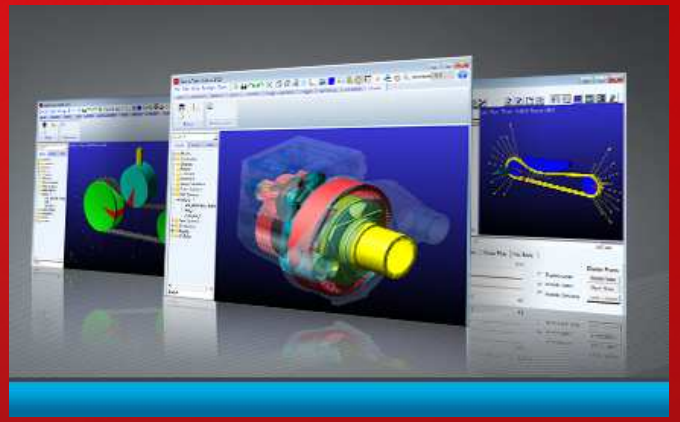
Die Bedeutung der Mehrkörpersimulation - Beispiele aus dem Mittelstand

Adams/Machinery

Bayreuth, 19.September 2012

Joachim Schwope, Manager

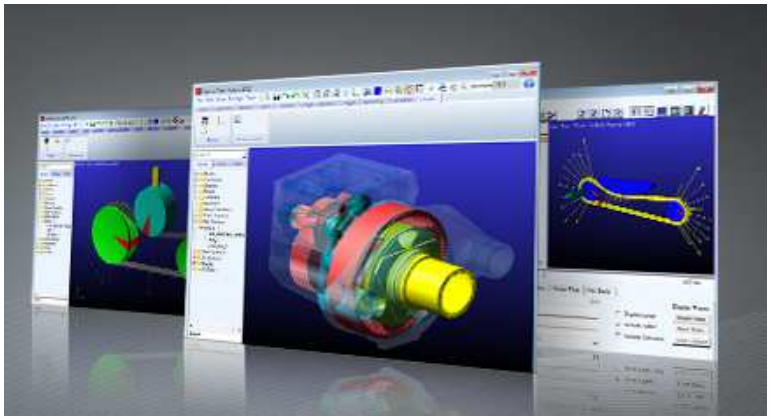
Dr.Tarik El-Dsoki, Direktor Sales und Marketing



MSC Software®
Simulating Reality, Delivering Certainty™

Agenda

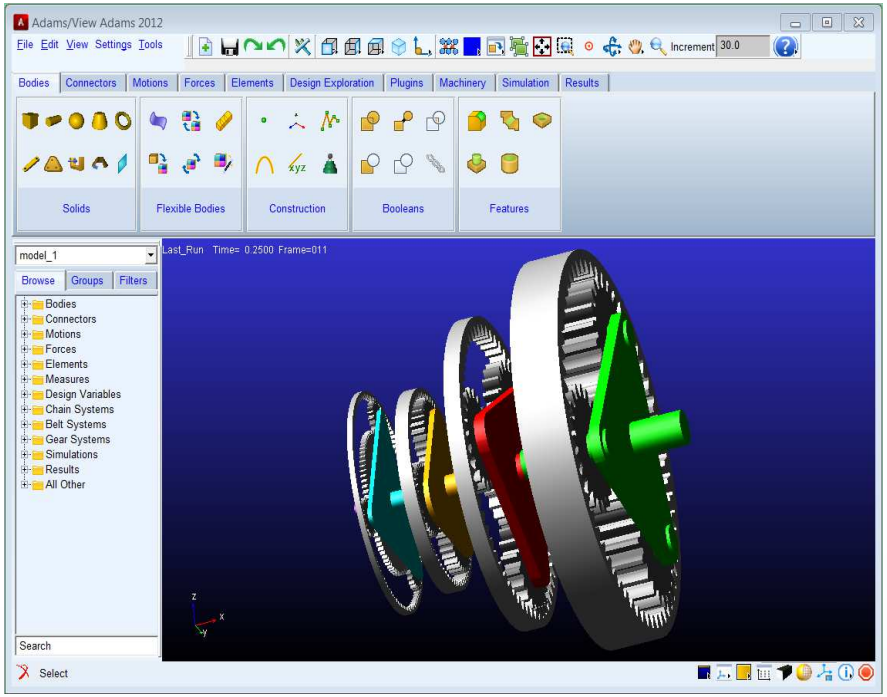
- **What is Adams/Machinery?**
- **What Problems Does It Solve?**
- **Key Benefits for Engineers**
- **Adams/Machinery Capabilities**
  - Gear Module
  - Belt Module
  - Chain Module
- **Belt Demo**
- **Adams/Machinery Roadmap**



What is Adams/Machinery?

