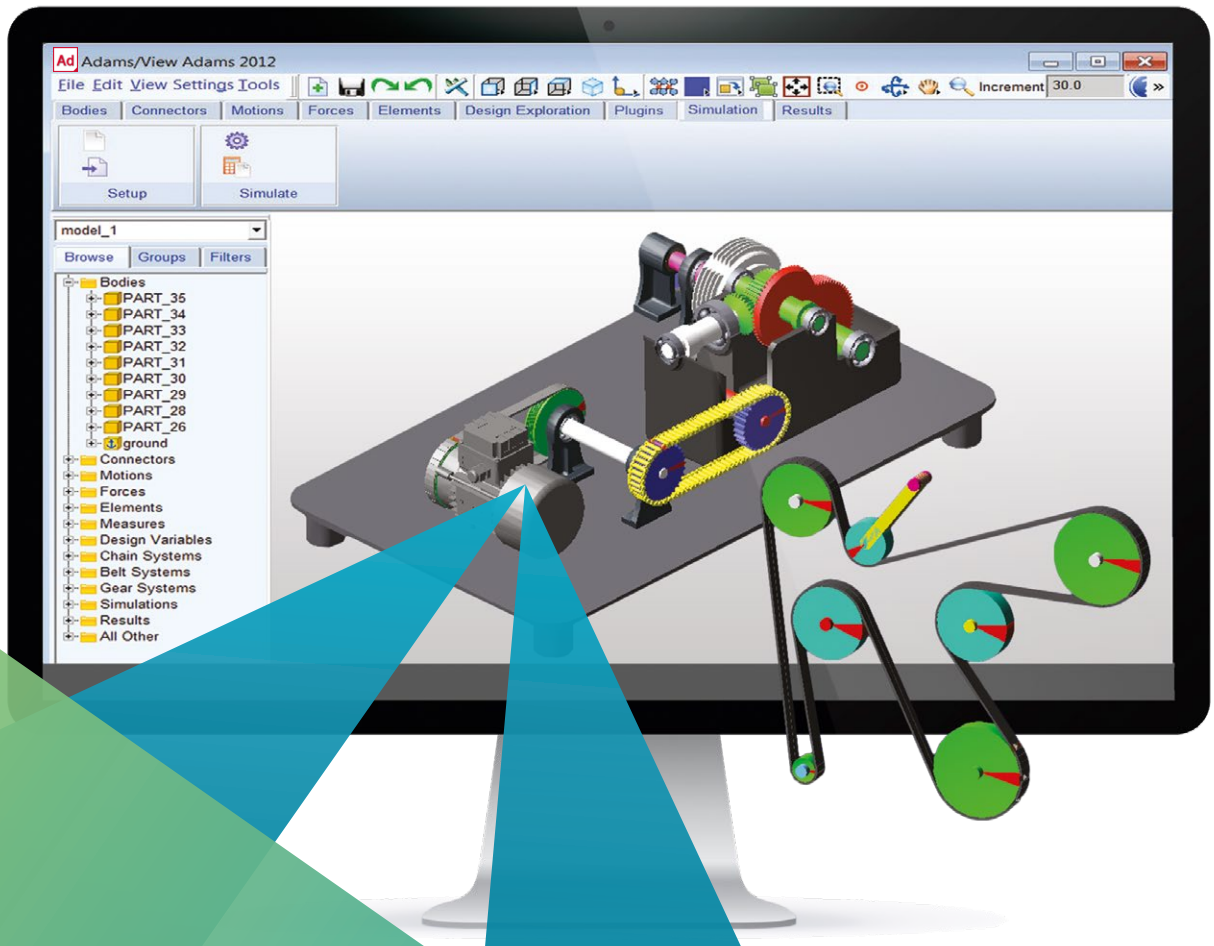
HEXAGON | MSC Software

Brochure

Adams/Machinery

A powerful simulation suite for mechanical drive systems.



