WHITE PAPER

Can You Design Tomorrow's Vehicle With Yesterday's IT Systems?

New requirements and trends require modern tools

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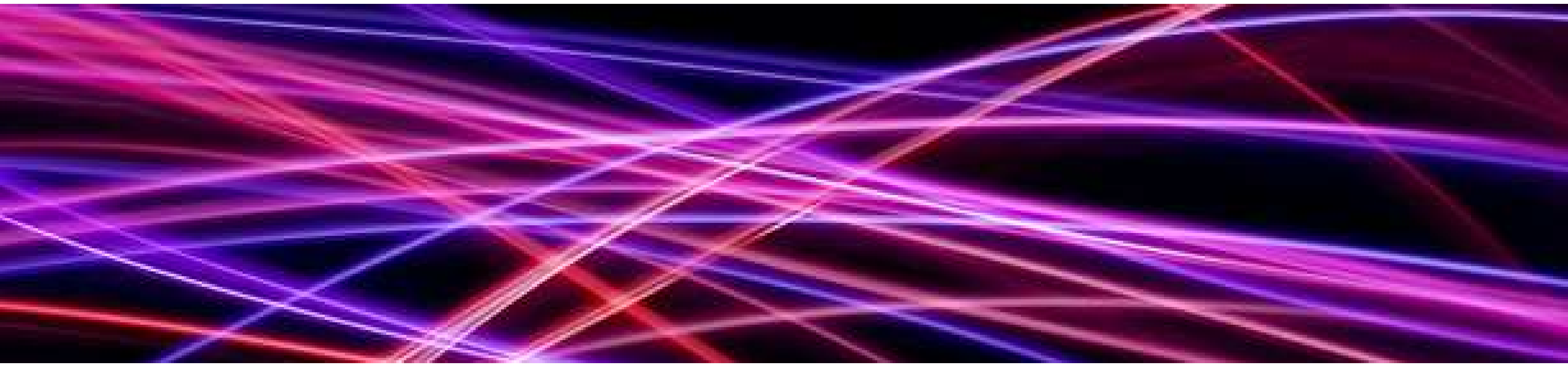
SUMMARY

In today's rapidly changing automotive environment, companies need to be innovative to the point of anticipating what consumers want before they even ask for it in order to stay competitive. Today, personal vehicles offer more than simply a means of transportation; they also provide connectivity, navigation, entertainment, as well as the assurance of occupant safety and convenience through intelligent safety systems and autonomous functionality. As quickly as new consumer demands evolve, companies need a vehicle development process that can quickly adapt to new business models, rapid advances in vehicular and manufacturing technologies, changes in global regulations, and even changes to the global demand. Today's vehicles are no longer mechanical machines, but rather a complex ecosystem of hardware, electronics, and software. Man landed on the moon with less complex systems and systems of systems than are in today's vehicles. There is no anticipating what tomorrow's consumers will require.



To increase development agility, companies need enterprise software that can evolve quickly to fit their increasingly changing needs. Additionally, interdisciplinary, collaborative processes are more important than ever across all aspects of the design stages. Companies can no longer afford to cascade development from one discipline's silo to the next. Concurrent engineering has become an absolute necessity.

As the need for maintaining relationships between disciplines, early visibility, and ad hoc collaboration grows, a single, integrated data representation of the emerging design and changing requirements is increasingly necessary. At the same time, data in all its forms, i.e., documents, decisions, changes, configuration, specifications, statuses, etc., needs to flow effortlessly from the first requirements, to engineering and production, all the way through to maintenance and end of life.

OEMs developing tomorrow's vehicles are often dependent on yesterday's technology to support the development process. Companies often rely on legacy systems that need to be maintained and operated with great effort and considerable expense. These legacy systems often have rigid architectures that cannot be configured rapidly enough to support emerging, unanticipated requirements.

Aras' resilient platform extends throughout all phases of the product life cycle, across disciplines, locations, and supply chain. An open, resilient architecture enables companies to implement change incrementally. It can synchronize data from old systems while those systems continue to meet the business needs of the company while addressing new requirements with simple configuration, and incremental deployment. Agile and open platforms that manage hardware, software, and electronics are necessary to empower the design of tomorrow's vehicles today.

