Rational software

Requirements engineering for the automotive industry.

Improving the product development process using IBM Rational DOORS software

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Requirements engineering and its role in automotive product development

It's easy to plan meetings or events when there are few people and resources involved. But when either the number of people or the required resources grows, planning can quickly become difficult and execution even more so. Therefore, effective collaboration and communication becomes essential.

Likewise, successful product development depends greatly on collaboration among the many individuals and teams involved, including systems, software, electrical and mechanical engineers and others such as the engineering director. They must all understand and work toward the project's requirements, which is the thread that connects all project stakeholders and teams with common objectives. Requirements also create a link between development teams and customers, suppliers and business partners. Ultimately, requirements define a product designed to satisfy a customer need or marketplace demand—so they must tune into those needs and demands.

For industrial product development, the requirements-engineering process helps companies manage complex requirements, improve team collaboration and ultimately produce high-quality products more cost-effectively. This white paper explores requirements engineering and its groundbreaking role in product development and engineering for the industrial segment. It discusses the best practices and benefits of requirements engineering, and how automotive manufacturers can overcome today's quality and cost challenges using those best practices supported by IBM solutions. Several case studies illustrate how automotive original equipment manufacturers (OEMs) and industry suppliers have used IBM Rational® DOORS® software to help improve communication and collaboration through the requirements-engineering process. As a result, these organizations can boost productivity, increase time and cost savings, and create higher quality end products.

Meeting challenges in the automotive industry

Due to the poor economic climate, the issues facing the automotive industry
permeate the daily lives of industry professionals and consumers alike. Headlines
in daily newspapers warn of increasing fuel costs and shifts in consumer behavior.
And TV newscast tickers provide constant reminders of the pressure to reduce
CO_2 emissions and the fluctuation in exchange rates.

With those concerns at the forefront, automotive companies must focus on new
ways to develop higher quality products faster and more cost-effectively. Most
important, they must clearly understand what they are building through-
out the development lifecycle — in other words, they need to know whether
all customer requirements are fulfilled. Therefore, automotive companies
can successfully manage product development and engineering by taking a
requirements-driven approach. Requirements engineering can help meet some
of the following key challenges.

Cost-effective innovation

OEMs and suppliers need innovative products to win marketshare. But to improve
profit margins, they need to differentiate their brands and enhance performance
while accelerating lifecycles, reducing costs, assuring quality and delivering prod-
uct excellence.

Highlights

A requirements-engineering framework and requirements-management support tools enable manufacturers to tailor their development practices to suit their project types, constraints and organizational cultures.

Supplier collaboration

Reducing development cost and managing complexity require close association and integration between OEMs and suppliers and some fundamental changes in the way they do business. Suppliers need to align design and product development with rapidly changing OEM requirements while increasing product quality and reducing time to market and cost.

Increased demand for electronic and software content in vehicles

"The complexity of the vehicle will grow exponentially as future innovations enable it to become more intelligent and connected. Executives we interviewed estimate that 90 percent of future innovation will be based on electronics, most of which will be embedded software."[1]

As the rate of innovation and complexity of these embedded devices increases, automotive manufacturers will require a more disciplined approach to systems and software development.

How can automotive companies manage these challenges? A first step is to eliminate poor requirements practices and adopt a requirements-engineering process for product development.

Defining requirements engineering

Requirements engineering—in terms of systems and software engineering—defines, manages and systematically tests requirements for a system. It does so in three stages: needs analysis, requirements analysis and requirements specifications.

Requirements engineering helps OEMs understand what they intend to build by first defining requirements and then managing them throughout the product lifecycle.

Although this definition of requirements engineering is more than a decade old, a standard process has only recently evolved with the availability of integrated suites of automated lifecycle development tools featuring requirements management solutions. In basic terms, requirements engineering helps OEMs understand what they intend to build in two stages. The first stage is to define requirements up front. The second is to manage them by having clear visibility throughout the product lifecycle.

