Siemens Digital Industries Software

A digital thread for autonomous vehicle aftersales service and maintenance

Executive summary

Growing vehicle complexity due to the rise of advanced driver assistance systems (ADAS) and autonomous vehicle (AV) technologies is creating new challenges for technical authoring and aftersales service departments. Traditional manual technical authoring and troubleshooting processes will not suffice in the face of this growing complexity. Modern wire harness engineering solutions provide a solution. A robust digital thread pushes critical data to the technical authors who can generate documentation with advanced automated layouts. Then, automated troubleshooting processes can help technicians diagnose and resolve issues quickly and accurately.

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Introduction

The automotive industry has had to adapt to several disruptions, both large and small, over the last few decades. Disruptions can be caused by several factors, including breakthrough technologies, new trends in customer demands and changes in regulations at various levels of government. Early disruptions include the invention of power steering and anti-lock braking systems, as well as the sweeping environmental regulations of the early 1970s (figure 1). With each disruption, vehicles have tended to grow more complex as new features and functions increase the sophistication of each vehicle sub-system.

Since 2012, however, the pace of change and the growth of automotive complexity have both quickened. This is the result of an ongoing disruption in the automotive industry (likely the largest in its history), driven by the concurrent megatrends of electrification, autonomy, connectivity and shared mobility. Even today's mid-range vehicles contain several hundred electronic control units (ECUs), miles of electrical wiring and hundreds-of-millions of lines of software code to support the features modern consumers expect. The continued development of electric, autonomous and connected vehicles will only increase the electrical and electronic (E/E) and software content required in each vehicle.

The steady growth of vehicle complexity has certainly amplified the challenge of designing and engineering modern cars. But, other parts of the automotive industry and starting to feel the pressure of change as well. Automotive aftersales and service and maintenance departments will need to undergo a significant evolution due to growing vehicle complexity and the increased importance of E/E features and systems. This is especially true for the maintenance and repair of autonomous vehicles (AVs), in which the safety of passengers, pedestrians and others is directly dependent on the functionality of the self-driving systems.

AVs bring unique and intricate challenges to the service environment that may require special training or bespoke processes to manage. Service technicians will need new techniques and expertise to diagnose and repair AVs effectively and, most of all, safely.

Figure 1. The automotive industry has undergone several disruptions throughout its history.

The impact to aftersales

Aftersales departments depend on high-quality technical documentation in the performance of their core duties. For example, service documentation and manuals help technicians to complete vehicle maintenance, diagnosis and repair accurately and safely. Today, the number of data sources that needs to be considered in the creation of technical documentation is growing in pace with the rapid development of vehicle technology.

Technical authors must synthesize information from vehicle engineering, component suppliers, compliance data, manufacturing and more to produce useful documentation. Now, software updates, late engineering changes, and the sheer complexity of AVs have greatly increased the challenge of collecting, synthesizing and organizing all the necessary information into a form that provides value to the service technician.

Furthermore, even partial automation in vehicles significantly heightens the responsibility of aftersales departments. Aftersales has always had a responsibility to ensure safe maintenance and repair procedures to protect customers and ensure that vehicles operate as expected. As vehicle systems take over a larger share of driving tasks, the obligation of aftersales departments to ensure the safety of these systems also increases.

Any organization that fails to adapt to the new challenges of AV service and maintenance will put themselves and their customers at risk. For the company, this could mean significant financial consequences and diminished reputation for safety, undercutting overall brand image in the market. The need to adopt new processes for the creation of technical documentation is imminent and growing more pressing as technology advancements continue to push the pace of change. While technicians will receive additional training to manage sophisticated AV systems, the importance of clear and concise technical documentation is paramount to their success.

However, traditional methods of authoring technical content for aftersales (including technical documentation and service manuals) are disconnected and based on manual processes. This will not suffice as we move into the future of autonomous and connected vehicles. As vehicle complexity continues to grow, it will be critical to ensure that aftersales departments can quickly access all the information they need and apply it accurately to AV repair and maintenance.

The inefficiency of current methods

The time and attention of technical authors is precious. These employees play a critical role in the safety of customers and the vehicles out in the field. In traditional processes, the technical author's time is split between two primary tasks: investigation and 'value authoring' (figure 2).

