NX Digital Simulation
Experimentation is the key to innovation

UGS delivers a complete solution for digital simulation and prototyping throughout the product development lifecycle.
Your business benefits

- Faster to market with innovative new products
- Lower costs from:
  - physical prototyping
  - engineering change orders
  - in-service warranty
- Increased product quality

Why digital simulation?
Industry pressure to reduce costs and improve quality is driving growth in the use of digital simulation throughout the product lifecycle.

Choosing the right tools is key to achieving the business benefits of digital simulation. Companies need to consider technology, scalability, integration and management.

- The right technology ensures that digital simulation can accurately represent the physical environment.
- Scalable solutions adjust to a broad range of users’ skill levels and a growing scope of requirements.
- Integration with other simulation tools and with product development applications is important to both the efficiency and effectiveness of the CAE solution.
- Management of data, processes, product knowledge and workflows is critical to overall enterprise efficiency and collaboration.

Why UGS?
NX™ helps manufacturers develop products right the first time with a complete range of simulation, validation and optimization tools. At every stage of development, these integrated tools check products and processes to ensure quality, performance and manufacturability.

Product quality with fewer prototypes
With NX digital simulation, companies accurately model and analyze product performance characteristics while minimizing physical prototypes.

NX product simulation applications include dynamic motion simulation, basic strength analysis, system-level performance evaluation and advanced response, durability, fluid flow and multi-physics engineering analysis for robust simulation of functional performance.

NX also manages CAE processes, workflows and data to deliver vital performance feedback where it is needed to improve your products.
Transforming digital product development

From the leader in CAE
UGS is a world leader in CAE and digital simulation. Our solutions are backed by an experienced staff of engineering analysis experts and a distinguished 35-year history of developing leading-edge digital simulation technologies. The UGS team has a unique vision to take the digital simulation community into the future.

Scales to the challenge
NX simulation, validation and optimization solutions are suitable for users of all levels and are highly scalable to help solve even your most advanced challenge. Most importantly, all are available within an open and collaborative PLM architecture that includes leading product and process management solutions that help manage and improve digital simulation processes.

Simulation that fits your needs
Manufacturers can easily configure NX to best fit the specific digital simulation needs and the skill levels of the product development team. NX simulation solutions are used to evaluate and optimize products throughout the world in the automotive, aerospace, high-tech electronics, industrial machinery, medical equipment and consumer products industries. These offerings include embedded best-in-class technologies as well as many integrated specialty solutions available directly from a network of over 30 affiliated CAE companies.

PROVEN RESULTS

“Simulation is transforming from a reactive and defensive tool to a proactively deployed competitive weapon.”
Daratech, Inc.
Industry update, March, 2004

NX enables manufacturers to digitally simulate, validate and optimize products and their development processes. By simulating performance earlier in the development cycle, manufacturers can improve product quality while reducing their reliance on physical prototypes and costly, time-consuming design/build/change cycles.
A key to business success

Manufacturers rely on product development to deliver products that add value to their portfolios. Efficient designs reduce material and manufacturing labor costs. Designs that have been studied and improved have lower warranty costs and fewer liability issues. By increasing the effective use of engineering simulation, project managers can reduce many downstream costs and risks.

**Improving the process through simulation**

Digital simulation enables improvements throughout the development process, allowing exploration of more concepts while reducing direct costs associated with expensive physical prototypes. Simulation enables faster, more informed decisions that lead to better products. Better products have better performance and higher margins, which directly benefit the bottom line. Integrated within enterprise data management systems, digital simulation enables management to leverage knowledge of product performance to reduce development cycle time.

By getting to market faster, companies gain significant financial and market share increases, but the benefits reach beyond the balance sheet. Increased confidence that designs will work enables suppliers to reduce contingencies in contract negotiations, while efficient process tools and scalable environments release scarce resources to focus on new business opportunities with new revenue possibilities.

**Reducing waste, improving quality**

Automation and infrastructure enhancements bring immediate value to engineers, analysts and teams tasked with developing the infrastructure to increase the use of simulation. Simulation, validation and optimization capabilities are pervasive attributes of NX. NX Digital Simulation directly supports core business initiatives like Lean Design and Design for Six Sigma, helping reduce waste caused by defects with associated warranty and support costs, improving performance and manufacturability and reducing the lengthy and costly design-build-test cycles of physical prototypes.