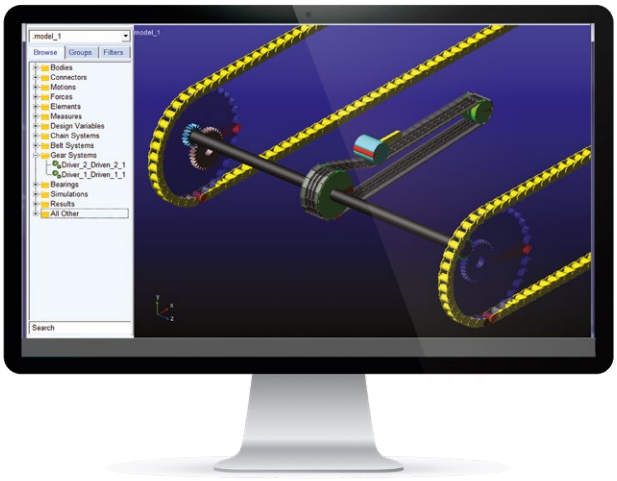
Introducing Adams/ Machinery

A powerful simulation suite for mechanical drive systems

Adams/Machinery is a new Adams software solution that allows engineers to efficiently build functional virtual prototypes of their machinery components and systems early in the design cycle, so they can perform a series of virtual tests before committing to building a physical prototype. With this new solution, companies will reduce the number of prototypes, decrease the design cycle and meet their functional specifications in less time.

Adams/Machinery is fully incorporated inside the Adams/View environment. With productivity tools for modeling and pre-processing gear, bearing, chain and belt components, Adams/Machinery provides an extremely approachable, easy-to-use interface with in-line help and useful information about the components, their connections, and the applicability of various modeling fidelity options. Wizards help guide users through the model setup process and provide the ability to manipulate model parameters and modeling options with ease.

As the world's most famous and widely used Multi-body Dynamics simulation software, Adams improves engineering efficiency and reduces product development costs by enabling early system-level design validation. Engineers can evaluate and manage the complex interactions between disciplines including motion, structures, actuation, and controls to better optimize product designs for performance, safety, and comfort. Along with Adams/Machinery capabilities, Adams is optimized for providing system-level dynamics solutions for Machinery industry.



Why Adams/Machinery for functional virtual prototyping of machines

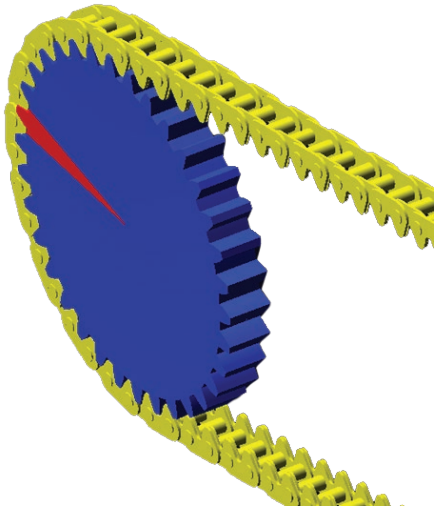
Ease of Use

Adams ribbon-style interface and model browser makes it easy for even novice users to create complete, accurate mechanical models. A core package (Adams/View, Adams/Solver, and Adams/PostProcessor) allows you to import geometry from most major CAD systems or to build a solid model of the mechanical system from scratch. You build a system the same way you build a physical system – by creating and assembling parts, connecting them with joints and driving them with motion generators and forces.

Adams/Machinery enables users to create some common machinery components more efficiently by guiding users in pre-processing via automation of activities like geometry creation, subsystem connections, etc. It also assists users in post-processing by providing automated plotting and reporting for commonly desired output channels.

Multidiscipline mechanical system simulation

With functionalities like Adams2Nastran export and ViewFlex, Adams introduces bi-directional integration with MSC Nastran that allows re-use of validated Adams models in MSC Nastran to perform modal and frequency response analysis. Adams/Mechatronics easily incorporates control systems into mechanical models by dynamically linking an external system library from a controls application, such as Easy5 and MATLAB. Control system parameters can be quickly adjusted for evaluation and included in a design study for simultaneous optimization of both control system and mechanical system.



High performance for improved productivity

Adams/Solver is a powerful numerical analysis application that automatically solves the equations of motion for kinematic, static, quasi-static, and dynamic simulations. You can use Adams/Solver to build, test, and refine mechanical system models.

