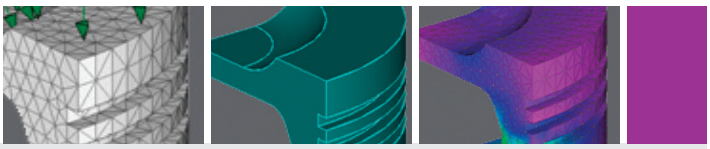
Velocity Series

FEA for all engineers

www.siemens.com/plm/femap

white paper



Siemens PLM Software delivers advanced CAE technologies for engineers at SMB-level companies.

PLM Software

Answers for industry.

SIEMENS

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Executive summary

SMB manufacturers (small- to medium-sized businesses with revenue between $7M and $700M) are seizing the opportunity to improve their product development process with investments in CAE applications over the next several years, according to AMR Research. The objective of this investment is to bring product design and engineering closer together in order to reduce product development cycle times for more efficient use of engineering resources, to reduce costs and create products that are more likely to meet customer requirements.

Both engineers and engineering analysts can now work more closely together leveraging the same finite element modeling tool regardless of the type of CAD or CAE (FEM/FEA) tools they use in order to bring higher-quality products to market sooner. Siemens PLM Software's new Velocity Series™ software delivers an integrated engineering environment of world-class product lifecycle management (PLM) – including computer-aided design (CAD), finite element modeling (FEM), finite element analysis (FEA), computer-aided manufacturing (CAM) and product data management (PDM) – that can also interoperate with other design and analysis systems, helping companies to reduce their product development cycles.

SMBs are being challenged, like large corporations, to get a product from design to manufacturing in a shorter time with the highest quality possible, while maintaining profitability. There are several factors that manufacturers need to take into consideration – design for easiest manufacturability, material selection, size, shape, weight, stress, operational performance, durability and cost to mention a few. Optimizing these constraints is now possible and allows manufacturers to continue to be competitive. Siemens' Femap® software combined with NX™ Nastran software has been designed to help SMBs meet that challenge.

Twenty years ago, draftsmen and CAD users did not have the knowledge, training or tools to analyze how the parts they were designing would perform in their operating environment. During the last 20 years digital simulation and the integration of CAD and CAE has come a long way. Performing product analysis today is like going to the doctor. The first step is to see the general practitioner (the engineer) who analyzes and evaluates or stabilizes the situation (solution). Today's general practitioners are better educated, have access to superior tools and are more capable than ever before. When highly-specialized knowledge and analysis is required, general practitioners refer patients (parts) to specialists (the engineering analyst or consulting firms) depending on the symptoms (operating conditions) that need to be addressed. Today's engineers are capable of bringing analysis into the design process more efficiently than ever before.

The solution is to bring design and analysis closer together using the same FEA tools. Allowing the engineer to do more analysis in the design phase is a key to shortening the design-analysis cycle and bringing higher-quality products to market sooner with less overall cost.