System-level Dynamic Simulation for Machinery Applications

- **A set of productivity modules bundled into a single Adams/Machinery offering:**
  - Offers automated creation of common mechanical components via a wizard interface
  - Set in the Adams/View environment
  - Prerequisite: Adams/Studio (i.e. Adams/View & Adams/Solver)
  - Available via MK+ tokens and seat licenses



Adams/Machinery applications

CAD

Specific
Geometry
Design

Adams/ Machinery

System level
Dynamics analysis:
Loads and motions

FEA

Detailed
analysis

What Problems does it Solve

- **Quick modeling and functional simulation of common machinery components in the context of systems**
  - Today, no tools in Adams

- **Rapid performance of component performance and behavior on system, as well as system effects components**
  - Today, many have to wait for input from suppliers

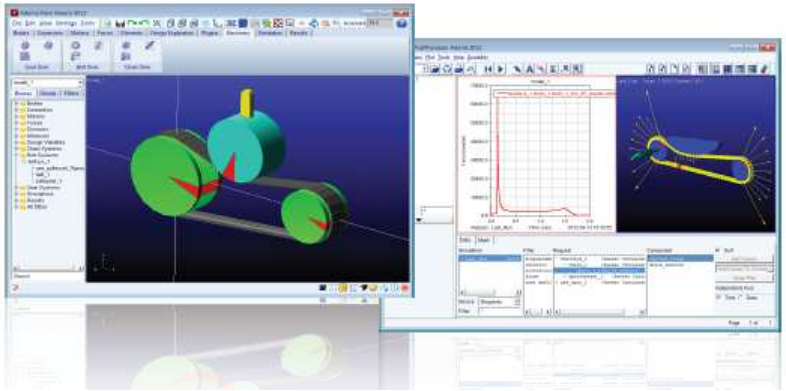
- **Gives machinery equipment manufacturers functional performance input earlier in design; for more rapid innovation**
  - CAD-embedded motion tools don't give enough information

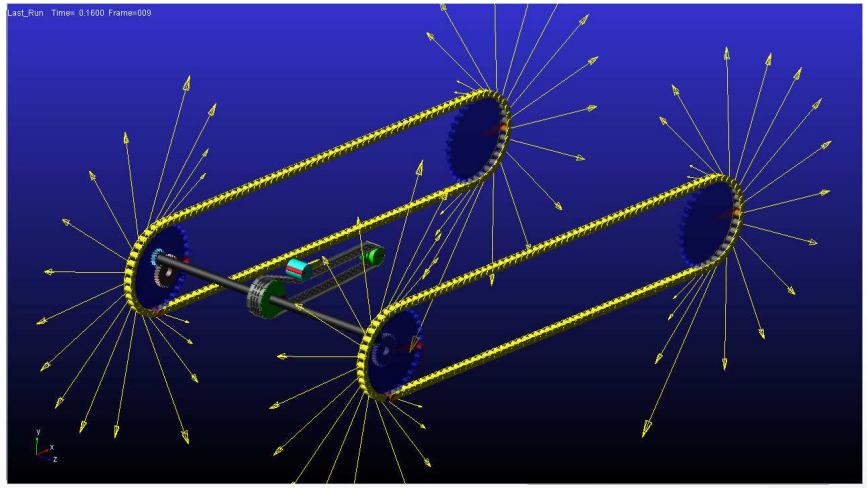
What Problems Does it Solve?

Gear Module: Study the impact of the design and behavior of gear pairs (e.g., **gear ratio**, **backlash prediction**) on the overall system performance.

Belt Module: Predict the impact of the design and dynamic behavior of pulley-belt systems, such as **transmission ratio**, **tension** and **load prediction**, **compliance studies**, or **belt dynamics**, on the overall system performance.

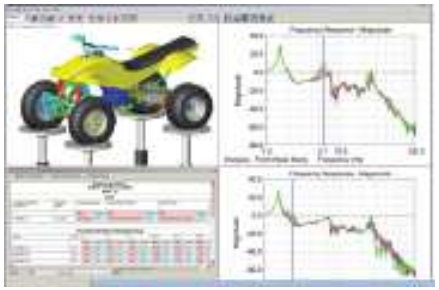
Chain Module: Analyze the impact of the design and behavior of chain systems, such as **drive ratio, tension, contact forces** or **chain dynamics**, on the overall system performance.

