PTC® Live Global

PTC 306 - PTC Creo Simulate 3.0

Product Update and Roadmap

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Director, Product Management

June 15, 2015

Agenda

Creo Simulation - Product Strategy

A Look Back: Highlights from Previous Releases

PTC Creo Simulate 3.0 - Enhancements

PTC Creo Simulate - Future Directions

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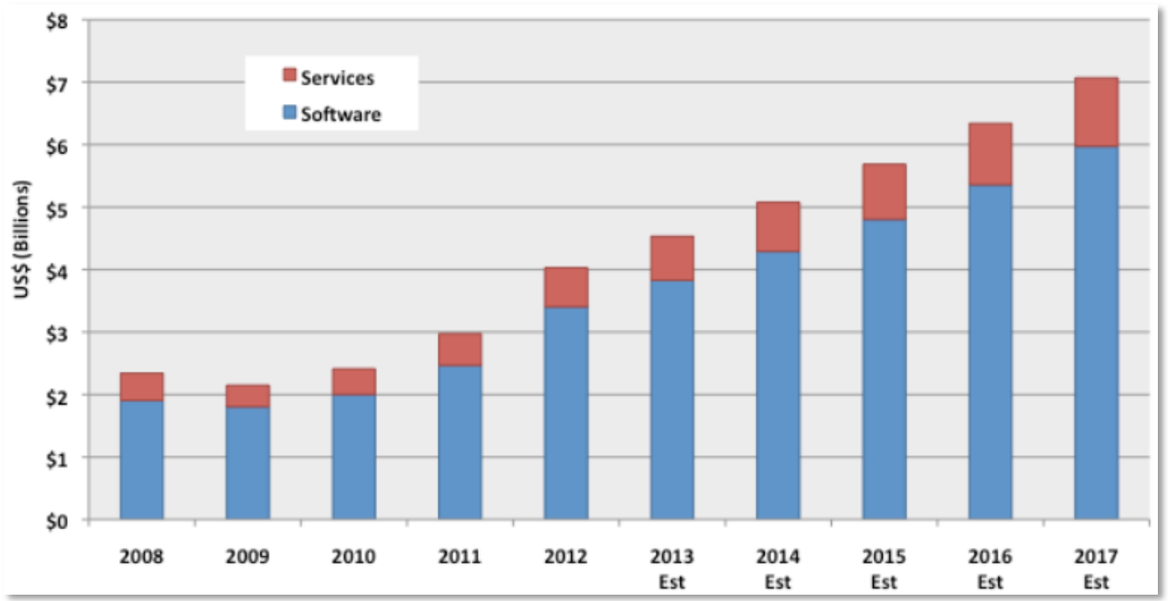
CIMdata Report (2013) - Simulation & Analysis Market Report

- **Simulation and Analysis** is the fastest growing tools segment of the PLM market
  - Simulation market growth is >2x the growth of the CAD market
  - S&A - 11.9% CAGR to exceed $7 billion in 2017
  - Geographic revenue distribution (S&A)
    - Americas – 29%
    - EMEA – 29%
    - Asia-PAC – 42%



- Discovered Trends:
  - Companies seeking S&A as a way to **improve designs and reduce the cost of** prototyping and physical testing
  - S&A tools need to be **easy to use and encompass all aspects of analysis**
    - Scalability to address the needs of designers through experts
  - Focus on **Simulation Data Management** and Systems Engineering
  - Essential part of the product and manufacturing **development processes**
  - Reasons for not adopting or slow adoption
    - Complexity, knowledge, difficult to use, personnel, not knowing which tool to use and when

PTC Creo Simulation Product Strategy

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Paving the way for Designer-Based FEA

Mission for Designer-Based FEA

– To provide PTC Creo users with a **fully-integrated suite** of world-class **analysis tools** which aid in the **evaluation, design and innovation** of product development.

- To deliver on our mission the following characteristics are required…
  - **Easy to Use, Efficient to Use**
    - Not just appearances, but integration of design workflow, engineering modeling concepts, data management, etc.
  - **Scalable**
    - Broad footprint and a robust ecosystem of capabilities and 3rd party development partners
  - **Accurate, Robust, Reliable…**
    - Not just any answer; a GOOD answer
    - Let the computer and application do it's work, while you do the engineering thinking

Strategy has remained the same since 1995!

