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Improving Electronic Engineering
Efficiency with Automated Processes

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Improving Electronic Engineering Efficiency with Automated Processes

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Abstract/Summary

Rising cost pressure is forcing manufacturers and their suppliers to jointly and consistently master product development. Our case study shows how Volvo over time is achieving effective interaction of engineering processes, tools and people on the basis of product and application life-cycle management (PLM / ALM). Starting from establishing the relevant engineering processes, we show how they can be effectively automated for best possible usage across the enterprise and even for suppliers. We practically describe how such a profound change process is successfully managed together with impacted engineers and how the concepts can be transferred to other companies. Concrete results for efficiency improvement, shorter lead time and better quality in product development combined with better global engineering underline the business value – specifically in times where cost are to be cut and performance must substantially grow.

Kurzfassung

Der steigende Kostendruck zwingt Hersteller und ihre Zulieferer dazu, die Entwicklung durchgängig und systematisch zu beherrschen. Unsere Fallstudie zeigt, wie Volvo ein wirkungsvolles Zusammenspiel von Entwicklungs-Prozessen, -Werkzeugen und den beteiligten Ingenieuren auf der Grundlage von Produkt- und Applikations-Lebenszyklus-Management (PLM / ALM) eingeführt hat. Ausgehend von der Einführung relevanter Prozesse zeigen wir, wie sie wirkungsvoll automatisiert werden können, um die bestmögliche Nutzung im gesamten Unternehmen und auch für Lieferantenschnittstellen zu erreichen. Wir zeigen praxisnah, wie eine solche Veränderung gemeinsam mit den Mitarbeitern umgesetzt wird, und wie die Konzepte auch auf andere Unternehmen übertragen werden können. Konkrete Ergebnisse zur Verbesserung von Effizienz, Durchlaufzeiten und Qualität in der Produktentwicklung hin zu einer durchgängigen globalen Entwicklung unterstreichen den geschäftlichen Nutzen – gerade in Zeiten, wo Kosten reduziert und die Ergebnisfähigkeit gesteigert werden müssen.

1. Improving Efficiency with Better Engineering Processes

The current automotive crisis demands cost reduction all along the product creation – including pre-development and product engineering. OEMs and suppliers both struggle to invest now in their engineering in order to fill the pipeline with successful cars some years down the road, while the available capital and resources are very much restricted. The challenge is to develop successful products under the pressure of decreasing development budgets. Specifically in areas where engineering and collaboration processes are only partly established, such as in the engineering of electronic systems, there is substantial room to improve efficiency. When done intelligently such improvements will sustainably cut cost all along the product life-cycle because rework will be reduced and changes are easier to implement.

There are numerous levers for engineering efficiency improvement. Many automotive companies, both OEMs and suppliers, operate with distributed teams leading to fragmented processes and tool chains with heterogeneous interfaces, redundant and inconsistent data management and insufficient transparency which results have been achieved and what needs still to be done. Activities such as project management, pre-development and product engineering are rarely integrated well due to the diversity of stakeholders with individual knowledge about projects, products and processes. As a result, engineering results such as specifications, documentation and test cases are inconsistent, items like signals and parameters are arbitrarily labeled, changes create lots of extra work to make sure that nothing is overlooked, and reuse is hardly possible due to the many heterogeneous contents. This pattern is amplified when collaboration across supplier networks comes into the picture, as it is today normal in E/E systems development.

We will show with this article how engineering processes can be improved and automated, thus enhancing efficiency, quality and lead time. Such changes need leadership and good orchestration to be successful. We therefore show how a sustainable change process is successfully managed together with impacted engineers and how the concepts can be transferred to other companies.

2. Product Life-Cycle Management: Process, Persons and Tools

Product Life-Cycle Management (PLM) is the overall business process that governs a product or service from its inception to the end of its life in order to achieve the best possible value for the business of the enterprise and its customers and partners. It combines people, processes and tools for the effective engineering of products. PLM is only cost-effective if there are the right engineering processes and if they are automated and instrumented with

appropriate tools [1,2]. Sustainable cost reduction is achieved when people, processes and tools harmonize instead of the typical fragmented and isolated silos with rework at each interface.

