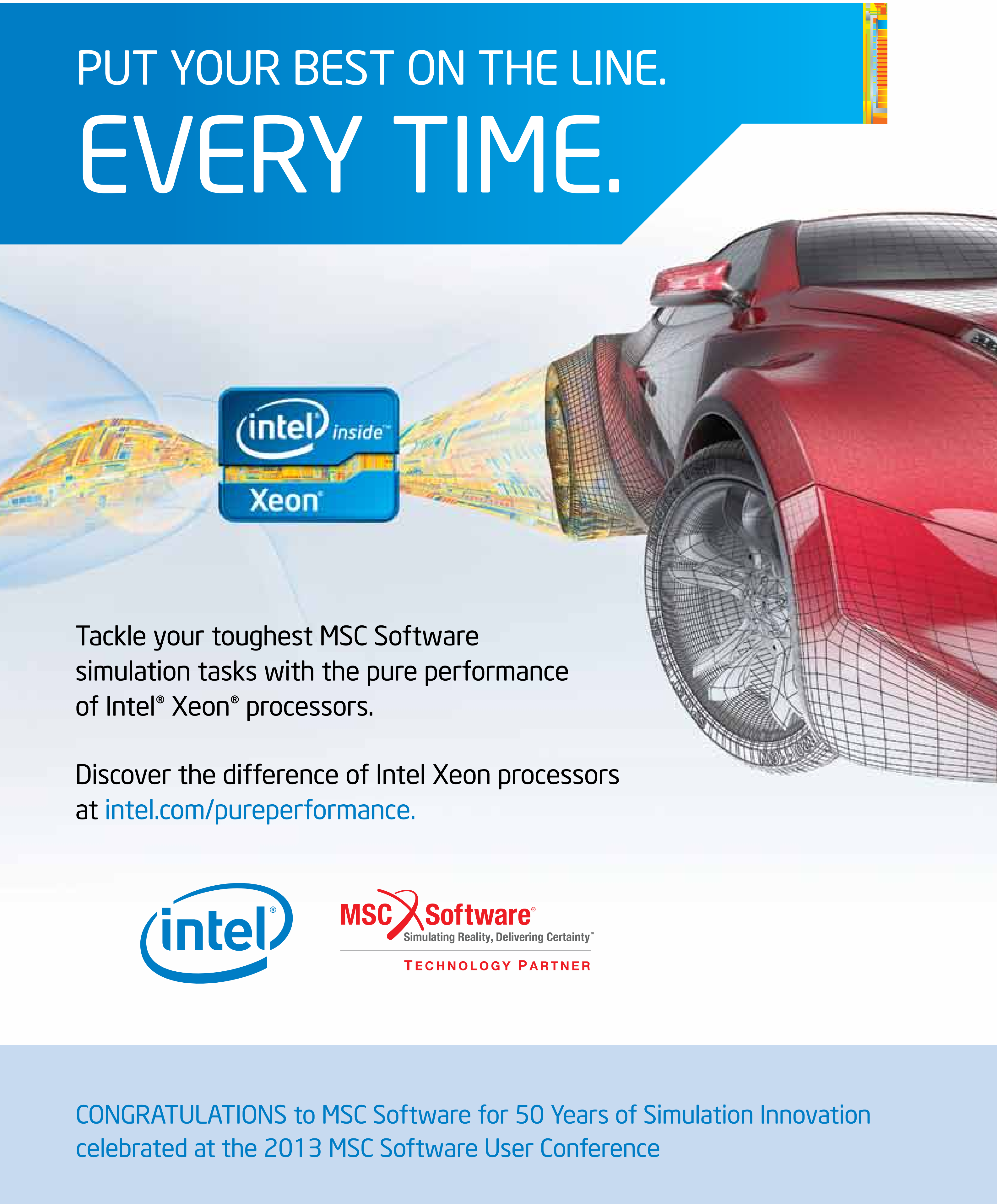
simulating REALITY

MSC Software Magazine

Volume III | Winter 2013

CELEBRATING 50 YEARS OF INNOVATION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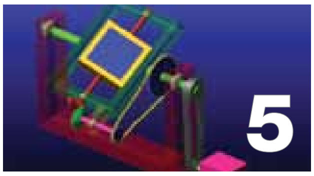
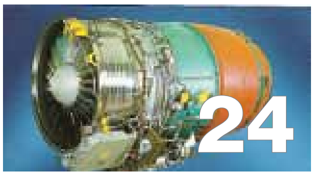
CONGRATULATIONS to MSC Software for 50 Years of Simulation Innovation celebrated at the 2013 MSC Software User Conference





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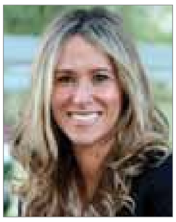
The Beginning of Something Special



Leslie Bodnar
Sr. Director,
Global Marketing
MSC Software

It's a big year for MSC Software. As we embark on the beginning of a New Era in simulation & analysis, we also celebrate 50 years in business as an engineering software and services company. It is our pleasure to share this special anniversary issue of Simulating Reality with our customers, partners, and friends.

A half a century ago, we began the journey on a path of helping society design better technology at lower cost and higher quality, and today we continue to do the same with more vigor than ever. With a rich history of software development that is recognized as the stepping stone for the CAE industry, it is both our mission and the time to pave new paths ahead that will address the growing complexities of engineering. As manufactured products become more sophisticated, materials more advanced, and assemblies and systems more integrated, the people and technology of MSC will be ready with wisdom, determination and adaptive solutions.

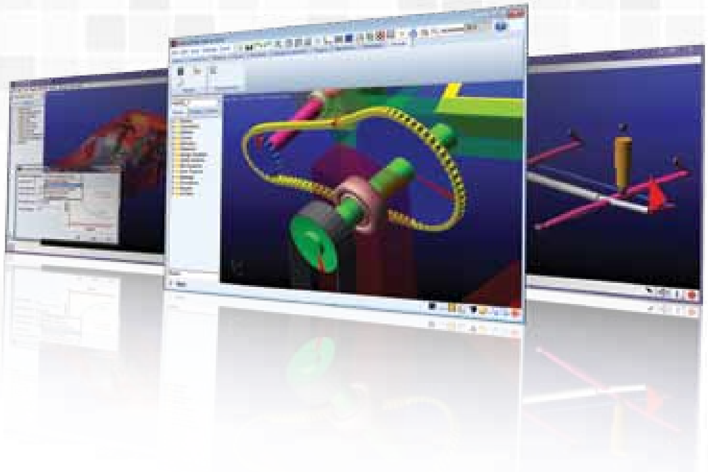
> “A half a century ago, we began the journey on a path of helping society design better technology at lower cost and higher quality, and today we continue to do the same with more vigor than ever.”

In this issue, we share a few special spotlights to celebrate the anniversary. On **page 14**, our very own innovation leaders are acknowledged with special thanks. The contributions and talents of these people throughout our historic timeline have brought rich capabilities and have contributed to great achievements in engineering.

On **page 32**, take a look at our Simulating Reality contest winners, who are acknowledged for their initiatives in new technology design and innovation. Our special Gold Anniversary winners, including NASA's JPL and their unprecedented use of Adams in the Curiosity rover mission to Mars are spotlighted in this feature article, along with other great customer projects.

Finally, special congratulatory excerpts from our valued customers can be found scattered throughout; and as with previous issues, please enjoy our customer spotlight articles that share new ideas for applying simulation in ways that are producing real business value and competitive advantage.

Designing Products that "Move"



Take A New Look at Adams 2013

By Leslie Bodnar, MSC Software

Proven in Automotive

As an engineer, you probably spend time thinking about new ways to improve product development.

It's likely that predicting product performance earlier in the design process and meeting design specifications more accurately are important to you. Couple these concerns with finding the right engineering software technology, and it can be a daunting task especially when faced with the array of technology options today.

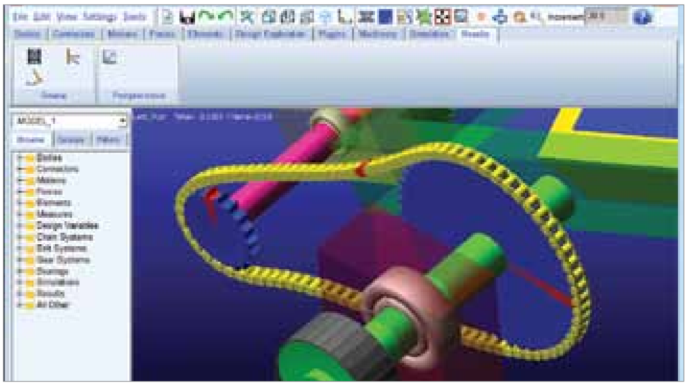
In Automotive, engineers know the value of Adams. They use it to simulate aspects of vehicle development including vehicle dynamics, ride & handing, safety, and durability associated with the design and test of ground vehicles. They know it works, and continuously produces results relied upon to optimize new product design.

Helping More Engineers

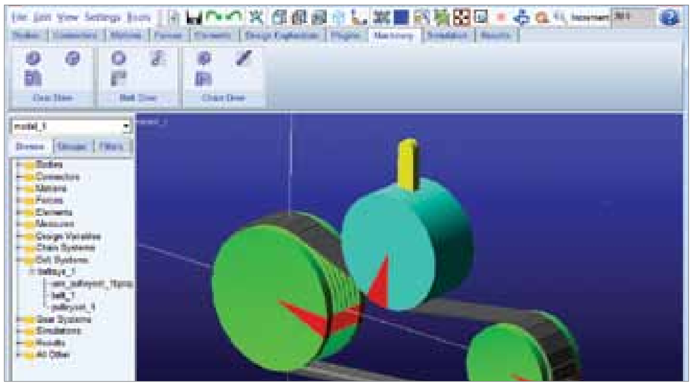
While automotive engineers see performance improvements with our new 2013 release of Adams *(for example, the new "Adaptive interpolation" approach has increased simulation speed by 4 times for the Rough Road ride test, and by 10 times for the Straight Flat Road ride test)*, engineers outside of Automotive receive new customized solutions that provide dramatic time savings in modeling and simulating equipment and machinery systems.

How Can it Help You?

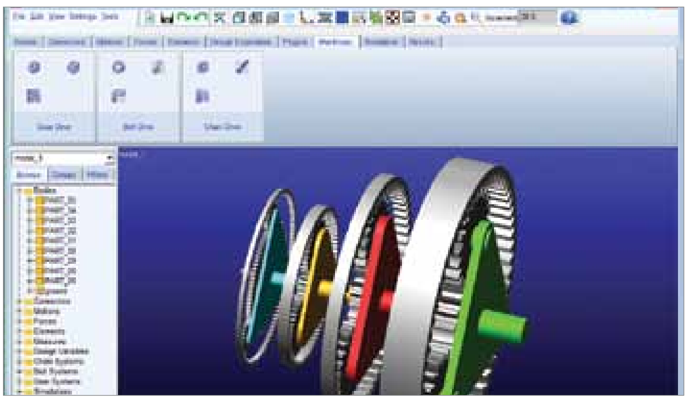
As Evan Yares, writer for Design World put it in a recent article, "the kinematic tools included in many CAD systems are quite good at modeling motion driven systems with frictionless connections and idealized constraints. They work well when all the motion in a model is prescribed. But that's not how real world machinery works. More



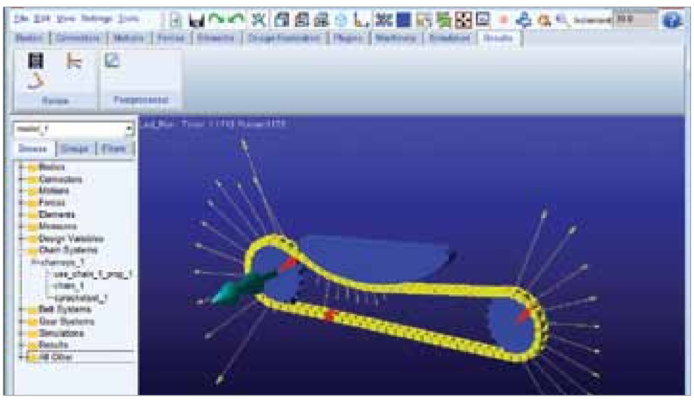
New Module –Bearing (New with 2013)



High Fidelity Modeling - Belt



High Fidelity Modeling - Gear



High Fidelity Modeling - Chain

often, you find force or torque driven systems, with slop and friction in the connections, and flexible bodies. To model these types of systems, you need to move beyond kinematics, to multibody dynamics.

Multibody dynamics software, like Adams, is used to study the dynamics of moving parts, and to determine how loads and forces are distributed throughout mechanical systems. The software can run nonlinear dynamics analyses in a fraction of the time that would be required by FEA software. The loads and forces computed by multibody dynamics can be used as an input when running FEA analysis on critical components in the system.

While multibody dynamics software has been available, in the mainstream, for many years, it has been more the realm of analysts than of design engineers. The complexity of creating dynamic models for many common mechanical components has skewed it towards high-value critical applications."

Easier for Designers

MSC has released a new member of the Adams family, Adams/Machinery, which could very well make serious multibody dynamics analysis practical for use by design engineers, early in the product development cycle, said Yares.

Adams/Machinery is a set of productivity modules, bundled into a single offering. It runs in the standard Adams/Studio environment (Adams/View, Adams/Solver, and Adams/Postprocessor), and can import geometry from most major CAD systems, or build a solid model of the mechanical system from scratch.

In the new Adams 2013 release, the Adams/Machinery solution adds a new bearing module to the existing gear, belt, and chain modules introduced in the 2012 release. The new Adams/Machinery Bearing module enables a user to select from a library of more than 24,000 off-the-shelf bearings spanning a range of 14 bearing types. The library supplies characteristic geometry values for bearings from 8 leading manufacturers. The novel modeling technique employed enables service life prediction based on widely-accepted industry standards.

	Traditional Method	Using Adams/ Machinery	Time Saved
Base model creation (frame & shafts)	0.25 day	0.25 day	0
Building the gear box	1.0 day (requires external geometry and limits modeling method options)	0.25 day (external geometry unnecessary; more modeling method options)	0.75 day
Building the belt system	5.0 days	1.0 day	4 days
Building the chain system	5.0 days	1.0 day	4 days
Post-processing (defining desired output)	0.5 days	0 days	0.5 days
Total time	11.75 days	2.5 days	9.25 days

Real Time Savings

The table below shows how much time can be saved using the customized machinery modules in Adams as opposed to creating components using the traditional approach.

Try it Today

Adams/Machinery makes analyst-level simulation practical and approachable for machinery designers. Use the multiple modeling productivity modules to create common machinery components more efficiently, while encountering a shorter learning curve.

To schedule a demonstration or request a trial license, please call 1-800-942-2072, or go to www.mscsoftware.com/adams to be contacted. ◆

MSC Software

NEWS

Global Collaboration Sparks Innovation

MSC AMERICAS

Aerospace & Ground Vehicle Users Symposiums

With nearly 400 attendees, 50 presenters and 25 Sponsors, MSC Software's 2012 Aerospace & International Ground Vehicle Users Symposiums were highly collaborative events. Participants were able to attend 4 Technology Tracks, consisting of 37 Technical Presentations, from presenters such as "Best Technical Presentation" winners, Boeing, NASA Goddard Space Flight Center, Pratt & Miller Engineering and Hendrickson Trailer Commercial Vehicle Systems.

Event high points included customer keynote presentations from Boeing, NASA, Fiat Automobiles, BMW Group and Toyota Motor Corporation and the symposiums' evening receptions. Attendees were exclusive guests at the National Air & Space Museum and Henry Ford Museum and were able to explore historical artifacts, namely the Space Shuttle Discovery, the Boeing B-29 Superfortress Enola Gay, John F. Kennedy's presidential limousine and the Rosa Parks bus.

See symposium highlights by visiting the links:

- **Aerospace**: www.mscsoftware.com/2012-Aero-Symposium
- **Ground Vehicle:** www.mscsoftware.com/2012-IGVS

2013 Americas User Conference

Join us on May 6th and 7th in Irvine, California for the first of MSC's 2013 50th Anniversary User Conferences to learn about the latest state-of-the-art technology and to see application to real world engineering problems.

Presentation topics will include CAE Methods, Composites, Fatigue, Motion, Nonlinear Analysis, Process and Data Management, Structures and Systems/Dynamics.

Learn more by visiting www.mscsoftware.com/conference-2013

MSC INDIA

MSC Software India User Conference 2012

MSC's long-awaited India 2012 User Conference took place in September at ITC Gardenia in Bangalore. More than 900 attendees from the MSC user and Business Partner communities gathered at the conference, making it one of the largest attended events in MSC India

history. The conference served as a platform for MSC users to talk with MSC global experts and industry peers about the future of simulation. Event highlights included a keynote speech from Dominic Gallello, CEO and President of MSC Software, who presented a view of the industry's current and future trends and how MSC is providing solutions to customer challenges. Attendees also participated in the highly anticipated Product Update Sessions throughout the event.

Join us at MSC's India 50th Anniversary User Conference on September 5th and 6th.

MSC CHINA

2012 User Conferences

MSC China hosted a collection of user conferences July through December of 2012. With two conferences focusing on industry and two on comprehensive solutions, the events acknowledged a wide variety of topics, specific to users' needs. Over 40 companies participated in the Heavy Machinery User Conference on August 16-17 in Wuyishan, with 3 key customers presenting applications on railway vehicles and wind energy.

Nearly every major OEM in South China joined the Automotive User Conference in November held in Shanghai to learn about industry-focused topics including NVH, Fatigue, Handling and Ride Performance. Conference attendees were pleased to learn how internationally advanced automotive companies are managing data with SimManager, MSC's simulation and data management platform. Another attendee highlight was the introduction of Digimat, e-Xstream engineering's nonlinear multi-scale material and structure modeling platform.

Read the recent TenLinks blog post about Digimat: www.mscsoftware.com/digimat-10

Join us at MSC's China 50th Anniversary User Conference on June 6th and 7th. Details to come.

2012 Seminars

Hundreds of participants from various industries attended seminars throughout China during the last half of 2012. The seminars address industry-specific challenges to optimize design with recent product releases such as MSC Fatigue and Adams Machinery. View the full list of Seminars at: www.mscsoftware.com/china-2012

University Activities

MSC China is proud to be a huge supporter of students. Since 2010, MSC China has sponsored university teams competing in the FSAE Competition. In 2012, an overwhelming 70% of the 40 teams participating in the competition used Adams to improve the design and performance of their vehicles.

Join us at the 2012-2013 annual campus road show. The series of

events kicked off in November and is sweeping through 7 university sites, including Tianjin, Chongquing and Chengdu before it wraps up in March. Learn more by visiting **www.mscsoftware.com/china-university**

MSC JAPAN

MSC Nastran Users Meeting

With customer presentations like Honda's Road Path Estimation on Weight Saving and Mazda's Analytical Estimation on Weight Saving, Japan's 2012 product specific user meetings attracted nearly 500 participants. One conference attendee from an automotive-related parts company spoke of the event, "It was an excellent opportunity to learn about many new features. I am thinking of many ways I can improve business productivity."

Vice President of Product Development, Doug Neil's keynote

presentation sparked a response with customers when he gave a preview of what to expect with upcoming software releases. "I could recognize the great potential of SOL400," remarked an attendee from a leading rubber manufacturing company, about the latest developments in MSC Nastran.

Please join us at Japan's 2013 "50th Anniversary" User Conference on Thursday, May 30th.

Online Solution Seminar

Over 350 registered attendees from a variety of industries joined 11 online solution web seminars to learn to effectively solve problems using Adams, Patran, Marc and MSC Nastran. The seminars focused on high performance computing and process optimization. These online events provided the opportunity to MSC and users in Japan, unable to attend the users meetings, to collaborate and address unique challenges.

MSC KOREA

Actran Road Show

MSC users in Korea were invited to a special set of events in Pusan and Seoul on November 21st and 22nd. The road show presented leading acoustics simulation solution tool, Actran, to discover how acoustics simulation technology is utilized across industries, both locally and globally. Conference attendees were also invited to attend an Actran technical training in December to address specific challenges and work directly with acoustics simulation experts.

University Students Learn Adams & MSC Nastran

MSC was pleased to host a special training for students in Korea for the first time in December. The technical training was conveniently held during students' winter vacation at MSC Korea's Education Center. Students learned how to use Adams and MSC Nastran, in the five-day training course that is also provided to MSC customers. The show was so well attended that another student training is planned for 2013. Look for additional details to come.

MSC ITALY

MSC Italy Teams Up with Renowned University

In collaboration with Politecnico di Milano, MSC Software is currently offering an introductory course in structural analysis to university students studying Aerospace and Mechanics Engineering. The free course lessons present techniques for building a finite element modal analysis using MSC Nastran and Patran. Students learn through a variety of interactive examples and applications. Politecnico di Milano Professors, Federico Cheli and Massimiliano Lanz commented, "We are very pleased with the results achieved through the educational activities we have started with MSC Software in recent years. Seminars and tutorials we have developed together in different courses, and in particular in the MSC Nastran course, have been positively evaluated by students and complete their technical preparation."

