A Web-Based Interactive Information Hub for Future Vehicle Engineering

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ABSTRACT

Mobility must change drastically within the next 5 to 10 years especially in urban areas. It must fit to societal and ecological requirements and expectations. Therefore, also vehicles and transportation products will change as well as related business models. New players and start-ups have to be integrated within the collaboration framework, approaches for cooperation, organization and process design have to be thought out in a new way. As a consequence, vehicle development itself has to look different. Complexity of product, process and cooperation will still rise [1] due to new product functions, increased individualization of mobility products and dynamic market changes. Players who are able to handle complexity and permanent changes and uncertainties ("VUCA") in a proper way will win this competition. An important aspect will be the question of how data and information can be provided efficiently, interdisciplinary and user-oriented over the entire lifecycle. Within the "Future Engineering Lab" research project, VIRTUAL VEHICLE, together with well-known partners from industry and research, addresses aspects of how vehicle development and the development environment should look in the future. These approaches will be presented in a laboratory environment in order to make them more tangible and to better support decision-making processes. One result is a demonstrator that graphically depicts information in the context of arbitrary views, allowing for intuitive and hassle-free navigation and exploration of engineering data for developers. This paper explains the objective, concept and claims of the demonstrator application.

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KEYWORDS

Future engineering, Information Hub, Future Engineering Lab, web-based information availability, graph-based information aggregation, graph-based exploration

1 Characterization and Challenges of Vehicle Development

New mobility concepts, legislative requirements, market demand and technology innovation are major drivers for the raising product complexity and variety of vehicle and transportation products [2,3]. Digitalization is increasingly influencing products, process and organization. The engineering approach is more and more driven by development speed and time to market.

The characteristic of future vehicle engineering will change drastically due to the fact, that products will look different and the lifecycle phases will be significantly overlapping. Vehicles will be developed and deployed continuously to be able to react on market, consumer or legislation demand.

To address current and future challenges 4 major topics are in focus of automotive and rail industry as shown in the figure below:

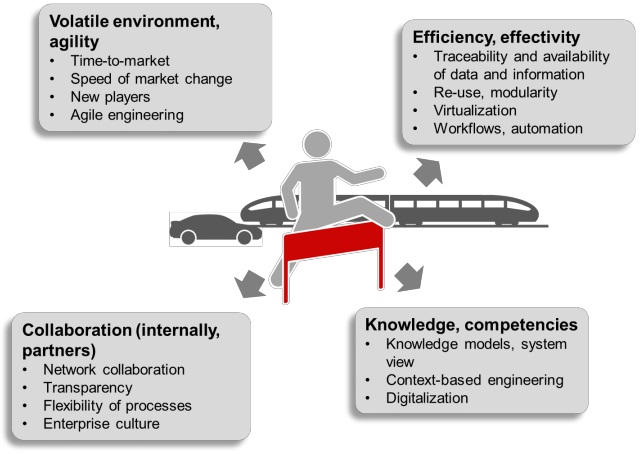

Figure 1 Challenges in automotive and rail industry

Volatile environment and agility: The market changes speed up. Companies must be more flexible to react on these changes to be competitive. Reducing time to market is still one of the mostly mentioned objectives in industry. Additionally, new players on the market are used to work and collaborate on significantly more flexible and agile developing approaches, they are driving the innovation speed with new ideas and new methods.

Efficiency and effectivity: Key factors for efficiency are availability and traceability of data and information, re-use and modularity of product, functions or models as well as a user-oriented and therefore well-accepted supporting engineering or lifecycle integration platform that enables knowledge-based workflows and automation.

Collaboration: Hierarchical organizations and collaboration approaches have to give way for network-based structures for cooperation. Processes and structures have to be flexible enough to enable scalable and effective collaboration between different partners with diverging development and project organization or processes. Enterprise culture is getting a key issue beside needed competencies – for future product function and development effectivity.

Knowledge and competencies: Product and engineering experience have to be available to the engineers. Re-use of knowledge and artefacts of development – as functions, components, models – is a crucial aspect for efficiency. A system view is required for a comprehensive understanding of a system behavior. Data driven technology and services have to provide a context-based support enabling the handling of complexity.

The speed of development and implementation of innovation either for products or for engineering processes plays a decisive role due to the global competitive situation. At the same time, the process of cultural change and the involved employees have to be closely examined. Companies in the automotive or rail domain are going to restructure themselves towards agile development and manufacturing enterprises. The transformation of companies is a complex and challenging process [4]. It is important to find ways to use the potentials of new approaches and at the same time to positively shape the cultural change in the company [5].
Research programs at VITUAL VEHICLE investigate in future engineering, aspects of efficiency and agility and in empowering cross disciplinary development teams.