To work efficiently, engineers need to handle a multitude of processes and different forms of knowledge to be shared with colleagues across business processes and even beyond the borders of the enterprise [1]. PLM helps to integrate those along the entire life-cycle of a release or product or beyond to an entire portfolio as is illustrated in Figure 1. Many companies have realized in this fierce climate that their traditional rather organically grown tools landscape with isolated unconnected processes not only won't scale up but also limit their engineering productivity due to manual data exchange, too much rework, inconsistencies and insufficient reuse across products and platforms (Figure 1, left side). A federation of processes and supporting tools with clear responsibilities improves efficiency by more consistency, quality, reuse and not the least employee motivation (Figure 1, right side).

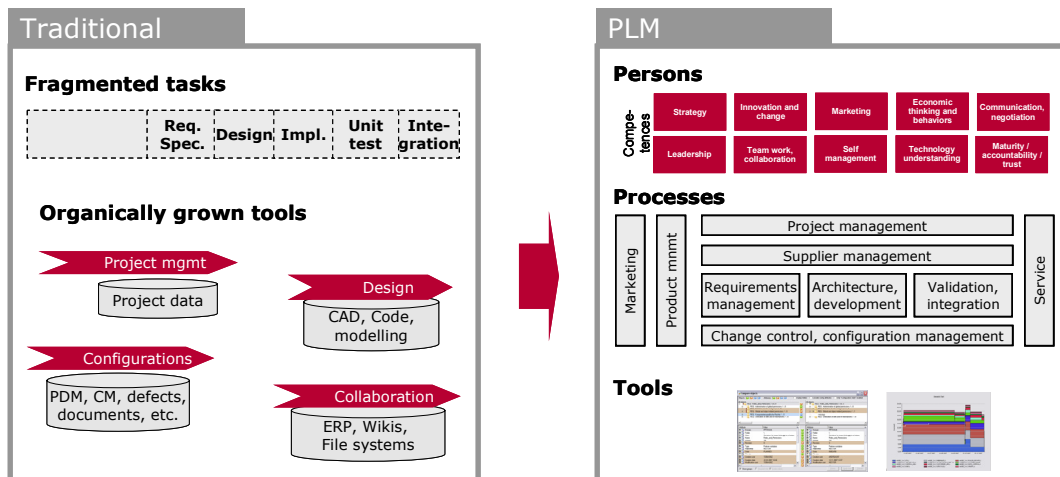


Figure 1: PLM integrates processes, people and tools for effective engineering

PLM needs both process and tools support as indicated by Figure 2 based on a study at London Business School [1,2]. Tuning processes, improving project management, and establishing visibility on new product introduction – techniques well described by common improvement frameworks, such as CMMI [4] – will not yield sustainable benefits if not adequately supported by tools. The prospect of new, high-margin products, combined with the delayed impacts of resource allocation decisions, seduce product managers into starting more projects than their development resources can handle.

The scope of an E/E-PLM system is on the one hand the creation and management of engineering data in one common engineering data backbone and on the other hand the management of processes. PLM as a concept and solution applies to software engineering as

well as to systems or hardware products. It applies to different types and sizes of companies, because it is not prescribing a solution suitable only for big companies but rather a clear focus on processes along the life-cycle. We use it for complex solutions with multiple hardware and software components as well as simple software services.

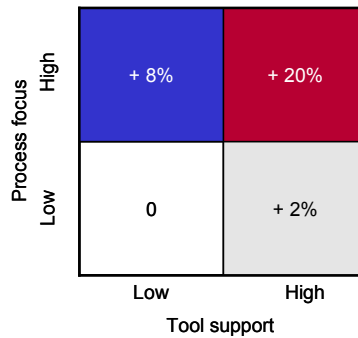


Figure 2: Tools without processes are nothing; processes without tools are not good enough

One example of an E/E-PLM tool is the “eASEE Automotive Solution” – a complete tool suite of integrated data and process management modules [3] (Figure 3). Based on a rich and extendable data model for features representing the logical and the physical system architecture and the software architecture, a set of eASEE modules can be used for highly integrated use cases. For instance in configuration and change control, issues are connected to system data objects, the related realization date is fixed in the release planning module, the implementation time and effort are planned in the project management module, the change of the related software parts are managed in the source code management module and finally the test are planned and executed in the test data module.