Ensuring simulations are performed with up-to-date design geometry even with multiple revisions helps ensure that the predicted performance characteristics more accurately reflect the final “as-delivered” product.

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**Table: Industry norm vs. NX environment**

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With advanced technologies, NX simulation solutions significantly reduce the overall cycle time required for typical simulation tasks.
By increasing the effective use of engineering simulation, program managers can reduce many downstream costs and risks. Digital simulation enables improvements throughout the R&D process, allowing more innovative concepts to be reviewed while reducing direct costs associated with expensive physical prototypes.

The value of an efficient design is well understood in terms of reduced material and manufacturing labor costs. Simulation enables faster, more informed decisions leading to better products. Better products have better performance and higher margins, which directly benefits the bottom line.

Effective simulation gives companies a competitive edge, enables immediate feedback during the design process and gives project teams better information to make better decisions. UGS is uniquely qualified to deliver simulation technology that adds value to the entire development environment. The unique combination of strengths in Teamcenter® and NX provides tools, data and process support for all areas of the product lifecycle.

**Benefits of digital simulation in the NX environment:**
NX simulation solutions cover the breadth and depth of digital prototyping requirements across a wide range of industry applications and user technical backgrounds. Applications include process-centric tools tailored for use by design engineers, to “multi-CAD” analysis environments for the most demanding specialists and industry-standard solvers, like NX Nastran.

- Front-loaded simulation supports better decisions earlier in the process
- Faster computation technologies mean a faster response
- Accurate results give you confidence in your design
- Scalable tools help drive collaboration among designers, engineers and analysts
  - Easy to use with solutions that are easy to understand
  - Complete in scope to support even the most demanding analyst
We understand your challenges
The right tools in the hands of the right people at the right time helps
development teams expedite their work quickly and effectively.
Analysts can deal with the most complex geometry using powerful
de-featuring and updating technology. The implementation and
automation of best practices with NX enables domain specialists
to capture knowledge and best practices and safely enable broader
use of simulation by more people. With pervasive use of validation
tools at every step, companies can build quality and speed into the
design process.

NX simulation is an integral part of the unified product development
environment. No other suite of product development solutions
offers such a broad and powerful range of product and process
coverage, completely integrated together. NX includes the widest
and most flexible array of product modeling abilities, coupled with
the most advanced simulation and manufacturing capabilities,
integrated into a single product development environment.

Management of data and processes in the NX managed development
environment adds to the efficiency and effectiveness of the whole
team. It delivers the power to find and re-use existing analysis models
and results. It automatically communicates design changes to avoid
problems, errors and wasted effort. NX enables companies to start
analysis at an earlier stage of design and provide real design impact.

> An open system: Founded on open standards and protocols, NX
can be readily integrated with other product development tools and
with business systems. This open system philosophy also enables
better communication and collaboration in your supply chain.

> Scalable: From individuals to departments to globally networked
development teams, from wizards to simple general-purpose
design tools to full-featured, industrial-strength analyst capabilities,
NX is packaged to meet the development needs of large or
small organizations.

> Adaptability,
flexibility,
scalability
FE modeling/meshing
- Advanced geometry modeling and automated abstraction tools
- Wireframe, surface and solid geometry can coexist in same model
- Unique topology simplification tools
- Free meshing, mapped meshing, mesh smoothing and manual mesh generation
- Complete FE element library and physical property definition tools
- Advanced quad mesher for complex surfaces
- Robust, automated tet meshing for complex 3D solid parts
- Automated quality checking tools
- CAD-associative updates to CAE models
- Robust beam modeling
- Spot welding connections
- Seam welding connections enable joining of incompatible meshes
- Assembly-level FE modeling
- Assembly constraints on virtual parts
- FE-based as well as geometry-based loads and boundary conditions
- Cyclic symmetry
- Laminate composites modeling with multiple-ply material definitions
- Adaptable GUI for different FE solver environments/languages