2 Future Engineering Lab

The research project "Future Engineering Lab" deals with the question of how future development shall look like [6]. It is investigating a way how to establish the context of the entire lifecycle (concept, development, production, operation) right from the early product definition as well as in the required enablers or fields of action. Aspects such as changes in the product definition (the blurring boundary between vehicle and operation services - new business models / "hybrid service bundles") as well as functional complexity have to be considered. Together with well-known partners from industry and research, approaches shall be made tangible and decision-making processes shall be supported.

The following questions are in the focus of the research activities:

- How may collaboration look like in the future?
- How can transparency and consistency be achieved?
- How can complexity be handled successfully?
- What could a future development environment look like?

As a result of the project, a space, a laboratory - a "Future Engineering Lab" - will be designed and established. In a specially designed room, it will be possible for visitors from management, development and development-related areas such as IT or Engineering IT to get to know, to experience and to access future approaches of virtualized development, of information consistency and of Digital Twins to discuss solutions for their own company.
An important current and future aspect will be the question of how data and information can be made available across disciplines and along all lifecycle phases in an efficient and user-oriented way. Overcoming the silo boundaries between geometrical and functional vehicle design is an essential research aspect. Future agile and cross-disciplinary development teams should be able to obtain all relevant information quickly and efficiently within the scope of their task and utilize it in context.
The following chapters outline the intended future cross-disciplinary engineering approach (chapter 3) and present the concept and status of the prototypical realization of an information hub for data availability (chapter 4).

3 Cross-disciplinarity as Key Factor for Complex System Perspective

A key factor for efficiency and effectivity in development is interdisciplinarity [6]. Most industry companies have historically grown hierarchical organizational structures – dividing domains and disciplines into silos and struggle to overcome the silo barriers. How can effective interdisciplinarity be realized? How can communication within networked engineering look like?
Current and future vehicles have a huge complexity of functionality and properties and expectations. New functions like advanced driver assistance systems (ADAS) or autonomous driving (AD) have to match with a high amount of established and highly interacting functions. The derivation of a new vehicle concept, a significant change of a technical concept or the solving of challenging engineering problems require multidisciplinary views and involved human expertise.
A promising approach for future engineering is the organization of product development by "cross-disciplinary solution teams". The effectivity and practicability of a broad real-world implementation of this organizational approach requires some significant enablers to raise the potential.
Connectivity of data and knowledge helps to define the boundary for a task for the team as well as to define the relevant experts needed in the team. Therefore, the definition of task and team is

crucial. Once the team has started, it acts and works self-organized. It must be able to understand the boundary conditions and interfaces to the project, to other teams or to other roles and responsibilities. What is even more, the team must understand the complete system (product, vehicle) and its requirements and goals (Systems Engineering). It needs easy access to manifold information as well as to knowledge and analogies of former projects in the context of its task. All team members have to look on the same content and status at the same time, but from different perspectives – enabling them to discuss and balance every step and every trade-off immediately. The team as the sum of its discipline-specific views must always have the complete system or at least the integration into the complete system in their mind. The result is a continues integration of all aspects to a full system concept and behavior.

4 Collaboration-based Approach for Future Data Availability and Traceability

The Future Engineering Lab project team is working with renowned project partners from the automotive and rail industries to develop a prototype implementation of future data provision and consistency in engineering, along the product lifecycle.

4.1 Human-centered Scenario

One crucial enabling aspect for cross-disciplinary teams is the availability and traceability of data, information, and knowledge. A scenario of a future well-established development task team might be a creative environment, where all team members are standing in front of a big touch screen – navigating and exploring together easily accessible data from different projects, discuss possibilities, and derive solution scenarios and variants. When doing this together, no discipline-specific perspective may be relevant alone, and each team member will automatically understand other perspectives and objectives to be able to come to a consent at the end.

4.2 Requirements and Demands

The concept work of the team will cover investigation within available data and information from other projects as well as deriving and balancing new concept variants within a sandboxing environment.

As far as task and investigation questions, that have to be considered, will be quite heterogenous, the environment shall enable a generic use and interaction approach. The application(s) have to be highly intuitive. It is not the intention to define another expert tool, as there are already multiple ones in place.