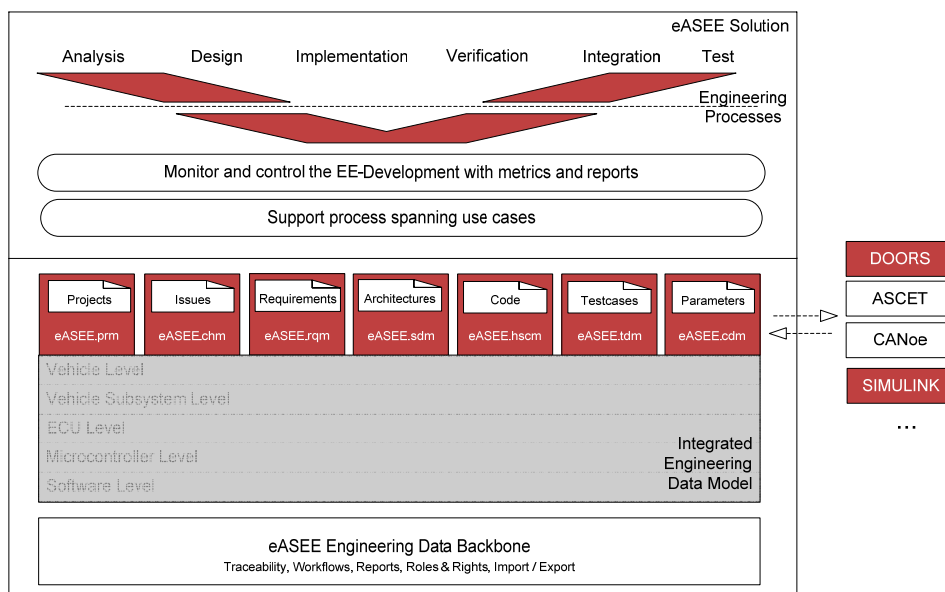


Figure 3: eASEE Automotive Solution

Being able to not only reuse information but also guide engineers through complex tasks generates immediate returns by making engineers more flexible and avoiding errors, specifically during last-minute changes and corrections under time pressure. Or, consider the time and effort necessary to move engineers from one project to another. Having standardized PLM solutions around a standard product life-cycle reduces the learning curve to allow focusing on real technical challenges instead of organization overhead.

3. Managing the Change

With current cost pressure PLM and new tools are introduced to automate engineering workflows. However, the expected benefits are often not visible. Instead, employees are frustrated and continue working with their current work practices. The new interfaces create additional frictions and delays. Our consulting projects show that the root cause is often the same: Implementation of efficient processes with adequate tools support with sustainable results requires profound change management – which is rarely taken into account. To manage such change and to ensure that impacted engineers not only pay lip service but actively support and buy into the new processes and tools, their needs and typical work flows must be understood to avoid that process overheads and heavy tools solutions hinder their creativity. This implies pro-active preparation way before a tool decision is made and good leadership, coaching and support through pilots and roll-out.

To adequately support the change process during PLM introduction, Vector has developed over the years a change methodology that is adapted to specific business goals (Figure 4).

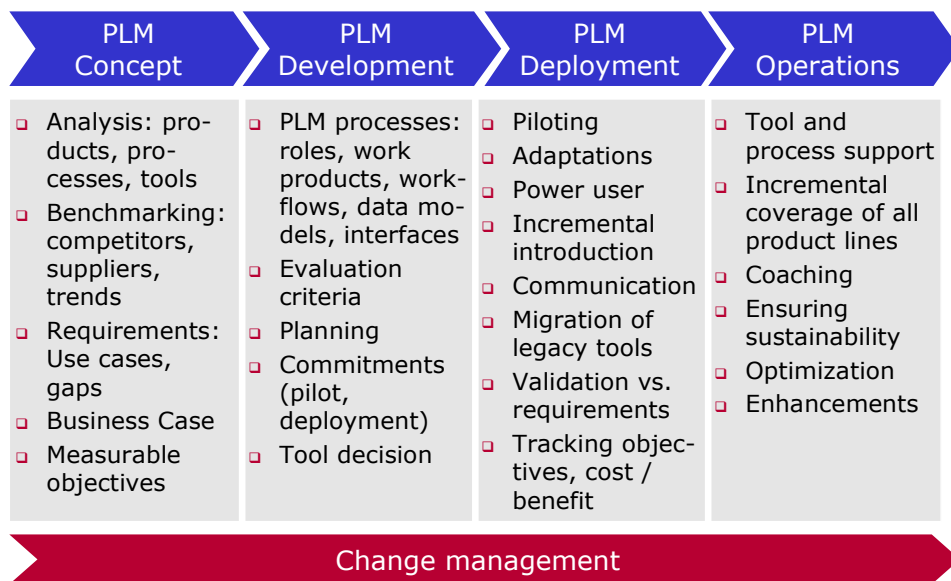


Figure 4: Vector change model for successful PLM introduction

A clear and objective-driven improvement strategy driven by business needs, such as cycle time reduction, reuse with shared platforms, less requirements changes and reduced rework ensures that process changes and tool support indeed translate to efficiency improvement. Such change process though it might look obvious typically needs an external catalyst in order to be followed through and thus avoiding that in the midst of such project, engineers are overwhelmed by the amount of small yet severe changes that impact their daily operational work.