CHALLENGES FOR THE AUTOMOTIVE INDUSTRY

No other industry is continually reinventing itself at the pace that automotive companies are innovating. Not only are the vehicles themselves changing rapidly, but the design processes and software development required to develop these complex machines is constantly changing as well.

Aside from the growing demands for interdisciplinary collaboration, vehicles are often developed with a highly complex network of suppliers that must work more collaboratively with OEMs. Manufacturers' IT systems must share data efficiently while guaranteeing the necessary traceability and security of intellectual property.

A unified product development platform that reaches across disciplines to enable concurrent design is necessary. However, disruption caused by switching product development systems can be lengthy, expensive, and highly demanding of internal resources. In the time it takes to implement many systems, they are already addressing yesterday's needs. This is where an incremental approach to IT system design can solve many problems before they happen. Rather than ripping out and replacing all of the critical systems at once, new systems must work in tandem with legacy systems until the point that the old system can be replaced with minimal disruption to the business.

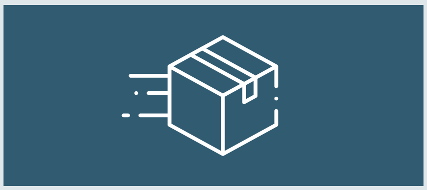
SYSTEMS ENGINEERING

The common platforms and similar technologies of yesterday's vehicles meant that the development followed anticipated patterns from target setting, to design and test, through to launch. However, rapidly evolving powertrain technologies and disruptive electronic innovations mean that the way an automotive program is planned and scheduled needs to reflect these unanticipated new requirements.

Vehicle programs have always been highly driven by requirements, but what is changing is how many of those requirements are completely different from one program to the next. Twenty years ago, product development processes naturally anticipated that all vehicles contain internal combustion engines, an assumption that is no longer valid. Requirements need to be developed for new technology and dropped for the old. Requirements management systems themselves need increasing levels of flexibility, traceability, and the ability to evolve as quickly as the technology itself.

As each unique vehicle development program has a number of unique needs, requirements from other programs can be incorporated to reduce development time and speed to market. Safety and performance requirements can often carry over between programs; consequently, program designers must pick and choose which to keep and which to replace. This type of data reuse doesn't concern parts (although that may be the final result), but the requirements themselves can benefit from variant management principles. Approaching the product development process from a product line engineering (PLE) perspective can help auto manufactures accelerate their design time and speed to market with the latest, most innovative products.

