5 KEYS TO POWERING PRODUCTIVITY

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The generator product development group at Siemens Power and Gas faces significant challenges in meeting stringent customer demands for delivery speed and quality. The team's goal is to increase customer value and productivity, without adding more resources. In designing complex rotating machinery, how does this team balance uncompromising product quality with rapid delivery of its systems — while keeping personnel costs reasonable? Roland Sievert shares five strategies for boosting engineering productivity.

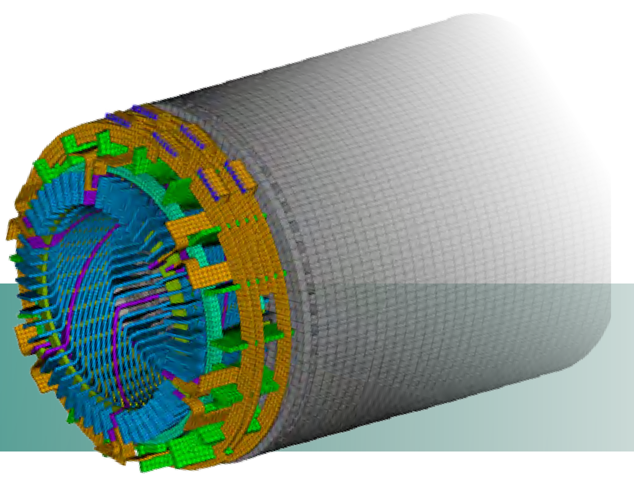
The Siemens generator business is part of the company's Power and Gas division, which supplies utilities worldwide with high-reliability, high-performance rotating power equipment. At its facility in Muelheim, Germany, engineers develop and enhance a comprehensive portfolio of turbo generators for large-scale power generation applications up to 2200MVA.

Backed by a 100-year history, an installed fleet of more than 1,300 units and efficiency levels up to 99 percent, Siemens generators are known for uncompromising product quality. In an industry where warranty expenses can be enormous and power outages can cost up to $1 million per day, Siemens' engineers cannot afford to make errors. For this reason, the company has invested in attracting the industry's best talent and assembling a portfolio of advanced engineering technology solutions that support creativity and productivity.

Today, the global power generation industry is characterized by strong competition. Large multinational companies are making significant investments in this sector. Original equipment manufacturers (OEMs) like Siemens are also facing tough competition and new challenges. Generators produced by Siemens are large, and they are also time-consuming and expensive to build. The engineering phase is a natural target for compressing the overall product delivery cycle time.

While facing tighter deadlines, the development team also provides diverse customer services. In addition to developing highly customized, clean-sheet generator designs or technologies, Muelheim engineers produce systems using off-the-shelf components to minimize complexity. All components need to operate together perfectly to meet or exceed various exacting performance needs. Plus, as Siemens' fleet of existing generators in the field ages, this same engineering team provides increasing maintenance, repair and refurbishment services.

How does the Muelheim team balance all these priorities, while still delivering the high quality demanded by the global power generation industry? Over the past several years, the management team at Siemens' generator business has worked hard to amplify the productivity of this highly skilled development team. Based on these efforts, Siemens' engineering managers have identified five keys to achieving higher productivity.



Simulation of the generator stator core system demands a real multiphysics approach using ANSYS simulation due to electrical field forces, heat generation, conduction and heat transfer as well as mechanical integrity assessment (e.g. during a short circuit) and for modal analyses.

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1 IMPLEMENT
A FLEXIBLE, FLUID TEAM STRUCTURE

On any given day at Siemens' generator business, engineers are focused on a number of competing priorities. To meet all these demands simultaneously, Siemens has created an agile, fluid organizational structure. A number of "priority teams" are always dedicated to critical projects, such as getting a customer back online in the wake of an outage. But the staff members not assigned to a priority project are flexible, changing assignments as projects evolve and personnel needs change. Experts in mechanical engineering, electrical engineering and other specialized disciplines rotate among different teams as their knowledge is needed.

To support this type of agile, ever-evolving engineering, Siemens has arrived at some general staffing and technology principles. First, the majority of staff members should have a range of general skills that make them extremely versatile across teams. Engineering simulation is a specialized skill for many development teams; however, at Siemens Generators about half of the engineering staff uses simulation software frequently.