4. Experiences with eASee-based PLM at Volvo

Current industrial experiences with an E/E-PLM implementation on the OEM side are shown by the ELEKTRA project at Volvo Car Corporation (VCC). We followed above mentioned change process (Figure 4) and thus use the same headlines. PLM deployment and PLM operations are combined in ch. 4.3 due to the ongoing deployment activities.

4.1. PLM Concept

Initial Situation: The main drawbacks of the initial situation at VCC were non-connected tool chains and a document driven subsystem and component engineering process with a lot of manually managed interfaces. Therefore the organization had to deal with a time-consuming and expensive reviews/rewriting process, a lot of redundancies and inconsistencies which often were not detected by these reviews, not standardized naming conventions and an ineffective way of developing and acquiring information. Further the information was spread over several data sources and a common version control was not really possible.

Objectives and Solution Approach: VCC's objectives were to increase the engineering efficiency, the quality and consistency of the working products and to shorten the existing lead times in the electronic engineering. The solution approach was to implement a seamless information management of engineering data from function to ECU software and hardware.

The main characteristics of such a solution should be:

- Alignment of processes.
- Single source of information.
- Simple hand shaking mechanism for changes.
- Reusability of information.
- Utilize AUTOSAR standard.
- Use commercially available tools.
- Continuous development instead of step-wise.

4.2. PLM Development

After an intensive market research and pre-phase, VCC decided to implement the information backbone in a close development partnership with Vector. The VCC application is called ELEKTRA, based on the Vector product “eASee Automotive Solution” (Figure 5). VCC uses the parts “System Data Management”, “Test Data Management”, “Requirements Management” and “Change Management” of the integrated eASee tool suite. Figure 6 shows the practical use of E/E PLM in VCC to relate different features and artifacts throughout the life-cycle.

The possible efficiency win of this approach was investigated by a wide set of interviews, done in the E/E-engineering departments. The result was an estimate of 2% efficiency increase in the first year of the ELEKTRA implementation and an efficiency increase of annually 13%, beginning with the fourth year of the ELEKTRA implementation. This estimate with the related profits for VCC was the reason, that ELEKTRA still is the number one IT-project in the entire VCC organization.