Open interfaces
- Bi-directional translators to NX Nastran, MSC.Nastran, ANSYS, ABAQUS, LS-Dyna, RADIOSS, PAM-CRASH, I-dea, Pro Test, PCB/ECAD
- CAD geometry – Catia, Pro/Engineer, SolidWorks, Solid Edge, Parasolid, ACIS
- Data exchange – IGES, STEP, VDA, STL, JT, MatLab, Excel, ADAMS MNF
- Over 30 third-party CAE solution partners provide direct interfaces to NX via PLM Components program

Materials
- Integrated materials libraries for common metals and U.S. Government handbook specs
- Elastic-plastic material models
- Gasket material models
- Hyper-elastic material model extensions – Ogden, Arruda-Boyce, foam
- Fluid material models (nonflow)

Motion
- Kinematics
- Multi-body dynamics
- Rigid and flexible bodies

Design optimization/variational analysis
- Geometry-based optimization
- FE-based optimization
- Design of experiments

Duration/fatigue analysis
- Strength and fatigue safety for cyclic loading (infinite life model)
- Advanced life and fatigue damage prediction (finite life model)
- Both uniaxial and biaxial stress cycles
- Utilize linear or nonlinear stress/strain results from FE models
- Utilize load time histories from physical test measurements

Thermal analysis
- Steady-state and transient response
- Conduction, convection and radiation
- Advanced radiation and environmental heating
- Coupled nonlinear analysis with 3D air flow, conduction, convection and radiation effects

Test/analysis correlation
- Validate mathematical models with physical prototype test results
- FE model updating – modal and FRF-based approaches

CAE data and process management
- Access high-level product performance requirements
- Define and share CAE targets based on design goals – system-level and components
- Capture key analysis processes across all disciplines
- Create CAE workflows for each project and discipline
- Archive and share important CAE knowledge and reports with virtual enterprise
- Store final CAE models in context of product BOM and associated CAD models for re-use throughout current product lifecycle as well as next generation products
- Retain required analysis results documentation for compliance with government, regulatory and legal liability requirements

 NX Digital Simulation disciplines

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Motion
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Design optimization/variational analysis
- Geometry-based optimization
- FE-based optimization
- Design of experiments

Linear and nonlinear structural analysis
- Static and dynamic stress
- Normal modes
- Buckling
- Stress stiffening and spin softening
- Modal analysis with differential stiffness
- Dynamic response analysis
- Nonlinear material models
- Large displacement, large strain
- Material hardening and creep
- Node-to-node contact including friction
- 3D surface-to-surface contact
- Laminate composites analysis

Durability/fatigue analysis
- Strength and fatigue safety for cyclic loading (infinite life model)
- Advanced life and fatigue damage prediction (finite life model)
- Both uniaxial and biaxial stress cycles
- Utilize linear or nonlinear stress/strain results from FE models
- Utilize load time histories from physical test measurements

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> www.ugs.com/go/nxsimulation
A managed development environment for simulation

UGS is unique. The advanced simulation and CAE technologies in NX are integrated with the entire NX product development and Teamcenter data management portfolios. Data management capabilities work “out of the box” and companies can implement a complete environment for managing CAE data, process and workflow as part of a wider product development environment. This reduces waste by promoting the re-use of existing designs and engineering knowledge. It synchronizes data and makes it readily accessible through data mining, visualization and reporting.

Advanced knowledge capture
A key strength of the NX environment is its capability to incrementally capture expert knowledge to automate simulation processes. Companies can harness knowledge with the NX Simulation Process Studio to standardize best practices and analysis procedures for use by less expert users. Companies can implement from the bottom up to help eliminate cultural barriers, reducing risks and increase effectiveness of the resulting simulation environment.

Processes implemented in NX Simulation Process Studio are self documenting, easy to modify and controlled within the corporate data management environment. Development teams can more effectively promote and implement process standards, supporting best practice implementations which are a key element of Design for Six Sigma and Lean Design initiatives.

Process integration
Integration is a key to both the efficiency and the effectiveness of a design environment. NX applications have been successfully integrated within multi-CAD product development environments. Simulation Process Studio demonstrates the value of advanced tools that can be built on a common product foundation that include knowledge-based engineering, system-based modeling, change management, configuration control, product requirements tools and other product lifecycle management capabilities. Niche CAE software suppliers cannot develop and deliver on the process integration vision.