Learn more about Politecnico di Milano by visiting **www.english.polimi.it**

EMEA EVENTS

EMEA 2012 User Conferences

The MSC 2012 user conferences in the EMEA region brought over 600 engineers, universities, researchers, developers and industry leaders together for the mix of industry and product focused events in Germany, Russia, Norway, and Hungary.

The events featured presentations from leading manufacturers such as IPMEKH RAN in Moscow and MSC solutions experts. Neil Bishop and Hans Zeischka delivered, "Coupling MSC Nastran Embedded Fatigue with Adams to Achieve Better Durability Performance" to users at the Global Adams/Car User Meeting in Germany in November.

Presentations from the conferences are available on **simcompanion.mscsoftware.com**

MSC Partner Events

Engineering professionals were invited to connect and discover the latest innovations in CAE technology at three MSC partner events in October. In Summa, a MSC partner specializing in data processing, welcomed 60 enthusiastic engineering professionals in Benelux on October 4th. The theme, "Simulation without Limits" was fully explored throughout the event with presentations from keynote speakers MSC CEO Dominic Gallello and Eddy Fadel, Director of Sales, discussing topics such as the future of simulation and revealing how MSC solutions are enabling engineers to build smarter with solutions such as MSC Fatigue and Composite Modeling.

MSC reseller, MSI Engineering, a firm that services the pharmaceutical, medical device and electronic industries, hosted a Users Info Day on October 16th at the Wohel Convention Center in Tel Aviv. 100 customers and prospects participated in the event, which included MSC keynote speakers and lectures, rich in technical content, from Actran and MSC Nastran experts.

More than 200 attendees were received at ESTEQ's Annual User Conference on October 19th in Pretoria, South Africa. ESTEQ Engineering, a technology provider focusing on business and engineering solutions, brought numerous industries together to share experiences and ideas. Henk Viljoen, Managing Director of ESTEQ summarized the event, "The theme of our conference was, "We Enjoy Solving Difficult Problems". And this is exactly what our customers presented using MSC Software's technologies in Vehicle Dynamics and Structure Mechanics." ◆

50 Years of Pioneering Spirit

Dominic Gallello
President & CEO
MSC Software

In Huntsville, Alabama, the dynamic test stand building which was constructed in 1964 stills stands today. At 111 meters tall, the gigantic Saturn V rocket was assembled in the building and the building shook the rocket to determine if there would be structural failure. A visionary at Goddard Space Center (Tom Butler) had the idea to do the same test in a computer instead of a building and NASTRAN was born. The building was declared a National Historic Landmark in 1985. In 2003, NASA stated the value of NASTRAN to society is over $10B.

The '60s was one of the most special times in the history of engineering. The race for space was romantic and inspiring, but it also created a very serious and time-critical mission for engineers. For the young MSC, it meant winning a contract to build Nastran for NASA to ensure the vibration in the Saturn V rocket would not put astronauts' lives at risk. This tiny company, competing against the giants like TRW, Douglas and General Dynamics, had a vision for the technology, a fighting spirit to compete and the follow-through to deliver.

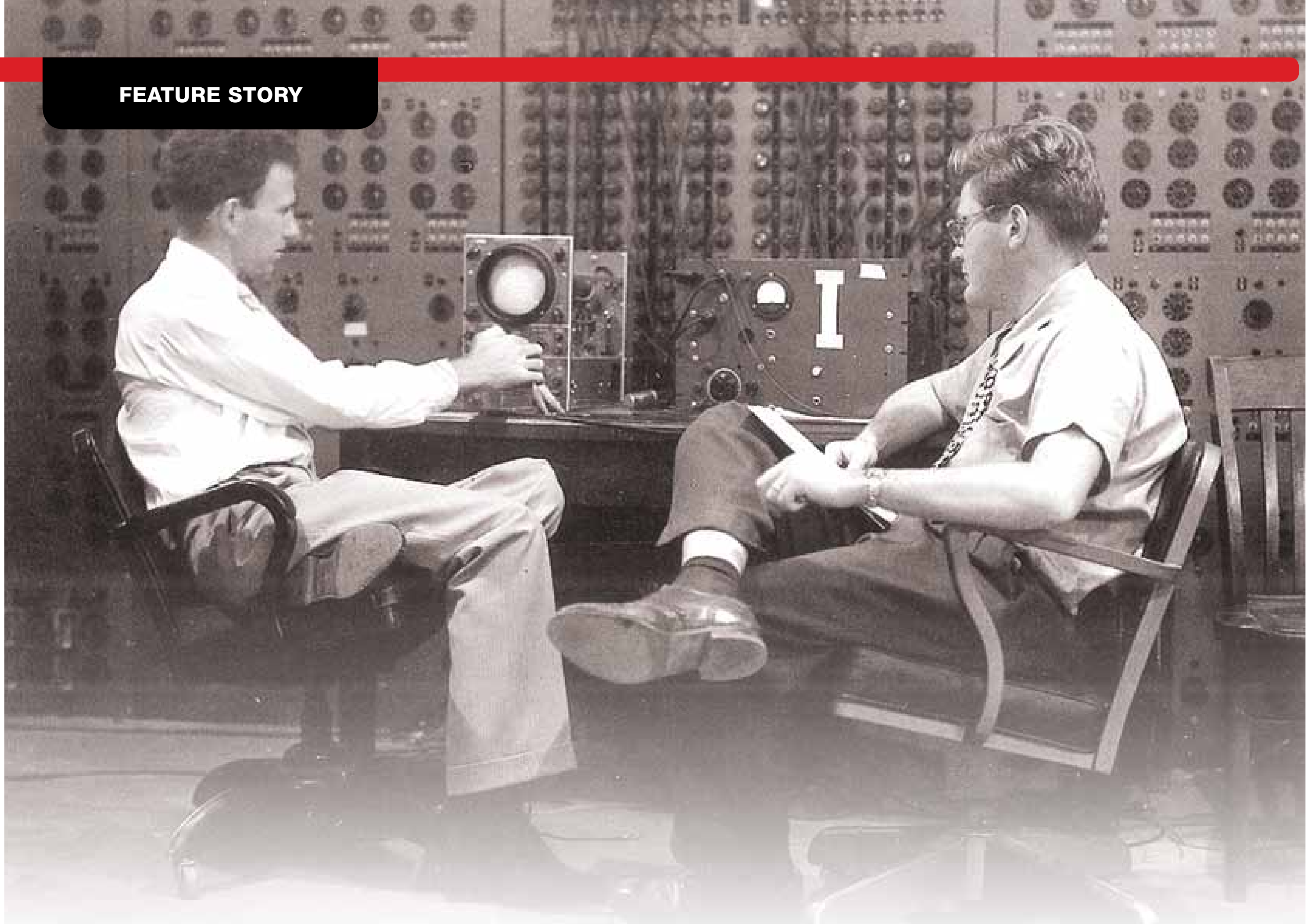
Later, in the '70's and '80's, the innovations continued with further extensions to simulation and with new methods to allow the growing power of the digital computer to be exploited. These extensions added to the confidence needed by the engineers using simulation to make decisions. Many of the major concepts that enabled the growth of simulation were first used in production applications in MSC's products. During that incredibly rich expansion period, MSC played a major role in introducing numerical simulation to a broad range of industries. As a result of that focus and a belief in the value of CAE, simulation is used almost everywhere in engineering and MSC's tools are used on virtually every transportation system being developed on Earth today.

Over the past few years, I have had the great fortune to meet and share ideas with pioneers such the MSC founder, Dr. Richard MacNeal, the father of Patran, Dr. Ed Stanton, and some extraordinary correspondence with Chris Craft, the flight director at NASA. Not even the President could override Chris, once the countdown for the launches started.

These were great men who showed me similar qualities. They were supremely confident in delivering to a completely uncertain future. Their personal commitment to success was selfless and unwavering. They are very smart, gifted with a thirst for knowledge, and with the ability to invent. They were leaders and they completed the mission. Dr. MacNeal had his mathematics; Dr. Stanton had the confidence of the government that he could deliver critical new innovation; and Mr. Craft, who started his career calculating structural loads by hand, and acknowledged to me how critical Nastran was in the development of space vehicles, had the confidence of a nation to guide every step of the missions.

> “As we bid farewell to the first 50 years of MSC Software, we look forward to the great human challenges that will inspire the next 50 years of a truly great company.”

These individuals, who all played a part in helping to inspire a society and move humanity forward, inspired me deeply. As we bid farewell to the first 50 years of MSC Software, we look forward to the great human challenges that will inspire the next 50 years of a truly great company. In 2013, a new era begins for MSC. Look forward to the introduction of innovation commensurate with our rich history that will again be the vanguard for the future of simulation.



FEATURE STORY

50 Years of MSC Software

When Simulation Met Reality

Computers were almost as exotic as rocket ships in 1962, when President John F. Kennedy challenged the nation to send a man to the moon. Humming away in cold rooms at universities and big corporations, few people had ever seen a computer, never mind worked on one.

The software that made computers tick was an even deeper mystery. It was buried deep in electronic brains, welded to application-specific hardware, part of monolithic machines that could be the size of a walk-in cooler.

That was the environment into which Richard MacNeal and Robert Schwendler launched, MacNeal-Schwendler Corporation in 1963. Fifty years later we are MSC Software, but only the name has changed. The company is still on the leading edge of simulation software. Our products make it cheaper and faster to design high-quality products – including the first rocket to lift humans off the Earth and propel them to the moon, virtually every space vehicle designed since, and generations of aircraft and automobiles.

"I can't think of a single instance where a car or aircraft that was not structurally analyzed by NASTRAN, particularly MSC Nastran," said Dr. Marc Halpern, vice president, research with Gartner and a 30-year veteran of the simulation software market. "MSC Software is deeply respected in the field of computer-aided engineering technologies, particularly finite element analysis. They have such deep expertise in that domain they're a de-facto standard, particularly in the aerospace and automotive industries."

Over 50 years, we grew from a two-man shop to a corporation of 1,100 employees. A new generation of leadership has returned our focus to our historical strengths while we chart a new path for the future of simulation and analysis software.

MSC Software Company Logos Over the years

1968

1971

1983

2004

> "In 2013, a new era begins for MSC. Look forward to the introduction of innovation commensurate with our rich history that will again be the vanguard for the future of simulation."

Space, The First Frontier

Richard (Dick) MacNeal was a member of Tom Brokaw's "greatest generation," which grew up during the Great Depression, fought World War II, and built the post-war American economy.

The U.S. military put Dick MacNeal's prodigious brains to work during the war calculating the trajectory of bombs dropped from aircraft. After the war ended, the $250 stipend awarded each serviceman upon discharge enabled Dick to relocate from his post in Massachusetts to Southern California, a hotbed of aeronautics and advanced engineering.

Dick worked for then-fledgling Computer Engineering Associates and aircraft giant Lockheed Martin before deciding he wasn't cut out for big companies. At age 39, with partner Robert Schwendler and an $18,000 investment, he launched MacNeal Schwendler Corporation in 1963.

That same year, the two pioneering software engineers developed the company's first product: SADSAM, (Structural Analysis by Digital Simulation of Analog Methods). Although SADSAM was designed for the aerospace industry, in a recent interview Dick remembers the company's first customer came from an unexpected industry.

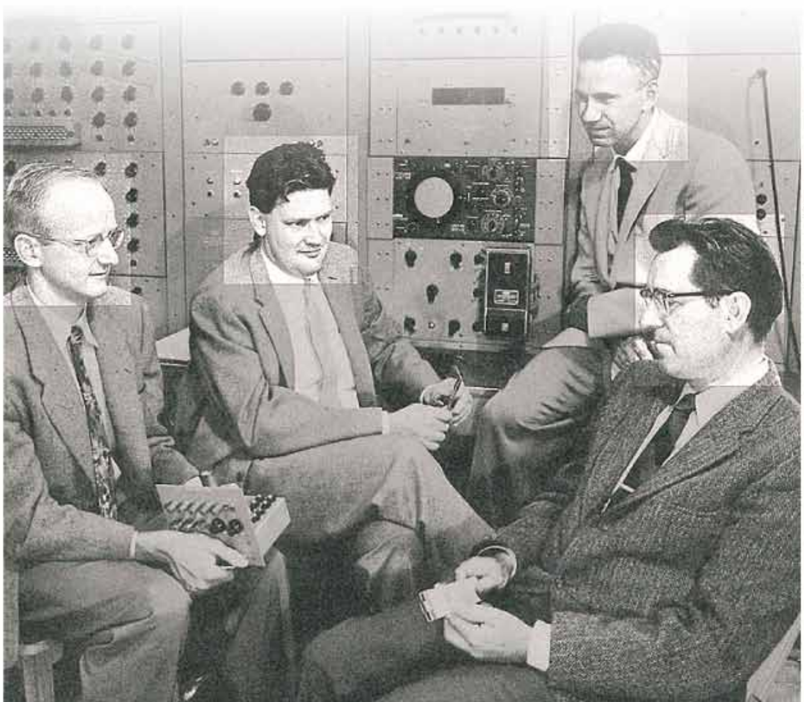
"Our first customer was named Raymond Hill. He was a civil engineer in charge of designing dams, huge dams. He needed someone to do an analysis and he found out about us," he recalled.

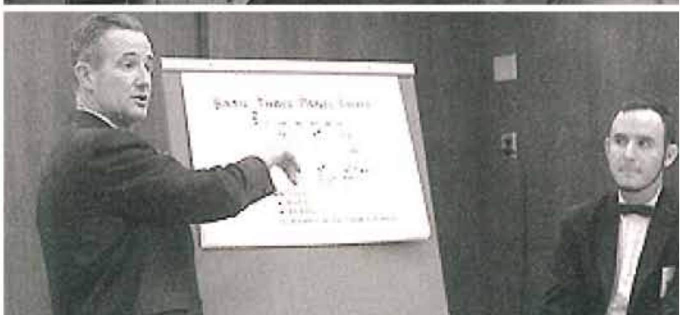
Growing Up with NASA

MSC got the break that would build the company in 1965, when we joined a team of private and government engineers developing software for NASA. The space agency wanted software that consolidated all computerized structural analysis functions in a single solution. The result was NASTRAN (NASA Structural Analysis) software. NASTRAN enabled NASA engineers to anticipate the effects of heat, vibration and pressure on the Apollo spacecraft. It has had a role in designing virtually every NASA spacecraft since.

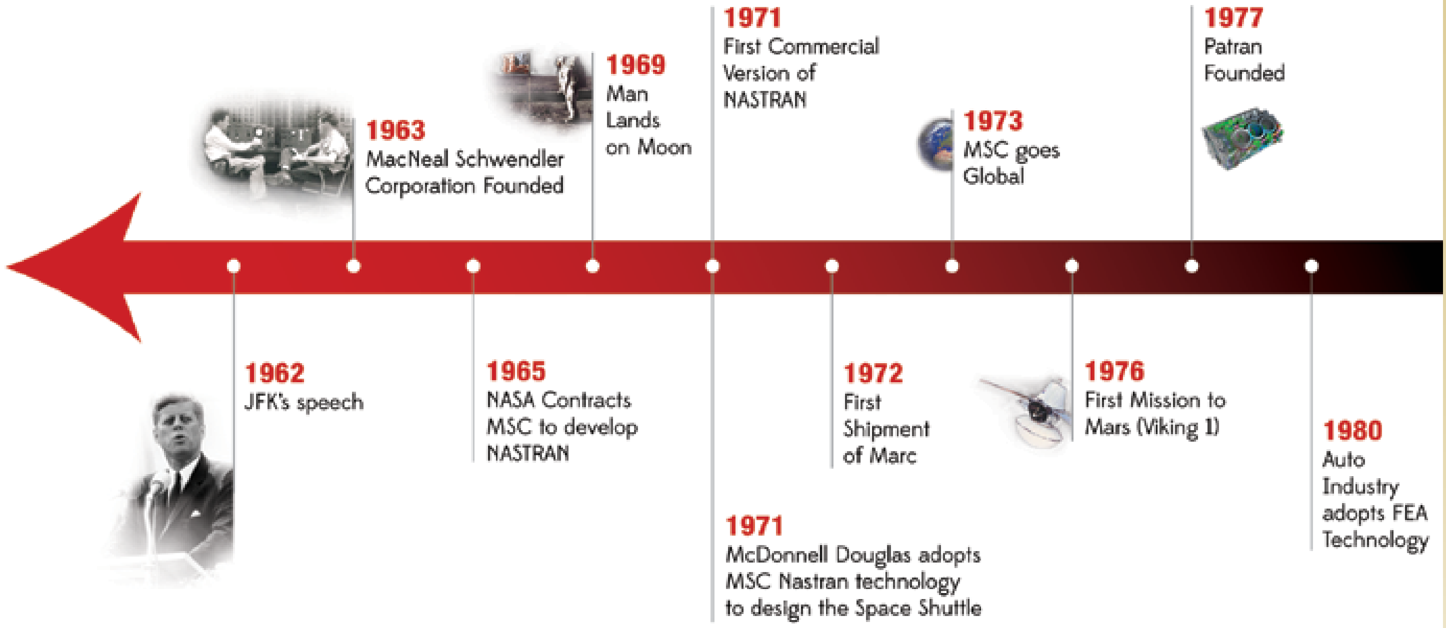
Six years later, in 1971, we released a commercial version of NASTRAN called MSC Nastran. Its launch coincided with IBM's decision to un-bundle its operating software from its hardware, which essentially created the independent software market and opened the doors for companies like MSC.

"MSC was among the earliest companies selling engineering analysis software commercially," said Dr. Halpern. "The company made a big contribution to the whole idea that you could sell software for the value of its intellectual property and offload development costs to a company 100 percent dedicated to improving the software, supporting it and advising customers. It also established an ecosystem of companies that had a common need for the technology. They were competitors, but they recognized that they all needed the technology. They contributed





MSC SOFTWARE'S 50 YEARS OF INNOVATION



resources and revenue to provide a tool that advanced their respective goals.

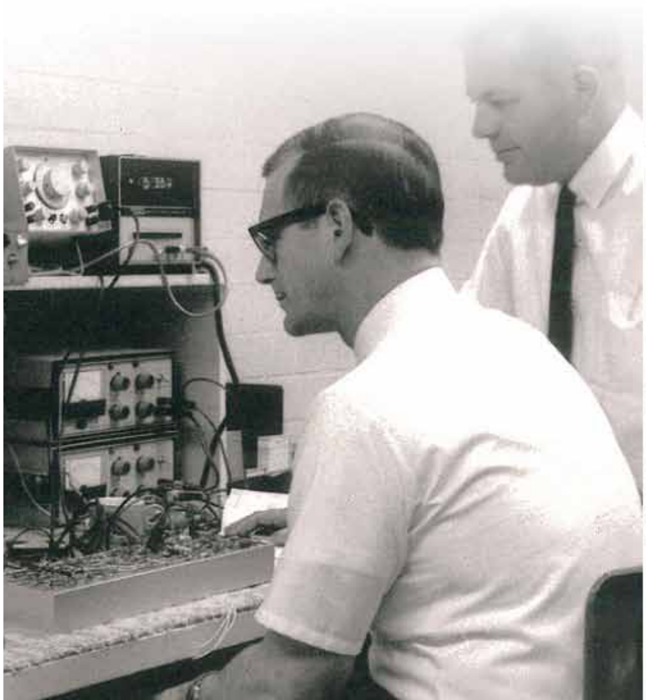
"They never could have accelerated the technology as rapidly as MSC did if they had tried developing computer-aided engineering software on their own. Had MSC not launched this ecosystem it might never have existed, or it might have happened much later."