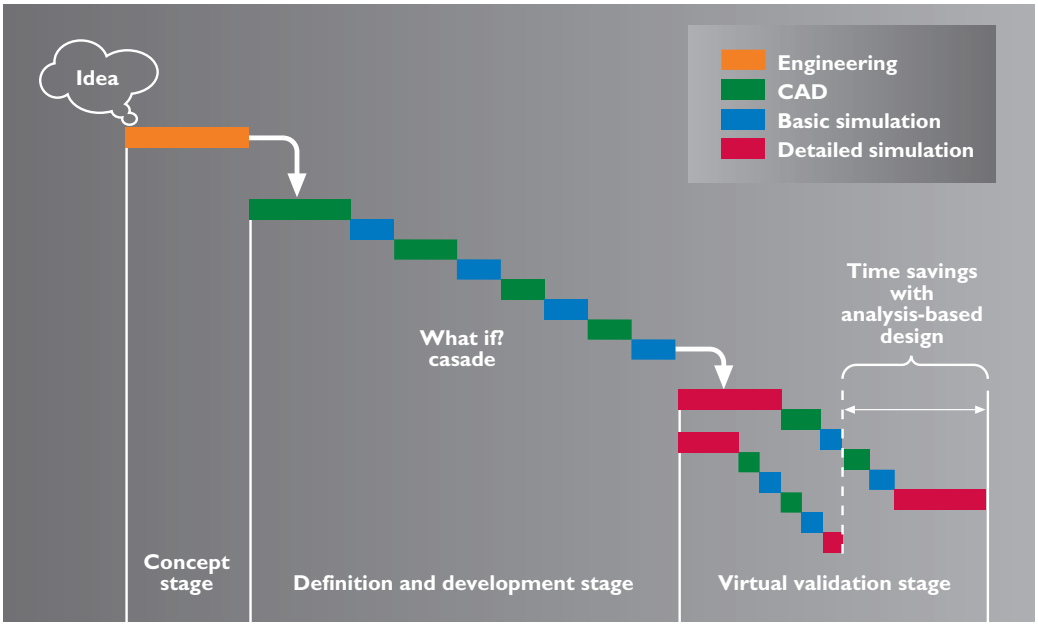
Introduction – FEA for all engineers

Over the past two decades, advancements in computing hardware and software have made the notion of product lifecycle management (PLM) possible through the effective integration of computer-aided design (CAD) and computer-aided engineering (CAE-FEM/FEA). Mergers and acquisitions of large engineering companies, plus the growth of mid-sized manufacturing businesses and worldwide outsourcing, have immensely increased the competitive climate creating a need for SMBs to invest in digital simulation tools. What was thought of as a set of engineering tools accessible only by large engineering enterprises is now available to mid-sized manufacturing businesses – and now they cannot afford not to utilize them.

SMBs, mid-sized companies with revenue between $7M and $700M, can now effectively compete with larger companies who command superior resources. In the past, CAD and CAE were used only by large engineering firms that could afford the hefty price tag to own or lease these tools. Today, CAD/CAM/CAE software, and the hardware required to run it, are more affordable to SMBs and the return on investment can be significant. In the past, CAD was performed by full-time design engineers and CAE by full-time engineering analysts, who were gurus of their respective disparate realms. Meanwhile small- to mid-size companies relied on the drawing board, hand calculation sand physical prototyping and testing. Today's engineers have had more exposure to CAD and CAE technologies and are quite capable of performing stress, natural frequency and other basic engineering analyses. Engineers with specialized analysis skills may still be required, but all engineers, at any size company, can have cost-effective access to one easy-to-use engineering tool that ties any CAD system to any CAE system, not to mention the added capability of complete product data management.

With the integration of CAE, finite element analysis can be performed during the design process, thus closing the design-analysis gap, minimizing design iterations and almost eliminating the need for physical prototyping and testing. FEA allows engineers to effectively simulate the operating characteristics of their designs digitally, well in advance of tooling for prototypes. Countless dollars can be saved by identifying design problems before entering into the manufacturing process.

> ***"The mechanical applications market has finally entered a healthy growth phase in all application areas. Product data management tools will continue to lead the way, with computer-aided design and computer-aided engineering tools also experiencing solid growth during the next five years."***
>
> *Laurie Balch, Gartner Group*
> *"Market Trends: Mechanical Applications, Worldwide"*
> *11 January 2006*



Speeding up time-to-market opportunities using design-analysis time compression. Engineers perform preliminary feasibility checks and analysis of model is done before the initial design is completed.

The business challenges facing SMBs today

SMBs must efficiently utilize their resources not only to be profitable, but to be able to fight off competitive pressures and grow. Time is money. Waste results in lower profits or missed opportunities. Failing to efficiently utilize time and resources results in waste whether it stems from not meeting schedules, customer needs and wants, or from quality issues relating to rework, warranty or legal concerns.

"Hedging against uncertainties about their financial prospects, manufacturers are aligning IT investments across three business scenarios. These include cost management, incremental growth and innovation."