> Collaboration
Knowledge-driven automation

Knowledge-enabled simulation
With NX knowledge-enabled capabilities, companies can create templates that can be instantly loaded and automatically executed as stored processes. As an example, a wheel manufacturer can capture its best practices for designing and analyzing various types of standard wheels and define that process in a template file. They need only drag that template onto the geometry and start the process. Process assistants can be developed by simulation experts who enable the same process to be executed accurately by new simulation employees or even design engineer users in a wizard-like tool. These same automation techniques enable preferred simulation processes to be followed for each type of workflow or product evaluation activity leading to higher staff productivity, higher product quality and consistency of engineering results. This effectively brings fundamental performance simulation activity into the upfront design process and supports enterprise-wide initiatives to capture in-house knowledge and proven repeatable simulation methods.

PROVEN VALUE

“Our goal is to use advanced analysis to significantly reduce dependencies on physical prototypes. This depends upon pervasive use of analysis throughout our product development organization. We are evaluating NX Simulation Process Studio for its ability to encapsulate specialist knowledge and best practices and deploy them in a way that is much more user-friendly and valuable to the design engineer.”

Fred Homma
General Manager
CAE and Systems Promotion Department
Isuzu
Simulation knowledge management

Transforming the process
The complexity of a managed simulation environment cannot be underestimated. Starting with requirements that define performance, market and regulatory needs, engineers need an environment that helps them understand what if anything is available for re-use; an environment that connects their initial concept models to later detail design and test data; an environment that encourages knowledge capture and re-use — extending the value of simulation to constituencies in the organization. UGS is unique in its ability to add value. No other company in the world combines the depth of understanding and market strength in data management with similar strengths in engineering simulation and the ability to implement a long-term vision.

Customer experience
The CAE element was especially crucial for the vehicle body design team. They have now evolved from a serial, post-design freeze CAE process based on multiple departments and manual data exchange across multiple CAD/CAE tools to a parallel, integrated body design and analysis process. The streamlined process is enabled by a common application platform and CAE master model, working in the context of a managed development environment.

Faced with increasing global competitive pressures, a major automotive OEM decided that the only way to design faster was to fundamentally change its design, engineering and manufacturing processes. To meet this challenge, the team identified a number of areas, including improving the group’s use of digital simulation capabilities at all points throughout the product development process.

PROVEN VALUE

“We have reduced our cycle time partly because we fixed disjointed processes — and partly because of the process changes driven by new IT tools. We are not constrained by a six-month or nine-month ROI target. We are looking at this from a holistic perspective — how do you design a car 50 percent more quickly. We know that companies that cannot do this will fade away. Private enterprises have to evolve at a fantastic rate to stay competitive.”

John Sullivan
Chief Engineer for Body Product Development
Ford Europe

Excerpt from “Digital Simulation to Meet Today’s Product Development Challenges”
Daratech, Inc. White Paper
December 2003

> System-level
CAE
Digital simulation and testing can no longer be viewed as a final validation activity. The true value of simulation is not limited to program activities but comes in the continual downstream re-use of CAE data and the application of CAE domain knowledge to future design programs. Simulation throughout the product development lifecycle requires the right tools integrated in a digital environment that constantly captures, updates and shares relevant engineering data and product knowledge to the entire global enterprise and supply chain.

**Simulation throughout the product lifecycle**

- **Initial design synthesis**
  - System model definition
  - Re-use existing data and create new models
  - Define subsystem loads and BCs

- **Initial concepts evaluation**
  - Component-level
  - Design optimization

- **Define the analysis tasks**
  - Multiple disciplines
  - Level of detail required
  - Pass/fail criteria

- **Detailed design analysis**
  - Updates to CAE models from CAD
  - Final validation of mathematical models and BCs

- **Release for prototype build**
  - Understand “as built” variances

- **Physical testing only when necessary**
  - Validate mathematical models with test data
  - Correlation to initial requirements
  - Correlation to digital simulation results

- **Access existing knowledge**
  - Based on product requirements
  - Find existing components/CAE data
  - Identify components for modeling
  - Create CAE workflows

- **Capture knowledge**
  - Archive appropriate data
  - Store CAE models for re-use
  - Capture key analysis processes
  - Retain data for regulatory requirements

- **Identify and track CAE requirements**
  - vs. product performance targets
  - vs. regulations and standards

- **Requirements**
  - High-level product requirements
  - Defined CAE targets

- **Build critical CAE knowledge base**
  - Capture and document “best practices”

**PROVEN VALUE**

“It makes sense to start meshing components of the geometry before all the design details have been determined. This allows analysis to start as early as possible. But when we started meshing before the content was frozen, we needed to focus on how to manage the evolving data. If design changes are significant, we can start updating the mesh immediately…but only if we know about them.”