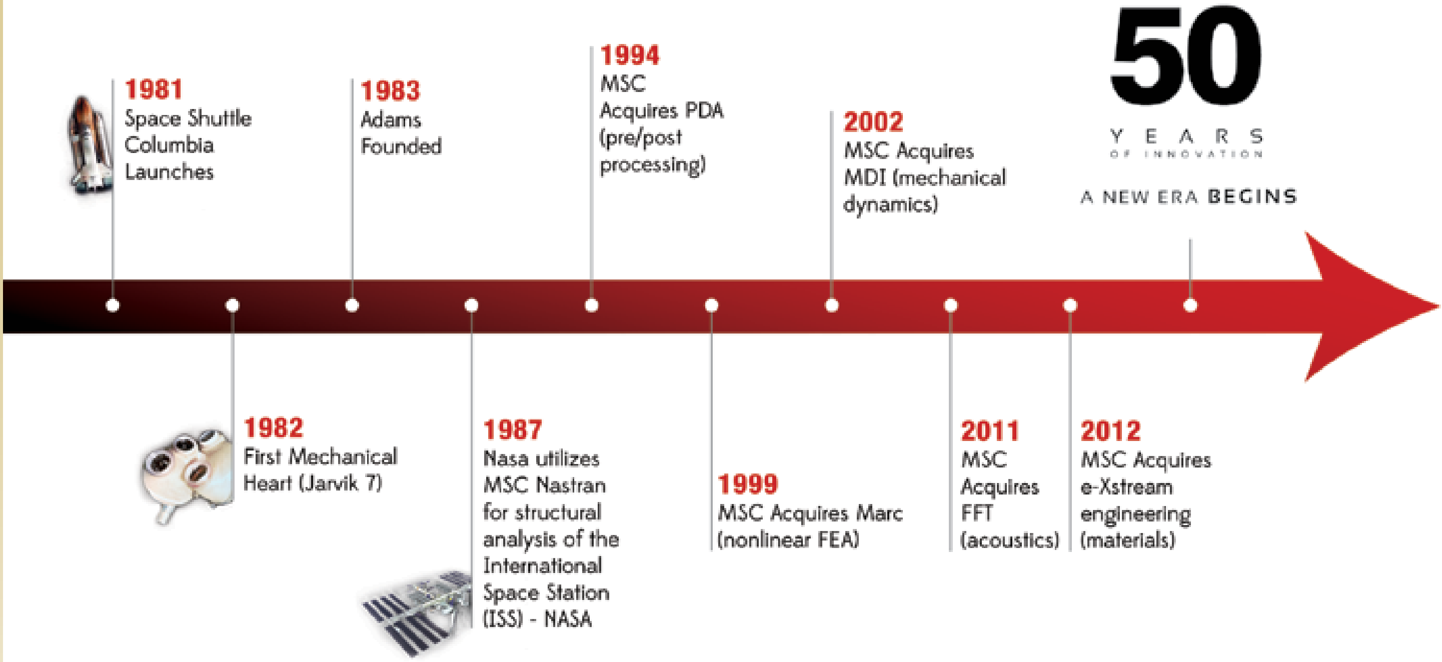
Through the rest of the '70s and into the '80s, MSC Nastran grew into one of the most widely-used simulation and analysis applications in the world. We expanded into Germany and Japan in the early 1970s as more automotive companies recognized MSC Nastran's ability to cut development costs while improving quality, performance, and reducing time-to-market. NASA has calculated that NASTRAN's value to society is in excess of $10 billion.

We went public in 1983, raising money to finance product development and acquisitions. Steady increases in computing power spawned workstations that brought CAE into industries such as heavy machinery and shipbuilding. MSC expanded into those areas while solidifying its positions in the automotive and aerospace markets. MSC continued to make important moves during the 1990s, such as releasing a Windows version of MSC Nastran.

In 2009, the investment group Symphony Technology Group & Elliot Management Corportation purchased MSC and installed design software veteran Dominic Gallello as our CEO.

Dominic engineered a growth period that focused on bringing MSC back to its roots of delivering great engineering software and working with key customers to develop new engineering methods. We added more than 40 PhDs to our development organization. R&D headcount expanded nearly 40 percent and approximately 40 percent of the development staff has been devoted to developing transformational technologies that promise to change how simulation is done in the future. Finally, two best of class simulation companies in acoustics and composites material modeling were acquired offering users better





understanding of these important real world behaviors. As a result, customer satisfaction and revenue are steadily growing; maintenance renewals are at near all-time highs and more and more customers are reaching out to MSC to provide services know-how.

Another Landing and a New Era

On August 13, 2012, a jet-powered delivery vehicle hovered over the surface of Mars and gently lowered the rover Curiosity to the red ground.

NASA engineers had never tried this method for delivering a probe to its destination. Earlier Mars probes had drifted down on parachutes or bounced to the surface in great padded cocoons. Curiosity's size made both of those approaches impractical. It would strike Mars' surface too hard and potentially damage the probe.

The jet pack was a completely new approach that worked flawlessly. MSC Software products helped NASA engineers simulate every eventuality, anticipate and correct every design weakness, just as it had 50 years earlier for the Apollo Moon missions. As the company celebrates 50 years and looks forward, its future promises to be every bit as rich, hectic, nerve-wracking, innovative and productive as its past. "MSC is as relevant now as it was in 1963 because now, like then, society is changing. Those changes bring new needs, challenges and opportunities," said Mr. Gallello. "From airplanes and automobiles to consumer products and industrial machinery, there will be tremendous change required. Products with better performance, zero carbon emissions, improved energy efficiency, compliant to increasingly stringent regulations and tougher safety requirements are part of the mantra that every engineering department will face as we go forward. In 2013, a new era begins for MSC. Look forward to the introduction of innovation commensurate with our rich history that will again be the vanguard for the future of simulation." ◆

Recognizing the Innovators

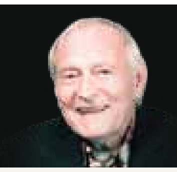
A Few Technology Inventors, Founders & Contributors Throughout the MSC Software Company Timeline

Dr. Richard MacNeal & Robert Schwendler

FOUNDERS OF MSC SOFTWARE & INVENTORS OF NASTRAN

MacNeal developed most of the mathematical techniques and procedures for structural analysis that are basic to the capabilities of MSC Nastran. His technical career encompasses state-of-the-art advances in numerous technologies including digital and analog techniques; airplane, helicopter, spacecraft and missile dynamics, and advanced structural analysis.

Dr. MacNeal received his BA from Harvard in 1943, his MS from Caltech in 1947, and his PhD from Caltech in 1949. He was an assistant professor at Caltech until 1955, and in 1955 and 1956 worked as a research specialist in the Structural Methods Department of the Lockheed-California Company. MacNeal received a Certification of Recognition from the National Aeronautics and Space Administration in 1974.

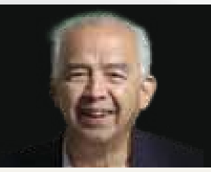


Dr. Ed Stanton

“FATHER OF PATRAN”

Dr. Stanton was largely responsible for the development efforts of Patran and was a key member of the team that negotiated the merger of MSC Software and PDA Engineering. After the merger of MSC Software and PDA, Dr. Stanton held the position of Vice President, Science and Technology, and had been one of the key members behind MSC Software’s technical development and software strategy. Dr. Stanton is fondly referred to by his colleagues at MSC Software as the ‘Father of Patran’.

Mr. Stanton holds a BSAE and MSAE from the University of Southern California and a Ph.D. in Engineering Mechanics from Case Western Reserve University. He also serves on the Dean’s Engineering Advisory Board at the University of California, Irvine.



Pedro Marcal

FOUNDER OF MARC ANALYSIS RESEARCH CORPORATION

Dr. Marcal began his career as a Lecturer at the Imperial College of Science and Technology, London University and then became a Professor in the Division of Engineering at Brown University (1967-1974). He is widely recognized as a developer of incremental nonlinear analysis, establishing methods for elastic-plastic materials as well as large deformations.

He founded the MARC Analysis Research Corp. in 1971, the software company that developed and marketed the Marc general purpose program. This program is used widely in industry for nonlinear analysis. He then became President of Phoenics North America in 1992. The appointment was a major opportunity to learn about fluid flow and CFD. In 1995, he established PVM Corp. and embarked on the development of the General Purpose Finite Element Program for Multi-Physics. His current interests are in the integration of Expert systems and the development of Smooth Particle HydroDynamic methods.

Michael E. Korybalski

FOUNDER OF MECHANICAL DYNAMICS, INC. & ADAMS

Mr. Korybalski co-founded Mechanical Dynamics, Inc. in 1977, as an outgrowth of technology that was originally developed at the University of Michigan in the early 1970s. In 1977, he was able to take what was essentially a research and development product from the university and commercialize it. That technology evolved into Adams and grew to become the world's largest developer and supplier of mechanical systems simulation software.

Mr. Korybalski led MDI and the industrialization of the Adams product until May 2002, when Mechanical Dynamics was acquired by MSC Software Corporation.

Mr. Korybalski graduated from the University of Michigan in Ann Arbor in 1969 with a Bachelor of Science degree in Mechanical Engineering. In 1972, he earned a Master's degree in Mechanical Engineering and in 1980 an MBA, both from the University of Michigan.

Dr. Jean-Louis Migeot

FOUNDER OF FFT & ACTRAN

Dr. Jean-Louis Migeot is the co-founder and CEO of Free Field Technologies, the acoustic CAE Company that recently joined the MSC Software group. He has devoted his career to the numerical simulation of noise and vibration problems after earning his MS, MBA and PhD at the University of Brussels. He first joined Structural Dynamics Research Corporation, and then was a co-founder of Numerical Integration Technologies, the original creator of SYSNOISE acoustic CAE software. In 1998 he co-founded Free Field Technologies, SA in Brussels, Belgium together with Jean-Pierre Coyette, where they created Actran acoustic CAE software and developed it for the past 13 years into the global technical leader for acoustic simulation.

Jean-Louis is also a professor of Acoustical Engineering at the University of Brussels. He has published numerous technical papers in journals and conference proceedings. He is currently a Vice-Director at the Belgian Royal Academy of Arts and Sciences.

Dr. Roger Assaker

FOUNDER OF E-XSTREAM & DIGIMAT

Dr. Assaker holds a PhD and MS in Aerospace Engineering with a strong focus on nonlinear computational mechanics where he totals more than 20 years of experience. Roger complemented his engineering education with an MBA in International Business and several advanced technology, business and entrepreneurship courses from prestigious universities such as MIT. In parallel to growing e-Xstream engineering to be the world leader in advanced composite modeling, Roger is the Vice Chairman of NAFEMS Composite Working Group and active member of other technical material associations such as SPE and SAMPE.

GREAT INNOVATIONS

made possible with MSC solutions

TSUNAMI CAPSULE

This modern Noah's ark is a floating capsule designed to preserve life in the event of an earthquake or tsunami. Idea International developed and tested the capsule with MSC Nastran and Patran.

Learn more about the life-preserving capsule.

ROCKET SLED

On August 13, 1981 PDA, under contract to the US government, set the World Land Speed Record for Unmanned rocket sled at 6,117 mph using a four-stage rocket train and 10,000 ft. helium filled bag. The entire experiment was simulated using MSC Nastran.

ROBOSAURUS

Inventor, Doug Malewicki's Robosaurus is a fire breathing, car eating, t-rex robot standing at 40 feet and weighing 30 tons. Converting from an industrial truck, the ferocious spectacle is referred to as the world's largest transformer. Designed and developed during the early '90s, you can still see the Robosaurus in action at Monster Truck and Air shows. MSC/Pal was used to analyze. the famous robot.

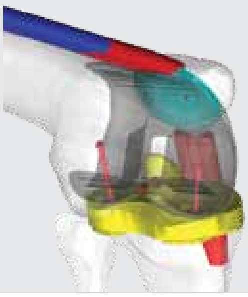
See Robosaurus in Action

LANDING OF THE CURIOSITY ROVER

Termed the "Seven Minutes of Terror", the simulation of the Curiosity Rover's landing on Mars was entrusted to Adams for a perfect touchdown on the first try. Adams was used to simulate aspects of the rover's landing on Mars.

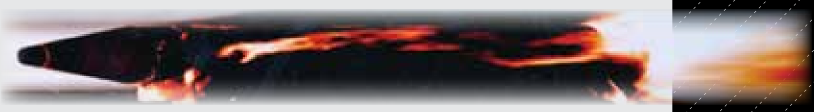
Watch the Curiosity's Landing

VIRTUAL KNEE MODEL



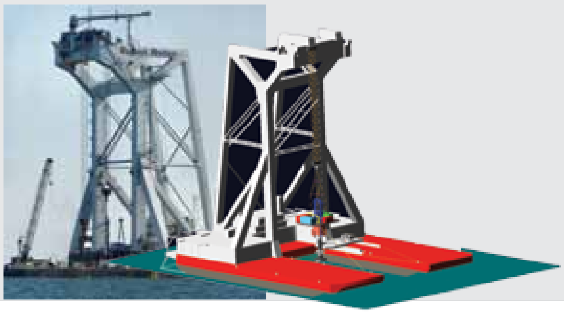
LifeModeler's Virtual Knee can walk, dance and even golf. Created using LifeMOD software with Adams and Marc, this powerful model is enabling innovation with fewer "live" trials.

FENDERS® PATENTED BASS NECK



The record stood for 20 years and was only recently broken using the same methodology from the first experiment.

LARGEST OFFSHORE WIND FARM



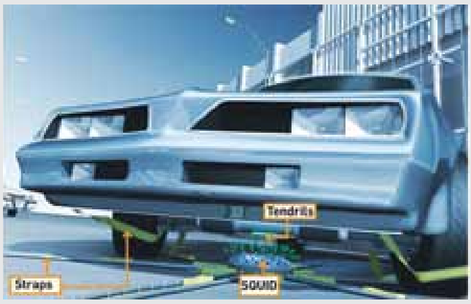
By its completion date in 2013, the Anholt Offshore Wind Farm will have capacity of 400 MW providing electricity sufficient to meet approximately 4% if Denmark's total electricity consumption. Adams was used to study the marine and offshore structures interfaces and reduce risks and costs of the installation and ensure safety of marine operations. At completion, the Anholt Offshore Wind Farm will be the biggest offshore wind farm in Denmark.

Go to page 20 to learn more about this story.

FASTEST CAR IN THE WORLD

With a 1000-horsepower engine, Bugatti's Veyron is the fastest car in the world. Adams/Car was instrumental in its design and development, according to Bugatti's technical director, Dr. Peter Tutzer.

REMOTE SPIKE STRIP



The SQUID is a remote spike strip that helps cops end car chases by stopping fugitives in their tracks. Commissioned by the Department of Homeland Security, the life-saving device was modeled and tested by ESACORP with MSC's Dytran.

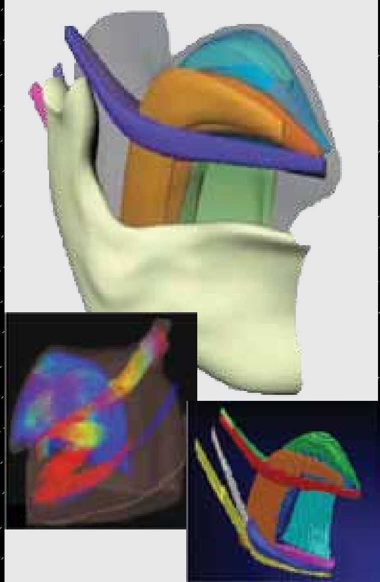
See how the SQUID ends car chases

Fender®'s Jazz Bass® and Precision bass necks were completely redesigned to balance stability and adjustability with MSC Nastran. The new design allows for optimum playability under widely diverse and every changing environmental conditions…all while maintaining the signature Fender tone. This innovation by Fender resulted in two patents!

B-1 BOMBER

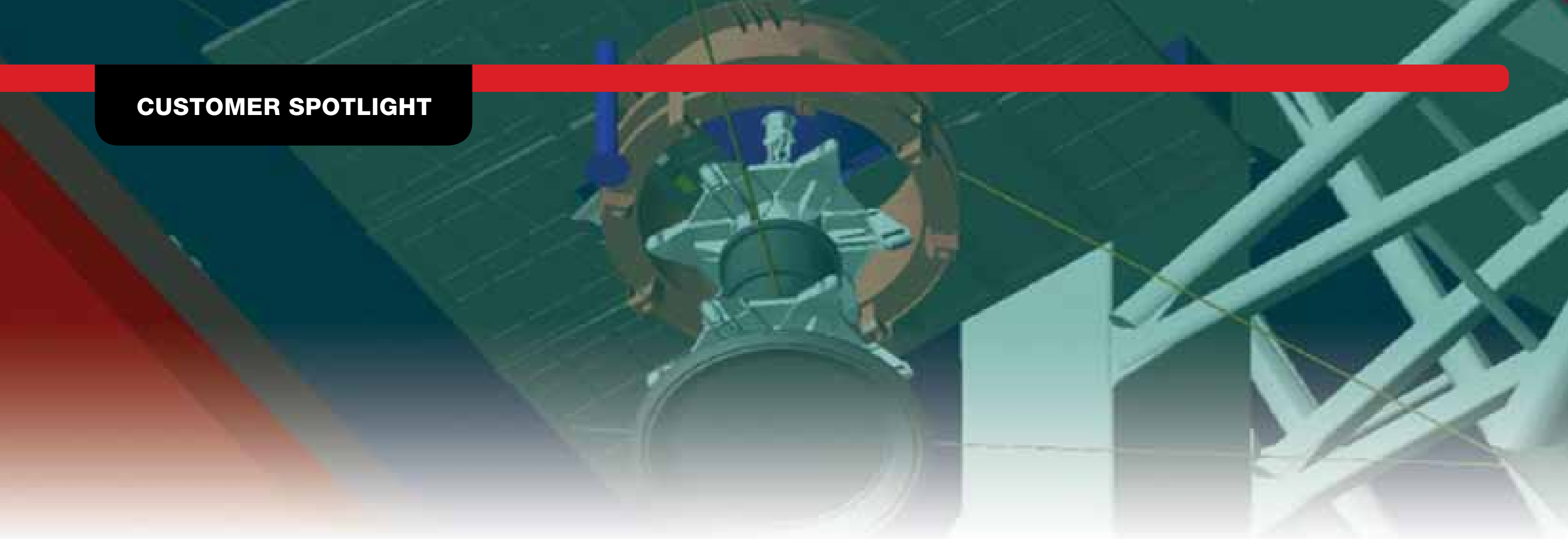
PDA designed, manufactured and tested the Passive Thermal Protection System (PTPS) for the B-1 bomber. Using MSC Nastran, PDA provided the B-1 bomber with a windshield that could instantly react to a nuclear flash to protect the pilot and the cockpit and withstand high-speed bird strikes.

HUMAN TONGUE MODEL



A precise musculature and motion model of the human tongue was created using Marc and Patran. Diagnostic Simulations, Inc. created the model to design an implant for the treatment of sleep apnea.

Learn more



CUSTOMER SPOTLIGHT

Safe Marine Operations in Wind Energy

Dynamic Motion Analysis for Wind Farm Drilling Rig Transport Operation

Knud E. Hansen A/S | Based on an interview with Mirco Zoia

Anholt Offshore Wind Farm

The Anholt Offshore Wind Farm is a Danish wind farm currently under construction, located in Kattegat, between Djursland and Anholt Island. The project was initially commissioned by DONG Energy with an estimated total cost of 10 billion Danish kroner.

In March 2011, DONG Energy sold 50% of the Anholt Offshore Wind Farm to PensionDanmark and PKA, with shares of 30% and 20% respectively.

The Biggest Offshore Wind Farm in Denmark

By its completion date, which is expected to take place between 2012 and 2013, the wind farm will have capacity of 400 MW providing electricity sufficient to meet approximately 4% of Denmark's total electricity consumption. As a result, it will become the biggest offshore wind farm in Denmark.

Wind Farm Construction Challenges

111 wind turbines of 3.6 MW each will be supplied by Siemens Wind Power and placed on locations with water depths between 15 and 19 m. The required foundations and installation have been contracted to the Danish company MT Højgaard A/S.

The foundations consist of monopiles with a diameter of approximately 5m and a wall thickness of 50-90 mm driven into the seabed. Their length is usually adjusted to the specific location and varies from 37m to 54m. By means of a large hydraulic hammer, the monopiles are driven between 18m to 36m into the seabed depending on water depth and seabed conditions. The heavy monopiles weigh up to 460 tons. If the monopile runs into boulders below the seabed, the boulders will be removed by a Drill Rig.

The Drill Rig is supplied by MT Højgaard A/S and transported from the storage location to the drill site using the installation vessel HLV SVANEN. The Drill Rig needs to be sea.

Fastened onboard the HLV SVANEN during the transport and also when HLV SVANEN needs to seek shelter due to adverse weather. For operational and safety reasons the Drill Rig can only be transported or deployed in waves of significant height up to 1.0m.

Knud E. Hansen A/S (KEH) was contracted by MT Højgaard A/S to assess the Drill Rig's waves induced motion while transported by HLV SVANEN, and to calculate the maximum tensions on the lashing cables for a maximum operational wave height of Hso=1.0m.

Multibody Dynamics Simulation Provides More Accurate Modeling

For the Drill Rig motion analysis, MSC Software's Adams was used. Adams is the most widely used solution for motion assessment of multi-bodies. Adams helps to study the dynamics of moving parts, how loads and forces are distributed throughout mechanical systems and to improve and optimize the performance of the design. Adams can easily simulate the reality of a complex multi-body system in motion.

> "Adams never placed any limits on what I wanted simulated, yet it made it possible to assemble the complex model very quickly."