The first stage of requirements engineering—requirements definition—consists of four parts: discovery, analysis, specification and verification. Requirements management, the second stage, simplifies and enhances communication and collaboration among all teams and stakeholders, resulting in better requirements management throughout the organization. This stage enables engineers to:

- *Evaluate the effect of proposed changes.*
- *Trace individual requirements to downstream work products.*
- *Track requirements status during development.*

As a result, they can monitor project status by knowing what percentage of the allocated requirements have been either:

- *Implemented and verified.*
- *Just implemented.*
- *Not yet fully implemented.*

Requirements and traceability management software gives engineering teams greater control over managing and analyzing the hundreds of thousands of requirements for automotive products.

The requirements definition and requirements management stages make up a dynamic process that flows from ideas, requirements and feature definitions to product and system specifications and models to mechanical, electric/electronic and embedded software implementations to testing and maintenance. All the while, requirements connect the global engineering teams—systems, software, electrical/electronic and mechanical—and keep them more keenly focused on common objectives. Furthermore, requirements provide a vital connection between the engineering teams and other peripheral stakeholders, including suppliers, customers and internal legal and quality-assurance teams.

Using a requirements-engineering framework and a supporting tool for requirements management and traceability, engineers can thoughtfully tailor development practices to suit the project type, constraints and organizational culture.

Requirements engineering for the automotive industry
Automotive systems and subsystems have many interlinked, dependent parts, so automotive engineers and developers must understand how all the parts work together. To do so, they must be able to see all of the connections. Otherwise, the end result will be distorted—and not what was expected by the customer.

As the demand for on-board software increases, these multifaceted systems become even more complex. Therefore, engineering teams must work as a cohesive unit to manage changes and reuse components so they can respond more quickly to customer demands. And requirements and traceability management software, such as Rational DOORS, can enable those engineering teams to manage system complexity, enhance communication and collaboration, improve product quality, and comply with industry standards.

*Rational DOORS supports
a requirements-engineering
approach to requirements
management, helping to clarify
agreements and negotiations
between OEMs and suppliers.*

Manage complexity
By using requirements and traceability management software, requirements engineering can help manage complex automotive systems by helping teams:

- *Decompose initial user requirements into detailed requirements.*
- *Link requirements and design to verify that requirements are satisfied by the design.*
- *Trace dependencies between requirements and changes.*
- *Analyze the impact of requirements changes.*

Engineering teams using Rational DOORS have greater control over managing and analyzing the hundreds of thousands of requirements for automotive products. By using this automated requirements management tool as the cornerstone of the requirements-engineering environment, they can reduce development time and increase productivity through standardized processes. Using the traceability functionality of Rational DOORS, engineers can trace a large volume of features back to the requirements. They can then reuse the requirements for common components across multiple product lines and models. The teams gain productivity, while the company saves money and gains faster marketplace delivery of customer-driven features.

Improve communication across globally diverse teams
In addition, better communication and collaboration among globally diverse engineering teams—including systems, software, electrical, electronic and mechanical—and other stakeholders—such as customers, suppliers and internal quality assurance teams—is a crucial part of the requirements-engineering process. Because requirements are shared in the Rational DOORS central repository, geographically dispersed teams can more easily share information and collaborate more effectively as well as spend less time tracking changes. As a result, they can get specifications right at the beginning of the project because they are working from a defined set of requirements.

Enhance collaboration with suppliers

In addition, a requirements-engineering approach to requirements management can help to streamline communication between OEMs and suppliers. Better communication helps clarify agreement on and negotiation of:

- *The requirements that the supplier will satisfy.*
- *The way in which the supplier intends to respond to the requirements, such as the proposed products.*
- *The way in which developed products will be verified on delivery.*
- *Evidence that the delivered products are satisfactory.*

A requirements-engineering approach can help improve collaboration with suppliers; build safe, high-quality systems; and comply with industry standards.

Build high-quality systems

System quality is vital to safety and vehicle performance. By using Rational DOORS in a requirements-engineering approach, each requirement is linked with testing to validate its performance. Teams can also integrate requirements and validate them against a model, making it easier to find gaps between requirements and models in development. In this way, systems engineers can achieve the goal of providing high-quality, safe products that truly meet customers' needs.

