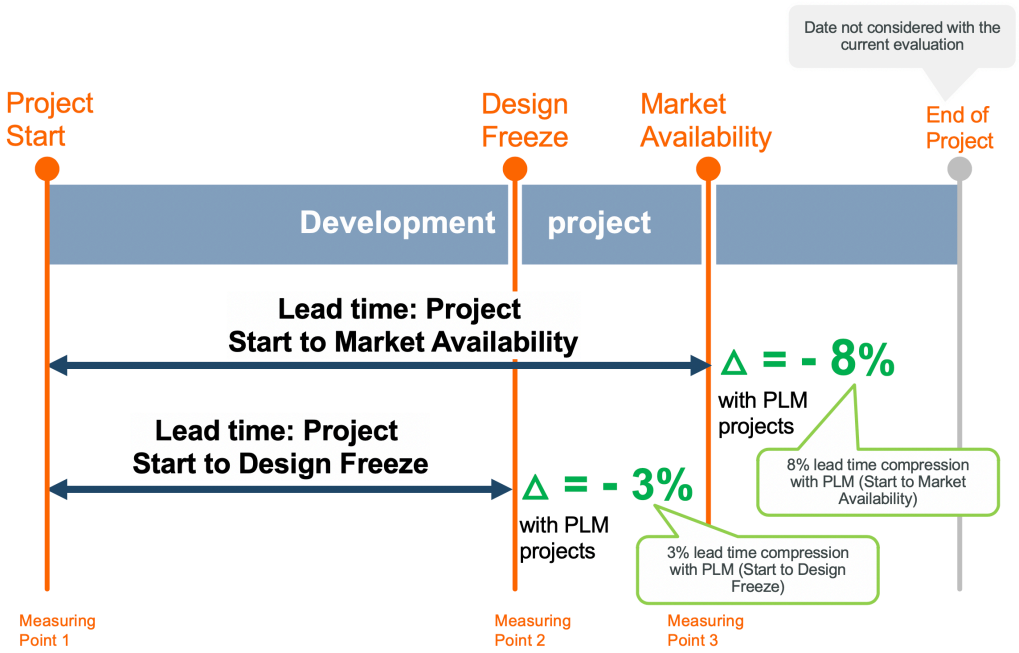

Figure 9: Reduction in project lead time due to PLM

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Digital Transformation

While Vaillant Group is still in the process of getting their Digital House in Order, they have come a long way already by tapping into the engineering change management process benefits that PLM inherently provides. Their short-term goal of improving efficiency from 2015 has been a real success story for Vaillant. And what is more important is that they took the time to measure and quantify the results of their efforts to bring Product Lifecycle Management into their organization.

Armed with these new metrics and results—clearly illustrating the value of PLM—the stage is set for the next level buy-in from the Vaillant Group C-Suite. What this means is that they have a great business case to continue pursuing their Phase II & Phase III plans of Digital Transformation (including technologies such as IoT and AR).

As a recommendation to other organizations looking to do the same: closely tracking how your PLM solution is working is just as important as implementing it in the first place.

For more information on PLM Change Management, visit PTC's Change Management solutions webpage.

PLM is not something that you just "set and forget."

PLM is a dynamic resource that provides the backbone for any organization seeking their own Digital Transformation.

Vaillant certainly looks to the future as they strengthen their Digital Thread with new technologies to deliver even more value back to the business.

> "Our partnership with PTC has helped us discover and set-up new manufacturing possibilities using the most advanced technologies on the market from 3D CAD, PLM, IoT to AR. With these coming online in the future, Vaillant Group is sure to prosper in Europe and abroad for decades to come!"
>
> — Dr. Gamal Lashin,
> Strategy & Performance Manager, Vaillant Group

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