In addition, the platform of engineering and design tools should make it easy for team members to collaborate on projects, even across different physics disciplines. For the Muelheim team's many simulation projects, a custom simulation base host governs most of the engineering data. This one-dimensional (1-D) host provides and receives parameters from ANSYS Workbench. Workbench provides a common, user-friendly numerical analysis platform where team members can converge, build shared models and hand off design concepts. This shared technology environment works with the governing master data host to ensure that everyone is speaking the same language and working toward the same objectives, even as individual team members come and go.

SIEMENS AT A GLANCE

→ 2014 revenues: 30.9 billion €
→ Number of employees: 343,000
→ Headquarters: Munich, Germany

2 CREATE
A SINGLE VIEW OF PROJECT STATUS

When an engineering organization is balancing multiple priorities and members are shifting among teams, it is critical that managers have complete visibility into the status of every project. The generator engineering team uses a software product called Concerto to visualize and monitor the many projects underway at any time. Regularly, project managers report their teams' progress in Concerto, including vital details such as milestones achieved, deadlines missed, and the availability or consumption of any "buffer" time that has been created during the design process.

On at least a weekly basis, top engineering management takes corrective actions, such as re-assigning a specialist if a particular team is falling behind or if another team is way ahead of schedule. In making these decisions, managers weigh the strategic importance of each project to the company, ensuring that key customers are not disappointed and technology development projects are not compromised.

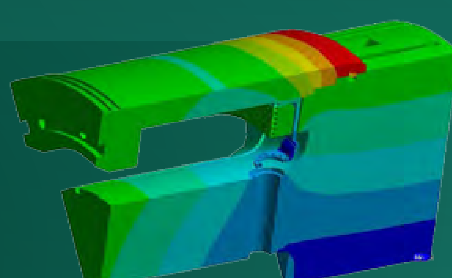
There are many software tools available for monitoring project progress, but the key is to have a system in place that creates complete visibility. A systematic, technology-based approach ensures that all decisions are made on a factual basis, with a comprehensive view of the whole engineering workload. These decisions are much higher in quality than those made on an ad hoc basis, or based on who is knocking on a manager's door and asking for help. By implementing a formal project-tracking system over the past three years, Siemens Generator has maintained the on-time delivery rate for engineering projects at well over 90 percent — while doubling the number of completed projects.

3 DRILL DOWN
ONLY AS NEEDED

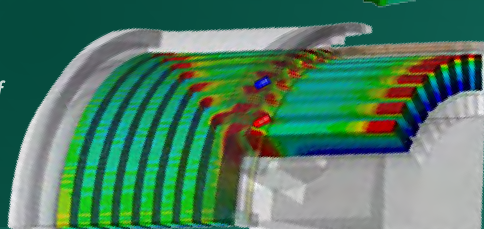
In the earliest stages of generator design, a full-blown, 3-D, multiphysics transient simulation of the complete product is not only unnecessary, it consumes a disproportionate amount of resources. While Siemens' finished systems are incredibly complex, the engineering team begins by working in an in-house 1-D design environment that Siemens created using custom software code. This allows engineers to quickly pre-optimize much of a product's geometry before moving on to more sophisticated, more exacting 2-D and 3-D modeling.

As projects move through the design pipeline toward completion, Siemens engineers drill down deeper and deeper to ensure final product quality and robustness. Accuracy is increased only as it adds relevance and value. Instead of relying on a single tool and a single level of design detail, Siemens Generators has created a broad toolkit, including its custom 1-D environment, that makes the best use of limited engineering resources — but is still capable of obtaining higher-fidelity results when needed.

Assessment of stress and displacement of conductors underneath the retaining ring. Siemens engineers use ANSYS structural software to determine shrink fit, heat conduction, material combinations and in-depth mechanics due to the rotating system.