Easy to use, integrated Adams/view user interface

Tightly integrated user interface to help you build, analyze and post-process MBD models with ease. Designed with a focus on system level analysis, Adams/View lets you build models of mechanical systems and simulate the full-motion behavior. You can also use Adams/View to quickly analyze multiple design variations until you find the optimal design.

Building models

- Import CAD neutral geometry formats including STEP, IGES, DXF, DWG or Parasolid
- Import native CAD geometry formats including CatiaV4, CatiaV5, Inventor, STEP, IGES, Acis, ProE, Creo, SolidWorks, Unigraphics, VDA
- Create rigid and flexible bodies representing the system's moving parts
- Apply constraints to define how bodies are attached and move relative to each other
- Apply motions to specifically prescribe the movement of bodies within the model
- Apply forces to define loads and contacts between bodies, and compliance and friction within connections
- Use the model browser to search the objects in the database as well as to create and manage filters and object groups
- Parameterize key model quantities to enable design exploration and easy modification
- Configure and customize the interface to suit your preferences and increase productivity

Testing models

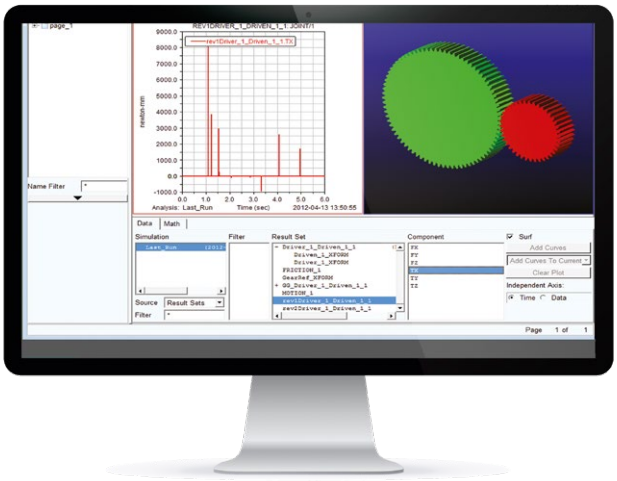
- Run a simulation to test the model's performance characteristics and response to a set of operating conditions
- Use solver parameters to refine simulation performance and accuracy
- Create measures to chart key characteristics of your model during or after a simulation
- Instrument your model with detailed output requests to investigate nearly any aspect of the simulated model

Reviewing results

- Interrogate important output channels via plot strip charts
- Animate simulation results to fully visualize model behavior
- View your system model oscillating at one of its natural frequencies by animating linear analysis results

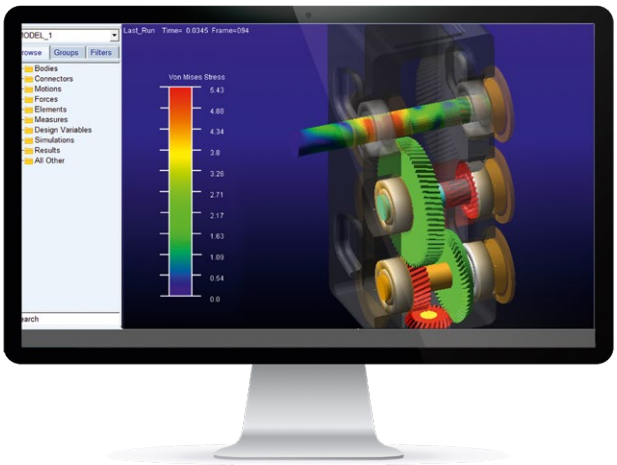
Adams/PostProcessor

- View results in tabular and plotted formats
- Import physical test data for comparison with analysis results to correlate your models
- Compare plots and animations from multiple simulations
- Perform collision and clearance studies
- Use broad animation controls to enhance the quality and realism of your animations
- Import CAD geometry to enhance the presentation of animations
- Create movies from animations and add movies to your presentation
- Show synchronized animations of your three-dimensional geometry along with plots and publish the results to the web