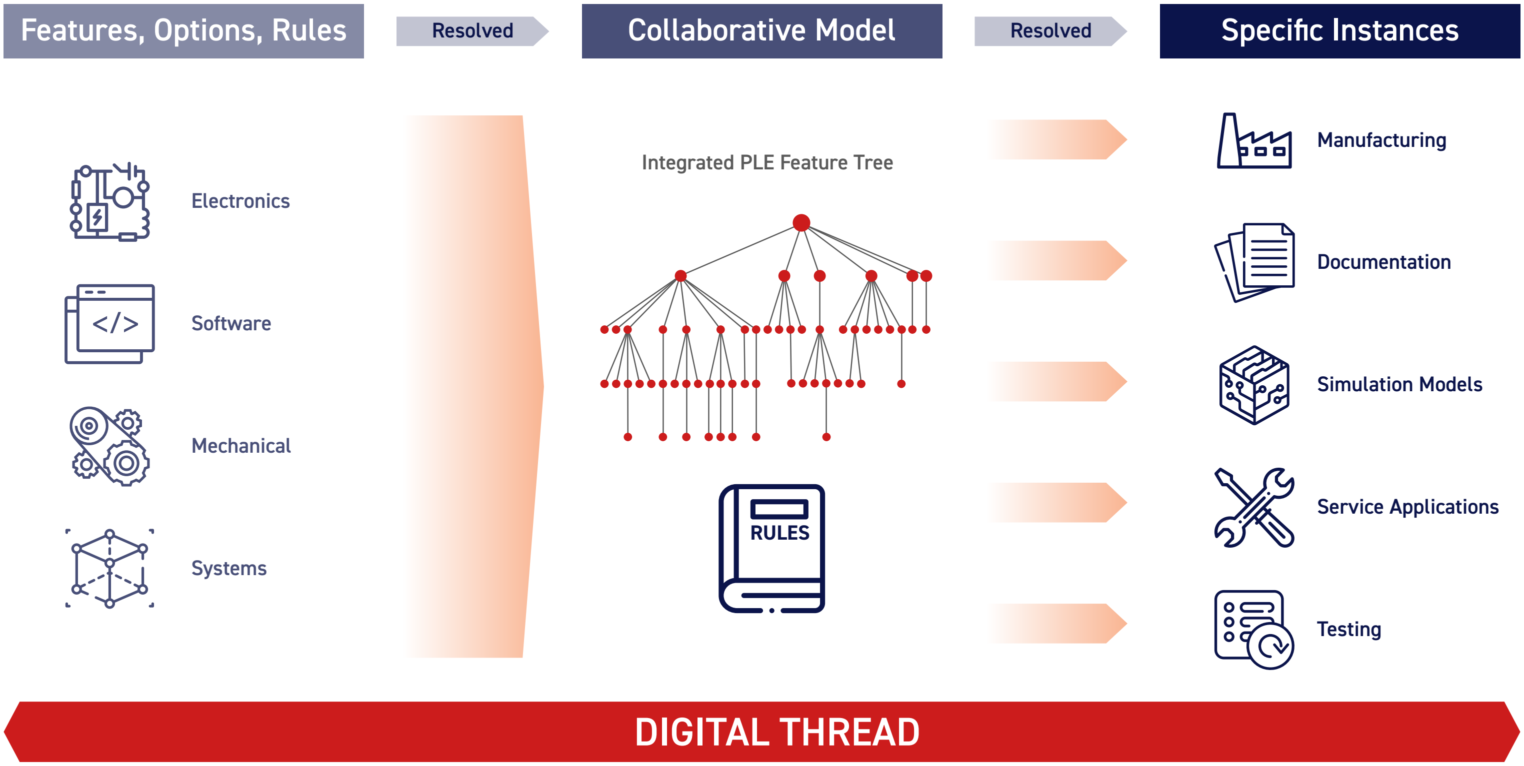
Companies who manage requirements manually have been found to:



*Suffer **twice** as many recalls*

*Incur **7 times** the regulatory fines*

*Face **50%** more production stoppages*



MULTIDISCIPLINARY COLLABORATION

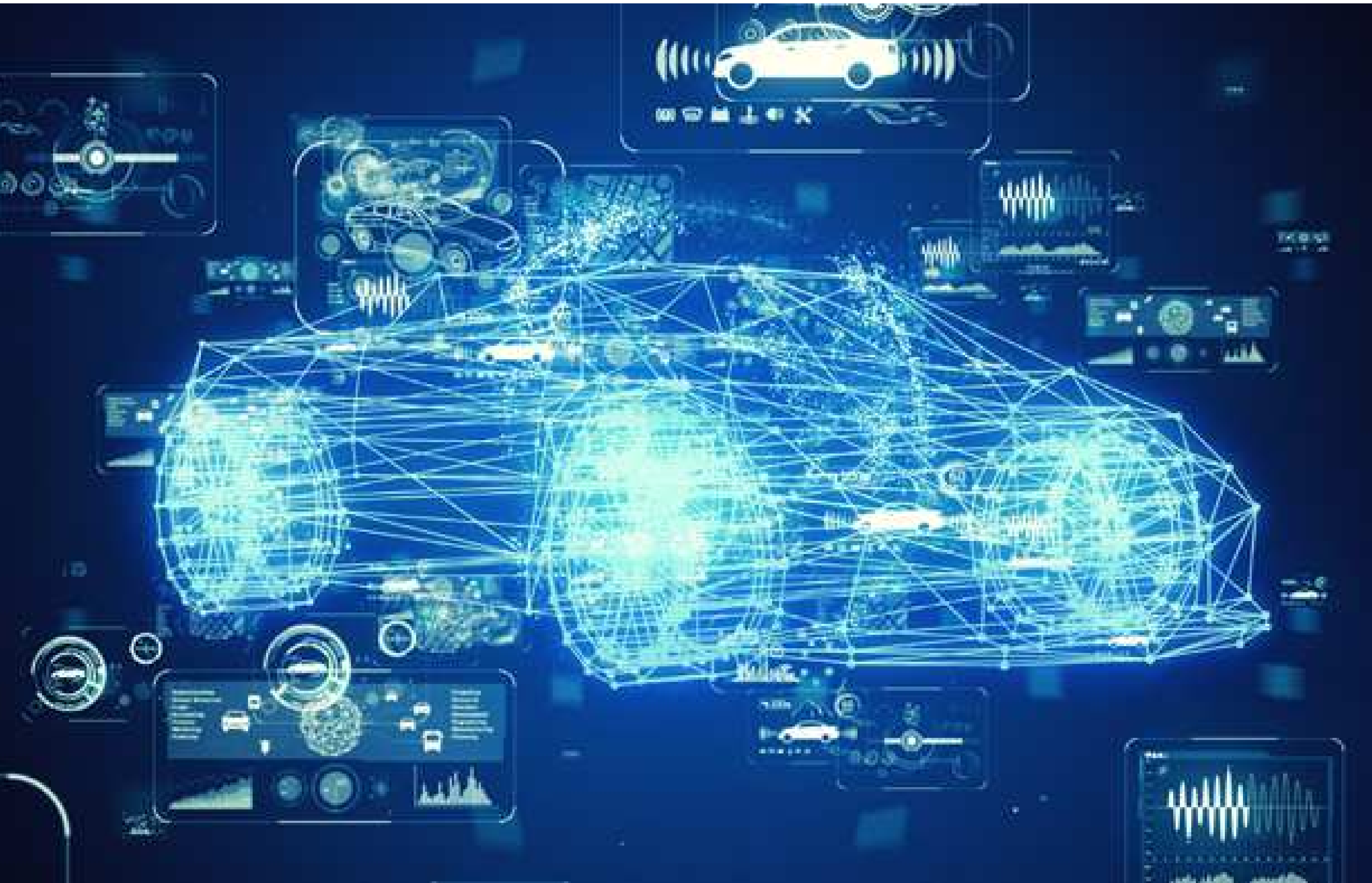
Ideas of agile development are taking hold in the automotive industry in ways that traditional product development models have not incorporated. Marketing, planning, and business development departments need to be closely aligned to the engineering, manufacturing, and aftermarket departments in order to best anticipate customers' eventual needs.

The fastest changing aspect of the automotive landscape is undeniably in vehicle digitalization. Development of autonomous vehicles, connected cars, and electromechanical drivetrains requires various disciplines to collaborate more closely than ever before and in real time. A bill of materials is no longer a list of parts but also contains crucial software components that have complex interdependencies with hardware that needs to be tracked and managed cohesively.

The interface and dependencies of electrical and mechanical systems introduces increasing complexity in co-development between development teams, creating an environment where data managed in separate silos will no longer work. "Over the wall" engineering is dead. The challenge of maintaining and accessing the concept, development, and manufacturing data often leads to inefficiency and incorrect data. These inefficiencies manifest in tasks such as querying different systems to get in-context, correct data, correlating this data from one global system to anther global system, etc.

The need for open collaboration extends beyond the confines of the OEM. Today's vehicles are co-developed in an increasingly complex network of suppliers that must work in harmony with OEMs. Manufacturers' IT systems must be able to not only share data efficiently, but also guarantee the necessary traceability. It is more important than ever for manufacturers to have reliable data on all installed components and their properties.

Realistically, the IT landscape of the automotive industry remains outdated in many areas. Legacy systems must be maintained and operated, often with great effort and considerable expense; however, these systems are still integral to the continued development of vehicle programs as well as legacy data reuse. Ideally, data management systems that can extend and complement these systems through data federation until the system itself can be rebuilt on a modern architecture, will ensure that development can continue uninterrupted. Furthermore, if these data management systems possess a capability that enables continuous integration where development of new features and applications can always be integrated into existing applications with low to no interruption, it will stand to increase productivity and benefit end users.



DIGITAL TWIN AND DIGITAL THREAD

As the product history is captured throughout the product development process, this becomes the digital thread. Decisions made on one program can be leveraged on another encouraging data reuse and reducing time to market. For a digital thread to be robust, it must record dependencies captured throughout the entire lifecycle—not starting and stopping at the design phase, as often happens. Version histories, Engineering Change Order specifics, and testing data must easily line up with cataloged and maintained simulation data. In today's environment, it is essential that vehicle requirements, systems and software development, version histories, and hardware dependencies weave through the thread as well, in ways that are not traditional in many systems.