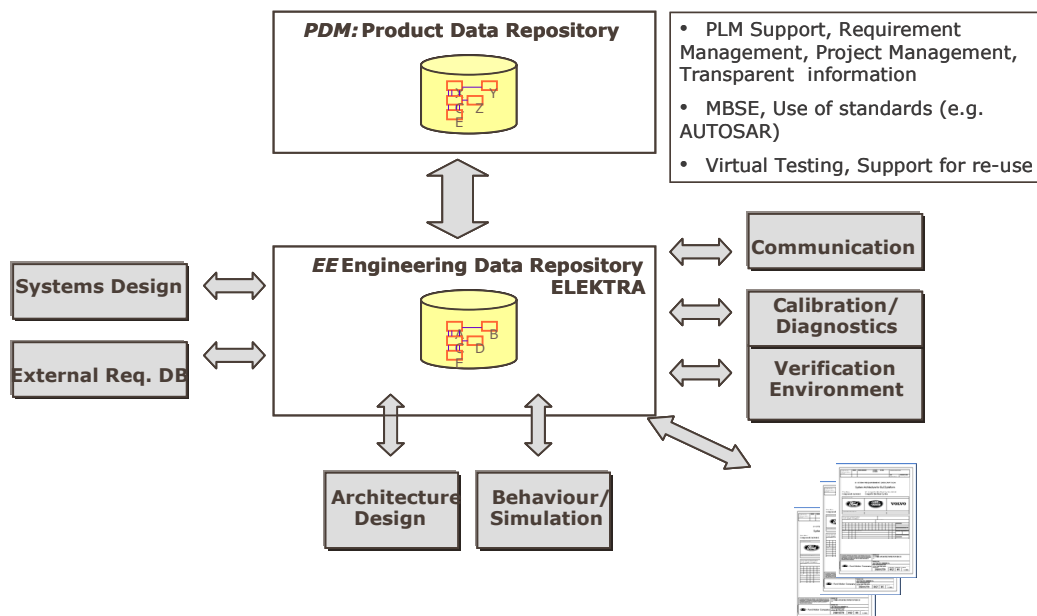


Figure 5: Practical use of ELEKTRA at the Volvo Car Corporation

As shown in Figure 7, VCC and Vector agreed to a four year implementation plan to realize a continuously increase of the ELEKTRA functionality and to achieve the completeness of the ELEKTRA application.

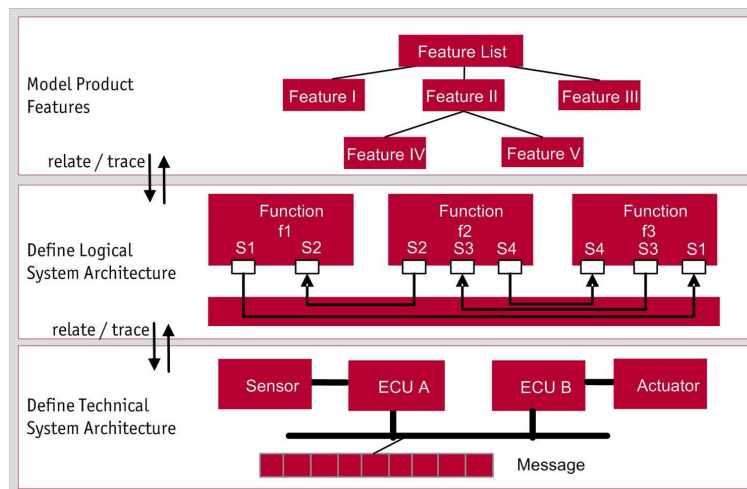


Figure 6: Practical use of E/E PLM in VCC to relate features and architecture across components and throughout the life-cycle

4.3. PLM Deployment and PLM Operations

A project like ELEKTRA is a long term activity which has to be funded by big budgets of money and significant internal resources. Therefore the *decision preparation* needs care:

- The necessity of a change must be accepted broadly in the organization and the reliable commitment of the top management is a key.
- The process tool has to fulfill the main requirements of the customer and it must have the potential to grow with the growing needs of the user base.
- The partner must be reliable and the chemistry between the main actors should secure the probability to realize a true long term partnership. As an important base for this, both – the customer and the vendor – should share the same vision of future E/E-engineering methods and processes.

Especially at the beginning of these kinds of projects the danger of too big ambitions and a too broad scope of functionality are huge. In the *planning and implementation phase* VCC had a lot of success with the approach to focus on one certain use case. For the first versions of ELEKTRA, VCC concentrated on the automated creation of SRD (subsystem description e.g. for locking) and SWRS (software requirement specification e.g. for a body controller). Further the close links between requirements and test cases was part of the first ELEKTRA release. Further design verification methods are documented in ELEKTRA. This focus was manageable for VCC in its role to define the requirements and for Vector to implement the agreed data model and the core functionality in the eASEE Automotive Solution. And – nevertheless, even with this first release a lot of the drawbacks of the former organiza-

tion and tool environment could be eliminated. Further both parties need a strong and competent leadership on project and management level.