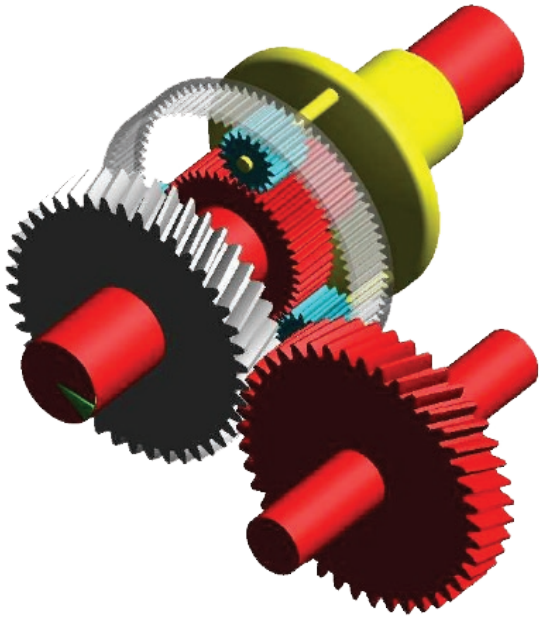
Improving results

- Use the model browser to conveniently modify the model to improve simulation results
- Perform parametric analyses to investigate the influence of design variables on system behavior
- Run a design study to adjust a parameter in you model to measure its effect on key design objectives



Adams/insight

- Advanced DOE capability to improve product design by understanding interaction of key parameters and performance goals
- Many popular statistical methods are available to define the model set
- Assessments of response surface quality and objective sensitivity to factors guide refinement of the simulation set
- Publish interactive web pages which enable viewers to easily interrogate the model's response to varied factors

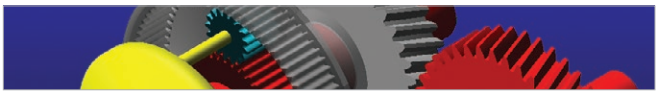


Adams/Machinery solution

Adams/Machinery is a new Adams product fully incorporated inside the Adams/View environment. It contains multiple modeling productivity modules which enable users to create common machinery components more efficiently than by using the more generic standard Adams/View model construction functionality alone.

Value proposition

- Improve engineering productivity: Enable direct, high-fidelity simulation of common mechanical parts and systems, such as gears, bearings, pulley-belt systems and sprocket-chain systems, reduce dependency on macro-creation skills, and improve analyst efficiency
- Accelerate time-to-market: Gain quicker, better insight into overall system performance
- Reduce Manufacturing Costs: Accurately predict and adjust design behavior much earlier in the design cycle; achieve an optimal design by analyzing multiple design variants faster
- Achieve Lower Warranty Costs: Predict system-level functional performance and accurately assess lifecycle service (safety, fatigue, durability); reduce risk by having better information at every stage of development



Gears

This module is for engineers who need to predict the impact of the design and behavior of gear pairs, such as Gear ratio, backlash prediction, on the overall system performance.

The detailed fidelity options include:

- Choose the gear type with the selection of Spur Gear(Internal/External), Helical Gear(Internal/External), Bevel Gear Straight and Bevel Gear Spiral
- Apply Coupler method when forces and components involved in it are neglected and only speed reduction or multiplication is of interest
- Apply Simplified modeling method when friction is neglected to have a fast calculation of the contact force
- Apply Detailed modeling method when friction is considered and study the backlash based on actual working centre distance and tooth thickness
- Apply Detailed modeling method to capture the effect of variation of loading between 1-3 teeth to calculate contact up to three teeth at the same time
- Apply Contact modeling method to use geometry-based contact and to support shell-to-shell 3D geometry contact
- Apply Contact modeling method to study the backlash based on actual working centre distance and tooth thickness
- Use Geometry settings to define the location and geometric parameters of your gears
- Choose the materials of your gears by defining mass or density
- Choose the connections of your gears to the ground or existing bodies with the selection of Rotational joint, Compliant joint and Fixed joint
- Create the planetary gear set by using the planetary gear wizard
- Generate the gear-specific output in the post-processor
- Use automated model parameterization as reference to perform design exploration

Belts

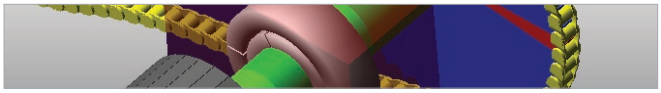
This module is for engineers who need to predict the impact of the design & dynamic behavior of pulley-belt systems, such as transmission ratio, tension and load prediction, compliance studies, or belt dynamics, on the overall system performance.

