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Lean, mean and clean – the **electrical system in today's eVTOL**

When you think about an eVTOL aircraft, there's no engine to power a hydraulic or pneumatic system. Everything is based on the electrical system. As a result, the industry is looking for high-powered electrical solutions in an extremely lightweight design.

How do you find the perfect balance between the systems required to make an eVTOL fly safely and efficiently? Increasingly, platform developers are taking a multi-disciplinary systems approach to platform development to optimize key performance metrics. Through a comprehensive digital twin, ideas can be developed in concert with knowledge of how a certain innovation in one discipline helps or hurts the implementation objectives of another discipline.

We are seeing electric vertical take-off and landing (eVTOL) vehicles of all shapes, sizes and configurations. Companies from around the globe are actively pursuing what they believe is the ideal aircraft, whether for air taxi, cargo delivery, search & rescue, or any other function deemed necessary.

Key trends driving eVTOL companies

The eVTOL market is an extremely competitive environment

There are currently 100's of new companies being formed with the goal to develop electric Urban Air Mobility vehicles to provide air taxi services in urban areas. The first few to reach production and adoption will win.

Many of these are companies are "startups" relying on investor funding. Large OEMs have also invested in the eVTOL market by establishing partnerships with eVTOL companies. Regardless of funding source, it is imperative that these companies demonstrate progress and minimize issues to retain investor and partner confidence.

Intense competition exists between teams pursuing the UAM market. Investors and OEMs will back strong companies with a robust plan and a demonstrated ability to execute. Missing one significant milestone undermines confidence and could put an eVTOL company out of business.

eVTOL is a new type of aircraft. There are many risks to stakeholders as technical unknowns are discovered and addressed in the development of the first prototypes.

Electric propulsion increases electrical systems complexity

eVTOL aircraft are reliant on electrical power for propulsion and have a high level of electrical and software content, resulting in a high level of complexity in the systems.

At the same time, performance margins are thin due to battery limitations. Battery energy density is not increasing fast enough.

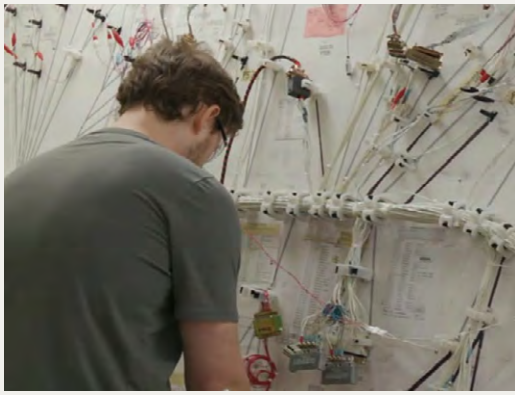
The startup nature of these companies means they are working in a fast-paced environment with a lot of change. It can be difficult to manage the complexity of the systems involved. This may lead to many additional iterative cycles of test-correct-retest.

This complexity coupled with energy density limitations poses a significant risk to meeting performance requirements including travel range.

Subcontracting approach to manufacture

Companies entering this market are focused on innovative solutions and time to market. Many of them are not planning to set up their own manufacturing facilities but rather will subcontract the work.

Data management and control of the design is crucial when companies are not manufacturing themselves. They must be prepared and equipped to gain advantage from digitalization of the manufacturing process.



Certification requirements are still maturing

The certification environment is currently being defined and is evolving rapidly. Currently, no vehicles have received certification, although many projects are in “the works”.

Certification requires time consuming and costly generation and reporting of evidence of regulatory compliance. This will require many iterations as regulation for eVTOL aircraft evolve.

New EWIS certification requirements require generation of maintenance publications that include documentation of both the physical design and the installation process.

Electrical Vertical Take-Off (eVTOL) Solutions have the potential to disrupt the Helicopter market

Electrical drives: more reliable, reduced complexity, easier maintenance -> Potential to disrupt Market

eVTOL compared to a helicopter:

4x quieter + **15x** higher reliability + **2x** safer + **10x** less expensive

Source: “The Future of Vertical Mobility”, Porsche Consulting, 2018

Electrical system challenges OEMs face today

As you might imagine, there are many challenges. But the two biggest challenges are: How does an eVTOL manufacturer achieve enough time in the air per-pound-of-payload to make an eVTOL a viable alternative for its intended mission? And second, how do OEMs ensure the safety of this new mode of transport?

It's no surprise that all-electric technology is plagued by the limitations on electric energy storage density. Modern batteries just can't compete with liquid chemical fuel (in some cases, they can differ by a factor of 10). In order to fly an eVTOL, teams need to be clever about how they optimize the platform. They have to design it – all of it – to address the specific mission objectives they are targeting.

The importance of power management and addressing platform weight

Increasingly, the most sophisticated platform developers are taking a multi-disciplinary systems approach to platform development to optimize performance metrics in two key disciplines: mechanical and electrical.