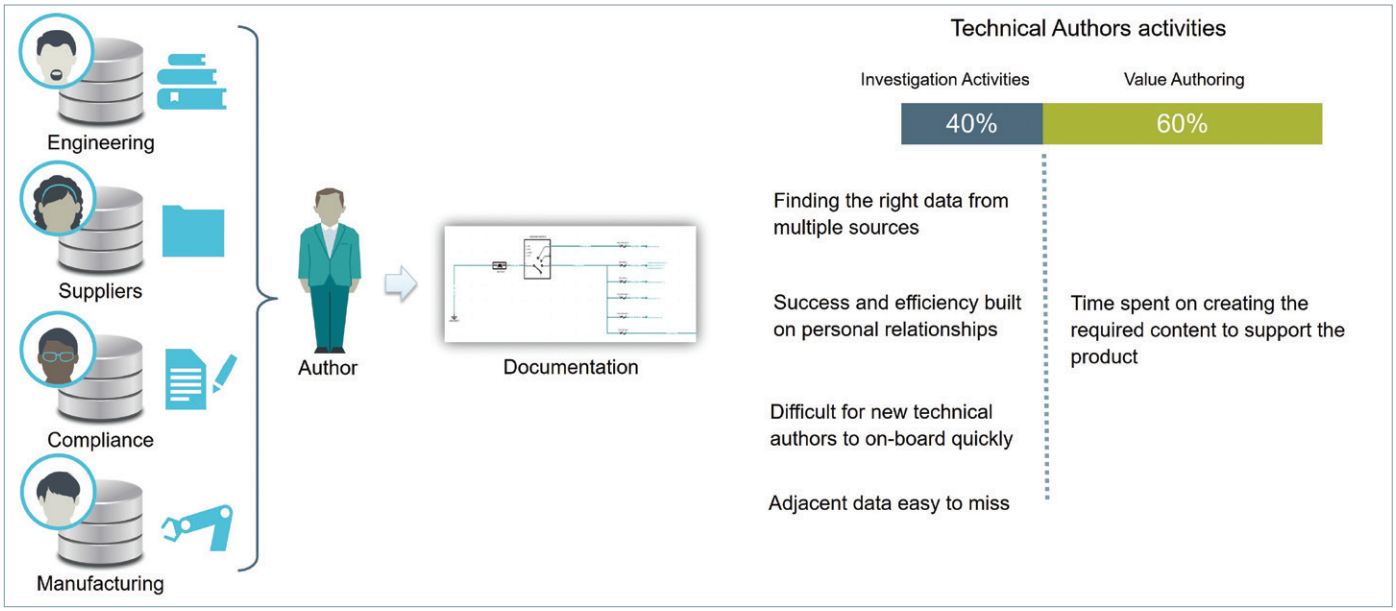

Figure 2. In traditional technical authoring flows, authors' spend a significant amount of time performing non value-add investigation tasks.

First, investigation tasks are non-value-add actions. These tasks encompass any time and effort the technical author must spend chasing data and information around the organization. Technical authors often must rely on personal connections just to find the information they need to produce documentation. Investigation tasks not only waste the technical author's time and energy, but also sap the time and energy of other departments as they help to gather and supply necessary information.

Second, 'value authoring' tasks are those that involve the actual creation of technical documentation. Value authoring is the core competency of the technical author. It involves synthesizing various sources of data, organizing information and packaging it into technical documentation that will be provided to the field to service and maintain the products. In sum, technical authors are employed to perform value authoring tasks. Yet, in conversations with our customers, we have found that technical authors often spend up to 40 percent of their time on non-value-add investigation tasks.

Likewise, traditional service manuals and technical documentation contribute to a slow, tedious and error-prone troubleshooting process in the field at workshops around the industry. Similar to its creation, the use of technical documentation to troubleshoot vehicle problems is a heavily manual process that takes up a lot of the service technician's time. A large portion of this time is spent hunting down information and resources to properly understand and diagnose an issue before a technician can even begin to implement a solution.