The detailed fidelity options include:

- Choose the belt type with the selection of Poly-V Grooved belt, Trapezoidal Toothed belt and Apply Constraint modeling method when forces and components involved are neglected and only speed reduction or multiplication is of interest
- Apply 2D Links modeling method to calculate the contact forces between the segments and pulleys when the axis of rotation is parallel to one of the global axes
- Apply 3D links modeling method to calculate the contact forces when the axis of rotation is not parallel to one of the global axes
- Use Geometry settings to define the location and geometric parameters of your pulleys
- Choose the materials of your pulleys by defining mass or density
- Choose the connections of your pulleys to the ground or existing bodies with the selection of rotational or fixed joint, or a compliant connection
- Apply tensioner pulley to the belt system to take up the extra slack and control the routing of the belt
- Generate the belt-specific output in the post-processor
- Use actuation wizard to apply force or motion to any pulley in the belt system
- Generate the gear-specific output in the post-processor
- Use automated model parameterization as reference to perform design exploration

Adams simulations permitted us to get different loading conditions to be studied through an FE analysis, putting to evidence the most critical loading combinations”

Bianchi F,
AgustaWestland



Chains

This module is for engineers who need to predict the impact of the design and behavior of chain systems, such as drive ratio, tension, contact forces or chain dynamics, on the overall system performance.

The detailed fidelity options include:

- Apply Constraint modeling method when forces and components involved are neglected and only speed reduction or multiplication is of interest
- Apply 2D Links modeling method to calculate the contact forces between the links and sprockets when the axis of rotation is parallel to one of the global axes
- Apply 3D links modeling method to calculate the contact forces when the axis of rotation is not parallel to one of the global axes
- Apply Linear, Non-linear or Advanced compliance to the roller chain
- Apply Linear compliance to the silent chain
- Use Geometry settings to define the location and geometric parameters of your sprockets
- Choose the materials of your sprockets by defining mass or density
- Choose the connections of your sprockets to the ground or existing bodies with the selection of rotational or fixed joint, or a compliant connection
- Apply Pivot, Translational or Fixed guides to the chain system
- Generate the chain-specific output in the post-processor
- Use actuation wizard to apply force or motion to any sprocket in the chain system

Bearings

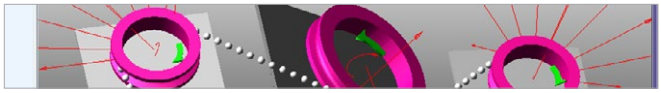
This module is for engineers who need to predict the impact of the design and behavior of rolling-element bearings on overall system performance. This includes an accurate representation of the bearing stiffness, sensitive to internal dimensions, offsets, misalignments, and clearances. Engineers can predict more accurately how bearing compliance influences the overall motion and loading of the system, as well as perform basic life predictions based on widely-adopted standards that consider bearing loading, lubrication, and speed. Module highlights are as follows.

The detailed fidelity options include:

- Choose from 14 different rolling-element bearing types
- Look up bearing parameter values from a library of over 24,000 off-the-shelf bearings and/or input values directly
- Calculate bearing reaction forces, optionally leveraging a nonlinear stiffness response from embedded technology delivered by KISSsoft, an MSC Software partner
- Select from over 120 oil- and grease-based bearing lubricants
- Predict the bearing service life (under the specified simulation conditions) based on industry standards sensitive to the loading, lubrication, speed, and bearing geometryprocessor
- Use automated model parameterization as reference to perform design exploration

The Adams model has subsequently been used to perform an extensive parameter study to find the root cause and solutions to the observed gear resonance”

Christina Exner,
Achates Power

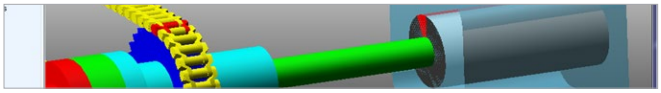


Cables

This module is designed for engineers to easily model and analyze cable based transmission systems.Module highlights are as follows.