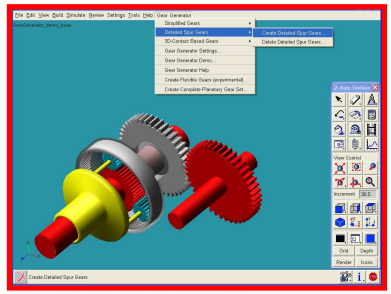




What will it do for Engineers?

- **Guides users in pre-processing via automation of activities like geometry creation, subsystem connections, etc.**
- **Assists users in post-processing by providing automated plotting and reporting for commonly desired output channels.**
- **Provides a GUI-driven wizard-style user interface which prompts users more for physical quantities than virtual ones.**
- **User friendly User Interface with in-line help and general useful information about the components and connections and applicability of the modeling fidelity options.**

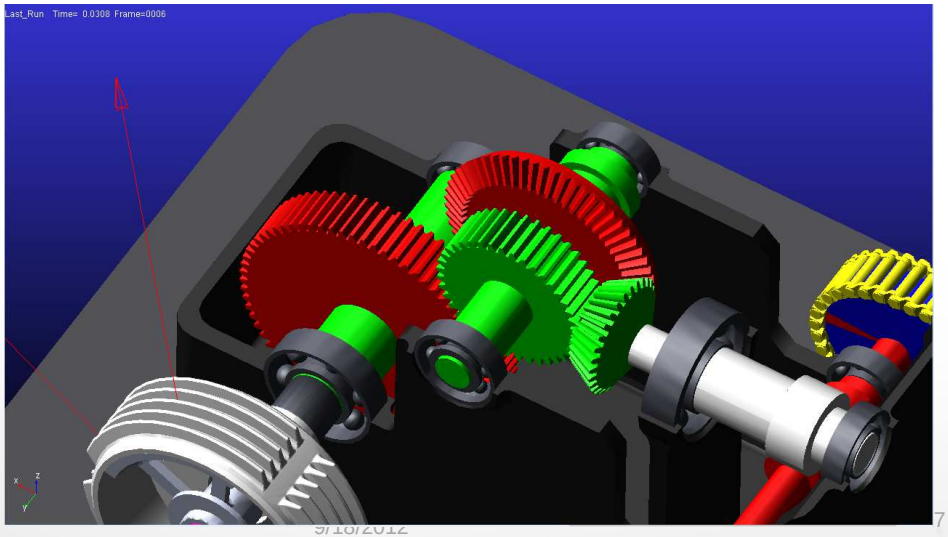


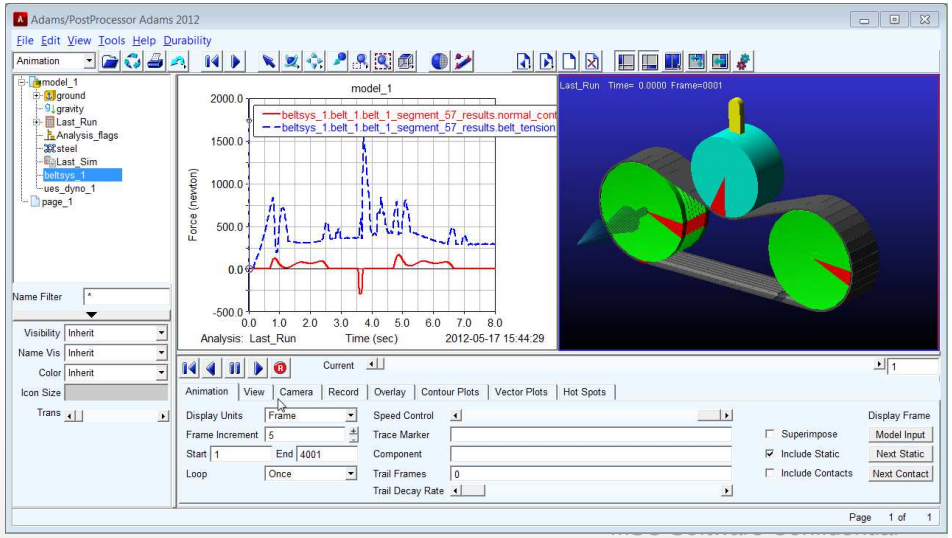


Key Benefits for Engineers

Productivity Benefits:

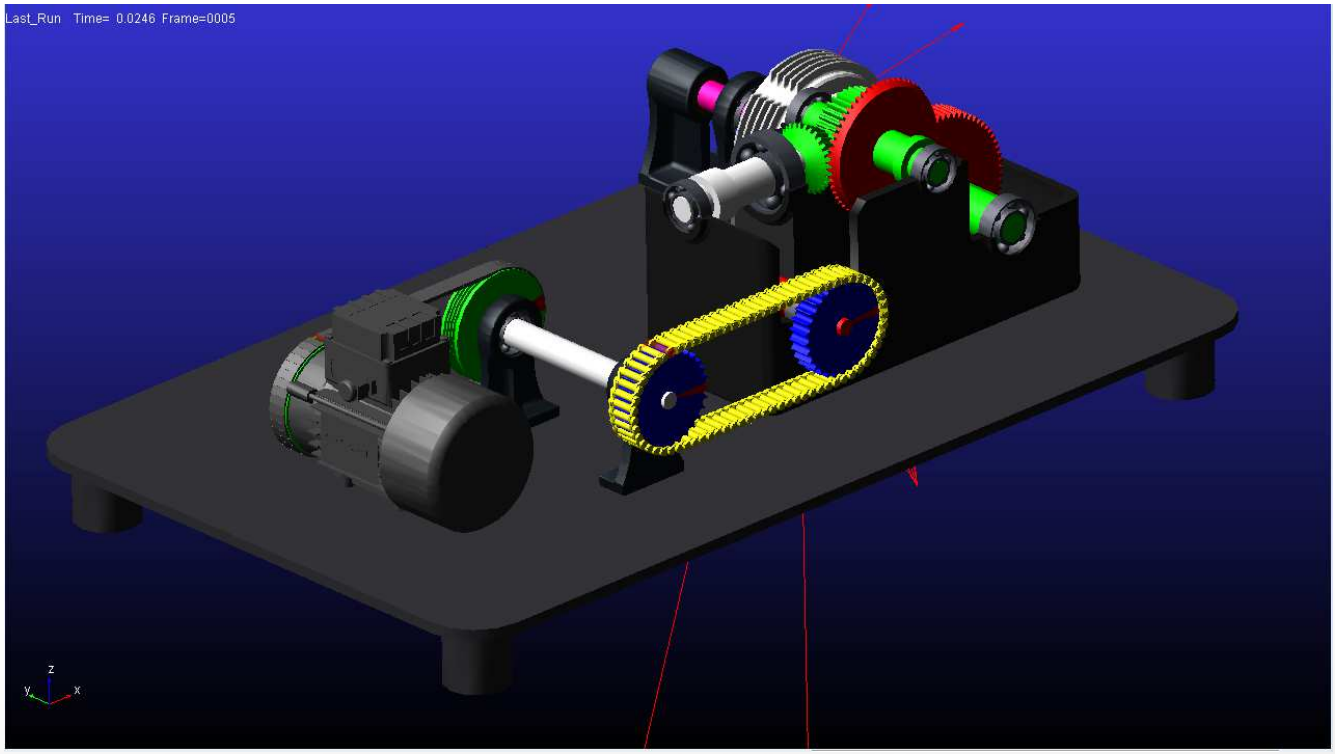
- High-fidelity simulation of common mechanical parts, such as gears, belts, and chains
- Enhanced productivity with incredibly quick model-solve-evaluate process times
- An automated, wizard-driven model creation process for ease-of-use
- Straightforward evaluation of results in Adams/Postprocessor





Adams/Machinery Capabilities

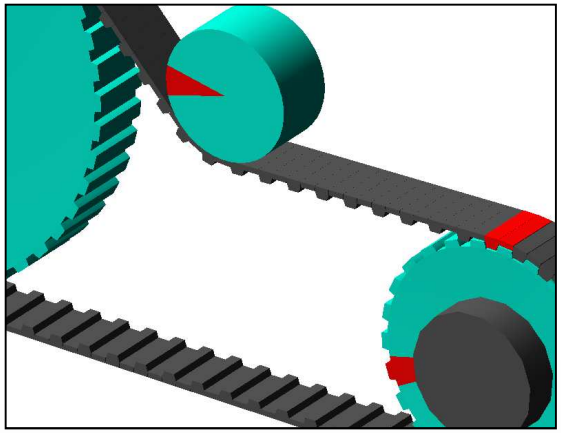
- **Modeling Fidelity Options**
  - Belt
  - Chain
  - Gear



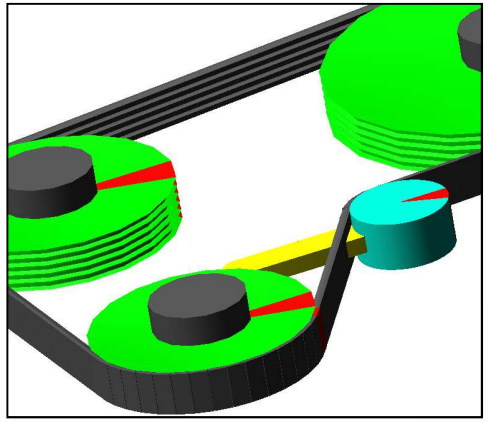
Belt Module

- **Constraint**
  - Kinematic joint coupler
- **2D/3D Links**
  - Discretized belt formulation
    - Rigid parts connected by field elements
    - IMPACT-based contact subroutines for contact with pulleys
  - For 2D: 2D *parts*, not 3D parts constrained in 2D

