



## DIGITAL INDUSTRIES SOFTWARE

# The power of automation

Using Capital Essentials to achieve rapid wire harness design

### Executive summary

Designing electrical/electronic (E/E) systems for industries such as aerospace and defense is increasingly demanding. Manufacturers must deliver innovative features within tight deadlines while adhering to ever-changing regulations. Reducing time-to-market while maintaining quality and safety is of paramount importance – but keeping pace with rising complexity makes this a never-ending challenge.

In this white paper we explore some of the many challenges engineering teams face as they design and manufacture complex wire harnesses for advanced systems, and how tools such as Capital™ Essentials software can be used to help them succeed while lowering costs and eliminating errors. We'll also see how Terma A/S, a Danish technology company specializing in aerospace, defense and security solutions, uses Capital Essentials to streamline and accelerate first-time-right, error-free electrical design.

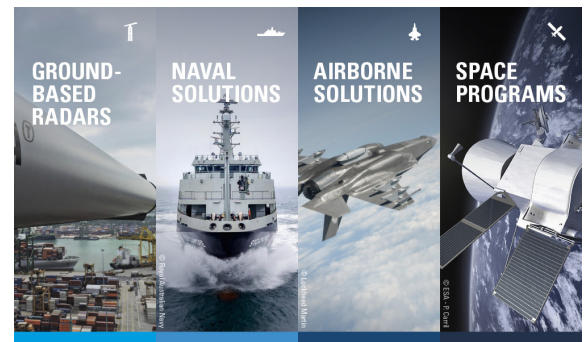


Image 2: © Royal Australian Navy, Image 3: © Lockheed Martin, Image 4: © ESA - P. Carril

# Challenges of traditional wire harness design

The wire harness is a crucial component of any aerospace and defense electrical system, responsible for establishing dependable electrical connections between critical components and subsystems. Its job is to ensure reliable connectivity, reduce electromagnetic interference and enhance safety, so careful consideration must be given to its design and implementation. Important factors include streamlining maintenance, optimizing weight and space, ensuring durability and meeting rigorous compliance standards.

However, systems and products designed for use in industries such as aerospace and defense often require hundreds to thousands of electrical wiring connections, often comprising connectors, backshells and close-out assemblies. Traditionally, engineers rely on manual methods and processes, but due to the increasingly complex nature of modern systems, manual methods are insufficient. Intense collaboration is required across multiple teams, partners and geographies, but even still design cycles have become unwieldy, delaying time-to-market and driving up costs.

## Disconnected tools and systems

To make things even more challenging, wire harness design is typically completed using many disconnected tools and applications. Engineering teams typically manage multiple Excel spreadsheets that document the various connections, ports, pins, wire types, part numbers, signal names, sensors and other details about the components within the wire harness. These are maintained manually – a tedious and time-consuming process that’s prone to error. What’s more, engineers must manually share this data with other team members, creating delays and frustration.

Engineers may define the schematic in a drawing/drafting tool such as Microsoft Visio or AutoCAD to visually depict the connectors, cable types, cable length and other parameters until it goes to a breakout point to the next branch or trunk line of the harness. Often, there are no details about the connectors and how to secure them to the vehicle, and routing splines from point A to point B requires a lot of guesswork. This approach to wiring harnesses is not only dangerous, but it can lead to added costs and performance impacts.



Engineers may also use PowerPoint slides and screenshots to determine where to place the various wire bundles in the target system, along with photos and sketches of the hardware. As a result of this inefficient, manual process, data is disconnected and inconsistent, and stored in random places, such as in folders on engineers' computers. Time-consuming reviews must be conducted to ensure quality and safety prior to product launch.

Using multiple applications to define, document, assemble and produce a wire harness makes it extremely difficult to maintain consistency or work efficiently. Not only that, if a team member leaves, important information may go missing. These challenges can further delay project completion.

## Capital Essentials: efficient, error-free design

Capital Essentials, which is part of the Siemens Xcelerator business platform of software, hardware and services, is a suite of wiring and harness design software tools for the demanding requirements of industries such as aerospace and defense, automotive, heavy equipment, etc. Offering a small information technology (IT) footprint and easy installation, Capital Essentials helps users achieve a dramatic return-on-investment (ROI) while leveraging powerful, intuitive design features and capabilities.