The detailed fidelity options include:

- Precisely compute the cable vibration and cable tension
- Predict the load history of pulleys to perform fatigue analysis
- Analyze the impact of cable slippage on system load performance
- Study the effect of cable compliance on the system output speed
- Study the winching effects in terms of the addition and removal of cable length from the system
- Define the pulley properties in terms of dimensions, contact parameters and materials
- Define the preloading, density, Young's Modulus, stiffness coefficient and damping coefficient to get the accurate cable outputs



Electric motor

The new Adams/Machinery Electric Motor Module enables engineers to represent electric motors with more sophistication and ease than via simple kinematic motions or via potentially complicated self-authored torque functions or subroutines.

The detailed fidelity options include:

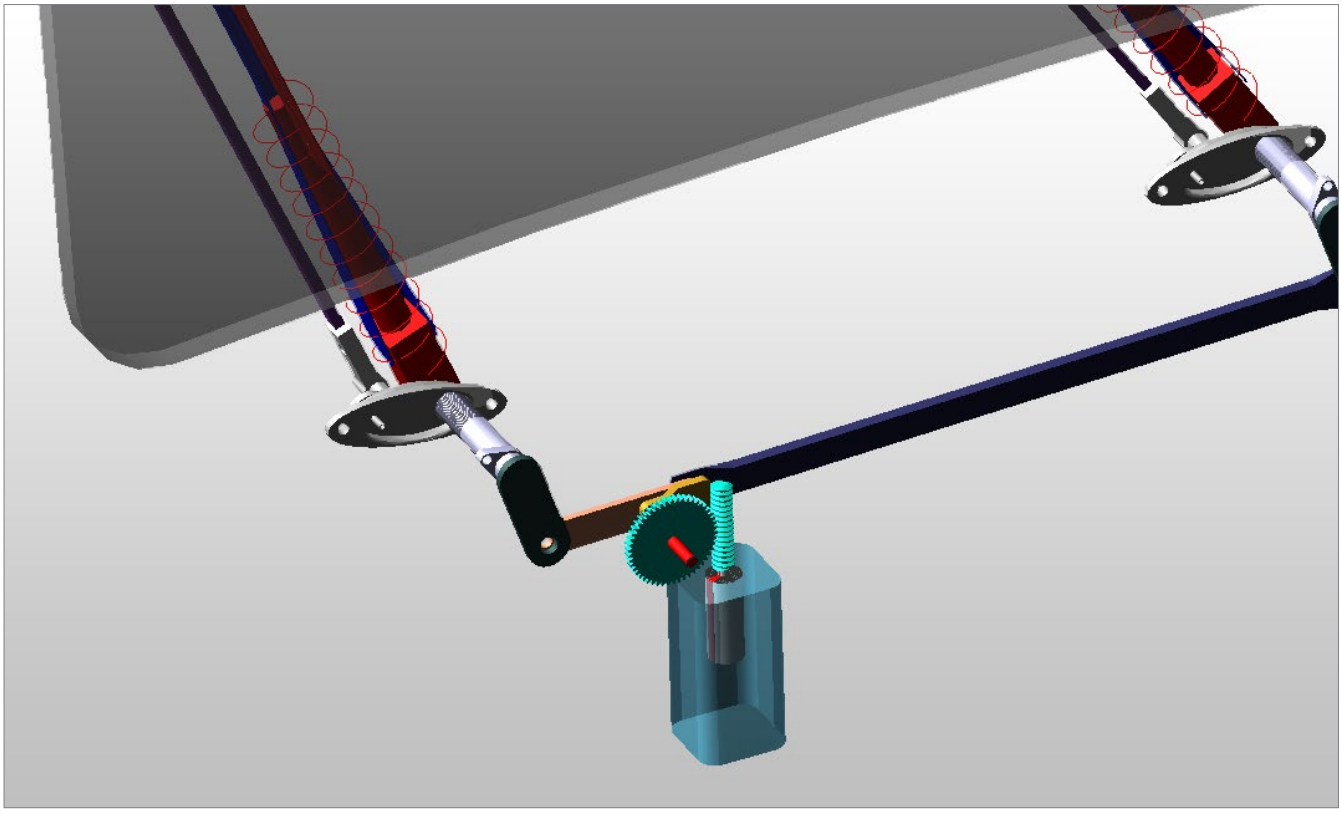
- Choose different modeling method for different applications
- Select from DDC (Shunt or Series), DC Brushless, Stepper and AC Synchronous motors using analytical method
- Apply external method by which the motor torque is defined by either Easy5 or MATLAB Simulink
- Calculate necessary motor sizing
- Predict impact of motor torque on system
- Perform precise position control
- Get a realistic drive signal for the rest of the machine components

Cam module

The new Adams/Machinery Cam module contains features to aid the creation of cam-follower systems. These systems may comprise various combinations of cam shapes, follower motions, follower arrangements and follower geometry.