Technicians first must understand the issue with the vehicle or the service to be performed (figure 3). With traditional documentation formats, the technician accomplishes this by manually trawling through flow charts, diagrams and procedures to find the relevant information. For instance, if the windscreen wiper system is malfunctioning, the technician must locate the wiper motor on a 2D diagram and mentally map this location to the actual vehicle. Next the technician needs to find the component specification to understand correct operating voltages for the wiper motor to correctly assess its condition.

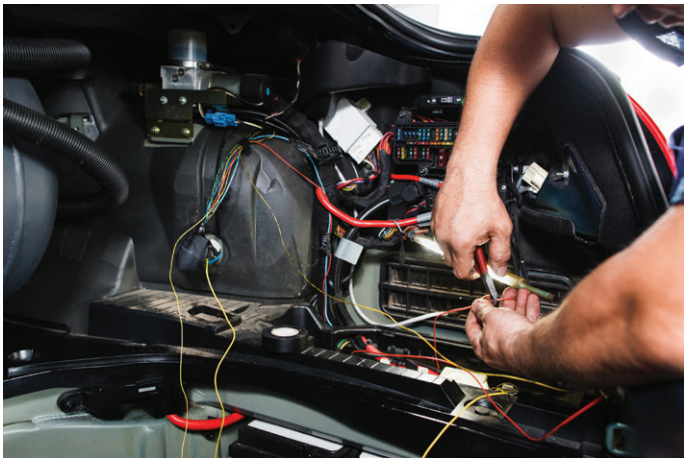

Figure 3. Traditional automotive service processes require technicians to manually comb through diagrams, flowcharts and text to identify and resolve issues.

Obtaining an accurate measurement can also be difficult. On complex connectors, an inexperienced technician may not know where to place the measurement prongs to obtain an accurate reading for the component. As a result, they will need to take additional time to get guidance on the procedure.

With the measurement of the wiper motor complete, the technician discovers an issue with the power feed to the relevant connector. Now, the technician needs to find the correct schematic to trace that signal back to its source, following the signal paths manually as indicated on the schematic, and ignoring any irrelevant information. Once the technician finds the part that needs to be replaced, they can identify the correct part number. Finally, the part must be replaced. Again, technicians must rely on 2D diagrams and drawings to understand the correct procedure for replacing the malfunctioning part. If you have ever assembled furniture out of a box, you have an idea of how difficult this can be.

New tools enhance automotive documentation and service

What sort of tools will service organizations need to prepare for the challenges of AV aftersales service and maintenance? Today, software vendors offer highly advanced electrical system and wiring harness engineering tools that span the electrical system lifecycle from definition through production and maintenance. One of the most important features of these tools is their ability to digitize and automate previously manual processes, such as the creation of service manuals and signage.

A class of these new design tools is focused on reducing the time and resources required to create technical documentation. Advanced examples, such as Capital Publisher, can reuse data directly from upstream engineering processes. Technical authors no longer need to manually import and organize information. All the necessary data can be imported and automatically laid out into accurate wiring diagrams. The robust digital thread underpinning these solutions ensures the accuracy of information and greatly accelerates both technical authoring and vehicle service processes.

How a digital thread improves aftersales documentation and service

The foundational source data for technical publications originates in the same departments as before, but the data is integrated into a cohesive digital thread that stretches from the initial product definitions all the way through to the technical authoring process. Engineering data is then available to other stakeholders throughout the value chain. For the technical author, the key data they need to begin value authoring tasks is now pushed from the source departments, rather than manually pulled.

By automating the flow of data from engineering teams to the technical authors, companies can eliminate a majority of the non-value-add investigation tasks for the authors. Technical authors can then focus more of their time and effort on the task of creating documentation rather than hunting down information. This also reduces the secondary drain of documentation authoring on other departments. Critical data is automatically captured by the digital thread as it is created and updated, minimizing the effort required by vehicle design and engineering.

Furthermore, modern harness engineering solutions can leverage data from this digital thread along with automated, rules-based documentation layouts to further accelerate the creation of technical documentation.