By seamlessly connecting wiring design data to harness designs, Capital Essentials:

- Provides rapid, right-first-time, error-free electrical and harness design with numerous validation features
- Enables simulation for continuity, voltage drop, current directions and calculations
- Automates harness engineering by generating production-ready drawings, bill-of-materials (BOMs), costings and manufacturing reports
- Integrates with 3D computer-aided design (CAD) systems for seamless data sharing

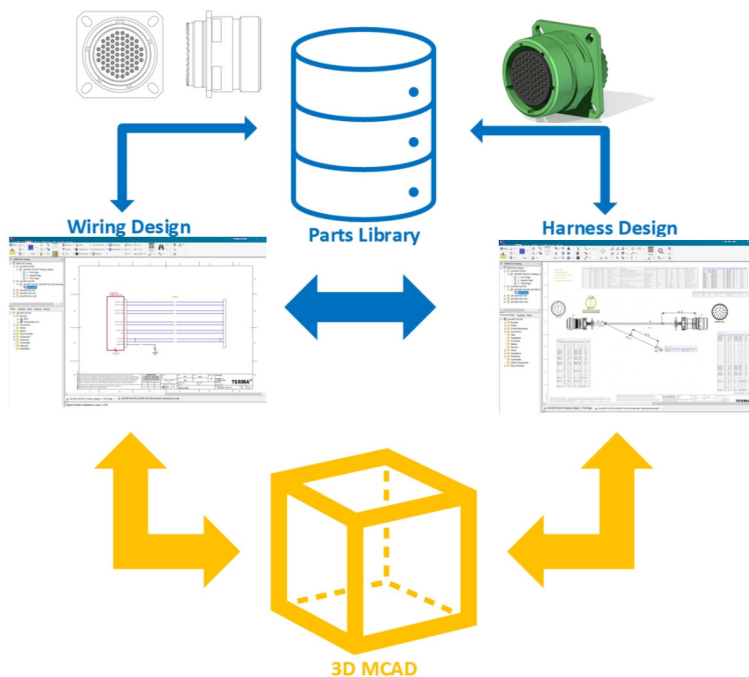


Figure 1. Capital Essentials provides a centralized parts library that acts as a repository for components needed for both the wiring and harness design.

### Leveraging a centralized parts library

Capital Essentials is a parts-centric wire and harness environment that provides a repository of parts data for creating wiring and harness designs (see figure 1). You can synchronize connectivity between the wire and harness design, leveraging a digital thread and transferring the 3D harness topology to the harness drawing, or transferring wire lengths to the wiring design for electrical analysis.

Capital Essentials includes data compatibility with companies using Capital software, making it ideal for partners, suppliers and subcontractors of original equipment manufacturers (OEMs) across industries. Capital Wiring Designer Essentials and Capital Harness Designer Essentials can be used individually or together, depending on the needs of your organization.

# Capital Essentials and Terma A/S

Terma develops and manufactures advanced technology for radar systems, command and control systems, electronic warfare and protective systems for military aircraft. The company also provides surveillance and security solutions for border surveillance, maritime domain awareness and critical infrastructure protection. In addition, Terma has a presence in space technology, aviation, cybersecurity and climate and energy sectors. As such, they must collaborate with global clients, including governments and industries, to deliver innovative and tailored technology solutions aimed at enhancing security, safety and efficiency across various domains.

Since harness design is an overlapping or hybrid engineering discipline in both the mechanical and electrical domain, the ability of engineers to work in parallel leveraging the digital thread enhances collaboration and accelerates design cycles. Another key objective was to eliminate the manual transfer of data between engineers and teams working on the project. It was critical not to compromise quality, performance or safety.

Using Capital Essentials, the team at Terma was able to replace its mostly manual design process with a data-driven, model-based design approach, reducing mundane, time-consuming tasks such as manual reviews and documentation. Thanks to the Capital Essentials design automation and auto-generation capabilities, Terma is reducing redundancy while eliminating error-prone manual processes.

“The implementation of Capital Essentials is allowing us to significantly reduce review time and eliminate the need for review of certain documents altogether,” says Danny Christensen, systems engineer at Terma A/S. “This is reducing design time and human error thanks to automation.”