Belt Types	Modeling Fidelity Options		
	Constraint	2D Links	3D Links
Poly-V Grooved	✓	✓	✓
Trapezoidal Toothed	✓	✓	✓
Smooth	✓	✓	✓



Trapezoidal Toothed

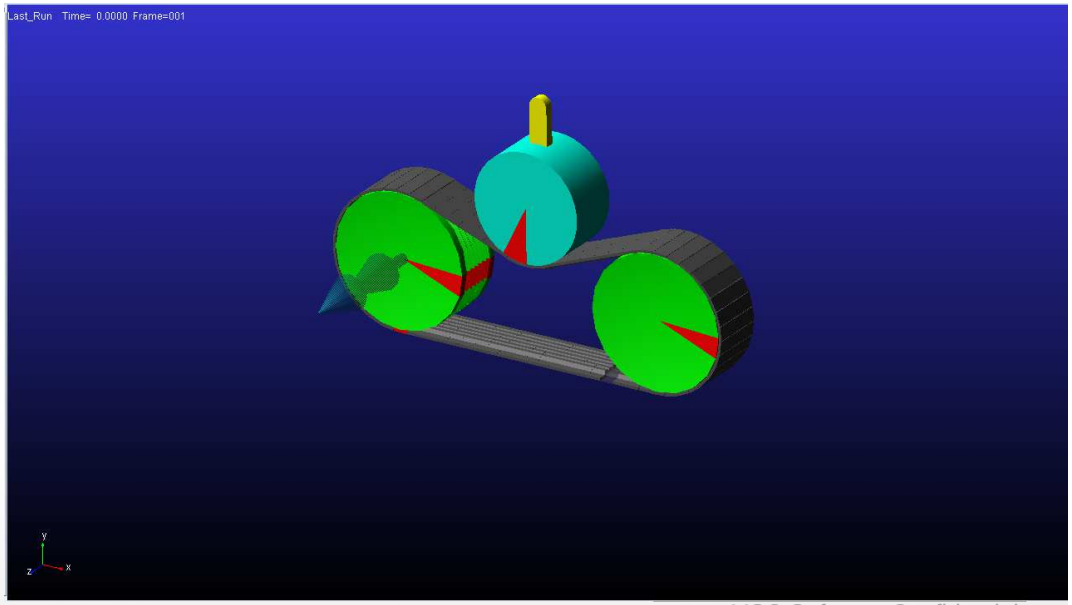


Poly-V Grooved

Belt Module

- **Tensioner**
  - Arm and Smooth Pulley
  - Rotational or Translational Spring Damper
- **Actuation**
  - Torque or Motion Functions
    - Constant
    - Harmonic Series
    - Curve
    - User Defined

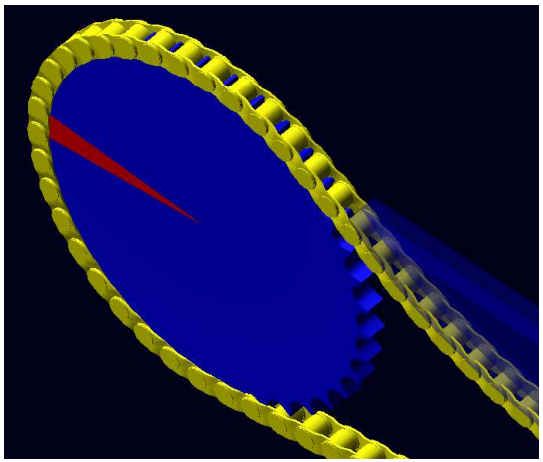
- **Output Considerations**
  - Belt Tracking
    - Fixed Position on Span
    - Follow Individual Segments