Availability of the application at any site and flexibility of the frontend hardware (monitors, tablets etc.) require a web-based architecture. Graphical visualization shall be possible independently from the configuration of the frontend hardware.

A big touch screen (~ 65 inch) turned out to be the best solution for a group of up to 6-8 persons standing before it and working with the application. 4k resolution is a must to grant sufficient information density on the screen.

4.3 Web-based Solution Approach and System Architecture

The approach of the research project is to collect the heterogeneous data sources and to develop aggregating and view-based access to them. Metadata is virtually merged in a graph database, which allows to define unlimited viewpoints and connection labels within manifold data structures of the original data. Additional data sources can easily be integrated and therefore enrich the user perspective step by step.

To enable various perspectives on the same database, data has to be organized in a network-based way as far as team members and teams shall be enabled to work as network. Graph based information organization allows different views, which may already be created instantly.

Taking these requirements into account, the project team developed an interactive web application for engineers of a cross-disciplinary development team, providing information access via improved data visualization. An interactive graph makes it easy to explore and navigate through the data and serves as a base for digital decision-making.

Figure 2 shows the basic concept of the prototype application that has currently been built during research and is under evaluation together with industry partners.

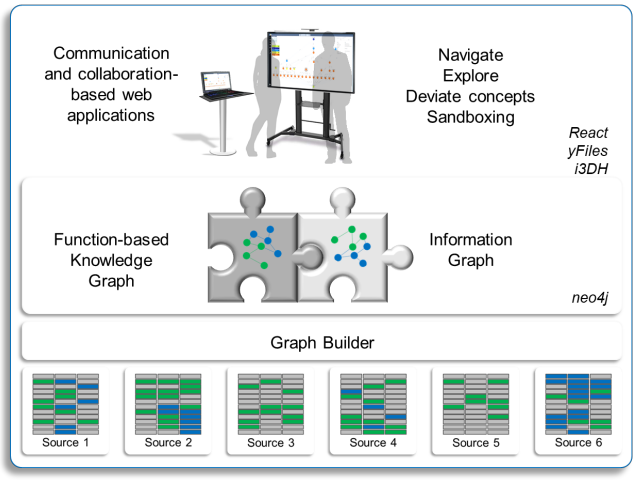

Figure 2 Graph-based architecture of information hub

For visualization of engineering-related artefacts (pdf, pics etc.) different viewers have been integrated. A specific research-based application from Fraunhofer IGD /Germany (instant3DHub) for visualization and analysis of 3D geometry is also integrated allowing instant changes of views between generic data elements (e.g. neutral product structures), project specific instances (e.g. project-specific product structure) and artefacts.

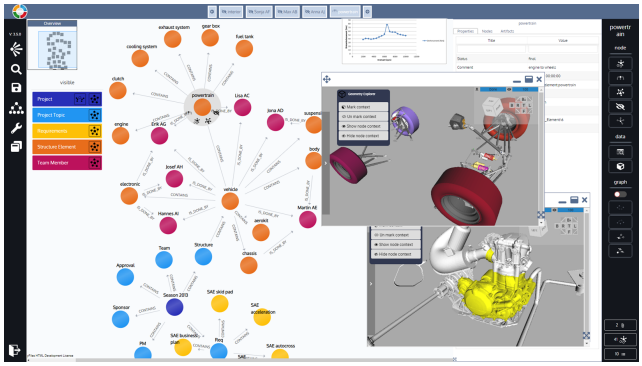

Figure 3 User Interface of the information hub

Various features help the user to search, explore and analyze the aggregated information and to handle the quantity and complexity.

5 Outlook

The prototype of an application of a possible future development environment enables both engineers and management to experience the potential of having easy access to context information at any time along the product lifecycle within a future engineering and product lifecycle environment. Information access for engineers is the first level of usage and business case for the research result. Furthermore, it enables engineering organizations to organize work in a different matter. Information structuring will be no more a question of departments or silos, it enables topic and solution specific support for cross-disciplinary engineering teams. Additionally, it is the fundamental base for establishing a Digital Twin, tracking all relevant information and data on properties and behavior of a real-life product along its lifecycle. Efficient and effective usage of a Digital Twin also requires manifold perspectives on the same accessible data base. The research project "Future Engineering Lab" is continuing research until 2020. The prototypical applications will be finished in a way that allows the demonstration of the ideas and concept for visitors of the established lab in combination with some variants of a serious game. This role play will help to tell a story to be able to experience a perspective on future engineering and future engineering environment and support beyond the digital technologies used.

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