The detailed fidelity options include:

- Create cam model much faster than before
- Make mechanism motion and cam profile design changes more easily
- Choose different cam shapes: disk, cylindrical (barrel) and single sided grooved
- Generate cam profile using existing follower motion
- Create a follower motion that is either time based or cam angle based
- Optimize the motion function to minimize or maximize acceleration or jerk in a more automated way.
- Predict impact of motor torque on system
- Perform precise position control
- Get a realistic drive signal for the rest of the machine components



Efficient solvers with capabilities for higher productivity

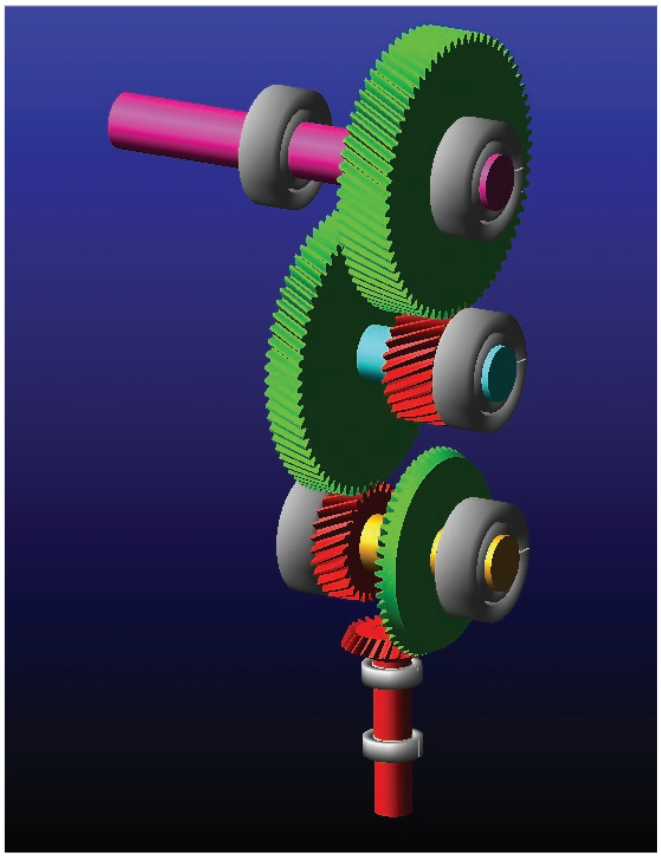
As a powerful numerical analysis application, Adams/Solver automatically solves the equations of motion for kinematic, static, quasi-static, and dynamic simulations. It is designed to build, test, and refine mechanical system models.

High performance computation

- Enable parallel evaluation of Jacobian matrix
- Enable parallel thread for results computation
- Enable parallel execution of LU factorizations

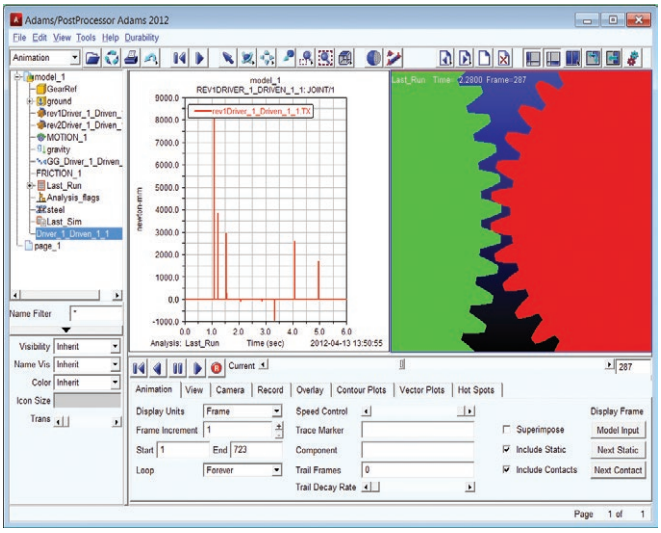
Unique capabilities

- Use state of the art Linear analysis capabilities
- Use high fidelity Adams-to-Nastran translation utilities to replace manual translation
- Use HHT integrators for a faster numerical integration of the equations of motion for a dynamic analysis