Geraldine Cruz, Gartner Group
"Market Trends: Manufacturing, United States, 2004-2005"
19 November 2004

All SMBs face the same business drivers such as development time compression, product cost/price reductions, overhead cost reductions, combined with improved product quality and longer life. These drivers can have a great effect on profitability.

"Small- and mid-size businesses (SMBs) have to deal with many of the same issues as their larger counterparts when designing and launching new products. In fact, small rarely implies less complexity. In many cases, these manufacturers are in specialty businesses that tackle complex designs that larger customers are not capable of handling."

Michael Burkett, David O'Brien, AMR Research
UGS Thinks Big About Midmarket PLM
September 2005

The effect of worldwide competition and outsourcing is also putting pressure on SMBs to reflect on how they do business.

SMBs involved in a supply chain are being affected by larger businesses that are changing the working relationships by passing design and warranty responsibility down to them. This is forcing suppliers to come up with their own designs and analyzing those designs – in essence, doing more in less time for the same or lower cost.

In 2004, AMR Research reported that the SMB (mid-market) is the fastest growing segment in the PLM marketplace with an expected growth rate in CAE of 12-16 percent annually. Not only is the number of SMBs growing worldwide, they are aggressively investing in PLM (including FEA) to become more competitive.

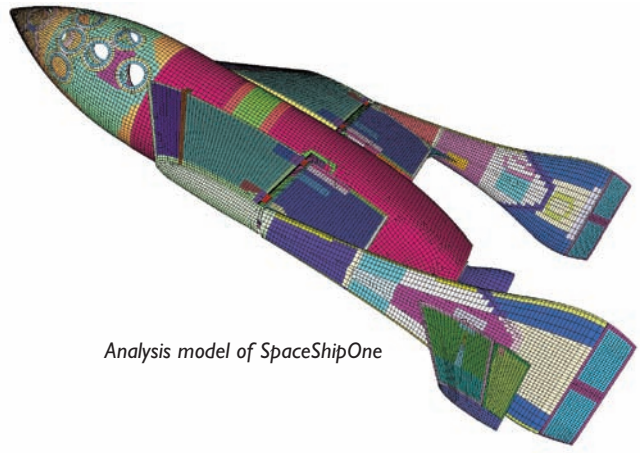
"North American mid-size businesses will experience the most growth of any company-size sector through 2007."

Robert P. Anderson, Gartner Group
Market Trends: Midsize Business ERP and SCM Market North America, 2004-2007, 2 November 2004

The solution is to invest in fully integrated PLM (CAD/CAM/ CAE/PDM) systems where both designers and engineers can easily use FEA to eliminate poor designs, digitally, early in the design-analysis process.

"The real value of simulation in aerospace is that you could not do what we're currently doing without it. Typical program schedules that used to take 5 years are now done in 2 years or 1 year. In our opinion, Femap is one of the best solutions on the market, and it's very easy to use."

Chris Flanigan, Quartus Engineering
www.quartus.com



Analysis model of SpaceShipOne

Why FEA?

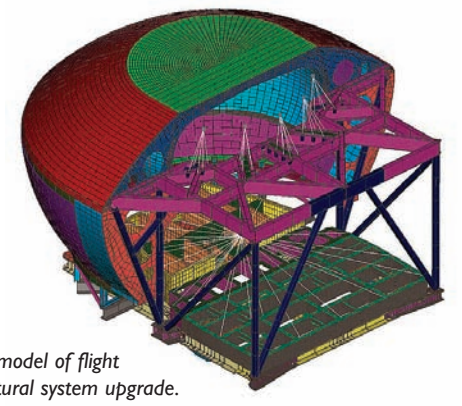
CAD has been accepted by SMBs for several years as a key to product design and being competitive. Because SMBs will be responsible for the design, analysis, manufacture and warranty of the products they develop, they need to utilize FEA to be cost-efficient. The design-analysis phase (CAD/FEM/FEA) of product development will be the key to determining whether or not the product design will perform as required, meet customer expectations and reduce warranty claims. But the desired product delivery time remains the same or needs to be shortened. Therefore, SMBs need to move the analysis phase closer to or into the design phase of product development in order to make their delivery commitments. Moving the analysis phase closer to the design phase will help SMBs to develop more feasible designs earlier in the design phase, thereby reducing design and analysis rework. Developing more feasible designs early will also reduce the number of physical prototypes built and tested, thus eliminating additional design-analysis-physical test cycles resulting in time saved. FEA allows SMBs to digitally perform tests that they would not have ordinarily undertaken, leading to more innovation, better designs, and less risk – providing a balance between perfection and cost.