## How Terma A/S uses Capital Essentials

As mostly an integrations company, Terma designs and manufactures numerous subsystems they integrate into larger customer-defined projects. To support integrations, one of the things the team uses is data from interface control documents (ICDs). Capital Essentials is used to store all the components and predefined interfaces in the parts library, eliminating duplicate work and providing right-the-first-time design. This makes iterations faster and easier, because unlike a Visio schematic, Capital is used to synchronize connectivity, pulling data from the library.

The Capital cavity component management feature autogenerates terminal selection, so all that’s left to do is create the wire bundles. Finally, engineers can accessorize the wire harness design with identification labels, insulation and other components stored in the library.

### Identifying a digital thread

A digital thread is a seamless and integrated flow of digital information throughout the entire lifecycle of a product or system. It encompasses all the data related to the product, from its initial design and development stages to its manufacturing, operation, maintenance and eventual retirement or disposal. A digital thread provides a unified and comprehensive view of a product’s data and history, making it easier to manage, analyze and optimize the product’s manufacture and lifecycle.

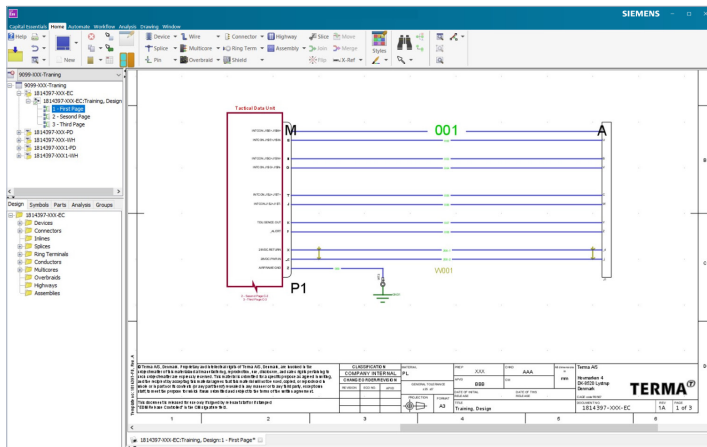


Figure 2. Maintaining predefined interfaces in the parts library simplifies connectivity manipulation and retention.

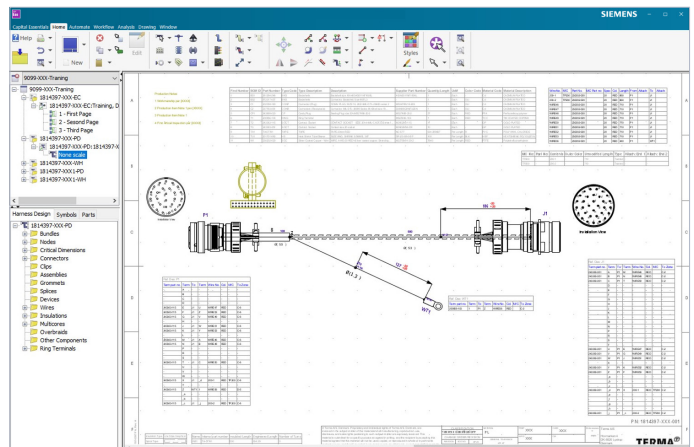


Figure 3. Using Capital Essentials leverages automation to eliminate errors and redundancy.

Other Capital features the team finds useful include:

- Automation features such as the ability to insert additional cavity components in the connectors, eliminating the risk of change requests later in the manufacturing process
- The ability to analyze and verify designs are ready for manufacturing using built-in design rule checks
- The auto calculation of wire length and insulation requirements based on bundle lengths and parts definitions
- The ability to add components such as insulation or tape markings to the harness from the parts library
- The auto generation of an accurate BOM

### No more manual reviews

The typical wire harness design process is review heavy. Disparate systems must be used to produce multiple documents that must be developed and finalized through several iterations. Every document must be reviewed after each iteration, and there's a lot of redundant data to verify across documents.

Capital Essentials enables selective reviews. Since all the data used to generate the harness schematic has already been verified, manual reviews of redundant data are unnecessary. Capital also auto generates any required documentation. Previously, a physical mockup might be necessary, but now they can take advantage of the digital representation in 3D CAD tools (like NX™ software, Solid Edge® software, CREO, SolidWorks or CATIA) within Capital Essentials. Terma can pull data from the Capital parts library to implement the wiring design, transfer this connectivity to a 3D model and back into Capital Essentials to prepare the verified and production-ready output for manufacturing. Since all the data from the wiring and harness designs live in the same environment, generating reports such as the BOM and wire manufacturing lists is quick and painless, and the output is guaranteed to be correct.