RASNA

↓

Pro/MECHANICA

↓

PTC Creo Simulate

Removing the barrier that separates design and analysis...

...unparalleled CAD/CAE Integration

Typical Simulation Process

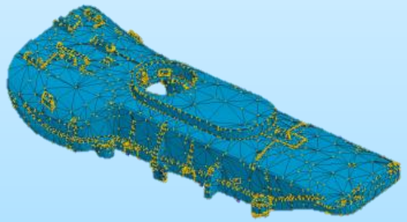
A simulation with PTC Creo Simulate always follows a typical four-step process with an optional fifth step.

PTC Creo Parametric

PTC Creo Simulate

1 Model Definition

2 Preprocessing



Materials

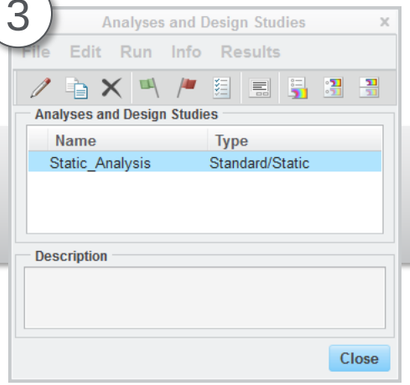
Displacement

Measure

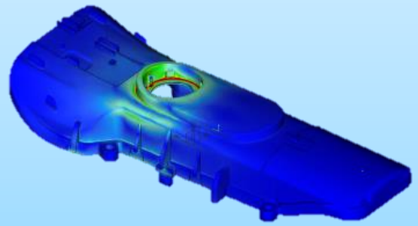
Force/Moment

Analyses

3



4 Results



5 Optional : Design Optimization and Design of Experiments

Enabling Analysis and Simulation with PTC

Linear Structural Analysis

Nonlinear Structural Analysis

Optimization

Engineering Calculations

Structural Dynamics

FEM Analysis Validation

Fatigue Analysis

Tolerance Analysis

Integration with PIDO Solutions

DOE

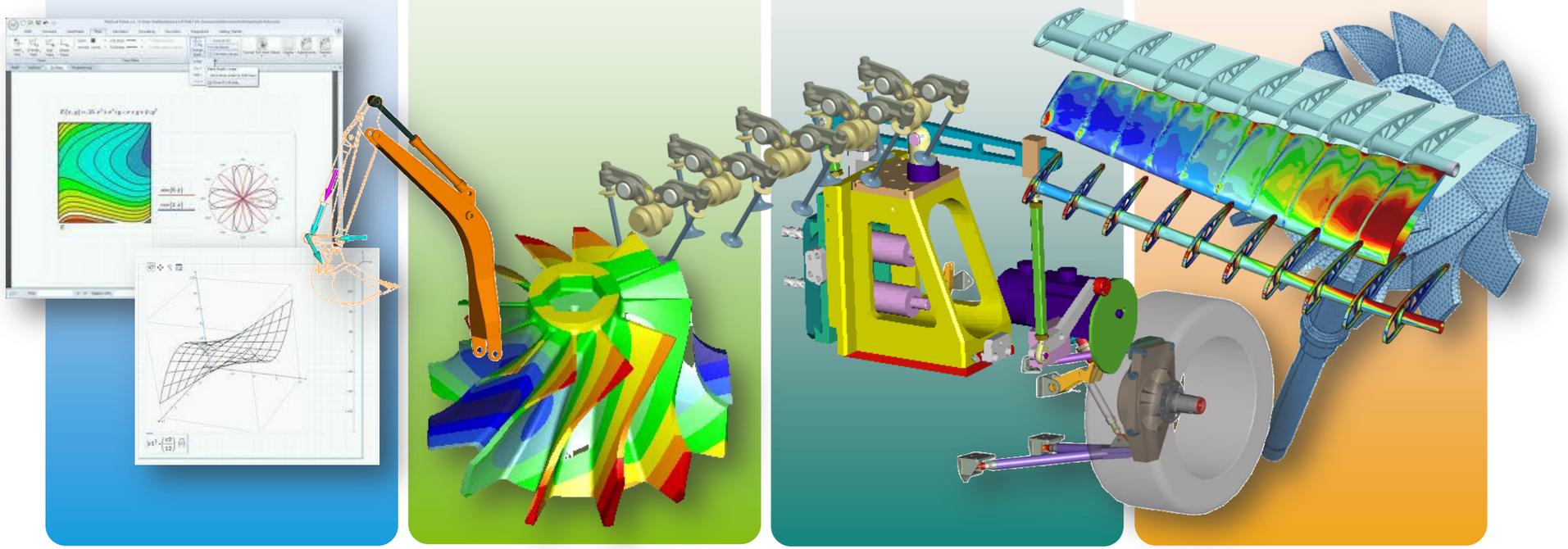
Mechanisms

Integration to System Simulation

Thermal Analysis

Nonlinear Thermal Analysis