Mr. Zoia, the KEH Naval Architect who performed the study said: "Adams Software helped us to understand the motion and forces involved by capturing the full gamut of real world complexities including rigid bodies, flexible bodies, springs, dampers, joints and all others mechanical components. The software never placed any limits on what I wanted simulated, yet it made it possible to assemble the complex model very quickly. Every part of the construction could be visualized during the simulation and the plots of the results easily shown. All the wave motions have been easily applied to the dynamic system in order to study the dynamic behavior in detail while ensuring the safety of the marine operations

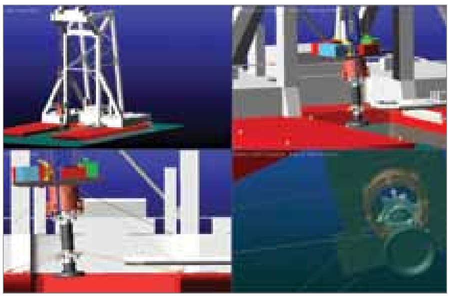


Fig. 1: Adams 3D Dynamic Model

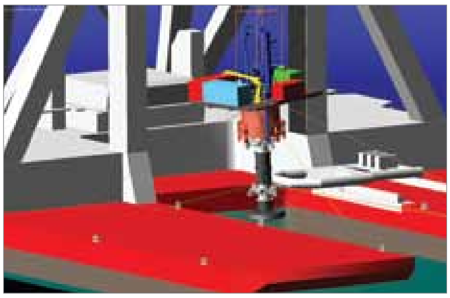


Fig. 2: Adams 3D Dynamic Model

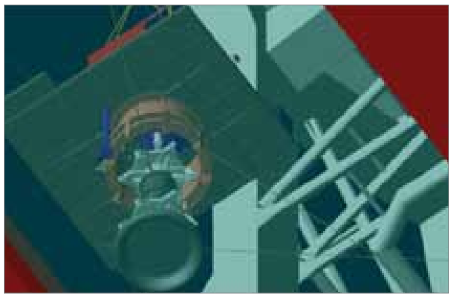


Fig. 3: Adams 3D Dynamic Model

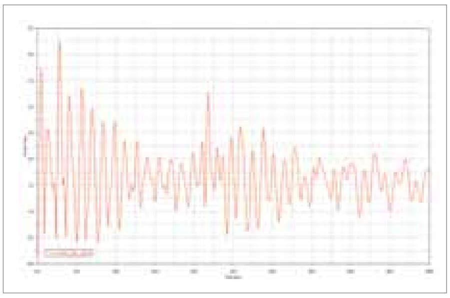


Fig. 4: Plot of the maximum angles between the Drill Extension and the BHA DR as function of time

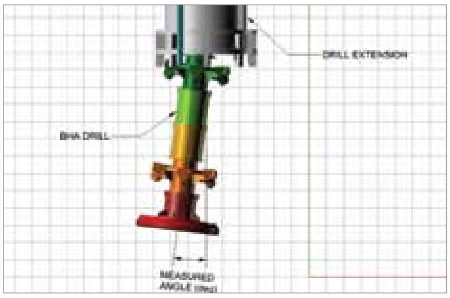


Fig. 5: Angle between Drill Extension and BHA DR

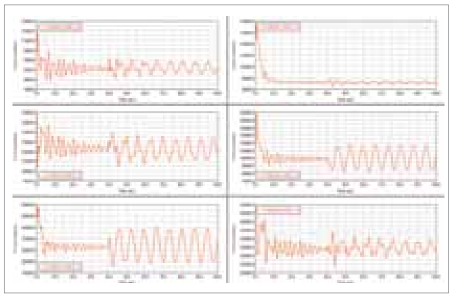


Fig. 6: Plots of the tensions of the winch cables as function of time

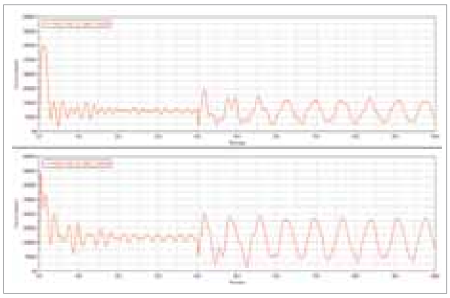


Fig. 7: Plots of the tensions of the fixed point cables as function of time

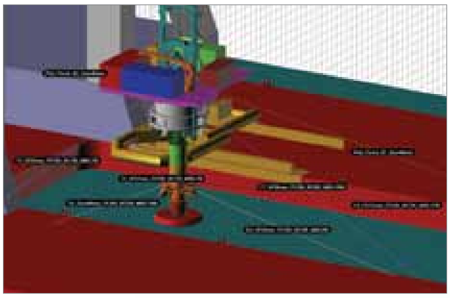


Fig. 8: Name and position of the lashing cables

CONDITION ONE – TRANSPORT OF DRILL RIG IN WIND AND WAVES HEADING 90 DEG.					
MEASURMENT (In steady motion condition)				MAX VALUE	
DR MAX TOT DISPL.				0.57m	
DR-BHA MAX ANGLE				1.99deg	
DR-TENSION OF THE WINCH CABLES	INITIAL PRETENSION FORCE				
	WINCH D3	51993N	5.30T	65727N	6.7T
	WINCH T2	122625N	12.50T	133416N	13.6T
	WINCH T3	318825N	32.50T	441450N	45.0T
	WINCH T4	85347N	8.70T	87309N	8.9T
	WINCH T5	96138N	9.80T	133416N	13.6T
	WINCH T7	316863N	32.30T	346293N	35.3T
DR-TENSION OF THE FIXED CABLES	CABLE 1	0N	0.00T	154017N	15.7T
	CABLE 2	0N	0.00T	272718N	27.8T

Table 1: Results for Heading of 90deg

and reducing the risks and costs of the installation of this wind farm".

Methodology

Initially, the 3D Multi-body Dynamic model of the system composed by HLV SVANEN, the Drill Rig and its crane lifting components (Lifting Spreaders, Lifting and Lashing Equipment), was created in a CAD software and then imported to Adams. Densities and other material properties were given to the parts of the 3D Model. All the parts in motion were joined together with translation, revolving, spherical and cylindrical joints to simulate as close as possible the real behaviour of the system. The steel and fibre ropes of the system were defined as flexible dynamic bodies with the same material properties (density, young's modulus, poisson's ratio, and damping coefficient) as the actual ropes. The winch pretensions were defined using preloaded spring-dampers. Motions, constraints, wind forces and winch pretension loads were then applied to HLV SVANEN. The motion analysis was based on the HLV SVANEN maximum response motion previously assessed.

The dynamic analysis was carried out to assess the maximum displacement of the Drill Rig, and the minimum required winch pulling force to fulfill the requirements of the client and to safely carry out the necessary marine operations. The full 3D Dynamic Model is shown in Fig.1-3."

Marine Rules & Safety Factor

The dynamic analysis was performed in accordance with DNV Rules for Planning and Execution of Marine Operations. According to these rules, an Alpha Factor α=0.85 was used. The Alpha Factor defines the safety margin of the marine operations.

For example, an Alpha Factor α=0.85 means that for a design wave height Hsd=1.00m, the maximum allowed operational wave height shall be Hso=1.00*0.85=0.85m. ◆

CUSTOMER SPOTLIGHT

Optimizing Machine Performance

Armor Increases Machine Productivity by 20% with MSC Software's Adams and Easy5 Simulations

Armor | Based on an interview with Gildas Hubert, Process Engineer

With sales of 137 million Euros in 2011, Armor is one of the leaders in producing inked ribbon used in thermal transfer printing for product identification and other applications. Ribbon is produced by applying ink to polyethylene terephthalate (PET) film in a web coating process in which the speed, tension and position of the web and other variables must be closely controlled in order to ensure the highest possible quality while maximizing throughput.

Gildas Hubert, project manager for Armor, has simulated many of the company's coating machines with Adams and control systems with Easy5 multi-domain modeling and simulation software. "Simulation helped us work out the optimal coating conditions and make engineering changes to our machines," Hubert said. "Over one year we improved productivity by 20% while also increasing quality of the finished film. Simulation is a great way to improve our manufacturing process at a relatively low cost without disrupting production as is required for physical experiments."

Based in Nantes, France, Armor was one of the first companies to manufacture carbon film, introduce ribbon cassettes for typewriters and introduce thermal transfer technology in the early 1980s. The company has over 760 employees worldwide and produces 110,000 thermal transfer film rolls per day at five production sites around the world. Armor is the leading producer in Europe with a 53% market share. The company offers over 12,000 different ribbon configurations.

Thermal Transfer Technology

Thermal transfer printing consists of applying thermofusible ink using a heat source emitted by the printer. The thermal transfer ribbon passes over the thermal print head with the coated side pressed against the label surface. The heat energy produced by each dot causes the pigment to transfer off the carrier film and bond to the surface of the label. The largest application by far for thermal transfer printing is the marking of individual products during manufacturing with information including model number, serial number, use-by-date, composition, price, etc. Other applications include flexible packaging, ticketing, personal identification and plain paper fax machines.

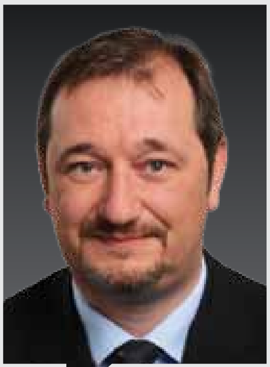
During the manufacturing process, a transparent PET film is unwound as a single or several layers of ink are applied on one side and a protective layer called the backcoating is applied on the other side. The PET film used as the carrier has a thickness of 4,5 to 12,5 µm, high resistance to tearing, good thermal conductivity and very good heat resistance. The backcoating protects the printhead as the ribbon unwinds, provides high thermal conductivity to transfer heat to the print medium and reduces the formation of static electricity. A range of different inks are used including wax, wax-resin and resin types. A rubber coated metering roll feeds the ink to a gravure roll which in turn feeds the ink to a format transfer roll onto the web. The coating weight is controlled by the velocity of the rolls and the footprint between the metering roll and the gravure roll. All rolls are heated with thermo oil. A jumbo roll 20 kilometers long is coated and then the jumbo roll is unwound onto smaller rolls as required for customer applications.

> "Coupling Adams, MSC's multibody simulation solution, with Easy5 turned out to be the ideal way to model our roll machines and control systems."

Moving from Physical Experiments to Simulation

"We have always been concerned with eliminating defects to ensure a positive experience to our customers while at the same time increasing the productivity of our web coating process," Hubert said. "In the past the primary method of improving operations was with physical experiments. But there were several problems with this approach. First of all utilizing coating machines to run physical experiments disrupts our production operations. The limited time available for and high cost of physical experiments greatly reduces the number of different conditions that we can

CUSTOMER CONGRATULATIONS



Dr. Yens Bold

DLR - German Space Agency

"50 years of Anniversary!
If you realize there was one man standing in front of a nation saying we have a dream to go to the moon not because it's easy but because its hard - and realize 50 years later the software that helped deliver this dream is still there and the name is still there. There is a continuancy that you don't see in software products or even in some industries these days - So I say great job and continued success in the next 50 years."

evaluate. Physical experiments also provide only a very limited amount of diagnostic information. The number of physical measurements that can be captured during these experiments is limited by the difficulty of instrumenting the coating machines."

Armor has long been interested in using simulation to evaluate a much larger number of different process conditions while reducing the need to disrupt production operations. But in the past the company found it difficult to model the complicated mechanisms and motion control systems involved in roll coating. This challenge was overcome with the use of Adams and Easy5 which enable controls systems to be integrated into mechanical systems simulations to optimize systems performance. Adams, the world's most widely used multibody dynamics simulation software, automatically formulates and solves the equations of motion for kinematic, static, quasi-static and dynamic simulations. Easy5 is a graphics-based software tool used to model multi-domain dynamics systems characterized by differential, difference and algebraic equations such as digital and analog control systems. Integration is accomplished with the Adams interface block in an Easy5 model that provides inputs from Easy5 into Adams and vice versa.

Optimizing Roll Coating Performance

Hubert constructed an Adams model of the machine. He defined the rolls as cylinders and added connections between them to represent the gearing in the machine. He defined the material properties of the PET web and entered the friction between the web and the rolls based on physical measurements. Easy5 is used to simulate the proportional–integral–derivative (PID) closed loop motion controller. "I found it very easy to define both the physical and control model with Adams and Easy5," Hubert said. Hubert began his simulation efforts on a machine whose performance he felt left considerable room for improvement. The machine required continual adjustments in order to avoid defects. He began by simulating the machine's current operating conditions. Comparing the simulation results with physical measurements, particularly of web tension, showed that the simulation accurately represented the machine performance.

The simulation results showed that a small change in operating conditions could cause the machine to produce defects. Hubert evaluated changing the operating conditions, particularly the PID control values. He modified the model and re-ran the simulation multiple times, seeking to move the machine to a point where small changes in operating conditions would have no impact on quality. In the end, he discovered more robust operating conditions that substantially improved throughput of the machine by reducing downtime required for adjusting operating conditions.

Based on this success, Hubert turned his attention to other machines that were seemingly operating well to see if improvements could be made in either throughput or quality. During this process, he discovered the importance of accurately determining the friction between the web and the rolls in order to provide accurate simulation results. He evaluated more of the company's machines in order to identify optimal operating conditions.
He evaluated a range of different products with varying film thicknesses on each machine. For each product he evaluated different PID control values in order to identify values that provided stable operating conditions without defects. During this process, he optimized the control values for each film thickness. This required far more simulation runs than would have been possible with physical experiments. Running virtual experiments with Adams and Easy5 also eliminated the cost of downtime on production machines.

By optimizing control values, Armor was able to increase throughput of its coating machines collectively by about 20% over a one year period. The primary improvement came from increasing machine reliability and stability so that less time was required for repairs or adjustment. Web speed improvements were also achieved on many machines. "We are now able to set the PID values much more precisely to optimize the performance of the machine for specific products," Hubert said. "We have made other improvements with simulation such as increasing the throughput of a cutting machine by 8%. We have plans to apply simulation to additional processes such as our rewinding machines. We are looking to improve the precision of our models by integrated process related thermal phenomena into the analysis loop. Finally, we also see the potential for simulation to improve the quality of our labeling machines."

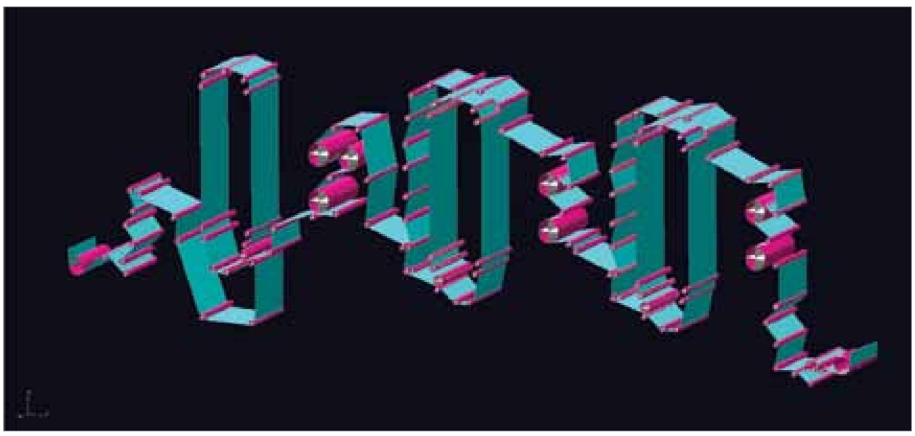


Fig. 1: Machine Model in Adams

"Our goal was to improve the coating process, notably by controlling the tension of the film on to which the ink is deposited," Hubert concluded. "Coupling Adams, MSC's multibody simulation solution, with Easy5 turned out to be the ideal way to model our roll machines and control systems. By simulating the operation of our machine we were able to determine the ideal parameters for operating them over a broad range of products. These calculations make it possible to run each machine at the optimal coating conditions. The end result was that we improved quality while at the same time making substantial improvements in productivity." ◆

CUSTOMER SPOTLIGHT

Stamping Out Waste

Aerospace Supplier Uses Simulation to Save Time & Money

DEMA | Based on an interview with Danilo Malacaria, Structural Engineering Manager

Design Manufacturing SpA (DEMA) is a major tier-one aerospace supplier to Bombardier, Alenia Aermacchi, AgustaWestland and other leading aerospace original equipment manufacturers. The company recently faced a challenge with an aluminum acoustic barrier which is part of a jet engine nacelle. DEMA performed finite element analysis (FEA) with the MSC Nastran implicit nonlinear solver which identified two problems in the initial design. These included a stress concentration around a radius and excess material beyond the dimensions of the finished part which would have required an expensive secondary operation.

Danilo Malacaria, Structural Engineering Manager for DEMA, addressed these problems by increasing several radii in the area of the stress concentration and changing the size and geometry of the initial blank to eliminate the excess material. He re-ran the FEA which showed that the changes solved the problem. "When we ran the operation with the new tool and flat panel, the resulting part matched the simulation results perfectly," Malacaria said. "Finite element analysis saved us a considerable amount of money and time by helping to identify and correct this problem before we made a major investment in tooling."

Based in Naples, Italy, DEMA also has a composite facility in Benevento, an helicopters assembly plant in Brinidis, a machining technology centre in Piacenza, Italy, an engineering and assembly operation in Montreal, Quebec and a composite processing and assembly facility in Tunisia. DEMA produces a wide range of aerostructures including aircraft fuselage sections, floor panels, cockpits, tailcones, fan cowls, ramps, cargo doors, slide boxes, horizontal stabilizers, helicopters fuselages and helicopter tail booms. DEMA's customers include Alenia Aermacchi, Bombardier, Airbus Military and AgustaWestland for aircraft programs including the Boeing 787, Airbus 380 and A321, ATR 42-72, AW139, AW169, CSeries and Learjet.

Challenge of Producing Critical Aerospace Component

The acoustic barrier is produced in a stamping operation in which a female die applies pressure to a flat aluminum blank, forcing the blank against a male die to form the finished part. The traditional approach would have been to develop the dies based on best judgment and send them to the press shop for tryout. Frequently the first stage of tooling would show problems such as cracking or excess trim. Changes would be made to the tooling and the new tooling would be tested again to see if the problem was fixed. In most

> "Finite element analysis saved us a considerable amount of money and time by helping to identify and correct this problem before we made a major investment in tooling."

cases, it was difficult to determine the cause of the problem so a considerable amount of trial and error would be required to solve it. It's not unusual for six iterations of modifications taking two weeks each to be required meet the customer's quality standards.

DEMA has pioneered the use of finite element analysis to simulate stamping operations with the goal of getting the die design right the first time. The company used the MSC Nastran implicit nonlinear solver. The solver allows users to perform advanced nonlinear structural analysis including contacts, large deflections, large rotation and large strain analysis capabilities.

Fig. 1: The nacelle houses a jet engine

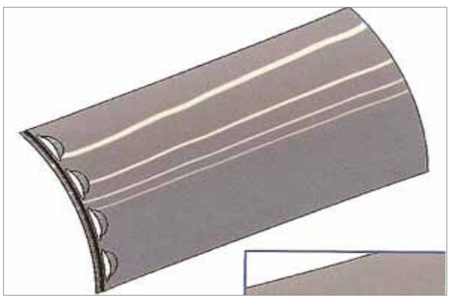


Fig. 2: Acoustic barrier assembly produced in stamping operation

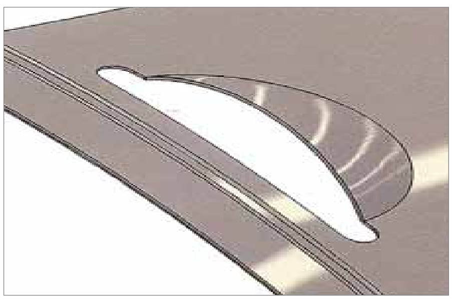


Fig. 3: Critical section of stamped component

Fig. 4: Left image - FE model of contact surface of stamping die. Center image: FE model of flat panel geometry. Right image - Model of tool & material combined

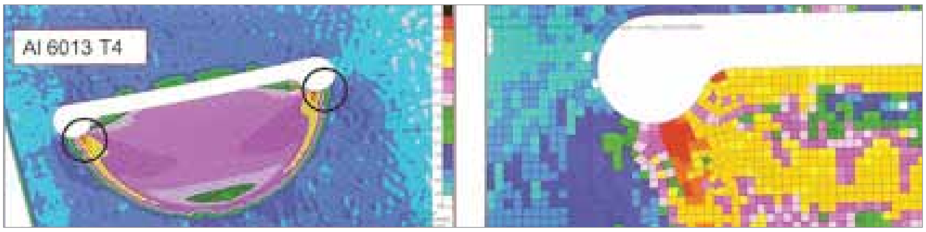


Fig. 5: Left image - Stress levels in material during stamping process. Right image - Material has exceeded its yield levels in area shown in red

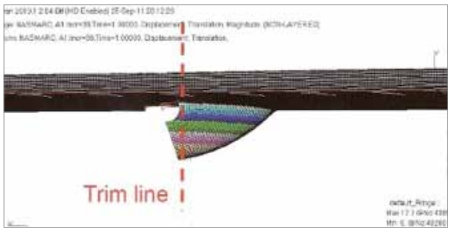


Fig. 6: Simulation results for initial die showing excess material

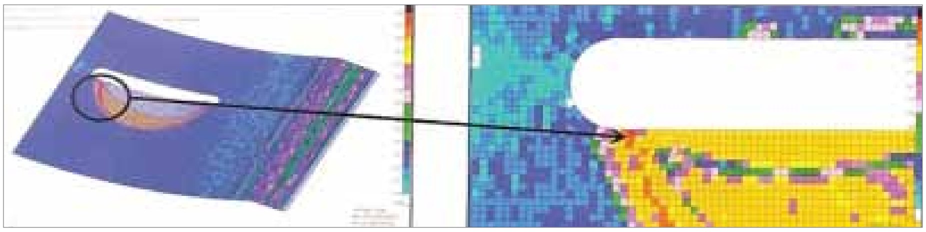


Fig. 7: Modified design with larger radius eliminates excess stresses

Fig. 8: Component built in press shop

The customer provided the part geometry in the form of a CATIA V5 computer aided design (CAD) file. DEMA engineers created an initial design for the male and female dies and the part and die geometry into the Patran pre-and post processor. They created a 2D mesh of the male and female tool and the flat sheet pattern. "2D shell elements provided a faster run with excellent accuracy when simulating sheet metal forming," Malacaria said. The 100 bar pressured applied by the press to the male and female dies was determined with physical measurements. The customer specified the use of 6000 series aluminum so DEMA engineers evaluated several different materials in an effort to determine which would work the best. DEMA engineers created a standard MSC Nastran input deck. The MSC Nastran nonlinear solver ran the analysis.