Comply with standards

Requirements engineering empowers automotive companies to manage compliance. They can use the requirements traceability in Rational DOORS to document the relationships between processes and the compliance framework. At any point in the engineering lifecycle, teams can easily check for requirements that are not satisfied by the design or for design elements with no linked requirements. They can also introduce automotive compliance processes — such as AUTomotive Open System ARchitecture (AUTOSAR) and the Software Process Improvement and Capability dEtermination (SPICE) model — as part of the requirements traceability process in Rational DOORS.

Rational DOORS: success stories in the automotive industry

Many global automotive companies and their suppliers have adopted requirements engineering supported by IBM solutions to successfully and cost-effectively gain team productivity and higher quality products as well as faster marketplace delivery. Using Rational DOORS, they have the capacity to manage and analyze more than 100,000 requirements in complex projects designed to build the innovative vehicles that drive profit margins. Rational DOORS can help improve requirements visibility throughout the engineering lifecycle. The traceability of Rational DOORS capabilities also helps teams ensure that critical features are not missed.

Global automotive OEMs are managing complexity and enhancing communication with suppliers and distributed teams using requirements engineering and Rational DOORS.

European OEM improves requirements validation

OEMs and suppliers need to validate requirements against models to increase model quality and use traceability to ensure that critical requirements are not missed from the development process. A European OEM uses Rational DOORS to manage and validate requirements against developing models and to identify gaps between stakeholder and system requirements. The development teams are able to stay focused throughout the entire process of creating a system, which is particularly important when they have to develop complex systems across several different brands. Consequently, the OEM has reduced time spent analyzing requirements for inconsistencies, including missed legal requirements.

OEM optimizes supplier collaboration

Communication among multiple geographically dispersed teams and the relationship between OEMs and suppliers can affect the development process and the quality of new products. A leading European OEM and a leading German supplier use Rational DOORS as a central support tool for their systems engineering process. The OEM also uses Rational DOORS to exchange requirements data with its suppliers at the electrical/component level.

Today's best-in-class companies in the industrial sector can engineer requirements across all disciplines of mechanical, electronic and software development industries.

The OEM's engineers can all work from the requirements expectations to deliver a product that meets customer and regulatory requirements. It has optimized communication and collaboration within complex projects and minimized risks, including reworks, recalls, integration issues, missing requirements and missed deadlines. Furthermore, it is able to validate requirements at each step and ensure that it does not miss critical information.

Conclusion
Orchestrating efficient and cost-effective product development is the key to success in the current global development environment. Using a requirements-engineering approach can help product development organizations work in harmony as they communicate and collaborate through standardized processes for requirements management.

Today's best-in-class companies in the industrial sector can engineer requirements from the beginning of the product and system lifecycle; through every phase of development; and across all disciplines of mechanical, electronic and software development. Having greater control over managing the complexity of requirements is the foundation of requirements engineering. Ensuring traceability across all levels of requirements is the only way that engineering teams can effectively and confidently reuse requirements across multiple lines and models.

Requirements traceability also drives cost savings and speeds time to market when integrated with testing and validation. It enables engineering teams to discover discrepancies and missed requirements far earlier in the development lifecycle, thus reducing rework costs in the short term as well as reducing the risk of lost profits and of products that do not meet customer needs.

*Companies that leverage
requirements engineering
position themselves to
ultimately yield a better
competitive advantage.*

Finally, requirements engineering helps organizations achieve enhanced collaboration among globally distributed teams and suppliers. As a result, all stakeholders can be involved in the requirements management process and be confident that everything they do will help fulfill customer requirements.

By embracing the requirements-engineering best practices of managing complexity, tracing requirements, and improving communication and collaboration, these companies can potentially achieve time and cost savings, higher quality products, improved customer satisfaction, easier regulatory compliance and, ultimately, a better competitive advantage.

For more information
To learn more about IBM Rational DOORS software, contact your IBM representative or IBM Business Partner, or visit:

ibm.com/software/rational

1 IBM Institute for Business Value, *Automotive
2020 – Clarity beyond the chaos*, Sanjay Rishi,
Benjamin Stanley and Kalman Gyimesi, August
2008, http://www-05.ibm.com/de/pressroom/
downloads/auto2020.pdf