"Femap and NX Nastran are industry recognized products and they send the message that we are a company that cares about its software and about doing quality work."

"The challenge that you face as a small business is to reach as many customers as you can. If we had to buy every pre-processor and every solver, we couldn't afford that."

"NX Nastran has the name recognition of Nastran, so our customers have the confidence that we use only the best tools, but because NX Nastran is sold by Siemens PLM Software, we get Siemens-quality support, which is essential. Even if you really know the software, there are still times when you need help. We've been very pleased with the customer support from Siemens. The response time is very good."

Mike Pagnotta, President
Pagnotta Engineering
www.pageng.com



Finite element model of flight simulator structural system upgrade.

What is FEA?

FEA is an engineering computational analysis methodology that helps to determine the health of a part, assembly or product – in a preventative sense. It can also help to determine why parts have failed. FEA involves the idealized mathematical model (or finite element model) representation of a part and the physical conditions which surround it, such as loads and boundary conditions. The finite element model is then analyzed by a finite element analysis solver, which returns information that can help to identify weaknesses in the part.

Finite element analysis allows engineers to get an in-depth understanding of all of the nonoperating and operating characteristics of the products they develop from several points of view including the geometric shape, materials used, physical constraints and loading conditions. Product characteristics from stress to normal modes (natural frequency excitation) are just the basis to understand how a product responds to its operating environment. Other, more complicated, product characteristics come from external dynamic response, thermal response, acoustic response, contact, motion and other multi-physical environments. These more complicated analyses may require engineers with specialized analysis skills.

Twenty years ago, draftsmen and CAD users did not have the knowledge, training or tools to be able analyze how the parts they were designing would perform in their operating environment. Only after initial product designs were drawn up, the designs were given to engineering analysts who evaluated the design and made redesign recommendations. After the design-analysis loop was completed, physical prototypes were then made and tested for another potential round of design and analysis.

▶ Where does FEA fit in the development process?

Today, FEA fits in both the engineer's and engineering analyst's process. The key to making this happen efficiently and effectively is to have all of a part's analytical properties assigned directly to the CAD geometry model – material properties, loads, boundary conditions and mesh properties. Therefore, when the CAD geometry changes, all of the physical properties automatically change accordingly, or when the analysis mesh changes, the geometry can be updated to reflect those changes.

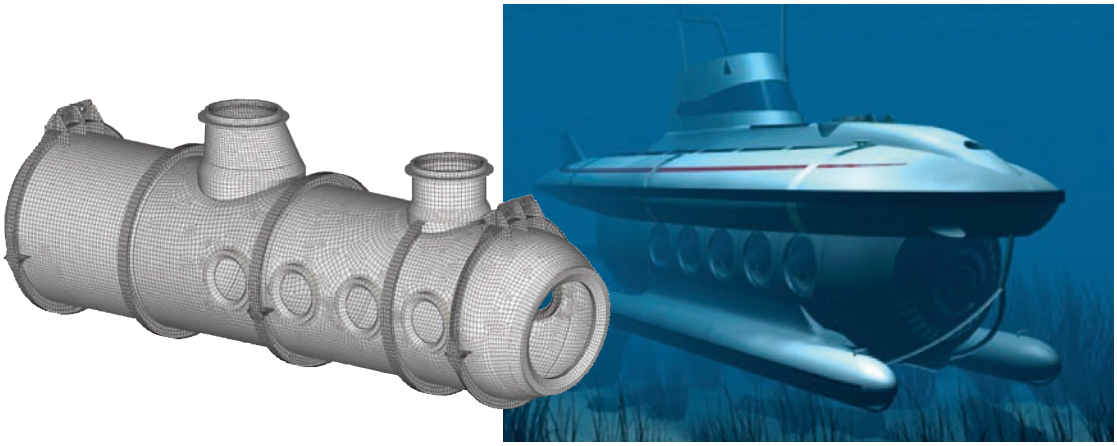
This process involves creating one environment that allows various types of engineering practitioners (engineers and engineering analysts/specialists) to perform their jobs. The environment has to have tools for creating the geometry (CAD), tools for creating the finite element model (FEM) and tools for performing the analysis (FEA) and interpreting the results.