Ulrich Fox
Supervisor, Body Methods Development Group
Ford Europe

Excerpt from “Digital Simulation to Meet Today’s Product Development Challenges”
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December 2003

**Knowledge**
NX Advanced Simulation: Defining best in class

NX MasterFEM
NX Digital Simulation provides comprehensive capabilities and world-class technology for building finite element models and understanding finite element simulation results, including the ability to create and modify 3D geometry and surfaces for the purposes of geometry abstraction and finite element modeling. This advanced application can accept input from a wide variety of geometry creation sources including Pro/Engineer, Catia, SolidWorks, Solid Edge and AutoCAD, as well as industry standard data exchange formats such as IGES, STEP, VDA, JAMA-IS, STL and JT. NX Digital Simulation also has direct solver interfaces available for MSC.Nastran, ABAQUS, ANSYS, PAM-CRASH, RADIOSS and LS-DYNA in addition to a tight integration with NX Nastran.

Many powerful tools are available within NX Digital Simulation to automate and increase the efficiency of the finite element analysis process. Wireframe, surface and solid geometry can all be used simultaneously in finite element model generation. Free meshing, mapped meshing and manual mesh generation techniques as well as automated tet-based meshing for 3D solid parts are all available in conjunction with unique surface abstraction and section meshing capabilities. Automated tools for checking the quality of elements, mesh smoothing and applying loads and boundary conditions are also included. The user interface can be tailored specifically to the targeted solver, making it easy for the user to understand the finite element model characteristics in the CAE solver language familiar to the user. Comprehensive material and physical property definition are included, making NX Digital Simulation the core suite of tools for a full multi-CAD, multi-physics digital simulation environment.
NX Nastran is deployed across many industries including aerospace, automotive, electronics, heavy equipment and medical to digitally analyze, validate and optimize the functional performance of new products. NX Nastran is known for its enterprise simulation capabilities with extremely high performance numerical capabilities. It provides comprehensive product performance simulation in a broad range of engineering disciplines, including stress, displacement, buckling, failure, vibration, shock, heat transfer, acoustics and aeroelasticity.

As an integrated component with pre/post processors offered by UGS, NX Nastran Desktop is a key element of the NX portfolio, providing comprehensive product performance simulation and complementing other advanced digital simulation and prototyping solutions in the NX suite of CAE products. NX Nastran SDK, a software development kit, provides users access to development tools and utilities designed to simplify the task of implementing NX Nastran as a core component to applications that extend the breadth and depth of capabilities offered by NX Nastran.

Additional advanced analysis technology is available to address multi-body mechanisms simulation, advanced thermal and radiation analysis, combined flow/thermal analysis for electromechanical systems, dynamic response analysis and advanced durability analysis.

Solution performance, a hallmark attribute of Nastran, is a key differentiator for NX Nastran. Solving the largest numerical challenges is critical to the ability of engineering analysts to positively impact design decisions and a key focus for UGS development and research. These graphs show the results of early performance improvement projects, enabling NX Nastran to provide performance leadership for our customers.

Nastran has been recognized for over 30 years as the analysis solution of choice in major manufacturing industries. In 2003, UGS acquired the MSC.Nastran source code, development environment and rights to develop and market Nastran as settlement of an FTC action to maintain competition in the market.

Image courtesy of Scaled Composites, LLC and Quartus Engineering Inc.

Image courtesy of DaimlerChrysler
**Advanced simulation applications**

- **NX Nastran:** Available standalone as an enterprise solution or seamlessly integrated at the core of many NX Digital Simulation products. NX Nastran delivers comprehensive performance simulation capabilities for a broad range of engineering disciplines and industries. UGS understands the value customers achieve from Nastran and is dedicated to extend its technology lead, incorporate advanced capabilities and aggressively leverage complementary third-party technology to further extend the reach and robustness of the current Nastran code. UGS is dedicated to making NX Nastran the most complete and powerful solution available for functional digital prototyping and simulation.