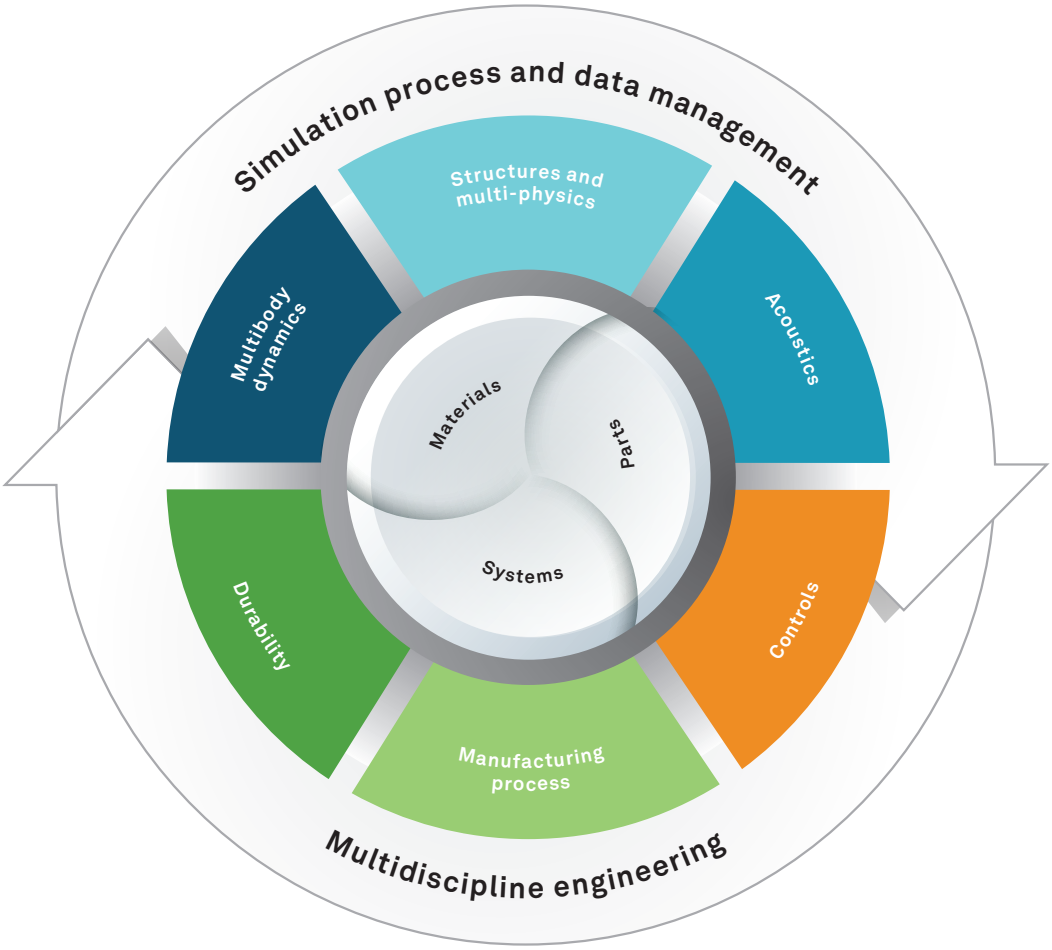
Adams has provided significant guidance to the design and development effort, reducing the number of expensive trials required and, therefore, the overall cost of the development programme"

Scott Bradley,
System Design Evaluation, Ltd



Product overview

MSC Software makes products that enable engineers to validate and optimize their designs using virtual prototypes. Customers in almost every part of manufacturing use our software to complement, and in some cases even replace the physical prototype “build and test” process that has traditionally been used in product design.



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.