Using the medical profession as an analogy, a general practitioner takes care of most of a family's health needs and refers patients to a healthcare specialist when the health problem falls outside of the general practitioner's expertise. Each healthcare specialist focuses on one or two areas of specialty. It's not feasible for a healthcare specialist to focus on all general cases. However, today's general practitioner is better trained, more knowledgeable and capable of handling more types of cases. The general practitioner's job is to analyze patients, provide a solution and/or then refer them to the next level of healthcare.

Similarly, let today's engineer, who is better trained and has more exposure to CAE (FEM/FEA), be the general practitioner who does all of the basic analyses to get an understanding of the problem and determine the best solution. The engineer can then pass the "quality" solution to the various expert analysts for further analysis or the analysis of component assemblies. The expert analyst may double-check or verify that the preliminary analysis has been satisfactorily completed before proceeding, but does not have to perform that preliminary analysis, thus freeing engineers up to focus on their specialty – thermal, fluid, dynamic response, nonlinear conditions or motion dynamics. Today's engineers can handle 80 percent, or more, of the required engineering analyses, leaving 20 percent of the analyses to the engineering specialist.

"What makes Femap unique is that it is independent. It doesn't have a particular solver preference and it isn't aligned with a particular CAD program. It supports them all. And when you need to create your own geometry from scratch, that's where Femap really shines. Femap is an engineer's pre- and post-processor. When engineers need to get real results, accurately and competently, they use Femap. It's industrial-strength and stable."

George Laird, President, Predictive Engineering
www.predictiveengineering.com



Custom submarine designed and analyzed for recreational use.

The Siemens solution – Velocity Series

Siemens' focus on CAE and the mid-market manufacturing enterprise has resulted in the development of its new Velocity Series which is the industry's first comprehensive, preconfigured offering that combines digital product design (Solid Edge® software for CAD), analysis (Femap Express and Femap for FEM and NX Nastran for FEA), manufacturing (NX CAM Express for CAM) and data management (Teamcenter® Express software for PDM) in one package from one vendor – also allowing for connectivity to other CAD geometries and analysis solver technologies.

Femap's seamless and robust dataflow brings analysis closer to design.

Femap Express is an intuitive, easy-to-use engineering analysis environment for stress and normal modes analysis that delivers fast and accurate results. Femap Express is the key component that focuses on bringing analysis closer to the design process and is intended to make FEA more accessible and easier to use by both occasional users and experts, while maintaining integrity of both the CAD model and the analysis.

To form a broad and comprehensive CAE solution, Femap – an extension offered to Femap Express – offers in-depth finite element modeling functionality that allows access to advanced analysis solutions such as dynamic response, nonlinear and heat transfer analysis. Femap is also highly integrated with all versions of NASTRAN, the industry's most reliable and leading FEA solver technology, including Siemens' NX Nastran. Femap, with an updated native Windows user interface and tighter integration with Solid Edge, further enhances general usability and productivity.

Both Femap Express and Femap deliver pre- and post-processing capabilities that provide the ability to update and improve product designs based on the analysis results.