Radial displacement of retaining ring mounted on rotor body



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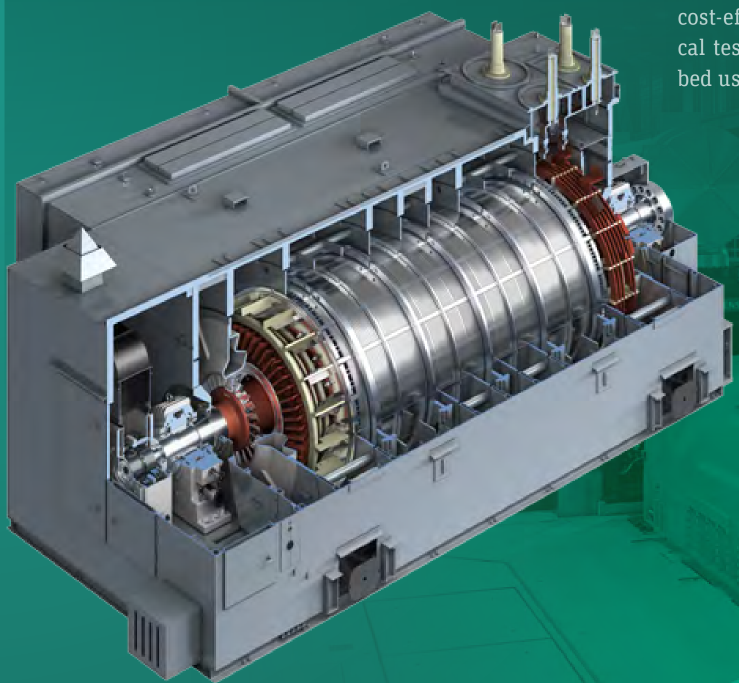
4 APPLY PHYSICAL TESTING STRATEGICALLY

Just as the engineering team at Siemens' generator business limits its use of full-blown 3-D simulation, team members deploy costly, time-consuming physical prototyping and testing only when it makes strategic sense. Siemens has constructed a large, one-of-a-kind generator test bed where systems are verified before being delivered to customers. When a company invests in this type of world-class resource, it can be tempting to use it frequently and perhaps over-rely on it as a quality check. To minimize the costs of both testing and physical prototyping, Siemens relies on simulation to not only provide early proof of machine performance, but to validate and calibrate predictive engineering methods.

Over the years, engineering simulation has proven highly accurate in predicting system performance, eliminating the need for multiple rounds of physical testing. When physical testing is needed, simulation allows Siemens engineers to use it in a very targeted manner, based on specific areas of concern identified in the virtual design space — such as regions of high mechanical stress or temperature.

When a finished generator design makes it to the test bed, engineers know exactly which areas to investigate and how to investigate them — the result of early planning and strategic thinking. And, if problems are identified in testing, targeted follow-up simulations help to address those issues quickly and cost-effectively. At Siemens Generators, simulation and physical testing work together in a closed-loop cycle, with the test bed used only when it adds customer value.



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5 WORK SMARTER

When an engineering team is working quickly and under constant pressure, it's easy to fall back on the philosophy of "That's the way we've always done it." However, this is contrary to increasing competitiveness over the long term via innovation and continual improvement. Development teams need to examine and re-examine even their most foundational processes to continually drive time and costs out of the design cycle. When managers shine a spotlight on daily work processes that have been accepted for years, the results can be surprising.

For instance, engineers at Siemens Generators once hand-typed a multi-page electrical data sheet for each project according to internal customer standards, which was very time-consuming. Recognizing that this was a major source of inefficiency, the Siemens team standardized this form by integrating the various customer requirements. An online version made it very easy for engineers to populate the form for each project with just a few mouse clicks. Now electrical specification happens in seconds, not days. Because the old way's resulting inefficiency impacted every downstream process, this single improvement has saved the generator business substantial lead time.

As another example, when 3-D designs are created, preliminary data is passed on for numerical analysis. As both physical design and numerical modeling continue in parallel, the design often evolves and does not match the numerical model anymore — increasing design uncertainty and decreasing the model's value. To ensure consistency, the engineers involved need to convene and verify the model's validity two times a week, even if they are working in different parts of the world. The engineers also agree on the subsequent action, with a focus on both quality and schedule. On many occasions, this saves weeks of rework and adds quality to the design at the same time — for no additional cost.

It's likely that every engineering team has institutionalized processes that have not been examined, and optimized, for years. By taking an objective look around their engineering organizations, managers may be able to identify and eliminate these kinds of hidden inefficiencies. Changing old, outdated ways of accomplishing daily tasks can power significant increases in engineering productivity, often at little or no financial investment.

ABOUT THE AUTHOR

Roland Sievert earned a master's degree in mechanical engineering in 2002 and a Ph.D. in fluid flow mechanics in 2006 from Ruhr University in Bochum, Germany. He went to Siemens beginning in 2002 as a doctoral student and was hired as a steam turbine development engineer in 2006. Three years later, he became section manager in steam turbine development, and in 2012 he was named department manager in generator engineering.