- **NX Advanced FEM:** An open CAE environment that enables rapid modeling and visualization of simulation results. Extensive geometry idealization and abstraction capabilities support rapid mathematical model development in a geometrically complex, multi-CAD, multi-physics environment. Comprehensive model review and results visualization capabilities enable design decisions to be based on insight into real-world product performance.

- **NX Advanced Simulation:** Combines the power of an integrated NX Nastran desktop solver with the NX Advanced FEM package.

- **NX MasterFEM:** (I-deas NX MasterFEM) builds on a 30-year CAE heritage and is a full-function, industrial-strength simulation environment suitable for both general engineering use and the most demanding CAE specialist. NX MasterFEM can be relied upon as a standalone simulation environment or seamlessly integrated within NX.

**Design productivity applications**

- **NX Design Simulation:** A design-integrated and easy-to-use NX application that enables design engineers to quickly evaluate the structural performance characteristics of 3D product design concepts earlier in the development process.

- **NX Motion Simulation:** A design-integrated environment for evaluating the kinematic and dynamic performance of new product designs.

- **NX Simulation Process Studio:** Enables company experts to rapidly develop in-house wizards for wide usage without the need to rely on expensive external consultancy services.

- **NX Strength Wizard:** provides users with clear and concise guidance to help guide them through simulation process steps to safely analyze their designs.

- **NX Optimization Wizard:** An automated design exploration tool that helps solve complex engineering problems by providing designers a fast and simple method for arriving at an optimal design solution based on multiple engineering variables and constraints.

- **Vis VSA:** Leads the tolerance analysis market. It combines tolerance analysis and compliant behaviors to determine the sensitivities of dimensions in the final assembled product to manufacturing tolerances and processes. FEA technology is seamlessly integrated. It supports many assembly operations including welding, riveting, etc. and component springback.

**NX Digital Simulation solutions**

Developing exceptional products that meet strict quality and performance criteria cannot be left to chance. UGS takes the guesswork and worry out of your product development process with a comprehensive suite of world-class digital simulation solutions that can be leveraged within an enterprise PLM environment.

UGS is uniquely a single source for a complete range of world-class CAD-integrated digital simulation solutions as well as enterprise-level multi-CAD simulation solutions.
Throughout its broad product application suite, NX leverages key attributes that help companies achieve business objectives of waste reduction, quality improvement, shorter cycle times and greater product innovation. These unique attributes directly support business process initiatives aimed at transforming product development:

- **Managed development environment**
  NX solutions include fully integrated, synchronized management of all product data and process knowledge to transform product development with a structured collaborative environment.

- **Unified product development solution**
  Seamless integration of NX applications rapidly propagates changes of product and process information, replacing point solutions with a unified development system, from concept to manufacturing.

- **Knowledge-driven automation**
  With NX, companies can apply product and process knowledge across all elements of product development to automate processes and maximize re-use.

- **Simulation, validation and optimization**
  Comprehensive simulation and validation tools in NX automatically check performance and manufacturability at every step of the development process for closed-loop, continuous, repeatable validation.

- **System-level engineering**
  NX structured conceptual models standardize design practices and allow rapid creation of variants, transforming development from component-based design to a systems engineering approach.
About UGS
UGS is a leading global provider of product lifecycle management (PLM) software and services with nearly 4 million licensed seats and 46,000 customers worldwide. Headquartered in Plano, Texas, UGS’ vision is to enable a world where organizations and their partners collaborate through Global Innovation Networks to deliver world-class products and services while leveraging UGS’ open enterprise solutions, fulfilling the mission of enabling them to transform their process of innovation. For more information on UGS products and services, visit www.ugs.com.

UGS leads to greater innovation
There is no single road to innovation, but there are signs you’re headed in the right direction. Leading innovators get to market faster, manage compliance, optimize resources and achieve globalization. They’re also four times more likely to use PLM software to plan, define, build and support their products. UGS’ family of PLM solutions helps businesses establish Global Innovation Networks that transform their process of innovation. Drive your business to greater innovation and accelerate your growth.

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