Simulation Highlights Potential Problems

The simulation results showed two potential problems. Figure 5 shows that the stress exerted on the material during the stamping operation is past its failure limits. The stress analysis results show that the peak is near the radius of a cutout in the component. Figure 6 shows that there is considerable excess material around the perimeter of the finished part. This extra material would need to be removed in a second trimming operation with a 4-axis computer numerical control (CNC) cutting machine which would add significantly to manufacturing costs. The simulation provided engineers with an understanding of these potential problems as well as diagnostic information that helped them determine their root causes.

DEMA engineers addressed the stress concentration problem by increasing the radius of the cutout in the component. They addressed the excess material by reducing the size of flat pattern geometry in the area of the excess. The engineers then re-ran the simulation to determine the impact of these changes. They saw that both of the problems they had addressed with the revisions were substantially improved but not completely fixed.

Engineers made several more iterations on the software prototype and re-ran the simulation to evaluate the impact of their changes until they found a design that eliminated both the excess stress and the need for a second trimming operation. In order to verify the results, DEMA engineers re-ran the simulation using the MSC Nastran implicit nonlinear finite element solver.

Getting the Die Design Right the First Time

Next, DEMA built a tool using the final design that was developed during the virtual prototyping process. The company installed the new tool in a stamping press and formed a few trial parts to evaluate the results. The simulation accurately predicted how the parts would be formed. In particular, the parts were free of flaws that would have indicated excess stresses and the finished part did not require trimming. Getting the die design right the first time reduced the time and cost involved in tool tryout since it is both faster and less expensive to try out possible solutions on the computer than in the press shop. Because of the demanding requirements for aerospace components, a certain amount of time to validate the die design is always required in the press shop.

"This application demonstrates how we can provide high quality and faster deliveries to our customers by utilizing the latest generation of computer simulation software," Malacaria concluded. "Rather than spending the large amount of time and money that would have been required to build and test the initial die design to see if it worked, we simulated a range of different designs and evaluated the results using the MSC Nastran FEA software. During the simulation process we eliminated a potential quality issue and also avoided the need for a secondary trimming operation. We determined the process, developed the initial blank and monitored stress concentrations before we even started building the die. The result was that the die worked perfectly the first time we hit it. There's no way to know for sure exactly how much money and time was saved by not having to re-cut and re-test the die but it's clear that the savings were substantial. Simulation has also helped us to create savings of the same magnitude on many other complex parts that presented similar challenges." ◆

Adams™

Customize the User Interface

By Walter Daniel, Sr. Technical Representative, MSC Software

ADDING YOUR OWN BUTTONS

Custom Menus and More in Adams/View

Did you know that the Adams/View Graphical User Interface (GUI) can be customized?

You can add your own menus, macros, dialog boxes, and more. All you need is a basic understanding of what is happening under the hood.

While most users are familiar with the GUI for building and simulating models there is a series of text commands for every action. All processes are implemented in the Adams/View Command Language, a custom script that is readable. For example, the command to modify the default value of an existing design variable would be:

variable modify variable_name=.model_1.DV_2 real=9.4

There is a full description in the Adams electronic documentation installed with the software. Look under *Adam Basic Package > Adams/View > View Command Language.*

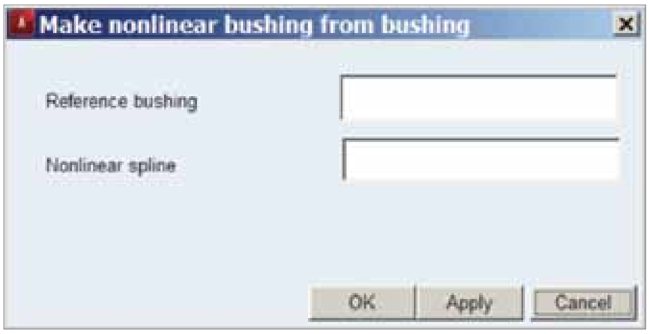
While you can type commands into a window for execution most users would prefer to use the GUI. The simplest tool is to add a custom menu with entries for the commands you'd like to execute. The Menu Editor (Tools->Menu->Modify) is straightforward and covered in the documentation topic *Adams Basic Package > Adams/View > Customizing Adams/View.* For example, these lines add a menu named "Custom" with the entry "Payload Visibility On" that turns on visibility of a part in the model named "payload."

```
MENU1 &Custom
  NAME=Custom
  BUTTON2 Payload Visibility On
    CMD=entity attributes entity_name=
        payload visibility=on
```

Custom menus are great for making pre-defined changes to a model such as one of a specific set of masses for a part, changing a point location, and so forth.

Advanced Adams/View users can use the command language to program custom macros for model building or modification. If you need to pass user input into the macro a custom dialog box will work well. Here's an example from SimCompanion KB8016111 that allows a user to convert an existing linear bushing into a nonlinear GFORCE defined with a spline:

> "Custom menus are great for making pre-defined changes to a model"



There are numerous examples of macros in SimCompanion. Start with KB8020616 for an overview then search on topics such as "part macro" or "bushing macro." There is an MSC training class that covers these topics: ADM704b, "Automating Tasks using Adams/View Scripting, Macros, and GUI Customization."

Didn't Adams/View 2012 bring a new ribbon-style GUI? Yes, but menus and dialog boxes work the same way in this updated interface. New with Adams/View 2013 is the ability for users to customize the ribbon. You can add tabs, containers, and buttons to execute commands and macros much the same way that custom menus function. Changes to the ribbon are made by editing an XML file; to add a custom button you will need to supply a small graphic. For example, here's a custom tab with a container for "Settings" and two new buttons.

Patran®

Useful Display Options

By Edwin Goei, Technical Representative, MSC Software

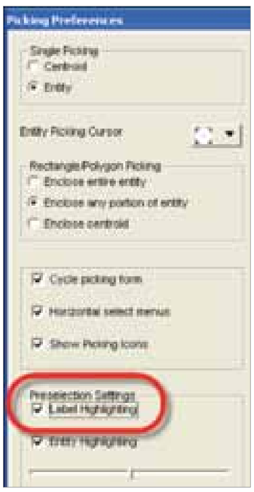
Sometimes it's the simplest things that may not be the most obvious. Here a few tips on the subject of Patran display options that you may have not known about, but will prove to be useful as you face more complicated issues.

HOW TO GET ID NUMBERS TO APPEAR ON AN ENTITY AS YOU HOVER OVER THEM:

There are some situations when you are working with a complicated model that you don't want to turn all of your ID labels on. To do so would make your screen too cluttered with IDs. Yet what if you still want to identify entities IDs on-the-fly?

The solution is to turn on "Label Highlighting" under Preselection Highlighting. This is found in Preferences/ Picking form.

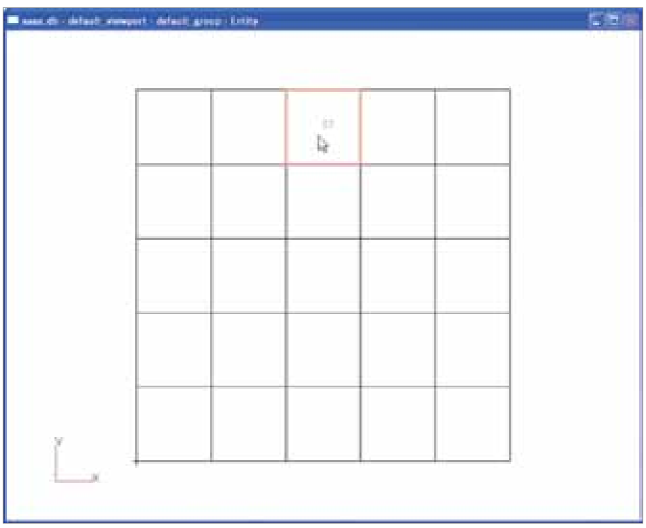
With the toggle turned on, the ID of the entity you hover over with your mouse will now highlight.



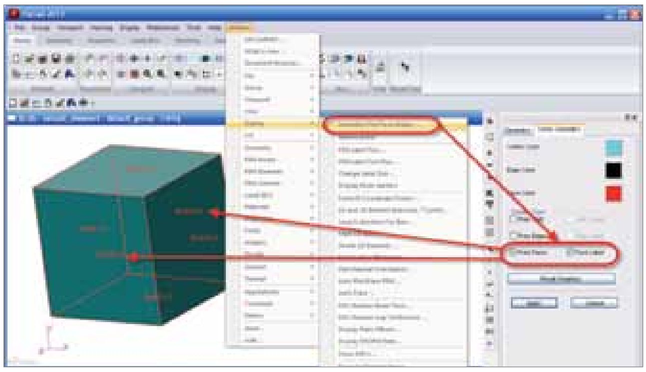
HOW TO GET SOLID FACE ID LABELS TOGRAPHICALLY APPEAR ON YOUR MODEL:

Solid face ID labels are usually not visible, and there is no option in Patran's main form to turn them on. However there are instances, such as pressure application, in which being able to see the ID labels would prove to be useful.

The solution is in Utilities, where there is a tool under Display/ Geometry Free Faces/Edges that



> "There are some situations when you are working with a complicated model that you don't want to turn all of your ID labels on."

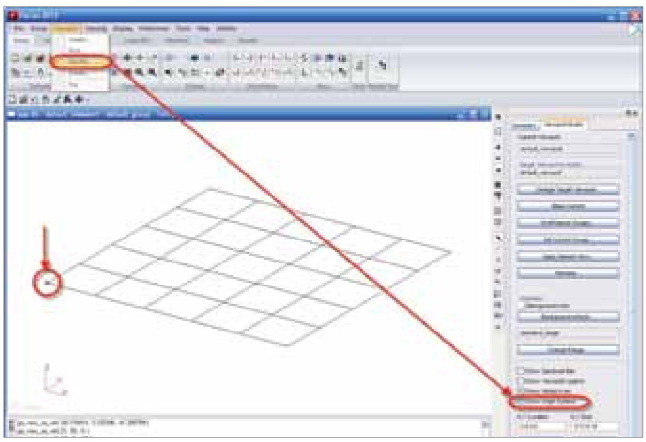


allows you to turn on the labels for solid faces as well as solid vertices and edges.

The labels will disappear after you Cancel out of the utility, however. So leave the utility open until you are ready for the IDs to be cleared off the screen.

HOW TO REMOVE THE "+" ORIGIN SYMBOL FROM THE SCREEN:

There are instances when you capture images of your Viewport for presentations and reports that you want the background to be as clean as possible. Most users are not aware that the origin symbol (the "+" which indicates where the location of (0, 0, 0) is) can be deactivated. You can turn it off in Viewport/Modify—a location that's not very obvious to some Patran users.



Actran™

Interpret MSC Nastran Model Data

Model Complete Vibro-Acoustic Behaviors with Actran

By Bernard Van Antwerpen , Senior Application Engineer, FFT, MSC Software

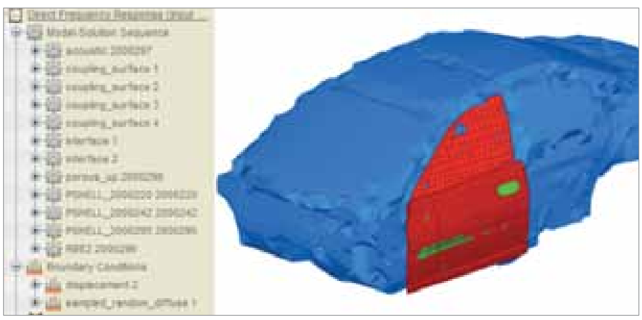
MSC NASTRAN TO ACTRAN CONVERTOR:

Actran 13 has introduced the capability to interpret MSC Nastran model data into Actran in order to leverage on existing structural FEA information when creating a vibro-acoustic model in Actran. Beside the mesh, most material and property information can be translated, including boundary conditions and control case commands. This is a very useful tool to enhance existing MSC Nastran complex structural dynamics models to model complete vibro-acoustic behaviors with Actran. This can be done by introducing acoustic excitations, acoustic treatments or others. In our example, we are directly importing an existing MSC Nastran model of an automotive door inside Actran VI, the graphical user interface (GUI) of Actran.

Additional boundary conditions can easily be created in Actran VI by creating or selecting the required set of nodes to be constrained.

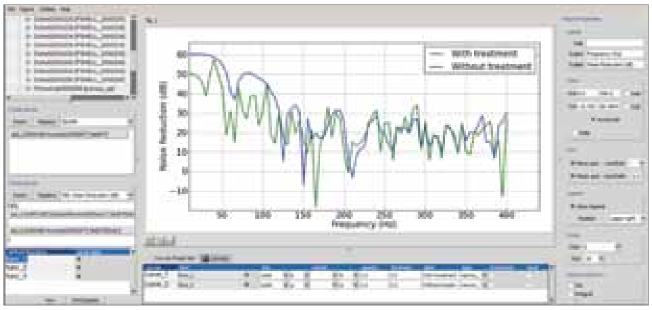
MODEL AN ACOUSTIC TRANSPARENCY:

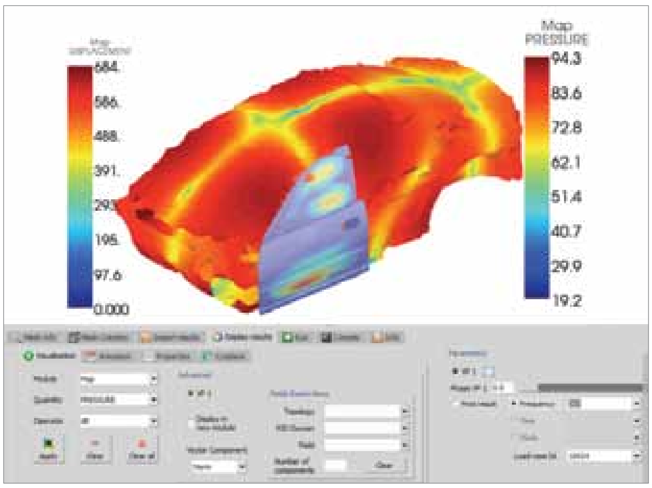
As the imported MSC Nastran case contains all structural model information, this can be easily updated for modeling an acoustic transparency model. For this purpose, an existing cavity (in blue) and acoustic treatment model (in green) are first imported, as shown below. Then, these are coupled to the structure using the un-congruent mesh capability (INTERFACE). A diffuse sound field excitation is applied to the exterior skin of the door.



> "The extension of an existing MSC Nastran structural model to a complete realistic transparency model within Actran can be performed in a few minutes."

A typical output for such problems is the Noise Reduction index, relating the incident pressure applied to the structure through the Diffuse Sound Field to the inner pressure within the cavity. By suppressing or adding the foam treatment, the influence of the foam treatment on the acoustic transparency can easily be retrieved.





As shown through this example, the extension of an existing MSC Nastran structural model for dynamic purposes to a complete realistic transparency model within Actran can be performed in a few minutes of time. Furthermore, this process can be entirely automated thanks to the Actran API (Application Programming Interface).

MSC Software: Trusted Services Partner

By Derek Barkey, Program Manager, MSC Software

Since the founding of MSC Software Corporation in 1963 as the MacNeal-Schwendler Corporation, MSC has been an engineering services company. The company was founded to provide expertise in using analog computers to simulate structures. Since that time, MSC's services offerings have expanded to keep pace with the state of the art in engineering and engineering simulation. Today, MSC engineers are engaged with customers around the world in a variety of disciplines to deliver training, engineering analysis, and engineering process improvement.

Reducing Risk in Product Development

The mission of MSC's services division is to help customers improve their products and their product development process. MSC's engineers reduce development risk, reduce time to market, reduce cost, improve performance, improve durability, enable long term product support, and maximize return on CAE technology investment. They do this by combining engineering expertise with the advanced capabilities of MSC's simulation software. A typical MSC engineer has twenty or more years of engineering experience in aerospace, automotive, naval architecture, oil and gas drilling, biomedical, and other industries. Their expertise typically includes strength, dynamics, fatigue, impact, thermal, power trains, suspension and braking systems, internal and exterior acoustics, fluid-structure interaction and aeroelasticity, hydraulic and pneumatic systems, blast, crash, and ballistic impact simulation, composite and metallic material performance, and air bags.

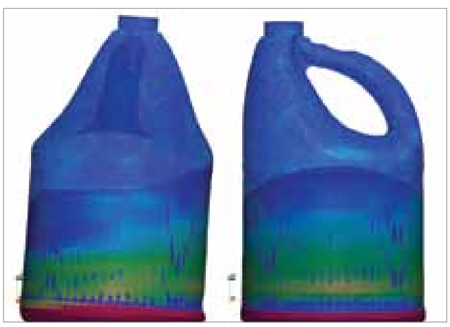


Fig. 1: Consumer Packaging Simulations

Improving Engineering Efficiency

In addition to expertise in technical disciplines, the experience of MSC engineers gives companies critical expertise in engineering processes that can be hard to find. For example, MSC engineers can be engaged to study and improve a customer's product development process. This can entail reviewing the process, identifying critical paths that increase risk and schedule time, and developing means for improving

Fig. 2: Fluid Structure Interaction

“Since the founding of MSC Software Corporation in 1963 as the MacNeal-Schwendler Corporation, MSC has been an engineering services company.”

those critical paths. For example, MSC engineers may assist customers in training engineering staff in advanced techniques through standard or customized training curricula. MSC helps customers improve engineering efficiency by implementing design optimization methods, stochastic methods, high performance computing, or automating processes. These methods reduce engineering time and labor while improving the quality and repeatability of the engineering process.

Managing Vast Amounts of Engineering Data

Frequently, the greatest challenge that MSC's customers experience is simply managing the vast amount of engineering data. Simulation models and simulation results for a single product are generated or used by multiple groups within an enterprise as well as suppliers and customers. In a rapid product development process it can be challenging to manage change in the data, mine and manipulate it to get maximum value with minimum effort, and control access to ensure that those who need the data get it while securing the data from unauthorized access. Product data management systems address part of this problem, but they have limited functionality for the specialized needs of managing simulation data. MSC services engineers can assist customers in implementing simulation data management systems using MSC's SimManager technology. These systems are used to control, manage, and disseminate engineering material and simulation data. A simulation data management system can be implemented for a single workgroup or for an entire enterprise to improve efficiency and provide long-term access and traceability for the product life cycle.

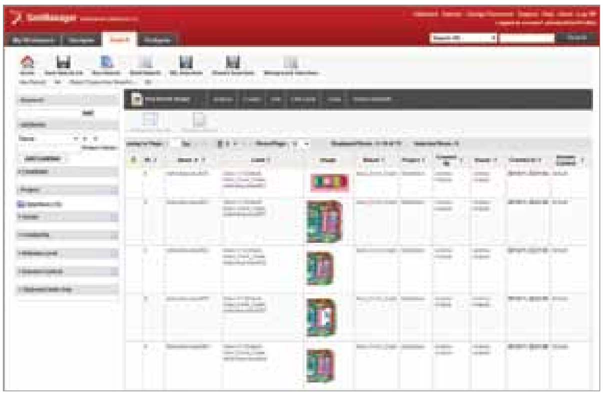


Figure 2: Manage, Control, Automate Simulations

50

CUSTOMER CONGRATULATIONS

Dr. Jaiwon Shin

NASA

"On behalf of NASA and certainly NASA Aeronautics, I congratulate the great success MSC has had over the last 50 years - not only for its significant engineering accomplishments but also for the tangible real-world benefits to the country and industry as a whole. I look forward to many more years of prosperous and productive collaboration between MSC and NASA. Congratulations MSC - job well done."