"For the best possible platform, mechanical and electrical systems are being developed in concert with knowledge of how innovative ideas in one discipline helps or hurts the implementation objectives of the other."

Further, model-based descriptions of the functions required from both disciplines are being brought together and assessed in tandem.

Configuration-controlled, electromechanical digital twins allow, not just designers, but systems engineers to make early predictions of how platform architectural trade-offs will impact key platform characteristics such as power, weight and other key mission parameters, such as flight time. In this case early means: in the early stages of architectural definition.

This kind of real-time insight was unavailable until recently. It is revolutionizing what is possible with today's technology – especially as it's applied to eVTOL aircraft.

Catalyst for the Digital Enterprise

An integrated portfolio of software, services and an application development platform that speeds the digital transformation cycle and unlocks a powerful industrial network effect. **Blurs the boundaries between traditional stand-alone engineering domains such as electrical, mechanical and software**.

Certification of an eVTOL

Ensuring safety and providing evidence that allows teams to understand that the platform will fly safely is a top priority. With the prospects of thousands of urban air vehicles buzzing about our cities and countryside, we need to be 100 percent confident that our mission systems and avionics will perform in all flight phases and under all flight conditions. Model-based techniques are already being employed by the most advanced organizations to address these concerns and challenges.

When it comes to certification, it's about having a trail of information so teams can audit themselves, which gives them confidence when it's time to certify with the FAA and other civil certification authorities. The model-based systems and techniques help establish that digital trail of information when developing these complex systems.

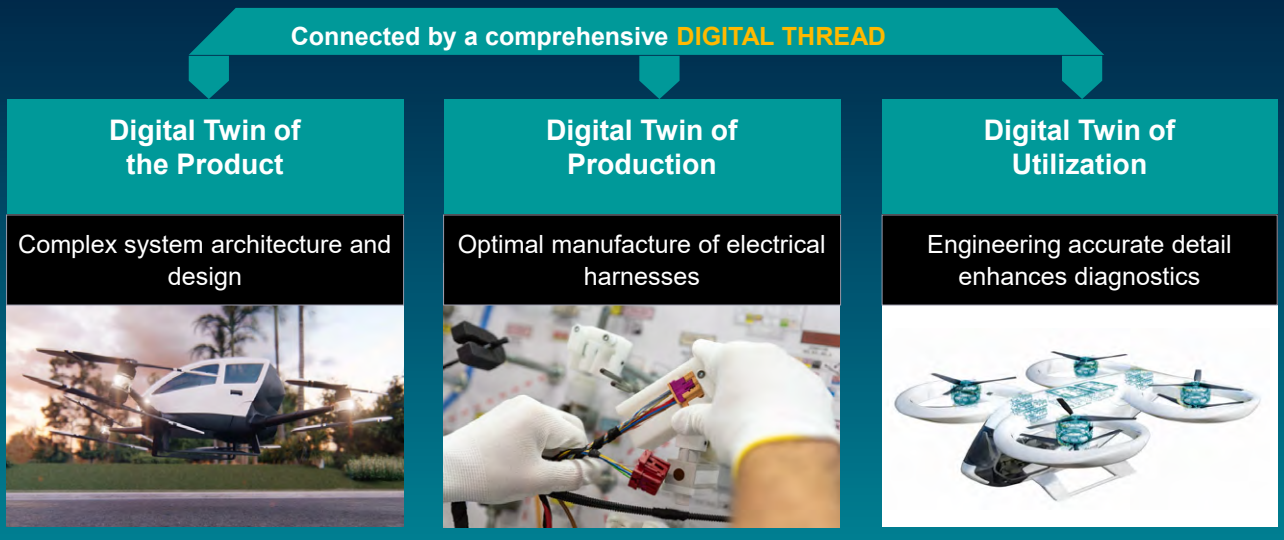
How the digitalized enterprise revolutionizes the development of eVTOL vehicles

Implementing a model-based approach allows teams to work together. It eliminates those isolated silos of how work was done in previous decades. A more digitalized approach allows teams to be proactive in meeting the demands of what they need to do, as well as being aware of what other teams need to do as part of the overall platform development lifecycle.

As already mentioned, a digitalized environment allows teams to understand how electrical architecture "trade offs" impact performance earlier in the process. By extending the digital thread, integrating the tools that perform certification and connecting with the platform's electrical and mechanical digital twin, teams know how implementation changes impact regulatory compliance in nearly real-time.

Having this type of capability allows developers to explore a much larger variety of solutions while taking into account the compliance impact. This can help with innovating new electrical systems and designs. Extending the digital thread, this time to reporting enables teams to accelerate the communication of the impact of the design changes to designated engineering representatives. We can do this in formats and frameworks that make it easier for regulatory authorities to understand what we changed and how it ensures regulatory compliance. Finally, what's great about this approach is that we can use these model-based techniques to reduce the cognitive load on both the development team and the regulatory team, allowing more individuals to work together more easily toward the common goal of implementing new, innovative and safe technology that will bring the eVTOL to market faster and within budget.