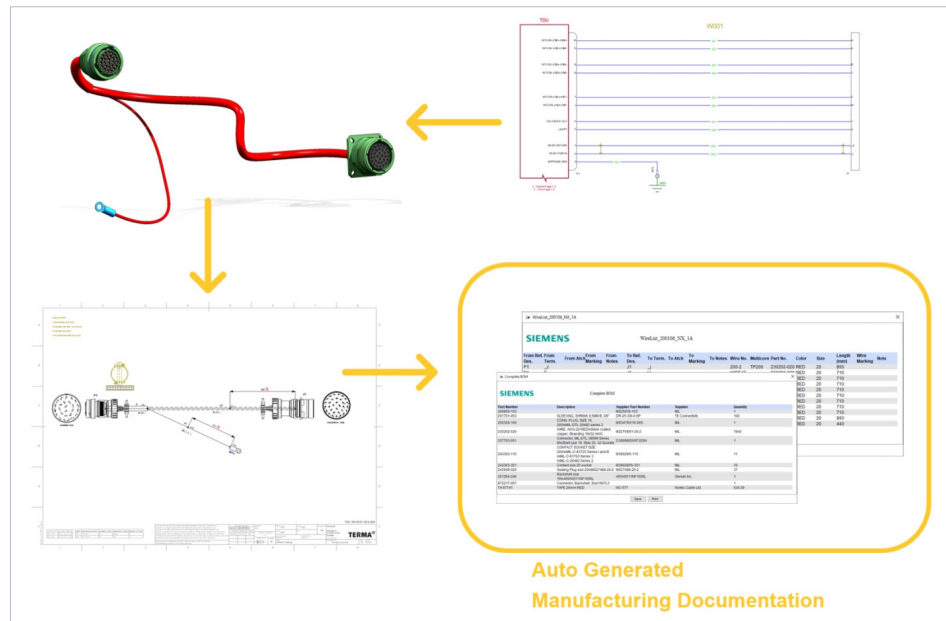


Figure 4: Using Capital Essentials helped Terma move from a labor-intensive, manual design process to data-driven, automated model-based design.

### Cross-domain collaboration

Terma manufactures harnesses across product groups. Each product domain may have different requirements; the company has appointed a component manager for wire harness development within each domain. Using Capital Essentials enables these managers to work collaboratively across all domains. Sharing a common design tool enables Terma to standardize on terminology and design style/appearance, delivering consistency across the organization – thus avoiding confusion and miscommunication.

### Key considerations for a successful implementation

Capital Essentials or Capital offer great value for improving design and manufacturing efficiency. As digital tools they support the end-to-end digital thread for product design. But how can these advanced tools be implemented? Let's explore some of the considerations and key factors for a successful implementation:

**Stakeholder inclusion:** Never underestimate the value of inputs from all your stakeholders – from manufacturing to operations and beyond. Ultimately, the wire harness design is the documentation they'll use to create the physical harness, so gathering their input early can help to improve quality and performance as well as time-to-market

**User buy-in:** User acceptance of changes are an important factor. If stakeholders are involved from the beginning, user buy-in is far more likely as it may require a culture/process change to the way designs are getting created to optimize the workflow with new capabilities

**Education:** It is preferred to provide education for using the solution that's tailored to the company and its processes. Consider creating courses that cover wiring design, 3D harnesses, harness design and library management

**Communication:** The surest way to kill an idea or an initiative is to stop talking about it. The same thing goes for strategies, especially if that strategy is for the long term. Communicate about the work you've done to date, and what to expect moving forward to keep strategies, ideas and initiatives top of mind.

## Conclusion

Using Capital Essentials is helping Terma reduce design time and human error by automating tasks associated with designing and building wire harnesses. The centralized parts library provides a single source of data and the ability to auto generate manufacturing documentation using consistent terminology and conventions that engineers across various product groups can easily access and understand. Additionally, by eliminating lengthy, time-consuming reviews, design cycles are accelerated, enabling Terma to deliver high-quality wire harnesses to customers quickly and cost-effectively.

To learn more about the Capital Essentials suite of products, visit <https://plm.sw.siemens.com/en-US/capital/products/capital-essentials/>

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