As Designed

As Built

As Running

As the product progresses throughout its lifecycle, a data driven, virtual representation is created to form a Digital Twin. The model-based enterprise thrives in this environment as the 3D geometry and Product Manufacturing Information (PMI) become the master representation of the design, accompanied by the related metadata. However, stopping with the twin at this point is a common mistake. Initially the digital twin data represents the "as designed" model along with the software versions related to it. As the product is built, each unit needs a unique dataset to serve as a twin incorporating manufacturing data such as part serial numbers, lot effectivity, or deviation reports resulting in an "as built" configuration. As the product moves into the field, more changes are made over time, and the only way to have an accurate data representation is to keep an "as running" record.

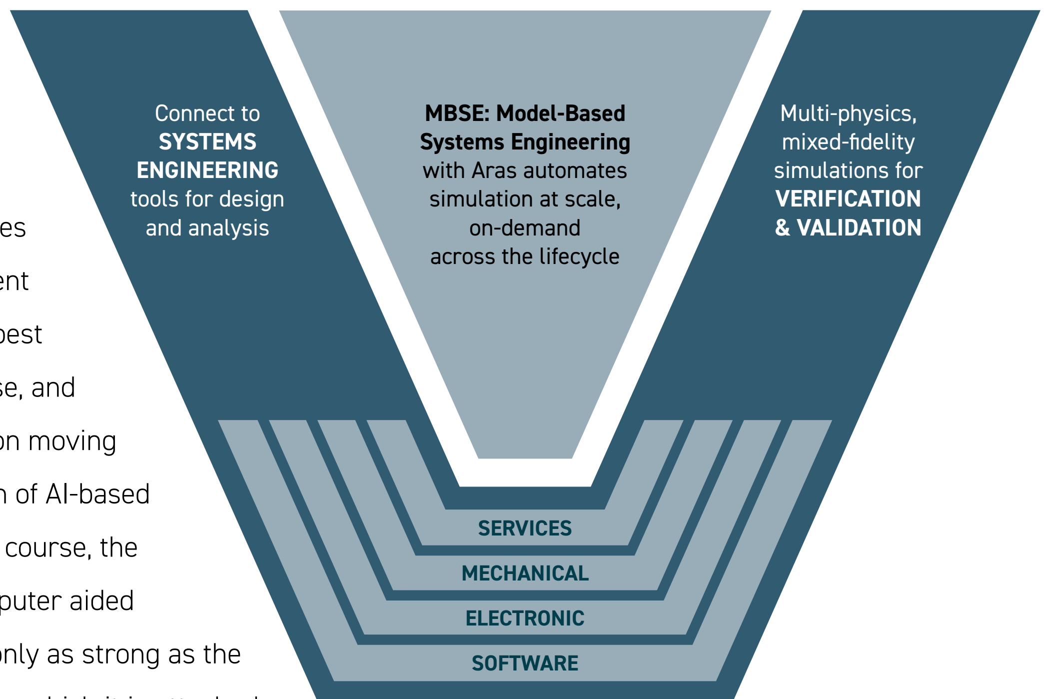
At the same time, the demand for customization continues to grow—resulting in an increased need for tracking the myriad variants and options applicable to any given vehicle. The vehicles of tomorrow are built with platform thinking, but modular design will ultimately rule the final result. That is not to say that there is a finite number of variations for any given vehicle. Running changes to a product line are common, as well as those needed to rectify quality issues or change vendors. These changes are effective on a subset of the produced VINs and must be tracked.

These variations can apply throughout the entire product lifecycle—from production to maintenance—and need to be tracked accordingly. As the product is produced and launched into the field, that vehicle is unique, the data that defines that unit evolves, and must be managed separately from the conceptual model. Once the vehicle is in service, parts or software versions continue to change as the vehicle is maintained. Ideally safety bulletins are only issued against affected vehicles, however it is impossible to identify these vehicles without tracking the "as maintained" configuration of each individual unit.