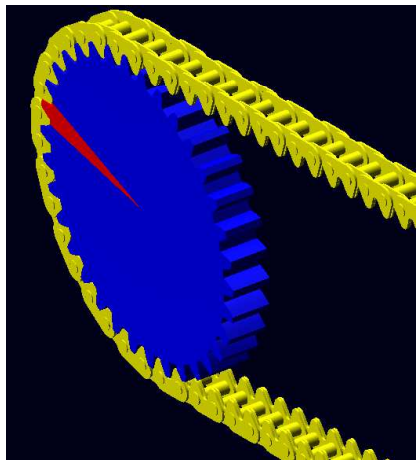
Chain Module

- **Constraint**
  - Kinematic joint coupler
- **2D/3D Links**
  - Discretized chain formulation
    - Separate rigid parts per link connected via various compliance options
    - IMPACT-based contact subroutines for contact with sprockets

Chain Types	Modeling Fidelity Options			Chain Compliance Options		
	Constraint	2D Links	3D Links	Linear	Non - linear	Advanced
Roller Chain	✓	✓	✓	✓	✓	✓
Silent Chain	✓	✓	✓	✓		



Roller

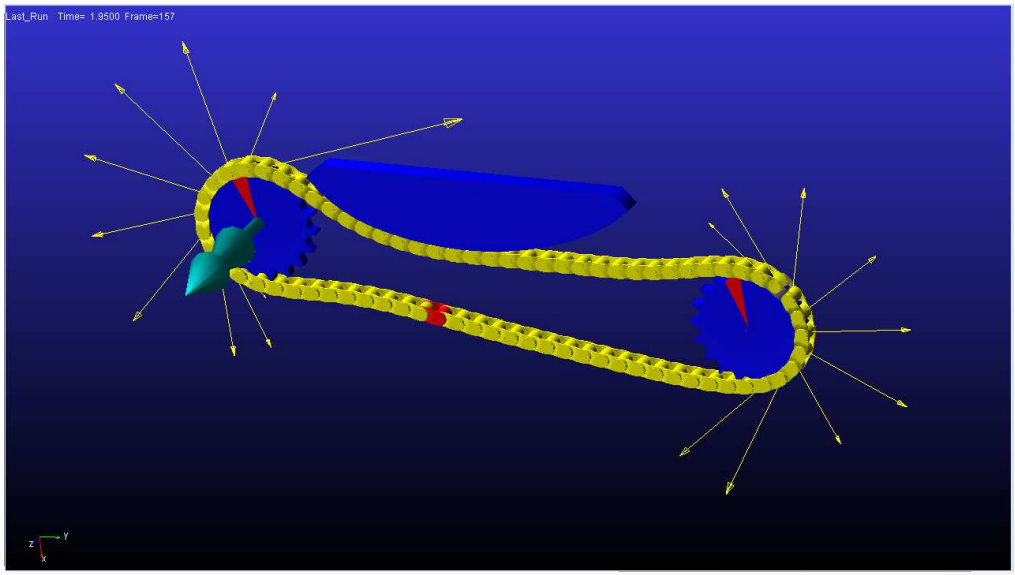


Silent (aka Involute)

Chain Module

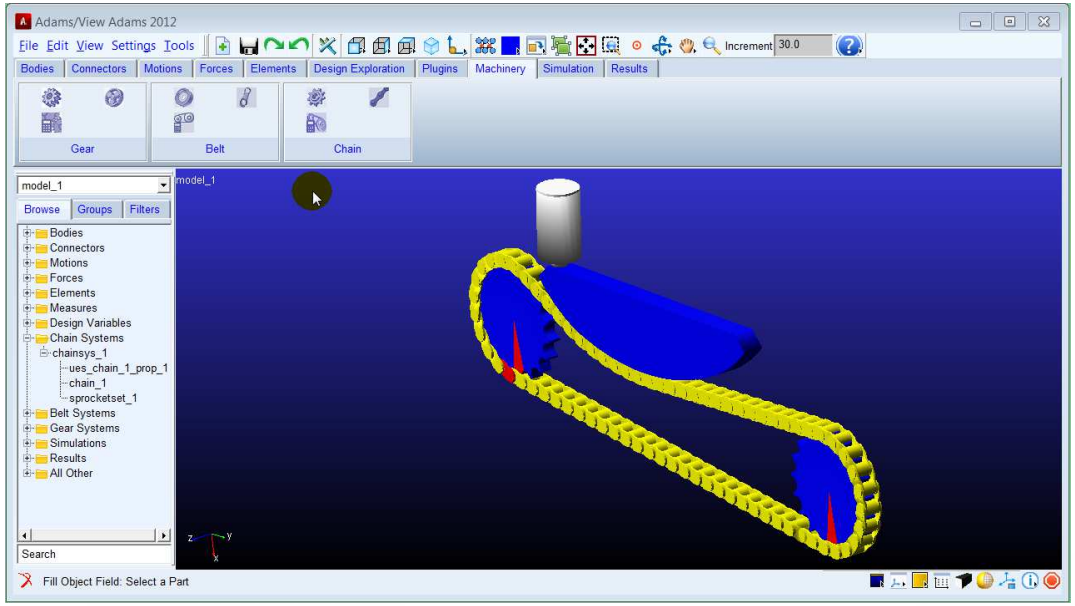
- **Compliance Options**
  - Linear
    - Linear bushings connect links
    - Only x-direction stiffness
  - Nonlinear
    - Uses field elements to connect links
    - X and Y-direction stiffness defined by a polynomial with 3 coefficients
  - Advanced
    - Link and Roller stiffness can be defined
    - Uses field elements to connect links
    - X and Y-direction stiffness defined by a polynomial with 5 coefficients

