MSC solutions for machinery industry

Creating differentiation in a competitive marketplace

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The limitations of physical testing

Machinery manufacturing companies worldwide are finding ways to differentiate from others in terms of value, functional performance, durability or other attributes that appeal to the consumers' decision or the OEMs supplier selection criteria. Competitive differentiation brings more revenue to the company's bottom line and companies are finding new ways to acquire the leading edge.

Companies are also continuously being challenged to reduce the time to market and product innovation has emerged as the key market differentiator. Companies in the supply chain must also contend with competition across the globe. It has become imperative to create customer-focused innovative designs without raising costs or sacrificing quality. Best in class companies are evolving from the traditional engineering "build and break" process to virtual prototypes, and simulation solutions are becoming an integral part of the design process.

MSC Software, the original developer of the highly trusted simulation solutions used by machinery industry OEMs and supply chain, provides proven simulation solutions across the broad spectrum of CAE. MSC also enables customers to maintain uniformity and reliable information sharing across departments and the supply chain.

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Simulate with confidence using the trusted solution for machinery industry

MSC Software is an innovative leader in CAE and offers an unparalleled depth and breadth of engineering simulation solutions that have been battle tested for over 40 years since MSC Nastran was first designed to address the design challenges faced by NASA in the 1960s. Ever since, leading companies in all industries have relied on MSC solutions to address business issues and understand existing designs, analyze their new designs, study failures and improve their products.

Relying solely on physical testing is not only expensive and time and resource consuming, it often leads you to incomplete data. Simulation solutions have the potential to reduce design and development costs when using the right tool and technology. Whether you are concerned with accurately computing loads and dynamics, noise and vibration, or durability and damage or conformance with international as well as local standards, you can rely on MSC to be your trusted product development partner.

Test design alternatives for improved functional performance

One of the most time-consuming aspects of product development is the lengthy process of building physical prototypes, testing them for durability, redesigning several parts and starting all over again. Companies are relying on MSC's simulation technology to evaluate and refine designs as quickly and accurately as possible.

Building a virtual prototype is just the first step in using simulation effectively to facilitate design innovation. MSC solutions offer you the environment to intelligently study your design and get the most of your virtual prototype.

MSC helps you:

- Perform a series of "what if" studies and understand the range of the system response

- Use automated methods to run a series of simulations to see the effects of varying model parameters

- Parameterize your model and run a series of virtual experiments since manual methods become ineffective as you deal with increasing number of design options

- Quickly analyze multiple design variations and understand how model parameterization is used to determine the influence of different modeling parameters on your design

- Use Design of Experiments (DOE) to run numerous iterative simulations using various sampling and statistical methods, including probabilistic design and Monte Carlo simulation to determine the range of the system response
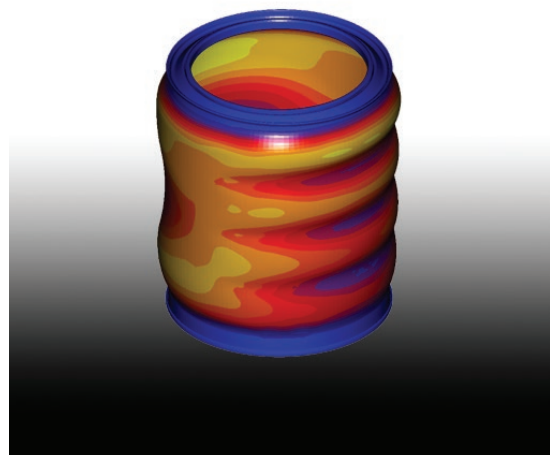
Managing complexity with multidiscipline integration

In most companies today, product portfolios are evolving to include more complex customized systems. In spite of this growing complexity, each of the different disciplines involved in the design process proceeds towards their objectives more or less independently.

A classical example of this is Finite Element Analysis (FEA) and Multibody Dynamics (MBD) efforts which are frequently carried out in silos with limited sharing of data. Loads are infrequently leveraged across the processes which drive large CPU times as well as very long process throughput times.

MSC Software's multidiscipline simulation solutions enable manufacturers to optimize their products while simultaneously considering all of the different design disciplines involved.

Benefits include:

- Integrated CAE analysis domains for - FEA, MBD and controls systems - This makes it possible to perform MBD simulations that correctly model components' flexibility in the presence of large overall motion and complex interaction with other modeling systems

- Flexible bodies for MBD simulation can be generated from the Nastran database to achieve more realistic simulation results

- As designs become more efficient, the effects of dynamic loads become more important. Dynamic loading is difficult to predict and FEA results may be based on inaccurate loads. Integration between Nastran and Adams helps predict loads with greater accuracy by allowing Adams to account for flexibility during simulations.