Range of Engineering Disciplines

MSC's services have come a long way in fifty years, from expertise in analog computers to a wide range of engineering disciplines. As MSC expands its portfolio of software products, our services offerings expand with it. In 2012, the addition of Actran acoustic software and Digimat material simulation software to MSC's portfolio has expanded the expertise of MSC's services division as well as the capabilities of our software. Today MSC's services division delivers technologies that were unimaginable fifty years ago. With new technologies like Actran and Digimat, MSC services will continue to grow. It will be an exciting time to partner with MSC for services.

To engage with MSC in a project, please email us at engineering.services@mscsoftware.com or visit www.mscsoftware.com/services for more information about our services offerings. ◆

SPECIAL SPOTLIGHT

simulating REALITY Contest Winners

By Yijun Fan & Leslie Bodnar, MSC Software

About the Contest

To celebrate MSC software's 50th anniversary, individuals were invited to participate in the "Simulating Reality" Contest by submitting a video or image demonstrating how they used MSC Software technology to develop products or design innovations for our future. The images or videos, and related descriptions, submitted by participants were to meet one or more of the following in connection with use of MSC technology:

- Showcase innovative industry application of MSC technology
- Demonstrate leading edge product design
- Demonstrate resulting business benefits of the project to the company
- Showcase great impact on human society or industry

Showcasing Our Winners

Ten winners were selected by a panel of judges based on how well they met the above criteria. On the next two pages their projects are described and displayed along with an image.

"Gold Anniversary" Winners

Three of the ten winners were selected as "Gold Anniversary" Winners. These winners are spotlighted below. Each will receive an iPad mini for their contributions.

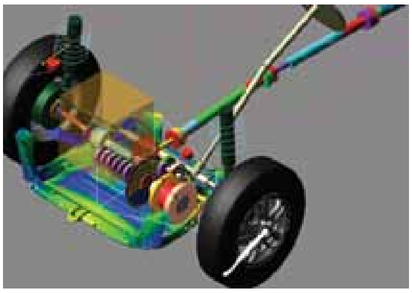
We thank all of our customers who participated in this contest and for being part of our special anniversary issue.

The "Gold Anniversary" Winners

NASA JPL. USA

Validated the landing sequence and determined loads on subassemblies and components on the Curiosity Rover during its historic landing sequence on Mars.

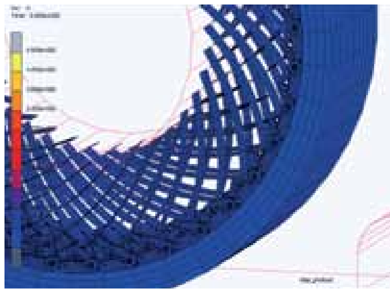
MSC Products Illustrated:
Adams



Jaguar Landrover, UK

Simulating automatic transmission torque converter performance to make damper selection more robust and shorten the development cycle.

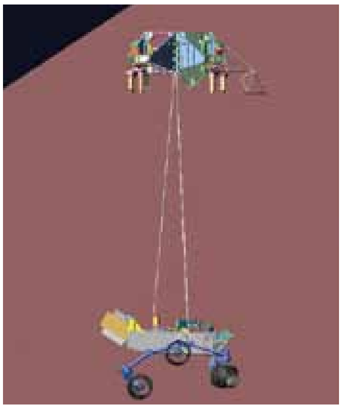
MSC Products Illustrated:
Adams



Big Tyre Pty. Ltd., Australia

Developing and simulating an innovative non-pneumatic, non-solid tire for improved safety and productivity in mining equipment.

MSC Products Illustrated:
AFEA (Patran and Marc)



BENG Consultancy Ltd., UK

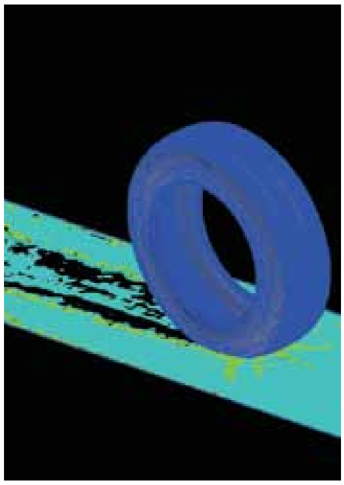
Studying the effects on motorcycles for structural flexibility and rider dynamics to predict design performance.

MSC Products Illustrated:
Adams

Korea Metro, S. Korea

Studying the dynamic stability of the railway vehicle to improve running safety.

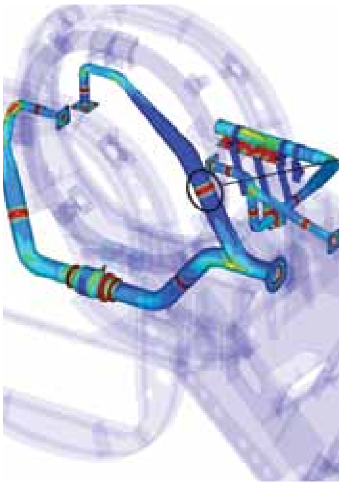
MSC Products Illustrated:
Adams



Kumho Tire Corporation, South Korea

Performing fluid and tire interaction analysis to predict wet performance in tire development.

MSC Products Illustrated:
Dytran & MSC Nastran



CSIR-Nat'l Aerospace Laboratories, India

Simulating the expansion joints in an ECS (Environmental Control System) for a light transport aircraft to minimize the testing time and reduce the development cost.

MSC Products Illustrated:
MSC Nastran

Magna, USA

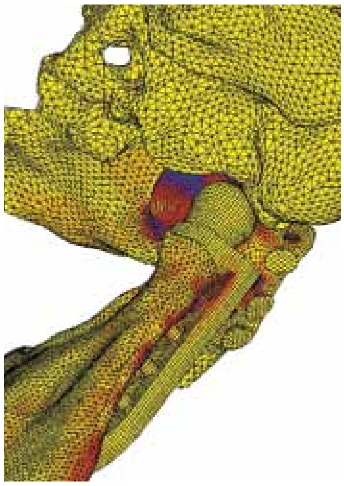
Performing DOE (Design of Experiment) on critical design elements of an innovative seating system to reduce the development cycle by 2/3 of the traditional design cycle.

MSC Products Illustrated:
Adams

Infosys Limited, India

Conducting stress analysis on a human heart to understand the stress and deformation pattern within heart tissues subjected to pressure loads.

MSC Products Illustrated:
Patran and MSC Nastran



University of Aveiro, Portugal

Analyzing the contact behavior under critical situations in a new TMJ (Temporomandibular) implant to improve the living conditions of patients suffering from diseases with the TMJ joint.

MSC Products Illustrated:
Marc

Journey Through Time with Adams

By James B. McConville, Sr. Engineering Analyst, MSC Software

History

This evolutionary tale begins in August of 1985. A customer pitched up on the doorstep of what was then Mechanical Dynamics Inc. (MDI) with the plans for an Eli Terry wooden clock, and with a challenge to model same in Adams! Such a gauntlet, when thrown, must, of course, be picked up, and modeling was initiated.

Methodology

In 1985 Adams/View did not yet exist, and models were generally built by direct editing of the ADM file. Some custom model-building tools did exist (old-timers will shudder at the mention of the FORTRAN-based "DMP"!), but these were of limited usefulness. This placed a heavy burden on the user. All the model entities had to be correctly located as well as uniquely and consistently named, and no two users would ever do it the same way. Limited post-processing was available, and progressive versions of the model had to be repeatedly fed to it to get some visual idea as to how the build was progressing. That said, the Adams 5.2 code being used still possessed sufficient power to render a creditable model. The early model is shown in Fig. 1.

Note that the initial Adams 5.2 post-processor images would have been black outline on a white background. The Achilles heel of this model was the correct modeling of the escapement contacts. Remember that this was before Parasolids geometry could be exploited using CONTACT elements. An attempt was made to define the toothed escapement wheel (Fig. 2), but that led to an enormous number of MARKERs and made the definition of the contact forces rather intractable. As a workaround, reasonable pawl/wheel escapement forces were 'tricked' into being by using very high tangential friction forces. Assisted by 'tweaking' of the dead weight slide friction forces, the time keeping was rendered reasonable. But…it just wasn't a real escapement mechanism.

Renaissance

And, so the model lay more or less dormant for nearly 3 decades, but the nagging gripe about the faked escapement wouldn't stay buried. The shame really began to fester when my marketing colleague got a hold of the model and opined that it might be a good tool to illustrate the capabilities of Adams. It reached a white-hot level when one of my co-workers gave me a fine Parasolids rendition (generated using Boolean operations in Adams/View 2013) of the escapement wheel in mmks units. It was as though the gauntlet from 1985 had been picked up and, again, thrown down! With the addition of flattened, ellipsoidal tips added to the pawl, a bona-fide escapement mechanism resulted (Fig. 3).

A superimposed plot of the full model while keeping time is shown in Fig.4. The analysis takes less than 2 minutes to execute to completion on a modest desktop PC. After a little tinkering, the performance shown in Figure 5 was achieved. The plot gives the angular travel of clock minute hand for a 60 simulation second analysis run in 6000 steps. In 60 seconds the minute arm of the clock

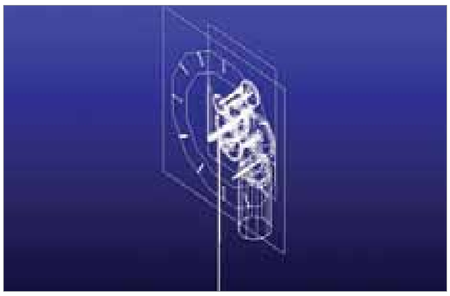


Fig. 1: Initial Clock Model - Adams 5.2 IPS Units - View 2013 Image

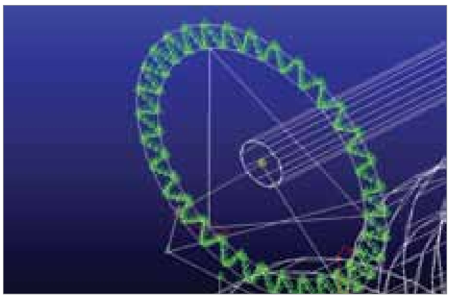


Fig. 2: Escapement Wheel and Pawl Forces - Adams 5.2 - IPS Units

should move exactly 6 degrees. Hence, the sweep in one hour would be 60 time this, or 360 degrees. Examination of the numerical value of this trace at the end of the simulation indicates that the model is gaining slightly less than one second per elapsed hour. The actual, Eli Terry clock would be hard-pressed to do as well! But, then, it doesn't have perfect gears…

Yet Another Gauntlet Thrown

Just as I was congratulating myself and looking for suitable laurels upon which to come to rest, my marketing colleague dropped the other shoe. "Gee, that's nice, but could you use CONTACTs for all the gears?" Considering there are 7, inter-meshed gear pairs, requiring 14 spur gears with anywhere from 8 to 40 teeth, I blanched a bit. However, considering that Adams almost always delivers, the gauntlet was picked up nonetheless.

To expedite the generation of the requisite Parasolids gears, a small FORTRAN program was created to determine the gear tooth profile based on the number of teeth, gear tip diameter, gear root diameter, and gear width. The computed gear parameters were then fed into a View macro to copy the tooth geometry onto the gear disk perimeter and do a Boolean extraction for each tooth. These Parasolids geometries were then read onto the appropriate gear shaft, after which the GEAR constraints were replaced by CONTACTs. Figure 6 shows the model with the escapement and gear pairs completely CONTACT-based.

This model made Adams work somewhat harder and resulted in slightly different behavior (ref. Fig. 7). This is to be expected since the gears are now elastic. The time needed for execution went up by a factor of approximately 4 or 5.

From the figure, it can be seen that the switch to finite-stiffness CONTACTs yield a less regular minute arm travel. The drop experienced at the beginning of the trace results from the mechanism 'tightening up', i.e., removing gear lash. After this, the clock keeps time at nearly the same rate as the previous model, but is not quite as accurate. Further 'tweaking' would yield better time-keeping. But that is left as an exercise for the marketing team who started this whole affair. After all, I can't have all the fun!

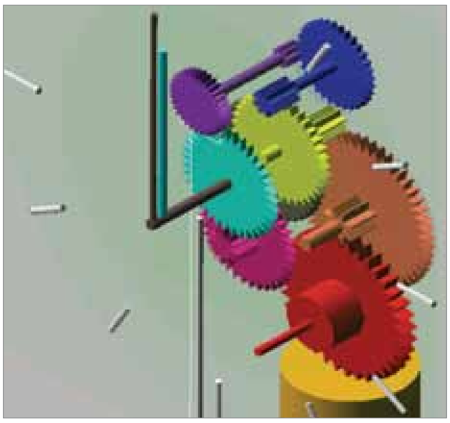


Fig. 6: Clock - Full Contact Modeling -- mmks Units

Fig. 3: Parasolids Escapement Wheel and Pawl Ellipsoids - mmks Units

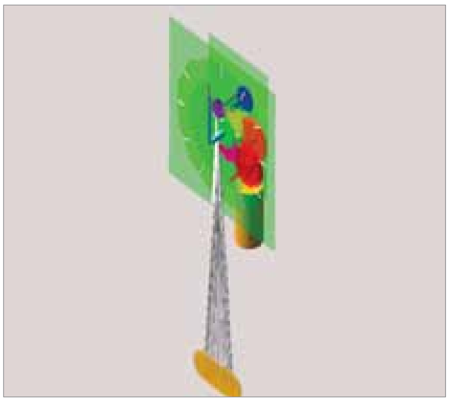


Fig. 4: Clock Model Contact-Based Escapement Gear Constraints - mmks Units

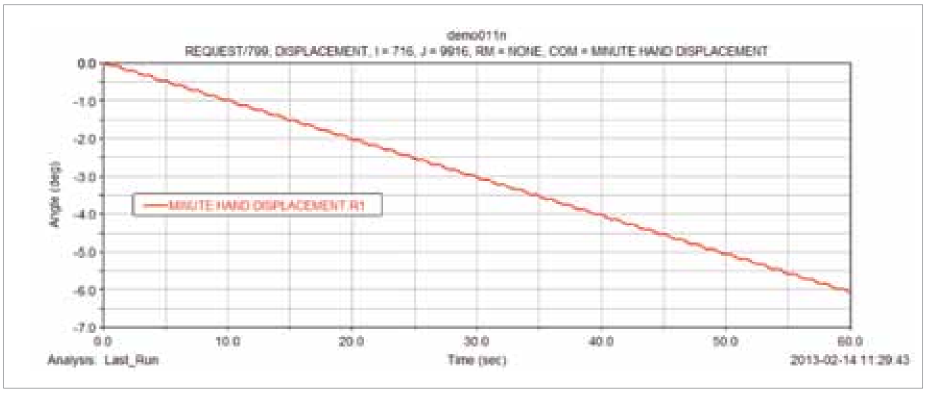


Fig. 5: Minute Hand Displacement – Contact-Based Escapement - GEAR Constraints - mmks Units

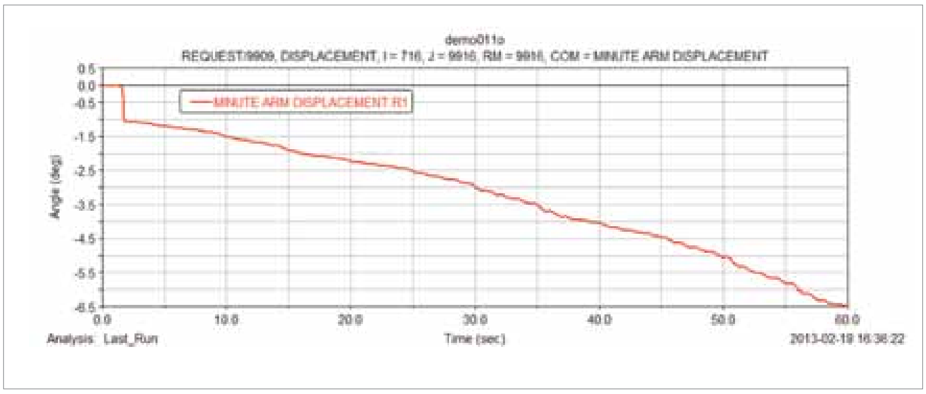


Fig. 7: Minute Hand Angular Displacement - Full Contact Model - mmks Units

A Summary of Some Things Adams Proves with this Model

A list of things that have been learned, thanks to this effort:

- Unlike 'old soldiers', Adams models don't have to 'fade away'. Even a model which is almost 3 decades old can be revived.
- Complex, interleaved gear trains can be accurately modeled with Adams using either idealized constraints or contacting elements.
- The C++ version of the code has 'picked up the torch' from the old FORTRAN F77 code in which Adams was initially written.
- Adams integrators just keep getting better. The original model was run using F77 GSTIFF/SI3 on a Microvax II computer (remember those?). The updated models were run on a Dell Precision T3400 using C++ HTT/SI3. While it is impossible to correctly attribute speedups between hardware & software, it is the author's opinion that, hardware factors being the same, HHT runs at least as fast as the older, F77 code and appears more robust as well.
- The Adams 2013 release is quite nice. On this and other (contemporary) models, it appears to be more robust as well as more stable. Improvements like this are always welcomed.

A Love Affair with Adams - Conclusion

I built my first Adams model in 1981. It was the beginning of a real love affair. Simply said, Adams is sweet… no brag… just fact. ◆

Scania Improves Heavy Truck Designs

Using Simulation to Evaluate Alternatives Early in Process

Scania | Based on an interview with Anders Ahlström, PhD, Structural and Vehicle Dynamics Engineer

Scania is a leading manufacturer of trucks, buses and coaches and industrial and marine engines. Scania's modular vehicle configuration system enables the company to build vehicles that are optimized to a customer's application from pre-engineered main components with standardized interfaces. A key challenge is ensuring that the different subsystems used in each unique vehicle design such as the engine, transmission, frame and suspension, perform together in a full vehicle assembly. In the past, there was no way to validate the performance of a unique truck design prior to building the vehicle and evaluating its performance on a road simulator test rig and test track. If the performance of the vehicle was not satisfactory, then the vehicle needed to be redesigned, rebuilt and re-tested, driving up costs and pushing back the delivery date of the vehicle. Scania has improved on this process by utilizing MSC's Adams/Car to simulate the performance of alternative vehicle designs on both the test rig and test track. "Simulation gives us the ability to explore design alternatives in the early stages of the design process," said Anders Ahlström, PhD, Structural and Vehicle Dynamics Engineer for Scania. "The result is that we have been able to significantly improve the handling, comfort and fatigue life of our vehicles."

Fig. 1: Scania is a leading producer of heavy over-the-road trucks

Optimizing Each Vehicle to the Application

Scania delivers optimized heavy trucks and buses, engines and services, that enable its customers to achieve the best operating economy. Scania's modular vehicle configuration system, which has been developed over several decades, makes it possible for the company to create individual configurations for a large number of different customers by using a limited number of standardized components. This approach makes it possible to provide each customer with an optimized product, while keeping costs throughout the value chain at a competitive level.

Providing a vehicle that is optimized for the application has enormous advantages for customers but creates challenges for Scania. The company must ensure that each unique vehicle configuration provides the required handling and comfort and also delivers the promised fatigue life under the wide range of conditions under which the company's vehicles are used. In the past, the first point at which the company could evaluate the vehicle performance was when it was built and could be tested on a test rig or test track.

Fig. 2: Virtual model of typical truck tractor

The problem with the traditional approach is by the time that feedback is received a considerable amount of time and money has already been invested in the design. Testing is expensive because of the need to outfit trucks with custom hardware and because a considerable amount of time is required on the part of highly-skilled employees or contractors to set up and run the tests. There is only rarely time available to evaluate different vehicle configurations in terms of their ability to provide the desired results.

Simulation Provides Feedback Early in Design Process

"We use simulation because it allows us to evaluate a much greater number of vehicle configurations than was possible in the past," Ahlström said. "We selected Adams/Car because Adams provides the premier solver technology and has become the de-facto standard in the automotive industry," Ahlström said. "Adams/Car supports

"Simulation gives us the ability to explore design alternatives in the early stages of the design process. The result is that we have been able to significantly improve the handling, comfort and fatigue life of our vehicles."