- **Tensioner**
  - Pivot, Translational and Fixed Guides
  - Spring Damper and User-entered function for tensioner



Chain Module

- **Actuation**
  - Torque or Motion Functions
    - Constant
    - Harmonic Series
    - Curve
    - User Defined
- **Output Considerations**
  - Chain Tracking
    - Fixed Position on Span
    - Follow Individual Links



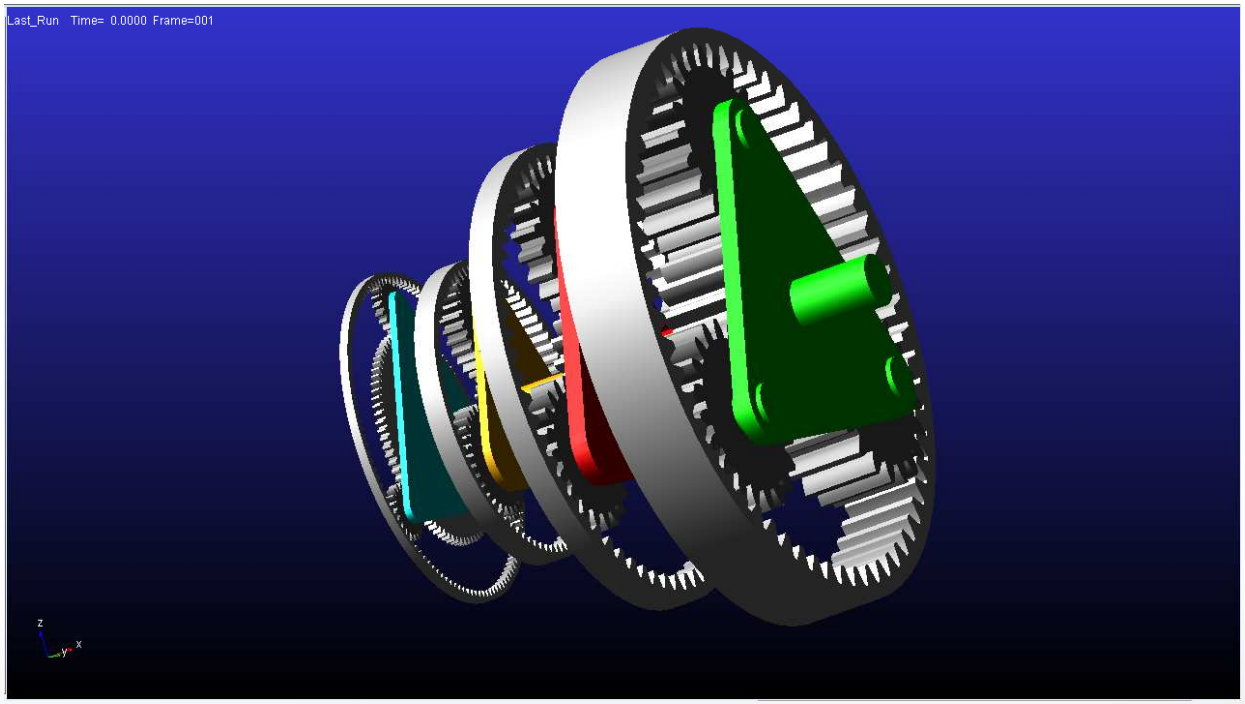
Gear Module

Gear Types	Modeling Fidelity Options			
	Coupler	Simplified	Detailed	3D Contact
Spur Gear (Internal/External)	✓	✓	✓	✓
Helical Gear (Internal/External)	✓	✓		✓
Bevel Gear Straight	✓	✓		✓
Bevel Gear Spiral	✓	✓		✓