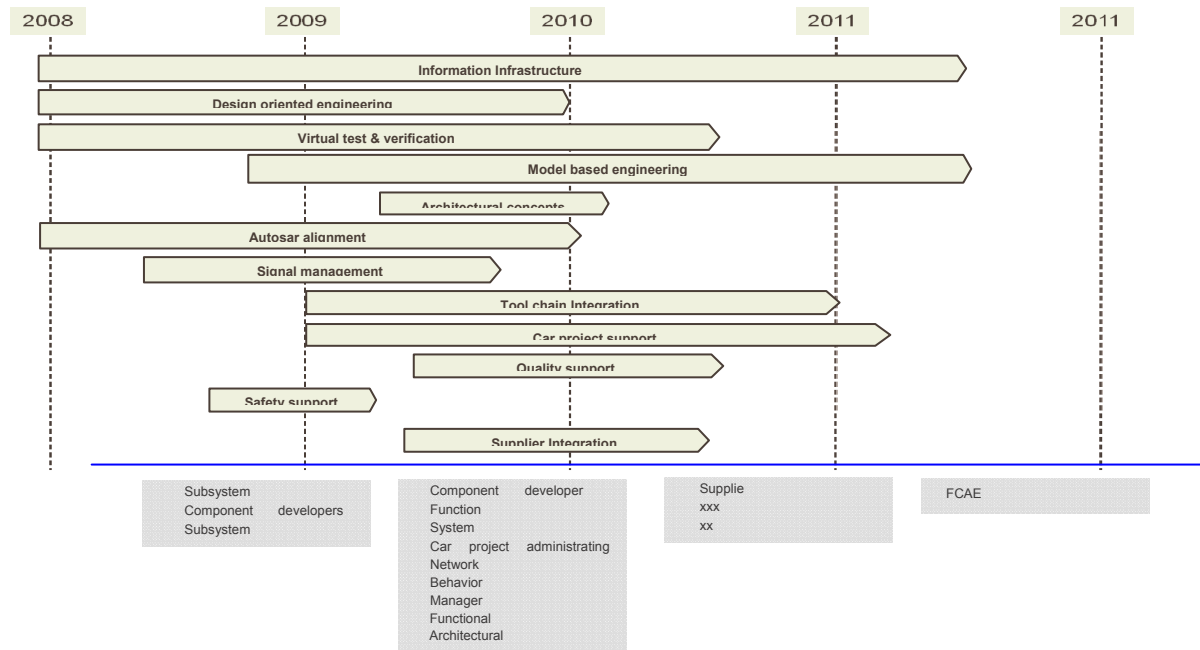


Figure 7: ELEKTRA implementation plan

Resistance out of the organization, lack of money, changes in priorities, pressure from the user groups, theoretic discussions – these are not the exceptions, these are normal influences in such a project. The partners have to be able to deal with it and put the best personnel in the position of project leaders and methods/process engineers. At least VCC made good experiences with an iterative-incremental development process for ELEKTRA – short implementation cycles, early validation with a small group of well experienced pilot users and a professional change management guaranteed mature deliveries for productive use.

In the *rollout phase* normally a small group of convinced pilot users are facing a big group of engineers, which are open for the change in principle, but they are in the conflict to invest on the one hand more upfront time for learning the new environment and to have challenging objectives for their normal work products on the other hand. Furthermore, migration to a new way of working often includes "clean up" of older specifications, which also requires effort. And there is the small group of engineers, who are convinced, that the current, traditional way of working is the optimum and that there is no need for a change at all. VCC managed this situation with special ELEKTRA trainings for key users and initiating "Jump Start Projects". In these projects the VCC engineers were supported by well known and well with VCC specific engineering knowledge experienced consultants, which have been trained in

ELEKTRA before. In this combination these engineers did the same work as a VCC engineer, but in addition they were able to train and coach the VCC colleagues in doing their daily work in the ELEKTRA environment. The "Jump Start Projects" are focused and have a predefined duration (typical two months).

5. Summary and Conclusions

For most companies, there is a wealth of untapped opportunities to cut costs from their development projects. Inefficiencies are rampant when engineers are distributed globally and many different tools being used. Concrete efficiency and quality improvements with reduced rework and faster throughput have been showed by applying consistent PLM. The efficiency and effectiveness of engineering processes directly influence engineering cycle time. For instance earlier defect detection in requirements or specs means faster and more comprehensive defect correction.

Utilizing a consistent product life-cycle and process repository is a necessary condition for reducing cycle time, as they reduce frictions of unclear interfaces and responsibilities as well as cutting rework because of inconsistent assumptions and cutting retrieval time for specific documents and work products. In implementing PLM we found the following lessons learned:

- PLM concept: First improve the process then the tools based on concrete improvement objectives that are set, measured and used to correct deviations.
- PLM development: Evaluate tools under realistic conditions. Agree specific requirements to the process and tools which are then used to drive changes.
- PLM deployment: Manage the changes as they impact the entire organization. Pilot changes, coach and train engineers, highlight power users that will set the pace.
- PLM operations: Support users and ensure continuous improvement.

Embarking on a state of the practice E/E PLM solution combined with strong change management triggered by external support had helped to sustainably achieve the anticipated efficiency effects in the different engineering processes across the product life-cycle.

Literature

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