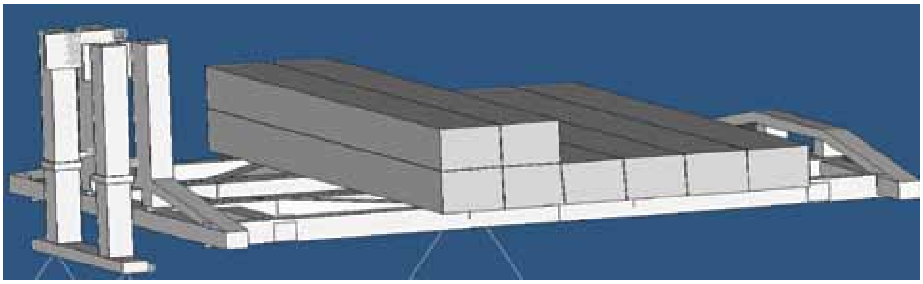


Fig. 3: Model of load frame and weights used to represent trailer

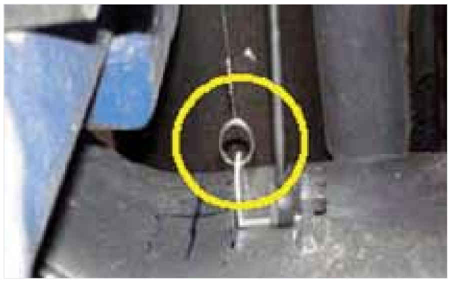


Fig. 4: Sensor installed in truck prior to physical testing

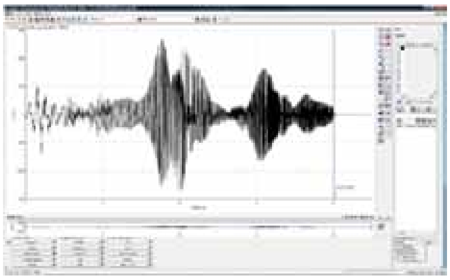


Fig. 5: Sensor output during physical testing

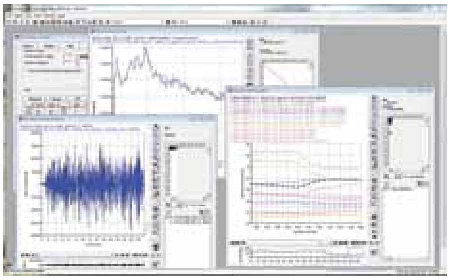


Fig. 6: Iterative process to derive drive signals to the test rig

Scania's modular vehicle configuration strategy by enabling us to model and simulate different vehicle configurations in a small fraction of time that would be required to build and test them."

Adams/Car enables engineering teams to quickly evaluate functional virtual prototypes of complete vehicles and vehicle subsystems. Working in the Adams/Car simulation environment, automotive engineering teams can exercise their vehicle designs under various road conditions, performing the same tests they normally run in a test lab or on a test track, but in a fraction of the time. Modifications can easily be done in the virtual world, which saves a significant amount of time and money in the design process.

Scania has already developed Adams/Car models of many of their vehicle modules. So in most cases engineers can create the model of a new vehicle configuration simply by selecting models of the appropriate modules and connecting them together. Figure 2 shows an Adams/Car model of typical truck tractor, the R420 LA4x2MNA, a two axle tractor design for long haul applications. The tractor is equipped with an R Highline cab and a 420 hp six cylinder diesel engine. A two-bellow air suspension is used in the rear while a parabolic leaf suspension is used in the front. It is an articulated tractor which means the payload is carried in a semi trailer connected to a fifth wheel on the truck. A load frame was added to the virtual as well as the physical truck in this study to represent the weight of the trailer. Scania engineers also often model the trailer.

The frame, load frame and front axle are modeled as flexible bodies using MSC Nastran to create the finite element (FE) models. The load frame shown in Figure 3 was modeled using shell elements while the weights are modeled using solid elements. The attachment between the frame and load frame was modeled using bushings because the connection is not entirely stiff. The use of bushings makes it possible to modify the stiffness and damping of the attachment to act similarly to the physical connection.

Ensuring the Accuracy of Simulation Results

Scania engineers have also modeled their 10-channel test rig and their test track and use Adams/Car to evaluate vehicle designs being excited by the simulator and driven over the test track. The vehicle is equipped with sensors at selected points when evaluated on the test rig or test track as shown in Figure 4. Markers were incorporated into the Adams/Car model to capture the same data that was measured in the physical vehicles, such as accelerations in three different axes, distance between the axle and frame, and hub forces.

An iterative process is used to determine a drive signal for the test rig that produces the same forces in the vehicle as were induced by driving on the test track as shown in Figure 6. First, a random noise is used as the drive signal while measuring the responses of the sensors on the truck model to derive the transfer functions. The transfer functions and the sensor responses are then used in an iterative procedure in which the model is excited with the drive signal and the response is compared to the measured response. Based on the error, the drive signal is then adjusted to bring the simulation response closer to the measured response. This iterative procedure continues until the model response matches the measured signal within an acceptable value of error.

Typically, Scania engineers are able to achieve simulation results that are within 5% of physical measurements on the test rig. If the model performs well on the test rig, the next step is to add wheels and simulate the model over 3D road. The Ftire (Flexible Ring Tire Model) nonlinear tire model is used. Simulation of the full vehicle on the test track is more challenging because of the difficulty in accurately modeling the tires and other interconnecting parts. However, in this case, Scania engineers are still able to achieve predictions that are within 20% of physical measurements.

Using Simulation to Compare Design Alternatives

Once the model has been validated it can be used to evaluate the handling of the vehicle, comfort of the driver and loads applied to various components, which can in turn be used to estimate their fatigue life. "On a new vehicle configuration, we typically simulate the vehicle performing steering maneuvers on a flat surface to evaluate steering and handling," Ahlström said. "We drive the vehicle over a number of different road obstacles and study the vehicle behavior and driver experience."

Scania engineers also evaluate alternative vehicle configurations, such as comparing the performance of several different suspension designs. Simulation makes it possible to evaluate the performance of the vehicle under very demanding conditions that would be difficult to duplicate with physical testing because they would require travel to a distant location or because they might involve damage to the vehicle or danger to the driver. These simulations also generate loads on the components that can then be used for stress analysis or fatigue life analysis. Finally, engineers perform failure mode analysis. For example, they simulate a situation in which the power steering becomes inoperable and evaluate the ability of the driver to steer the truck out of danger.

"Adams/Car helps us understand how the multiple moving parts of the chassis interact with each other and their environment," Ahlström concluded. "This knowledge helps us to identify potential problems early in the design process and make corrections on the virtual model at a much lower cost and in less time than would be required to correct the physical truck. Simulation helps encourage innovative design methods because engineers can easily explore alternative design concepts in very little time or expense. As a result, we have made significant improvements in handling and comfort of many of our designs. We have also reduced stress levels in many parts, resulting in improvements in component life." ◆

The Ups and Downs of Finite Elements

Schindler Lifts Automates its FE Calculations with CAE Tools from MSC Software

Schindler | Based on an interview with Warner Moretti

Schindler is a concern with business activities in all five continents and a market leader in the lift and escalator sector. Schindler's offering ranges from passenger lifts suitable for small blocks of flats to sophisticated transport solutions for skyscrapers. Service lifts ensure the stress-free movement of goods and people in shopping centres, office buildings and railway stations. Bed lifts provide for the smooth and vibration-free movement of patients and equipment in hospitals. In industrial buildings, many of the hoists and small goods lifts in use are supplied by Schindler, while glass cabin lifts in tall buildings offer both a novel experience and a feeling of safety. It is hard to imagine public transport without lifts, which are often heavily used and must therefore meet demanding requirements in availability and serviceability.

The concern's research and development facility in Ebikon devises complete lift systems as well as components for all applications. Here, CAE simulation is used to find reliable and energy-efficient solutions which make the optimum use of materials. The programs SimXpert and MSC Nastran from MSC Software are employed for structural calculations using the finite elements method (FE). These are used, for example, to simulate the wall fixings of lifts and determine whether deformations and loadings remain within the permissible range. The resulting design and its verification encompass the guiding system and the cabin, counterweight and drive components. In addition to static (strength) calculations, dynamic and vibration analyses are also carried out with the aid of FE methods. The field of non-linear FE calculations is also of central significance.

The finite elements solver MSC Nastran is capable of carrying out linear, non-linear, dynamic, thermal and many other calculations. MSC Nastran can look back on a history of almost 50 years. Originally a component of a NASA project, it was further developed into a comprehensive program that is now standard in many aerospace, automotive and mechanical engineering companies. Historically, Nastran from MSC Software has a reputation as a high-performance solver for static and dynamic calculations and is a leader in meeting the continually growing demands on model size – currently models with hundreds of millions of degrees of freedom. In the last decade, it was expanded to the multidisciplinary "MD" Nastran, which can cover all disciplines in structural calculations. It now includes a comprehensive range of non-linear algorithms, contact and material models, including crash simulation. MSC Nastran can carry out design and layout optimisation without the need for any additional optimisation program. MSC Nastran is closely integrated with MSC Software's multi-body simulation program, Adams, and provides an open interface for CFD programs.

SimXpert is a modern pre/post-processor that creates a model for MSC Nastran finite element calculations based on CAD geometry. SimXpert supports not only structural calculation but also multi-body simulation, regulation and control systems, making the linking of the different disciplines easy. A key feature of SimXpert is the ease with which it automates the generation of the model and the calculation using templates. Macros can not only be drawn up as in the customary programs but also edited in a flowchart mode. Additionally, a Python interface is available to users with programming knowledge. At run time, the user can interactively change the inputs. This is useful if, for example, the work flow is predefined by an expert and is to be applied by other users.

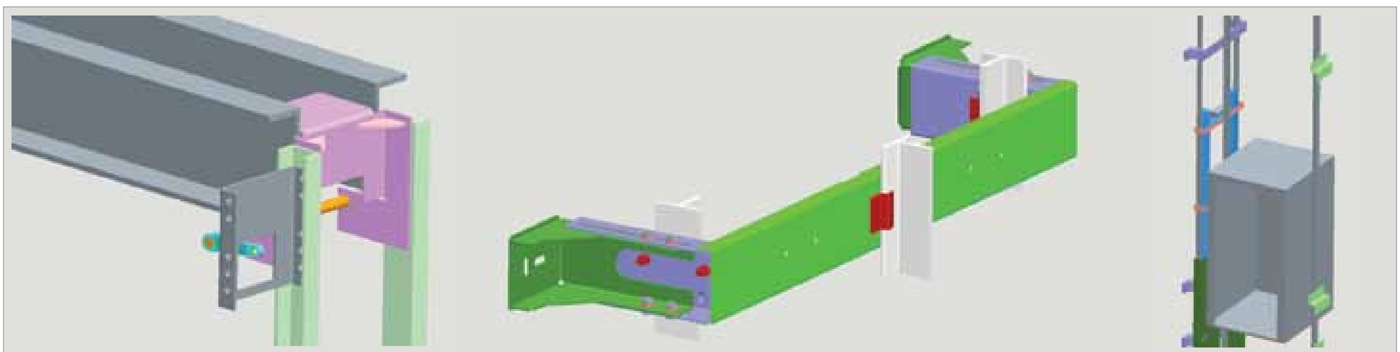


Fig. 1: 3D based development of lift components

> Thanks to SimXpert and template-based modeling and evaluation, we can ensure that we construct consistent models and also have repeatability in the simulation process.

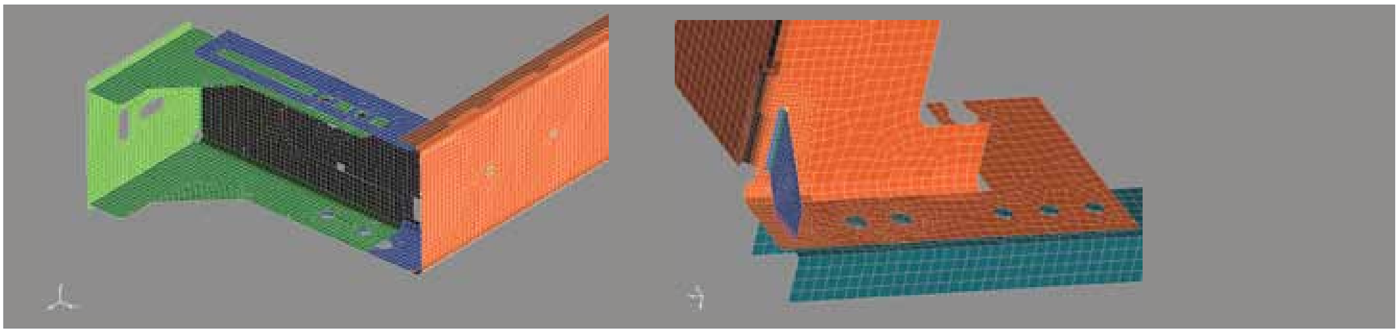
This template-based automation made SimXpert interesting for Schindler. The calculation of bolt forces and weld seam stresses is important in the design and verification of lift structures. This requires an appropriate FE mesh. The weld seams of shell elements must be of uniform size and perpendicular to the edges. The generation of such a mesh is very time-consuming. Templates were therefore created that automate the modelling of bolted joints and weld seams. In the bolts template, two or more plates are connected to beam elements and rigid body elements (RBEs) and holes are produced in the plates (if not already present). As a result, the FE mesh forms concentric circles around the holes. In the weld-seam template, two plates that previously did not have matching meshes are joined. For a T-joint, 3 different areas are set up. In this figure we see a simple example showing the initial model (3), and then the same model after application of the bolts and weld-seam template (4).

CUSTOMER CONGRATULATIONS

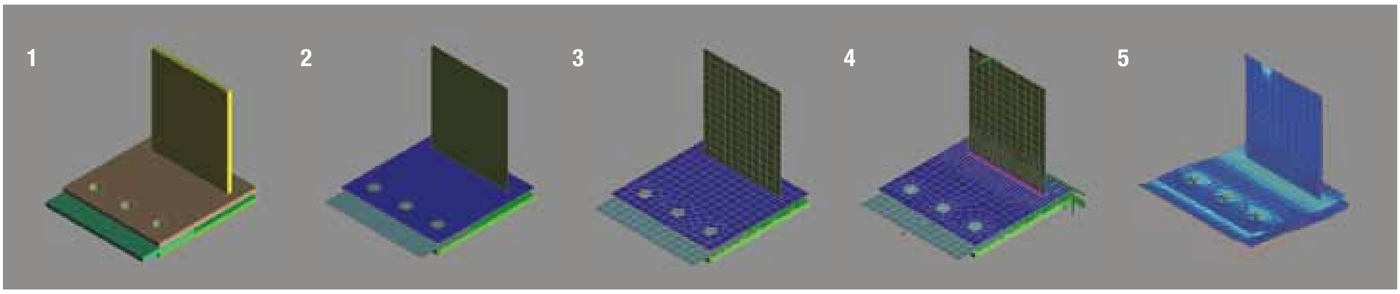
S.M. Lee

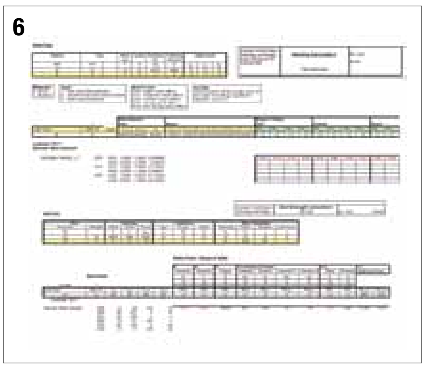
Vice President,
Hyundai Heavy Industries, Co. Ltd.

"I offer sincere congratulations for the 50th anniversary of the founding of MSC software. I wish to truly thank MSC for your great contribution with the finest technology to our nation's industrial development including Hyundai Heavy Industries. I congratulate MSC's 50 years of success and expect MSC to continue to be a pioneer in the new era."



SimXpert Templates - Examples Of Use





The stresses in components with beam elements or weld-seam elements are evaluated after the calculation. Considering that there may be 20–30 beam elements and hundreds of weld-seam elements in a model, automating the output of the results are highly desirable. To this end, a SimXpert template was written that reads the stresses from the binary results file from MSC Nastran and outputs them in Excel format (Fig. 6). The Excel file includes formulae for further evaluation.

"We use MSC Nastran and SimXpert because an efficient use of CAE tools is now a decisive factor in the development process. Thanks to SimXpert and template-based modeling and evaluation, we can ensure that we construct consistent models and also have repeatability in the simulation process. At Schindler, the modeling process can thus be methodically and centrally structured and made available for use by internal development departments spread across the world, as well as by external service providers. The advantage is that automated processes can help us to model and evaluate a greater number of design variants. This fosters innovation and helps us retain our lead over the competition. It also guarantees standardization of the simulation process and ensures that we are able to continuously improve quality," explains Schindler's Werner Moretti.

SimXpert templates free engineers from monotonous, time-consuming modelling steps; leaving much more time available for assessing and optimising designs. ◆

Structural Analysis Workload Reduced by 27%

Simplifying Structural Stress Analysis to Achieve Complete Aircraft Certification

Groupe Ingeliance, MSC Software Community Partner | By Nicolas Gehin & Francois Ribour

Introduction

The successful development of large structures, such as aircraft or aircraft parts, depends on the cooperation of all major component suppliers during the design phase. All groups must work together to analyze the different structural behaviors of each component for a successful certification of the entire structure.

The early design process and later optimization process require that the project be divided into several phases. However, the projects duration can result in desynchronization of detailed analysis with every design update, increasing the potential for quality issues.

In addition, the detailed analysis process often includes the development of multiple small programs or scripts by different stress engineers. The reliability of these "one-time tools" can hardly be assured as hundreds may be developed for a single structure. Combining the different programs from multiple engineers also increases the potential for quality issues.

STREAME has been designed to perform detailed structural analyses by post-processing MSC Nastran results. Within STREAME, the detailed analysis can be prepared, analyzed, launched, reviewed and the final results can be exported.

Aircelle Case Study

Aircelle is one of the leading global players in the nacelle market, producing large and small nacelles, thrust reversers and aerostructures. Aircelle is responsible for the complete nacelle on the A320neo aircraft powered by CFM International's LEAP power plants, including integration on the engine. The A320neo nacelles benefit from Aircelle's proven technology developed through its growing product portfolio, including nacelles used on Airbus' A380.

For the A320neo project, Aircelle starts with CATIA, moves to MSC Nastran and finishes with STREAME.

In September 2011, Aircelle began integrating STREAME at the development stage of the process. Since, the design team has reduced man-hour workload of structural analysis by 27%. This reduction is applicable to a workload measured in tens of thousands of hours.

Excel Spreadsheets for Detailed Stressing

The extensive use of Excel spreadsheets for detailed stressing is the root cause of hidden errors in the stress files. Root cause analyses of encountered errors are found in Table 1.

STREAME's integrated analyses include composites, interfaces, metallic (static and fatigue) and dynamics which allow for the structuring of stress teams' work to avoid non-controlled developments of macros or Excel spreadsheets.

"In September 2011, Aircelle began integrating STREAME at the development stage of the process. Since, the design team has reduced man-hour workload of structural analysis by 27%."

Managing Design Criteria

Despite significant improvements in numerical simulation technology over the last twenty-five years, there are still too many different analytical approaches in the detailed stressing of critical structures. For Aerostructures, damage tolerance principles impose that any damage leading to strength reduction below the ultimate load must be detectable by an appropriate inspection program. Holes, cracks, scratches, gouges and nicks must be taken into account during the design. If the damage

Typical Experienced Error	Root cause	STREAME advantage
Coordinate system transformation error	No 3D graphical verification	3D viewer of FE, technological data and detailed analysis results
Unit system mistake on a dimension	No verification of input data, such as technological information	Field and physical representation based checking
Inadvertent replacement of a formula by a value in a cell	Analysis Process: method and data mixed in spreadsheets	Methods separated from input data, like NASTRAN
Inadvertent double application of a load factor	Difficult to learn what a spreadsheet does. Lack of documentation. User of the spreadsheet was not its author	Online documentation
Errors in stress dossier found late after delivery	Lack in validation of automated calculations	As standard software, methods are validated

Table 1: Root Cause Analysis of Encountered Errors

location is not determined during the design process, placing a hole into the finite element model is not realistic. This would lead to millions of FE analyses.

An analytical approach that does take into account the damage by a knocked down factor analytically defined is STREAME.

STREAME includes a set of damages based on analytical methods:

- Composite ply damage due to nick, scratch, gouge
- Presence of hole in composite, due to VID (Visible Impact Damage)
- BVID (Barely Visible Impact Damage) in composites taken into account by appropriate material allowables
- Critical combination of 25% missing fasteners

These analyses are required to justify the structure before entry into service. During manufacturing and in service life, existing stress reports and analysis are used to substantiate real defects. Once the damage is determined, FE modelization of the damage can be used, but most often, other analytical approaches validated by tests are used.

No less than 20 failure modes are implemented for analysis of composites, essentially based on aerospace industry standards. These modes include interlaminar shear, ply failure, buckling and curved flanges, using specific or international standards.