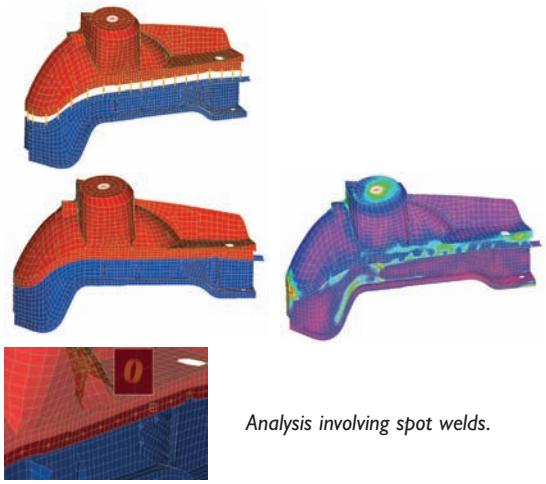
Femap's capabilities and benefits

In general, Siemens' Velocity Series is affordable, easy-to-use, easy-to-implement and provides a low total cost of ownership. SMBs will appreciate what Femap Express and NX Nastran can do for their design-analysis process. Femap Express (CAE/FEM) is integrated into Siemens' Solid Edge (CAD) and directly accesses NX Nastran (CAE/FEA).

Femap Express provides a scalable solution to extending your analysis needs. Femap, an extension to Femap Express offers direct file associativity with Solid Edge, and supports any version of Nastran and its advanced solver capabilities. Femap and Femap Express were designed with all engineers in mind – both the engineer and the engineering analyst – and support the most common analysis modeling as well as highly-specific analysis types. It was also designed with a built-in upgrade path allowing for expanded analysis capabilities as your business grows.

Femap with NX Nastran combines two of the world's most popular and powerful structural analysis programs for simulating product performance characteristics of structures and mechanical components. As such, Femap combined with NX Nastran provides a very cost effective Windows-native CAE solution that combines Femap's widely used pre- and post-processing capabilities with the well known and respected analysis capabilities of NX Nastran.

Based upon a 15-year history of working closely with Nastran solvers, Femap seamlessly integrates with NX Nastran and the Velocity Series environment. It directly supports a broad range of NX Nastran capabilities, such as linear and nonlinear statics, normal modes, eigenvalue, transient/dynamic, frequency/harmonic response, response spectrum, random response and buckling. There are also additional NX Nastran options available for aeroelasticity, superelements, optimization, DMAP, rotor dynamics and advanced nonlinear. Femap with NX Nastran also provides a comprehensive range of detailed functionality to directly define and control most aspects of modeling, simulation with NX Nastran and subsequent post-processing operations.

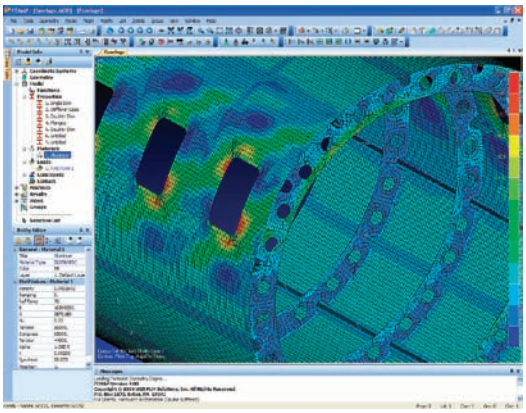


Analysis involving spot welds.

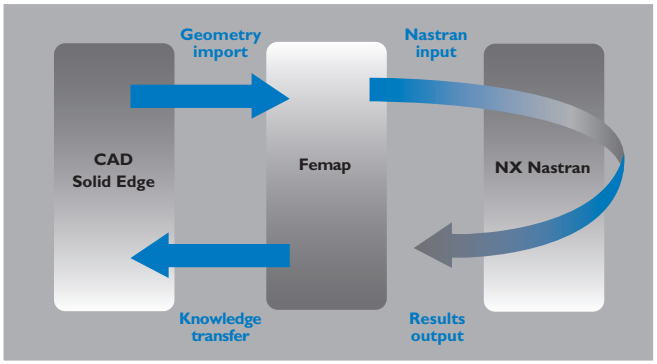
Femap's open technologies are Windows based, making them readily accessible. This not only provides a high degree of familiarity for the majority of users, but it also ensures that Femap brings powerful digital simulation directly to the engineer's desktop easily and affordably.