Multi-Body Dynamics



Concept | Design | Improve and Optimize | Validate

Creo Simulate Technology – Key Differentiators

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Ease of Use

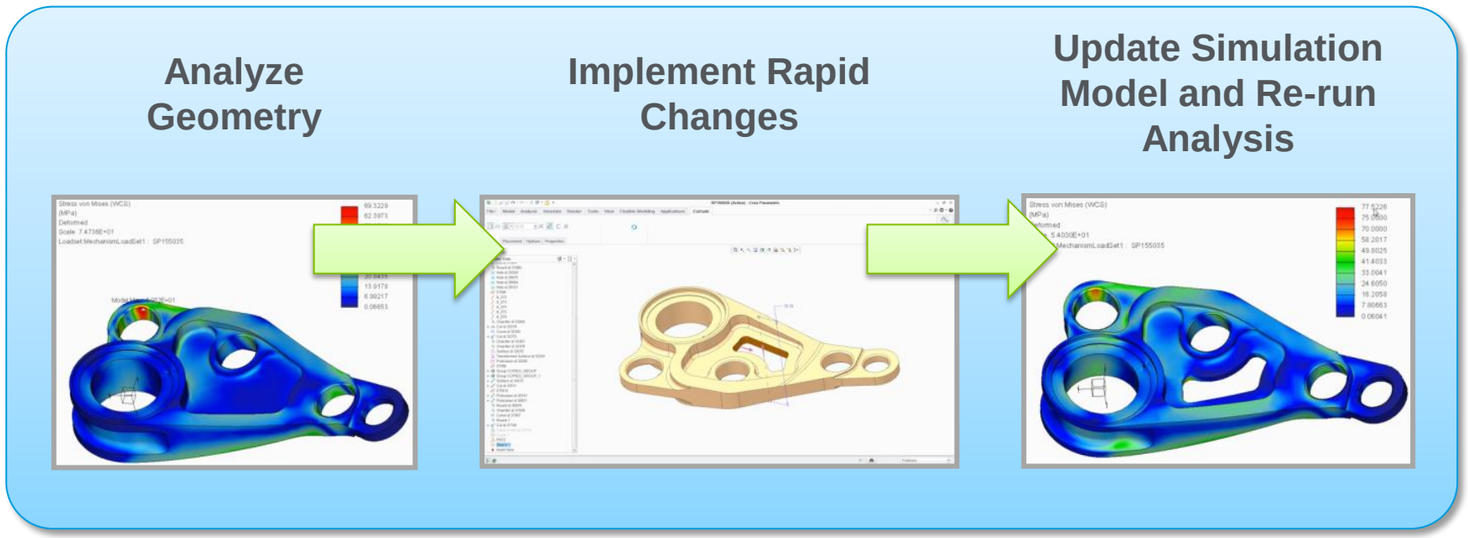
- Common, consistent PTC Creo UI
  - Consolidated command Ribbon UI
  - Context sensitive menus
  - RMB command access
  - Simplified workflows
- Engineering Terminology

Common Data Model

- Seamless integration of CAD and CAE
  - Directly read material properties and units from the model
  - Apply constraints and load directly to model geometry
  - Support design sensitivity and optimization studies

Accuracy and Reliability

- P-Element technology and auto-meshing
  - Eliminate the need to understand element types
  - Automatically create the mesh model
  - Accurately capture geometry contour
- Adaptive refinement and accuracy control
  - Mesh is automatically refined during the solving process
- Automatic Convergence



What is the difference between P and H-method?