Previously, technical authors manually pulled the needed data together, laid out the schematics, and checked that the wiring data matches the engineering data. Modern tools, however, can automatically generate technical documentation. A configurable engine consumes design data, 3-D models, location views, diagnostic codes, repair procedures, and corporate assets like symbol libraries and graphical styles. Then authors can mine and link adjacent data, re-partition diagrams, re-style documentation, and even export to multiple formats such as PDF, HTML, and S1000D (figure 4). After ensuring that the schematics fit on pages correctly and will be practical in the service environment, the tool can integrate connectivity information automatically.

Advanced digital thread and automation capabilities available in modern electrical system and wire harness engineering solutions can provide dramatic time savings for technical authoring processes. After implementing such tools, our customers have measured up to a 50% savings in full-time equivalents (FTE's) of the investigation and value authoring activities. Such time savings can be redirected towards innovation; using the skills of a technical author to investigate new ways of delivering technical support to the aftersales network. This may include using 3D imagery, integrated video content or more to improve the efficiency and effectiveness of technicians in the field.

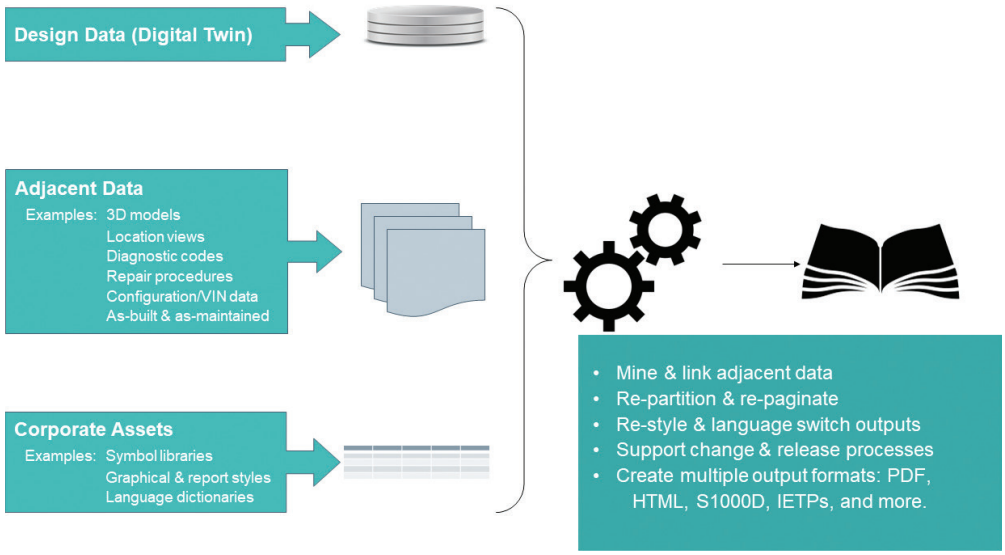

Figure 4. Advanced tools can automatically generate service documentation, removing hours of manual work.

Digitalizing the troubleshooting process

Likewise, modern wire harness engineering solutions can help improve the troubleshooting process in the field. To maximize the practicality of service documentation, these new tools output a smart, interactive, and standalone documentation package. This package can be integrated into any number of aftersales publications and OEM systems. With these interactive document packages, technicians no longer need to search for the correct schematic for the vehicle being serviced. The technician can simply give the system the VIN of the vehicle under service and the system will automatically pull relevant schematics. Digital service documentation can also dynamically supply connector and component views to the technician in step-by-step diagnosis and troubleshooting procedures (figure 5).

Stepping through a high-level fault diagnosis process using the smart documentation can help illustrate its value. Having identified a malfunctioning dome light, a technician can use the smart documentation to automatically generate a test plan. The test plan provides the technician with step-by-step instructions to locate the source of the fault. Inside each step are links that can supply the technician with additional information related to the part, such as its location in the schematic, connector and pin out views, and wiring diagrams.

The first step is to check the battery voltage. Clicking on the link in the first step automatically brings the technician to the wiring schematic. After verifying that the battery voltage is acceptable, the technician moves on to step two, the power distribution unit (PDU). In this case, the technician doesn't know where the PDU is located, but they can retrieve a 2D top view of the vehicle that highlights the relevant part. Having located and verified the supply voltage of the PDU, the next step is to open the box and measure the resistance across a specific fuse. The resistance of this fuse is within acceptable values, so the technician moves on to the next step in the test plan.