A market-leading component of Siemens' Velocity Series, Femap provides an independent backbone to a number of other well known and industry respected CAD/CAE simulation products.

Femap is based on an advanced set of open technologies that enable it to work simply and easily within customer engineering simulation environments. Femap leverages Parasolid® software, a widely accepted solid modeling kernel used in CAD/CAM/CAE systems to create and edit the mathematical definition of engineering parts and assemblies. In addition, Femap also supports a number of other types of CAD systems allowing it to interface with geometry from virtually any source, directly and seamlessly. Femap also works with a broad and deep range of finite element solutions from several types of solvers. This makes Femap a very logical and flexible solution that is simply tailored for even the most demanding customer needs.



Femap in a native Windows environment.



Femap's seamless and robust dataflow brings analysis closer to design.

Summary

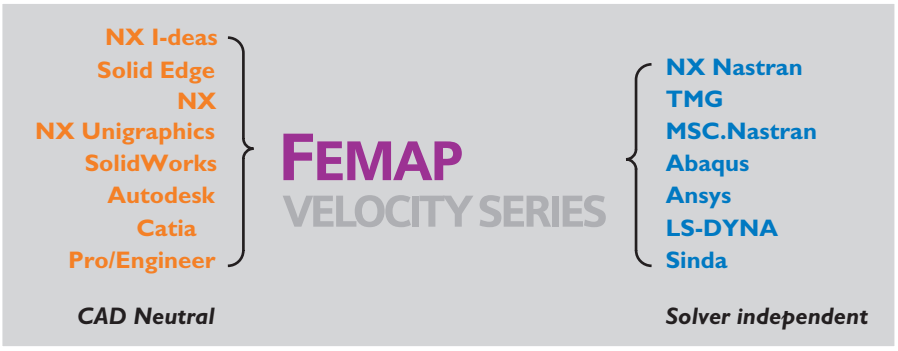
SMB manufacturing or engineering companies that are not utilizing the latest PLM (CAD/CAM/CAE/PDM) technologies are foregoing a competitive advantage. SMBs face challenges that can be mitigated by the strategic use of Siemens' Velocity Series solution of Femap with NX Nastran. By bringing product design closer to engineering, the time to manufacturing can be reduced, product quality can be maximized, and profitability can be increased.

Twenty years ago, design engineers did not have the knowledge, training or tools to analyze their designs. Today's analysts and engineers no longer have to build separate, meshed geometric models based on their CAD files in order to run FEA analyses. Femap Express is an FEA application closely integrated to CAD that allows CAD and entry-level FEA technologies to work together within a common user interface and give engineers a quick, easy way to see if their designs will meet specifications. When they need to run complex, high-end analyses, analysts can still choose to do more in-depth analysis with Femap.

Siemens PLM Software has been helping large manufacturing companies to be successful for more than 35 years in the automotive, aerospace, shipbuilding, electronics and other industries. SMBs can now take advantage of what Siemens has learned from serving these large manufacturing businesses. Siemens has the comprehensive PLM (CAD, CAE, CAM, PDM) solution to the engineering issues facing manufacturing SMBs to help make them more competitive and profitable.

Consider investing in Velocity Series with Solid Edge, Femap Express, Femap, NX Nastran, CAM Express and Teamcenter Express today. Contact a Siemens PLM Software sales representative for more information and a demonstration.

CAD and solver integration



About Siemens PLM Software

Siemens PLM Software, a business unit of the Siemens Industry Automation Division, is a leading global provider of product lifecycle management (PLM) software and services with 5.5 million licensed seats and 51,000 customers worldwide. Headquartered in Plano, Texas, Siemens PLM Software's open enterprise solutions enable a world where organizations and their partners collaborate through Global Innovation Networks to deliver world-class products and services. For more information on Siemens PLM Software products and services, visit www.siemens.com/plm.

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