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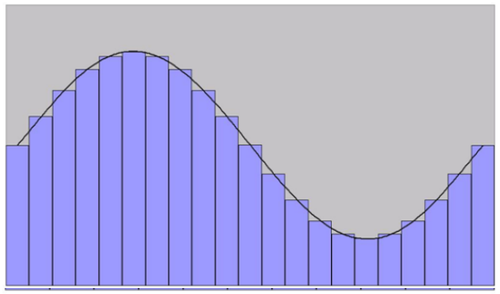
FEA method are different ways of adding degrees of freedom to the model.

- H-Element Method
  - The h-method improves results by using a finer mesh of the same type of element in different areas.
  - This method refers to decreasing the characteristic length (h) of elements, dividing each existing element into two or more elements without changing the type of elements used.
  - The number of elements must be increased in areas where the stress changes quickly over a small distance

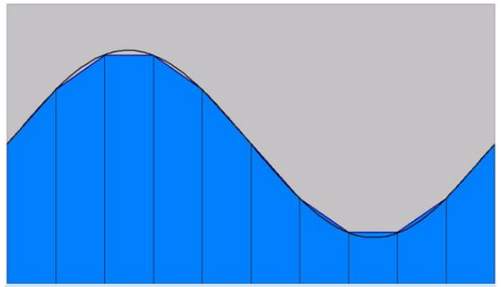
- P-Element Method
  - The p-method improves results by using the same mesh but increases the polynomial order of the shape function to improve the accuracy.
  - This method refers to increasing the degree of the highest complete polynomial (p) within an element without changing the number of elements used.

Since the Mesh uses linear elements have a shape function. linear shape, the Therefore, the stress and strain function for across each displacement element must be should be linear. constant.



H-Method with coarse Mesh

Mesh uses complex elements based on a polynomial shape function. This helps to accurately reflect the strain.



P-Method with 2nd order Polynomial

http://www.mae.ncsu.edu/klang/courses/mae533/Reference/Methods.htm

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PTC Creo Simulate 3.0 - Enhancements

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PTC Creo Simulate – Summary of Recent Technology

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- **Nonlinear materials Hyper-elasticity**
- Pressure field import and auto mapping
- Contact thermal resistance
- **Infinite (rough) friction in contact**

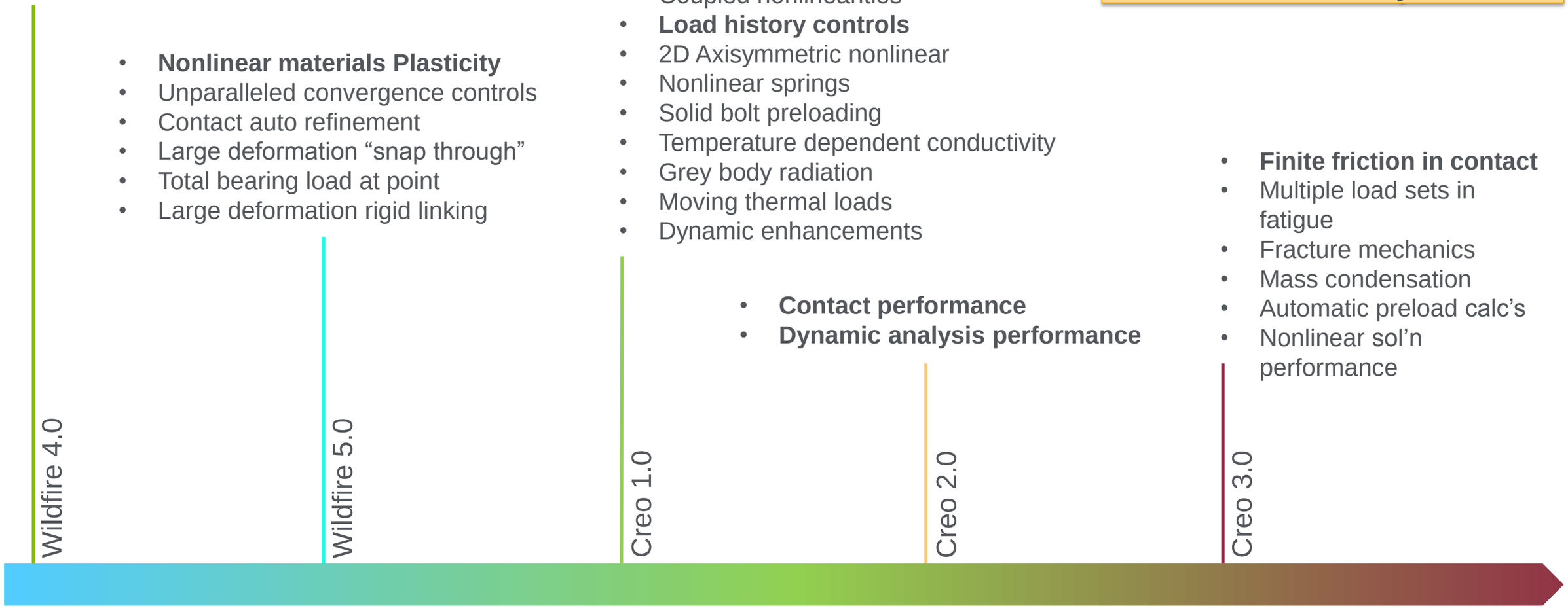
Removing the barriers to nonlinear structural and thermal analysis