Model based E/E systems development
Leveraging the configuration controlled, electrical digital twin



Conclusion

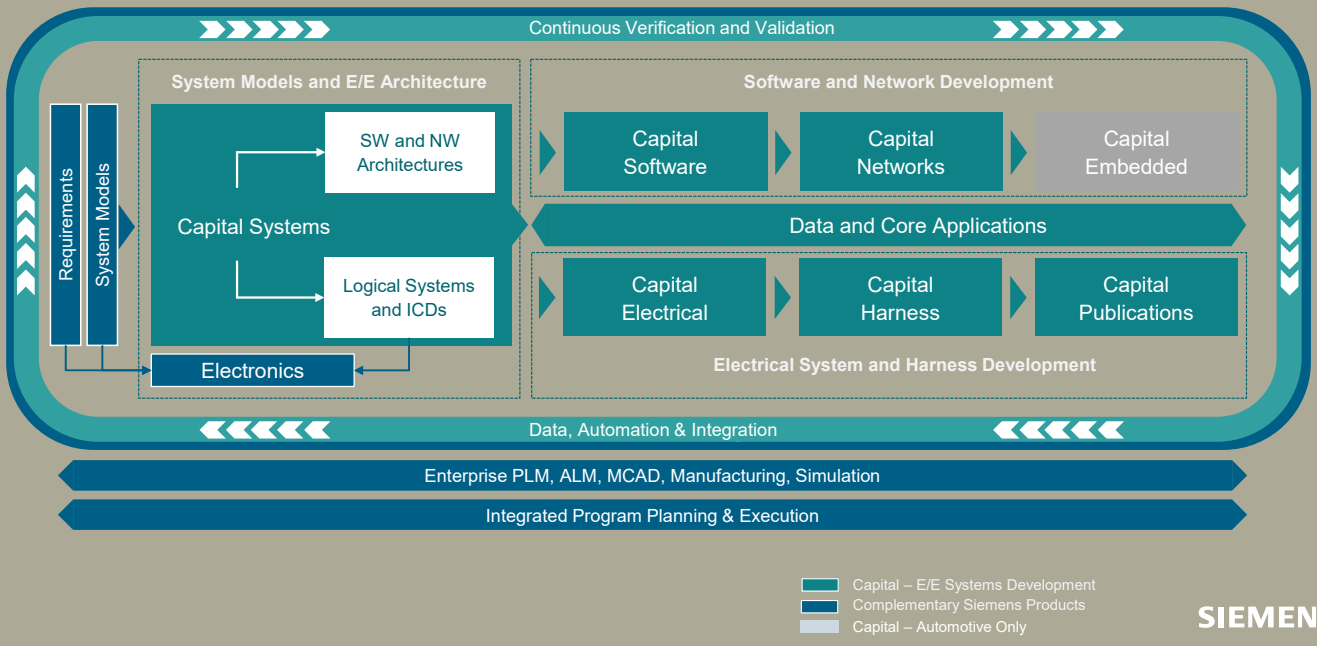
The challenges that many companies face today, the electrical systems on most aircraft in general and eVTOL in particular, are so very different than in past years. Once upon a time, teams used document-based systems to get things done. But today with the many new tools and solutions available, companies are embracing the digital transformation as a way to operate more efficiently. A way to virtually integrate, and sometimes even fly, the platform before the first test article is built.

Siemens helps eVTOL manufacturers and their supply chain with their digital transformation through our Xcelerator portfolio. It's all of our solutions packaged together. It's all of the tools that can be used to help teams move along – at their own pace – as they embark on their digital journey. As you're starting a new program, you're able to grow within this Xcelerator portfolio. It takes our comprehensive digital twin and digital threads and having this rich, robust understanding and the connectivity from engineering to manufacturing.

When it comes to an electrical systems solution, Siemens has invested over 2,000 man-years of effort in order to create a comprehensive electrical and electronic systems development portfolio. The Siemens Electrical/Electronic (E/E) systems development environment consumes system modeling data and requirements to enable eVTOL electrical system architecture optimization. It allows eVTOL systems engineers to choose a better architectural starting point with advanced knowledge of how it will impact platform performance characteristics and how to better achieve certification.

If you're interested in learning more about what Siemens Capital can do for your particular project, please visit the Capital website (www.siemens.com/capital).

Capital E/E systems development
An evolving story of capability growth



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About Siemens Digital Industries Software:
Siemens Digital Industries Software is driving transformation to enable a digital enterprise where engineering, manufacturing and electronics design meet tomorrow. The Xcelerator portfolio helps companies of all sizes create and leverage digital twins that provide organizations with new insights, opportunities and levels of automation to drive innovation.

For more information on Siemens E/E Systems Development solutions, visit www.**siemens.com/capital** or follow us on LinkedIn and Twitter.

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