- The MBD model can be integrated with a control system model using a software package such as Easy5® or MATLAB®. Users can incorporate MBD models into block diagrams to simulate the system's full motion behavior within the control system design software.

- Actual controllers from the controls design software can be imported into the MBD simulation environment.

Dealing with rough terrains and harsh operating environments

Whether you are manufacturing a tracked excavator or a dragline, your equipment can operate in some of the most challenging and harsh environments in the world.

MSC Software has a history of working alongside its customers to develop customized solutions that cater to industry needs. An example of this is the Adams Tracked Vehicle (ATV) solution which has been developed in cooperation with end-users and includes parameterized models and custom templates for quickly assembling models and modifying data.

The ATV solution can be used for a wide range of applications, such as:

- Dynamic mobility studies

- Road wheel suspension design

- Track tension optimization

- Generation of accurate loads for stress and fatigue analysis

MSC solutions provide a direct means for modeling tire-soil interaction forces for any tire on plastic/plastic grounds, such as sand, clay, loam and snow.

> **The ability to quickly and thoroughly evaluate mainly design alternatives with MSC Software's solutions made it possible to increase the processing speed of our machines by 50%, while reducing vibration levels below the previous generation of machines"**
>
> **Stefano Grassi**
> Kosme

Vibration analysis and operator comfort

For the operator inside a construction vehicle, tractor or a heavy-duty truck, ride quality is not just a comfort issue but is also beneficial for the health and safety of the operator. Using MSC solutions engineers are creating seating and cab suspension systems to control and manage vibration, and are providing operators with an ergonomic environment that improves worker productivity.

MSC solutions help analyze vibrations and improve operator comfort. MSC's Nastran has highly parallel and scalable direct solvers and eigenvalue solvers for large NVH problems that are industry standard and trusted. This enables companies to extract maximum benefit from their investments in simulation technology. So, whether you manufacture seating, suspension systems or entire construction vehicles, forestry equipment or scissor-lifts, you can take advantage of this proven technology to reduce harmful vibration.

### Integrate sustainability with material reduction

When you operate on tight margins, any material savings that can be achieved without sacrificing performance helps improve your competitiveness. Especially in high volume low margin products such as plastic bottles, removing a fraction of material cost from a bottle can mean millions of dollars of savings. Whether your designs contain materials such as plastic, glass, rubber or steel, or concrete, MSC solutions offers an extensive library of metallic and non-metallic material models.

Our consistent investments in technology ensure that you can use new material models to simulate new classes of materials.

Schematic-based controls solution for hydraulic, pneumatic and electrical Systems

Complex machine systems require a systems-engineering approach in which not only the components and subsystems but the entire system as a whole is tested.

For efficient and safe operation, machine control systems must be responsive, and also able to provide timely feedback. It is desirable to model the pneumatics, hydraulics, gas dynamics or the electrical system of the system with software during the design phase, and explore the effect of design changes on system performance using simulation. MSC solutions simplify the construction and analysis of dynamic systems by means of a graphical, schematic-based application, offering a comprehensive set of pre-packaged "components", stored in application-specific libraries, to simplify the assembly and simulation of such systems.

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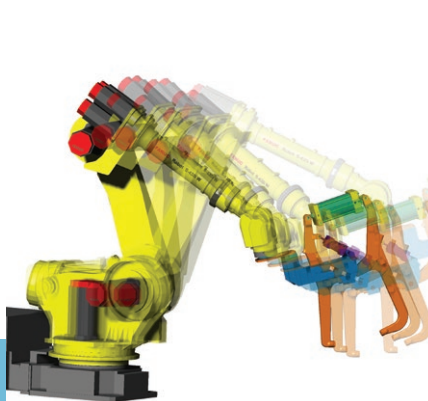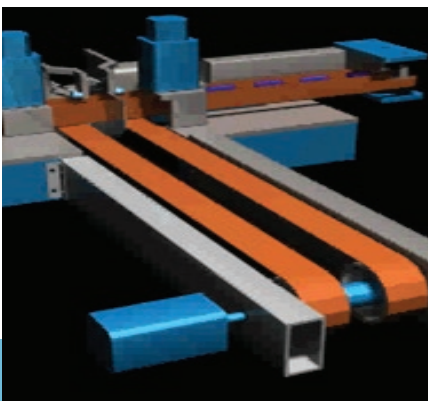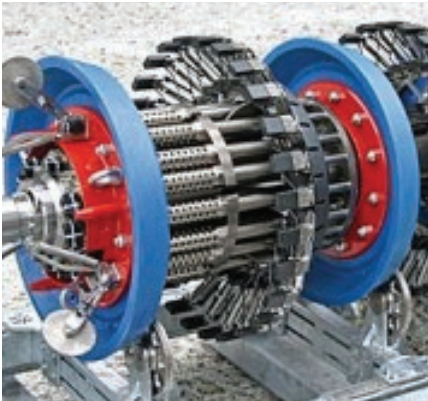
Promote innovation through design optimization

Weight optimization, performance improvements and manufacturability all directly affect the economic viability and competitiveness of your machine design. Design optimization solutions from MSC enable you to understand your products better, while reducing cost and improving reliability. You can go beyond trial and error design modifications by making effective use of MSC's various optimization technologies.