MODEL BASED ENGINEERING, THE LINK FROM REQUIREMENTS TO SIMULATION AND BEYOND

There is a common misconception that Model Based Engineering (MBE) begins with geometry. To reap the benefits of a true MBE, the knowledge must begin with pervasive links to the requirements that affected the design, intent, history, through to the related simulations and test and validation phases. After all, the "model" in MBE is based on requirements that must be linked and maintained throughout development.

In addition to strong PLM practices, robust simulation process and data management is crucial to maintaining an unbroken digital thread.



Systematic and traceable simulation across the lifecycle enables the development of simulation best practices, reuse, and democratization moving in the direction of AI-based algorithms. Of course, the benefit of computer aided simulation is only as strong as the digital thread to which it is attached. This configuration aware twin is crucial to accurate results.

As simulations run software-in-the-loop analysis, it becomes imperative that a single data management solution is in place to tie assumptions to versions and parameters to results and conclusions. This data can then be linked to verification and test results and even into maintenance. Traceability spans across numerous disciplines, organizations, and risks losing context as time passes. As systems of systems enter the equation, manual data tracking becomes simply impossible.

Enterprise-wide adoption of such comprehensive product development platforms is a key enabler for enterprise-wide implementation of MBE strategy:

Platforms must have:

- Transparent & interrogatable APIs
- Full API Capabilities exposed
- Open Data Model
- Dynamic Data Model
- Open Data Access

Platforms cannot be limited by:

- Proprietary APIs
- Proprietary data models
- Static/Hard Coded data model
- Obfuscated data

CHANGING BUSINESS MODELS

Digital connectivity is increasingly important in today's automobiles and many modern vehicles already offer value-added services based on data streams and connectivity. With today's new business models, such as subscription or car sharing, automobiles are moving toward a model of "transportation as a service (TaaS)." This increases the need for data streams and can also be used for predictive maintenance, which will lead to increased availability and increased billable hours. In the personal transportation market, OEMs generate significant revenue selling replacement parts in addition to the initial vehicle sale. While maintenance is the bread and butter of the dealership network, it enables the OEM to truly partner with the owner and keep that aftermarket revenue inside of the authorized service center chain.

Engineers can use this valuable data in several ways. In addition to predictive maintenance as a service, OEMs can enable over the air (OTA) fixes to software without requiring the customer to visit the shop—limiting downtime. The data generated is crucial to the development of new revenue streams for the OEMs. Data services such as in car entertainment, theft deterrents, roadside assistance, and safety monitoring are an increasing opportunity for building new recurring revenue through value added subscription models.

THE ROLE OF A PRODUCT DEVELOPMENT PLATFORM

Product development systems are not to be confused with the applications necessary to support them. Most PLM tools are limited to engineering collaboration. Even then, the focus is largely on the traditional mechanical space. An ideal product development platform has certain aspects that are necessary to run a nimble process.

The platform must be:

- Adaptable to changing business processes supporting rapidly changing customer needs
- Customizable to work the way you want rather than the way the system is hardcoded to function
- Open and transparent to enable cross functional collaboration and end-to-end visibility with traceability and integration to legacy systems
- Evolutionary in design, built to adapt and change in an agile manner, and open to easily meet future needs that are not yet apparent

In order to address constantly changing customer, regulatory, and economic requirements, a product development platform must be ready to evolve quickly. The Aras environment is built for customization. The industrial low-code platform provides an open, transparent, and multifunctional collaboration hub that's needed for today's agile product development process. The capability for low-code development assures automotive companies that their tools and systems will evolve with business needs rather than being stuck at a single point in time.

Read more about the Aras Resilient Platform.

Aras provides a resilient platform for digital industrial applications. Only Aras offers open, low-code technology that enables the rapid delivery of flexible, upgradeable solutions for the engineering, manufacturing, and maintenance of complex products. Aras' platform and product lifecycle management applications connect users in all disciplines and functions to critical product data and processes across the lifecycle and throughout the extended supply chain. Headquartered in Andover, MA with major offices throughout the world, Aras supports more than 350 global multinational customers and over 250,000 users. The Aras Innovator platform is freely downloadable. All applications are available at a single subscription rate, which includes all upgrades performed by Aras. Aras customers include Airbus, Audi, GE, GM, Honda, Kawasaki, and Microsoft.

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