Specific Design Criteria for Specific Design and Manufacturing Processes

In some cases, such as composite RTM components, the classical failure theories are not applicable. Classical failure theories are not suited when:

- Fibers are not properly aligned
- Fiber/matrix volumic fraction is low
- High Curvature areas

The best industrial practices consist of building a failure criteria based on sub-component tests. This approach is referred to as mixt of certification by analysis and certification by test.

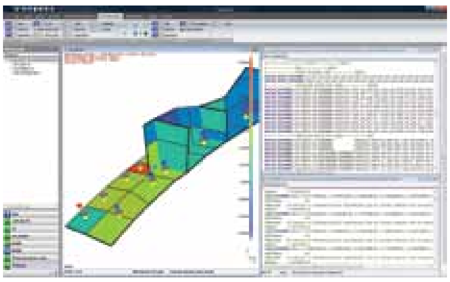
- Only testing can provide the allowable load for the subcomponent concerned detail. "A" or "B" allowable values (ref. Mil-HDBK 17) being derived.
- Analysis can extend sub-component tests results for manufacturing defects or in service damage: defects such as composite porosities are generally located where you don't want them, and generally you don't get porosities when you expect them on dedicated coupons for testing.

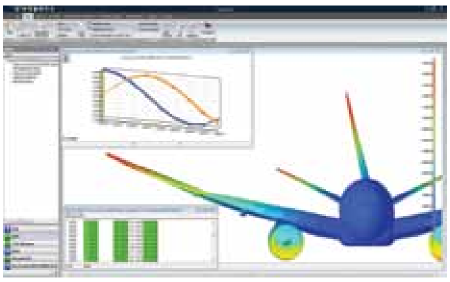
STREAME incorporates all the generic and customer oriented methods for calculation and failure criteria.

For the A380-GP7200 thrust reverser cascades, manufactured in Carbon/Epoxy by French company, Zodiac Aerospace, specific failure criteria based on allowable junction loads between strong backs and vanes of the cascades have been developed based on dedicated sub-component test results. An application within STREAME was developed specifically for this failure and is still maintained since entry into service of the A380. This failure criteria is a quadratic failure criteria based on tension, shear and bending loads in the junction with "B" value derivation of test results. The need for such criteria was due to a peeling type failure mode (matrix failure) which could not be assessed practically with a typical stress approach.

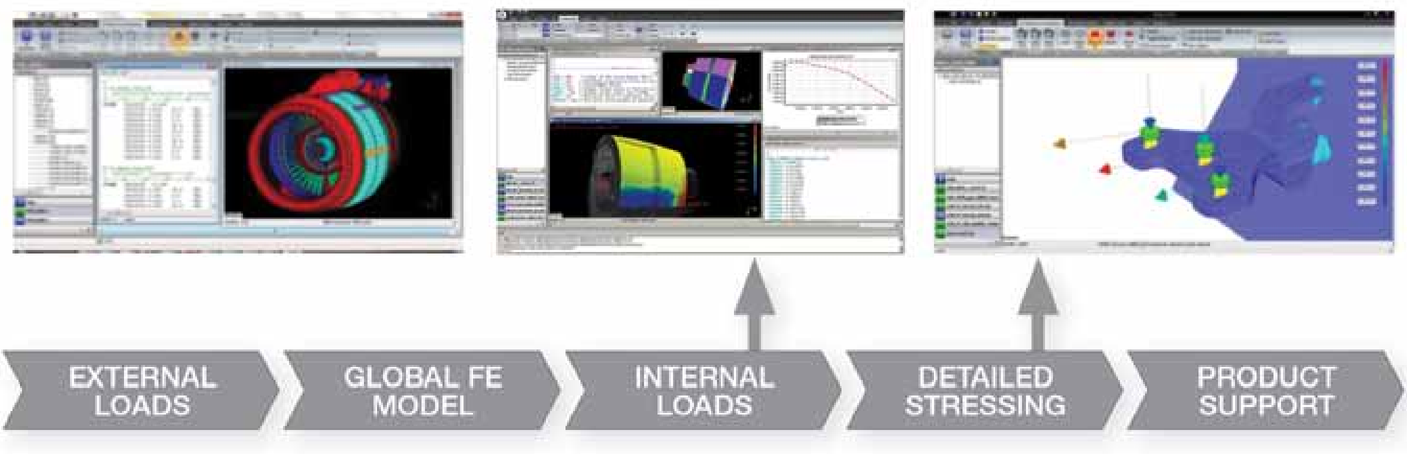
STREAME has been selected by Aircelle, Safran group in order to unify all in-house post-processing tools for all deployed programs. Throughout 2012, STREAME was also used for both AIRBUS A320NEO and COMAC C919 programs, with great satisfaction by both users and program managers.

For more information on STREAME, please contact Nicolas Gehin at nicolas.gehin@ingeliance.com ◆





Global Finite Element Model:
An Aircraft Propulsion System iteration is potentially a 6 month process.



Predicting Shock Attenuation

Studying the Interaction of a Shock Wave with a Rigid Barrier

Ben-Gurion University of the Negev, Beer-Sheva, Israel | By Shachar Berger

Detonations in corridor-type structures (tunnels) are situations in which a blast wave would be initiated, causing grave injuries to humans and significant damage to structures and equipment. Barriers of various sizes and shapes inside a tunnel can cause the incident shock wave to diffract, leaving behind a complex flow field that changes the impact on the target wall at the end of the tunnel.

The following study investigated the attenuation of a shock wave propagating through arrayed baffle plates. Two baffle plate arrays, oblique and staggered, were tested. In both arrays, the effect of baffle plate arrangements on the shock attenuation was significant. They found that shock attenuation occurred more quickly with the obliquely arrayed baffle plates than with the staggered array.

The interaction of shock waves with a rigid barrier was further investigated both experimentally and numerically using MSC Software's Dytran explicit nonlinear solution. The goal of this study was to investigate a means to attenuate shock waves in tunnels using geometrical barriers.
A deeper understanding of the flow pattern and the features affecting the shock wave attenuation enables the optimization of the barrier geometry in relation to a particular initial boundary condition.

Numerical Approaches

The analysis of the physical behavior of fluids and gases is found by using a numerical approach based on an Eulerian scheme.
A finite volume description, based on the Euler equations of motion, is used to represent the behavior of the materials' nature. MSC Software's Dytran explicit solver analyzes the behavior of fluids coupled to rigid structures and barriers of different shapes and sizes.

The study used Dytran as a second order accurate scheme in space based on a total variation diminishing (TVD) approach. This type of scheme is very accurate for simulating shocks, contact discontinuities, rarefaction waves and fine-scale flow structures.

Results

Test Setup

Experimental and numerical research were carried out for each single barrier configuration, using two baffle plates mounted opposite of one another forming a barrier with a defined opening ratio (i.e. the cross-section of the barrier that is open to the flow divided by the total cross-section of the tunnel). Three single barrier configurations were chosen to check the feasibility of the effect of barrier geometry on shock wave attenuation.

Baffle plates at a height of 25mm determines the opening ratio of .375. Barrier inclination angles were tested at 45°, 90° and 135° while maintaining the same opening ratio (Fig. 1).

Three pressure transducers were placed on the shock tube test section: one upstream from the barrier and one downstream of it. One pressure transducer is also mounted behind the barrier on the test section end wall. Fig. 2 presents the test section setup.

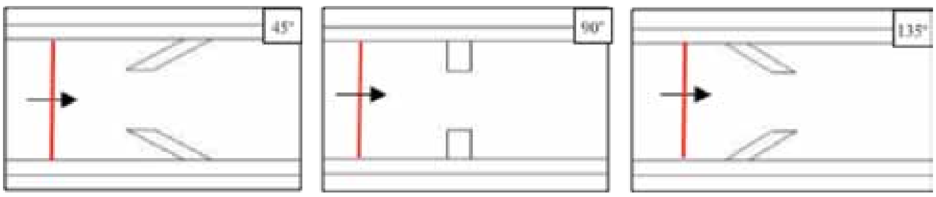


Fig. 1: Single barrier configurations

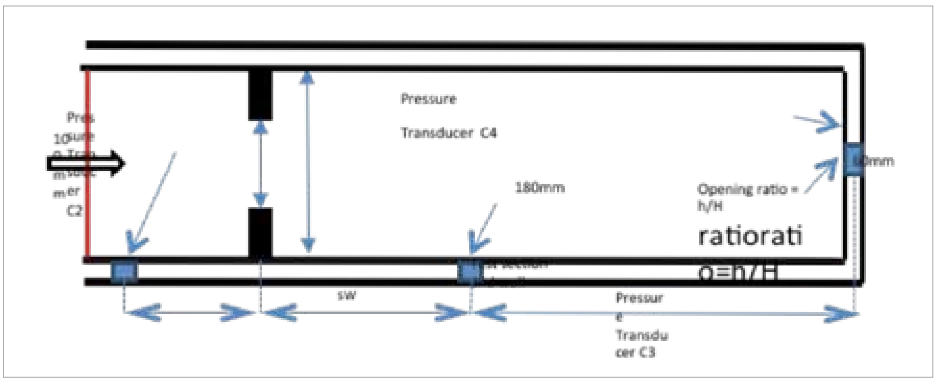


Fig. 2: Shock tube test section configuration

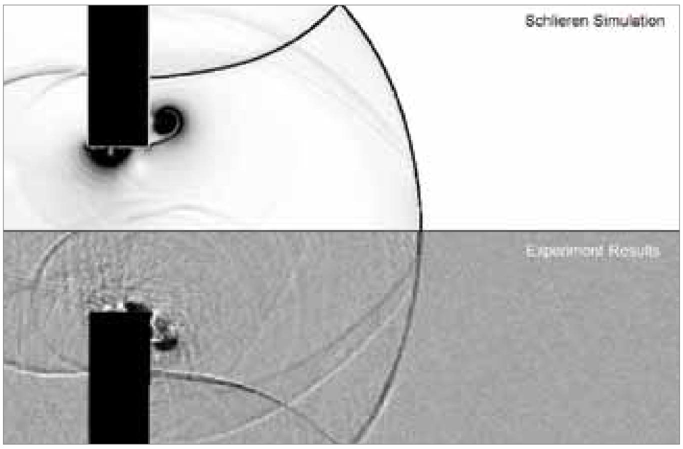


Fig. 3: comparison between numerical simulation and experiment results of shock wave at Ms=1.2 interacts with 90º barrier at 0.375 opening ratio

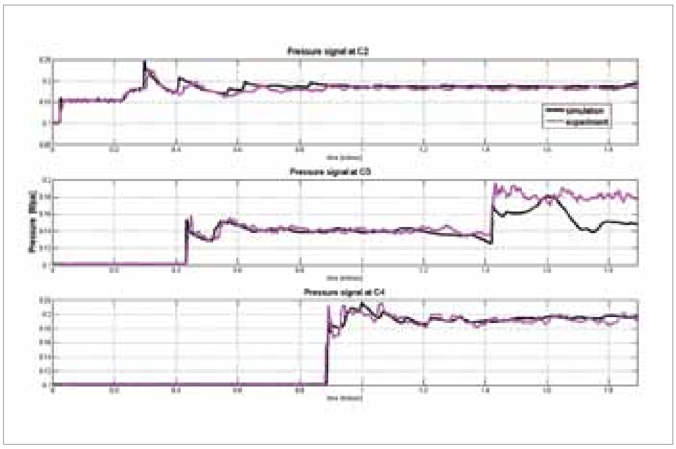


Fig. 4: Numerical and experimental results of the pressure history recorded at the shock tube test section (pressure transducers C2, C3 and C4 - see Fig. 2), single 135º barrier with 0.375 opening ratio

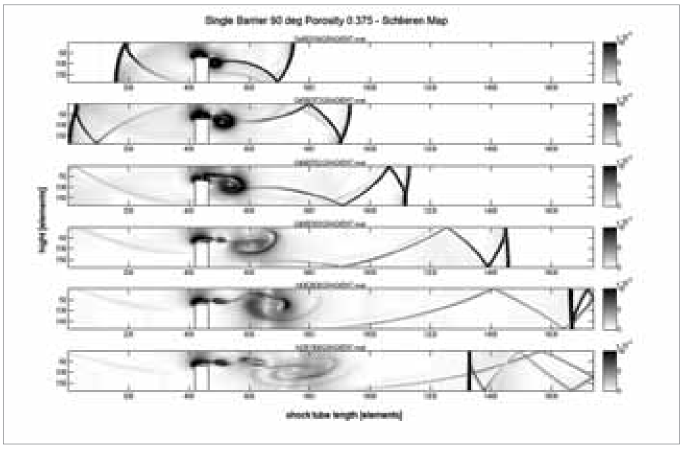


Fig. 5: numerical simulation of a shock wave propagating through a 90º single barrier configuration, with opening ratio of 0.375. Time between frames ~0.125 milliseconds

Results from the experimental results of the three single barrier configurations indicate that the opening ration and the inclination angle of a single barrier have significant effect on the shock wave attenuation. (Berger et al. 2010) It is observed that the 45° inclined baffle barrier provides the worst reduction in the shock wave load while the 135° inclined baffle barrier provides the best reduction in the shock wave load.

Another observation is that as the opening ratio increases, the effect of the barrier angle decreases, while as the opening ratio decreases, the effect of the inclination angle becomes more significant. These results are now used as a baseline for a wider numerical study to determine the physical elements governing the induced flow behind the shock wave and optimizing the barrier geometry for better shock wave attenuation in future work.

Numerical Results

In order to implement barrier geometry optimization, Dytran was chosen as the solver for the numerical aspect of the study. (Kivity et al. 2010) The numerical code was calibrated to results of the experimental aspect of the study, under the same initial conditions. Excellent agreement was established between the numerical and experimental results. Results from the numerical simulations are presented in Figs. 3, 4 and 5, with comparison to the corresponding experimental results.

Fig. 3 presents two Schlieren images; the upper half is the simulation and the lower half, the experiment. Both images are for a shock wave (Ms=1.2) interacting with a .375 opening ratio and 90° single barrier configuration.

Again, the experimental and numerical results were in agreement, indicating Dytran can be used as a reliable numerical tool in the investigation of shock waves and barrier interaction. It is clearly seen that vortex and turbulence is one of the most important physical mechanisms affecting the flow field induced by the shock wave, and one of the main contributors to the shock wave attenuation.

In Fig. 4, the pressure history obtained from the simulation (black) and the experiments (purple) from the three pressure transducers are presented (the transducer locations are shown in Fig. 2).

It is seen that up to approximately 1.4 ms, the C3 signals from the simulation (purple) and the experiment (black) agreed while at later times a discrepancy develops. Viscous effects that were neglected in the numerical calculation can explain this discrepancy. In Fig. 5, the full numerical test section is presented. It is clear to see that at t=1.4 ms, the vortex created at the barrier edge reaches the location of transducer C3.

Conclusion

In the present study, the interaction of a shock wave with a rigid barrier is investigated experimentally and numerically. The experimental investigation was carried out in a horizontal shock tube with a Schlieren-based optical system. The computation scheme was based on the Euler equations, which ignore viscosity effects.

A numerical method based on a second-order TVD scheme has been used to simulate the same conditions as in the experiment. Extremely good correlation was found between the numerical code and experiment results for the shock fronts and arrival times. However, when the interaction of the shock with the induced flow is more complex, with viscous effects becoming more important, discrepancies occur. From this, we conclude that in order to correctly predict the shock attenuation in this specific problem, the Euler scheme is insufficient and a Navier-Stokes (N-S) scheme is required. ◆

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Students Collaborate to Design Race Car

Professional Driver Test Drives Student-Built F-1 Car Designed with MSC Software

By Leslie Bodnar, MSC Software

The Partners for the Advancement of Collaborative Engineering Education (PACE) sponsored students from 26 universities in the design of a Formula One race car with the help of MSC Software's simulation technology. The car has been test driven in a series of time trials at the Miller Motorsport Park in Tooele, Utah.

> "The multibody dynamic simulation capabilities of Adams was highly instrumental in designing the car's rear and front suspension system."

The PACE program is a partnership between academic institutions and the industry which allows students from all over the world to collaborate on projects. The design of the F-1 race car itself involved 26 schools, spanning 19 time zones, and included the hard work of over 500 students. The entire design, engineering, and production process took over 4 years to complete.

The purpose of using simulation software was to help save time with the design process as well as to minimize cost. The multibody dynamics capabilities of MSC Software's Adams were highly instrumental in designing the car's rear and front suspension system. Adams was also used for the design of the car's steering linkage system. In additional to Adams, MSC Nastran was used to analyze and simulate the car's structural integrity to ensure that the finished product would meet design requirements.

To test the car's performance, the students took it to the track where it was physically testing under a series of laps by a professional driver. The professional driver was able to reach a top speed of 109 MPH on a 1300 ft straightaway and was able to complete 8 laps at an average speed of over 100 MPH.

The team of students will continue to make adjustments to the race car and test again until the design meets performance expectations. With the help of simulation technology, they were able to gain insights during the design process that they would otherwise not have been able to had they relied on physical testing alone.

For additional information about Partners for the Advancement of Collaborative Engineering Education (PACE), services, please visit: www.pacepartners.org ◆

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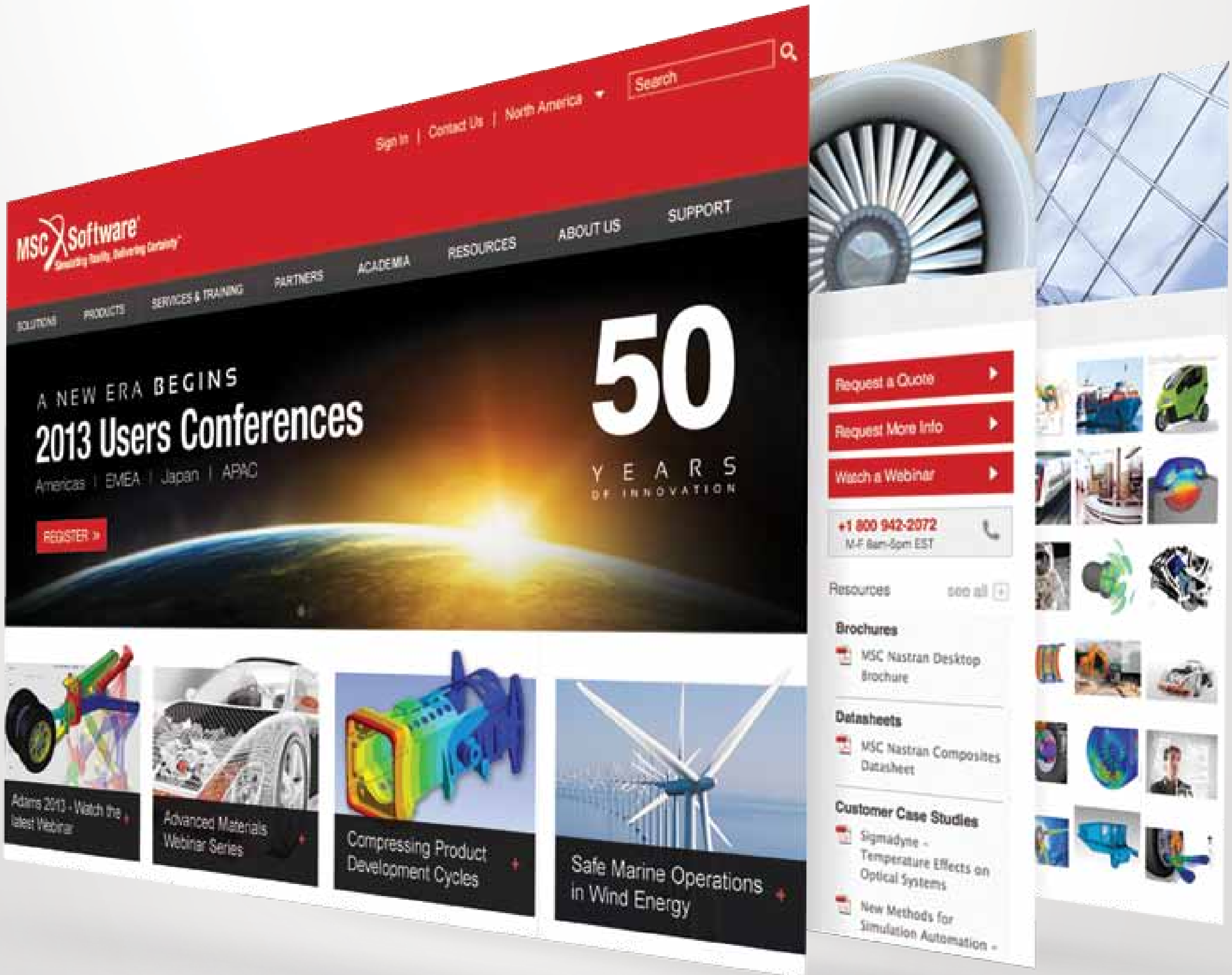

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