Benefits of design 0ptimization:

- Understand sensitivity of your product's performance due to sizing, shape configuration and property changes, enabling engineers to develop improved, optimal and robust designs

- Use automatic optimization methods to come up with better designs while meeting your design objectives and constraints

- With the use of external inputs and responses, include and integrate proprietary design criteria, margins, manufacturing and performance constraints

- Multi-model optimization (MMO) integrates models from different disciplines & evaluates a large number of designs against a wide range of objectives to provide an objective answer to the question of which design is best

Flexible solution that adapts to your needs

With MSC's flexible, token based licensing system, you gain access to the breadth and depth of MSC's world class simulation solution portfolio.

Benefits:

- Maximize your productivity and stretch your engineering budget by allowing you to use whatever simulation tools you want, whenever you need them

- Reduce the need to purchase products for specific tasks and gain flexibility opening up new simulation possibilities

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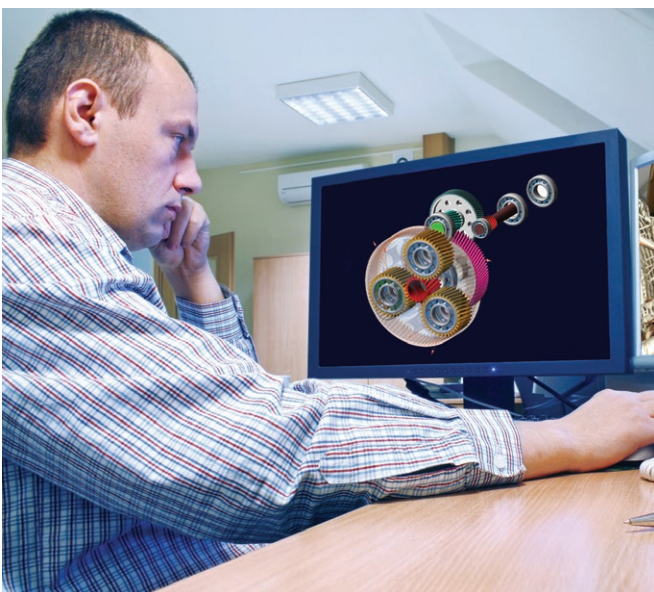
Manage your simulation process to improve productivity

Using simulation creates a lot of valuable data, which can be in multiple forms, including CAD/CAM files, CAE files, simulation results, material properties, requirements documents, and other reports or data that are relevant to design studies. If these massive amounts and various types of simulation data are not managed effectively, it could result in poor re-use and knowledge sharing in addition to communication and process inefficiencies.

SimManager from MSC Software helps everyone collaborate and get their simulation work done – better, faster, and more reliably. SimManager is a web-centric framework for sharing, collaborating, and controlling simulation data and processes allowing you to securely store, protect and tie together all of your simulation activity in a secure, version controlled, role-based access control environment.

Engineering services expertise you can trust

In addition to offering multidiscipline analysis technologies to meet your challenging simulation needs, MSC also has a global engineering services team to help you get the most out of your investments. Through services like training and mentoring, helping with your work overflow, and simulation process capture and automation, our experts can help you realize the benefits of Virtual Product Development (VPD) rapidly and effectively.

HEXAGON | **MSC Software**

Hexagon is a global leader in sensor, software and autonomous solutions. We are putting data to work to boost efficiency, productivity, and quality across industrial, manufacturing, infrastructure, safety, and mobility applications.

Our technologies are shaping urban and production ecosystems to become increasingly connected and autonomous – ensuring a scalable, sustainable future.

MSC Software, part of Hexagon's Manufacturing Intelligence division, is one of the ten original software companies and a global leader in helping product manufacturers to advance their engineering methods with simulation software and services. Learn more at mscsoftware.com. Hexagon's Manufacturing Intelligence division provides solutions that utilise data from design and engineering, production and metrology to make manufacturing smarter.

Learn more about Hexagon (Nasdaq Stockholm: HEXA B) at hexagon.com and follow us @HexagonAB.