Next, the technician needs to disconnect the inline connector that goes from the PDU to the battery and check a specific pin on the connector. To find the right pin, the technician can bring up a face view of the connector showing each pin number and check the voltage of the correct pin.

The technician progresses through the test plan, systematically locating and verifying only components that are relevant to the malfunctioning dome light. Eventually, the technician can determine that a damaged switch was the source of the fault. The technician replaces the switch and the issue has been resolved.

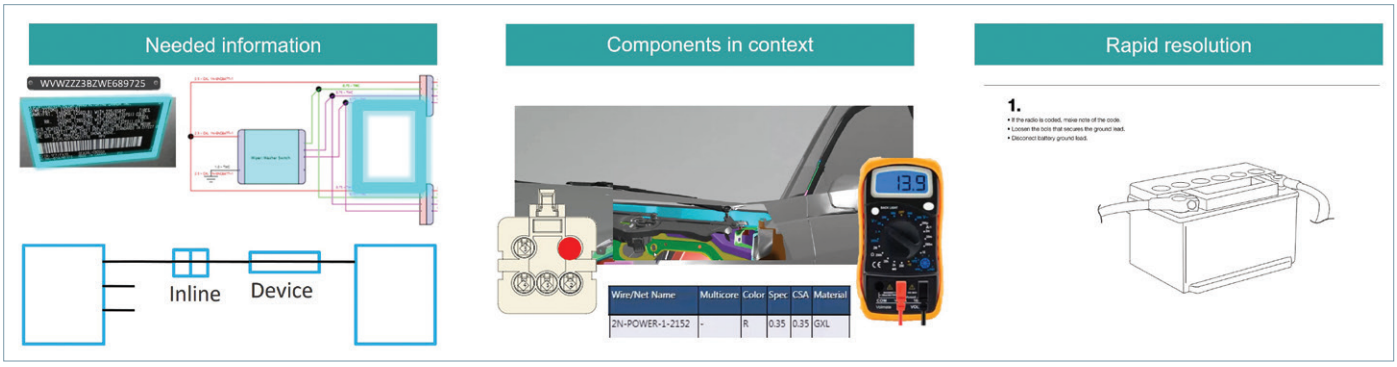

Figure 5. Interactive, digital service documentation can guide technicians through repair procedures with dynamic views and helpful information.

Integrations with 3D modelling software enable components to be viewed in the full context of the vehicle model. These models can include the appropriate locations to take measurements with highlights on the actual connector pins that are relevant to the process. Animated replacement procedures or video guides can also be embedded directly into the service documentation, providing a much more intuitive instruction than attempting to map 2D diagrams onto a 3D vehicle (figure 6). The result is faster issue resolution and a higher likelihood of a quality repair the first time.

Figure 6. Integrating the digital thread into service documentation enables advanced interactive repair procedures that may include animations or videos.

Conclusion

Growing vehicle complexity due to the rise of ADAS/AV technologies is creating new challenges for technical authoring and aftersales service departments. Traditional manual technical authoring and troubleshooting processes will not suffice in the face of this growing complexity. As systems become more sophisticated, technical authors are spending more and more time investigating and gathering the foundational information they will need to produce high quality documentation. Service technicians are also attempting to decode these complex systems with static 2D diagrams and paper manuals.

Modern wire harness engineering solutions provide a solution. A robust digital thread pushes critical data to the technical authors, saving significant time during the creation of documentation. Technical authors can then generate documentation with advanced automated layouts, adjusting styling and figures as needed. The smart documentation enables automated troubleshooting processes that help technicians diagnose and resolve issues quickly and accurately.

Technical documentation and the service and maintenance of vehicles will only become more critical as AVs become more common. With advanced electrical systems engineering solutions, automotive companies can equip technical authors and service technicians with the tools they need to overcome the challenges of maintaining such vehicles. This will ensure that vehicles continue to operate safely and efficiently as they move people and goods throughout the world.

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