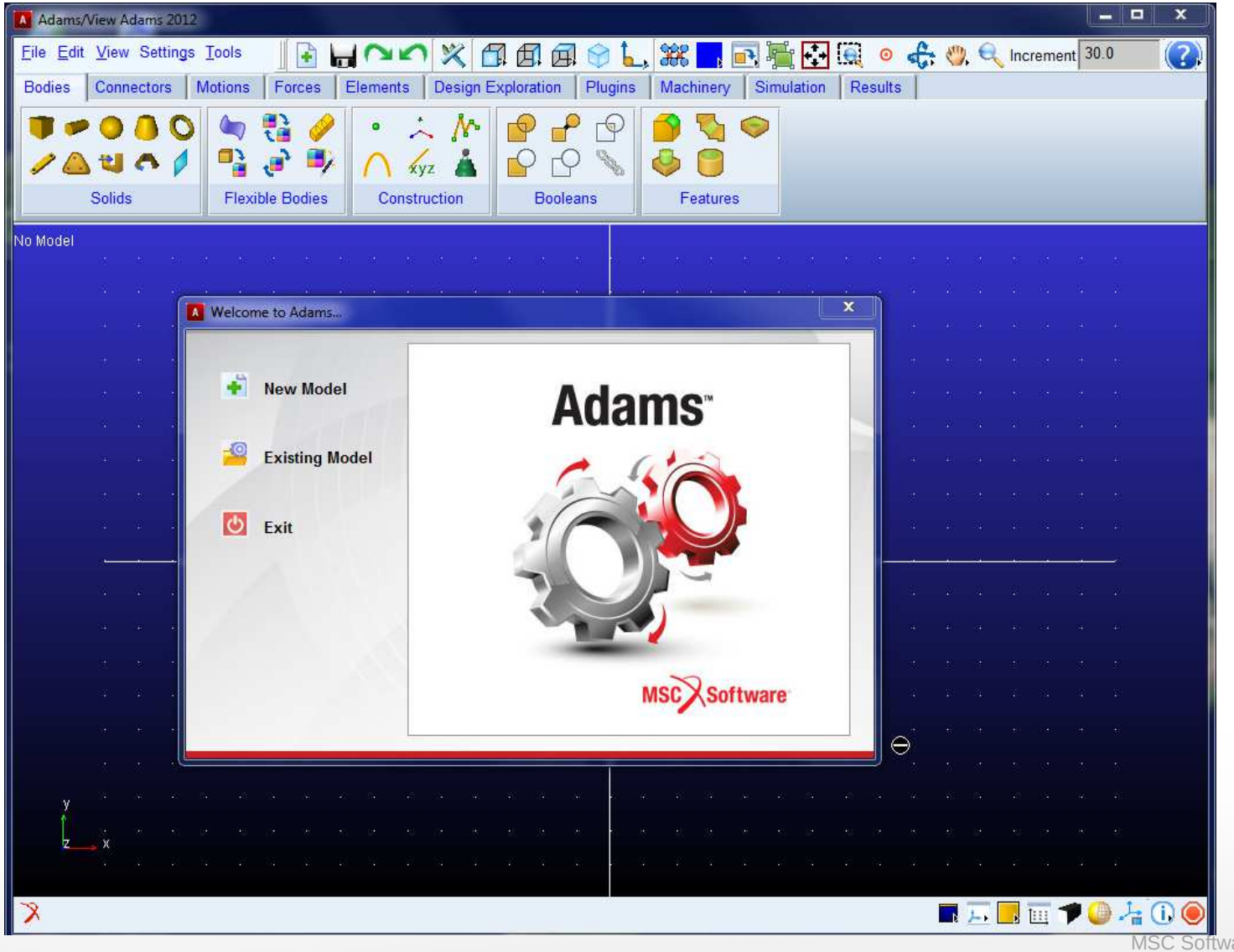
- **Coupler**
  - Kinematic joint coupler
- **Simplified**
  - Analytical contact calculation
  - Initial Backlash as input value (design variable) for rattle investigations, etc.
- **Detailed**
  - Analytical contact calculation
  - "True" backlash based on actual working centre distance and tooth thickness
  - Capture the effect of variation of loading between 1-3 teeth (noise generator)
- **3D Contact**
  - Geometry based contact
  - Gears can have all 6 Degrees Of Freedom
  - "True" backlash based on actual working centre distance and tooth thickness
  - Option to explicitly set backlash

Gear Module

- **Planetary Set**
  - Model construction automation
  - Simplified-level spur gears in a planetary configuration



Product Demo of Belt Module



Adams/Machinery Roadmap

- **2013 *candidate* components/modules:**
  - Conveyor
  - Electric Motor
  - Pump/Actuator
  - Cam
  - Paper/Media
  - Spring

- **Nonlinear Finite Element initiatives ongoing to complement development of Machinery offering in 2013**