- **Nonlinear materials Plasticity**
- Unparalleled convergence controls
- Contact auto refinement
- Large deformation “snap through”
- Total bearing load at point
- Large deformation rigid linking

- **Large deformation contact**
- Coupled nonlinearities
- **Load history controls**
- 2D Axisymmetric nonlinear
- Nonlinear springs
- Solid bolt preloading
- Temperature dependent conductivity
- Grey body radiation
- Moving thermal loads
- Dynamic enhancements

- **Contact performance**
- **Dynamic analysis performance**

- **Finite friction in contact**
- Multiple load sets in fatigue
- Fracture mechanics
- Mass condensation
- Automatic preload calc’s
- Nonlinear sol’n performance



PTC Creo Simulate 1.0 Enhancements

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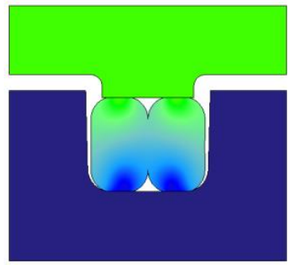
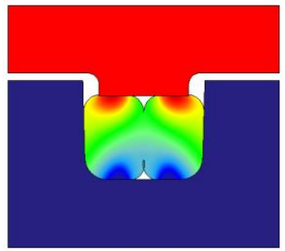
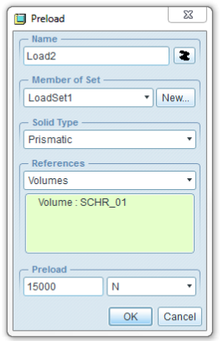
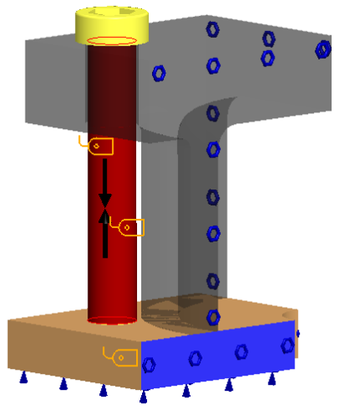
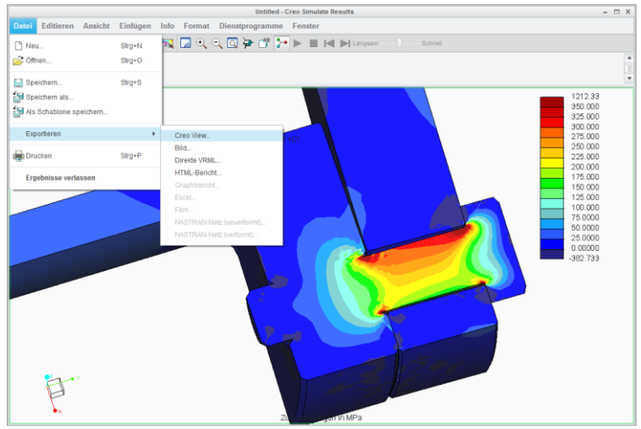
- PTC Creo Simulate Standalone
- Ribbon UI
- Mesh display in exploded view
- General Large Displacement Analysis:
  - Contacts
  - Plasticity
  - Hyper-elasticity
- Preload on bolts modeled as solids
- Animation of Dynamic Frequency results
- Output to PTC Creo View











PTC Creo Simulate 1.0 Enhancements

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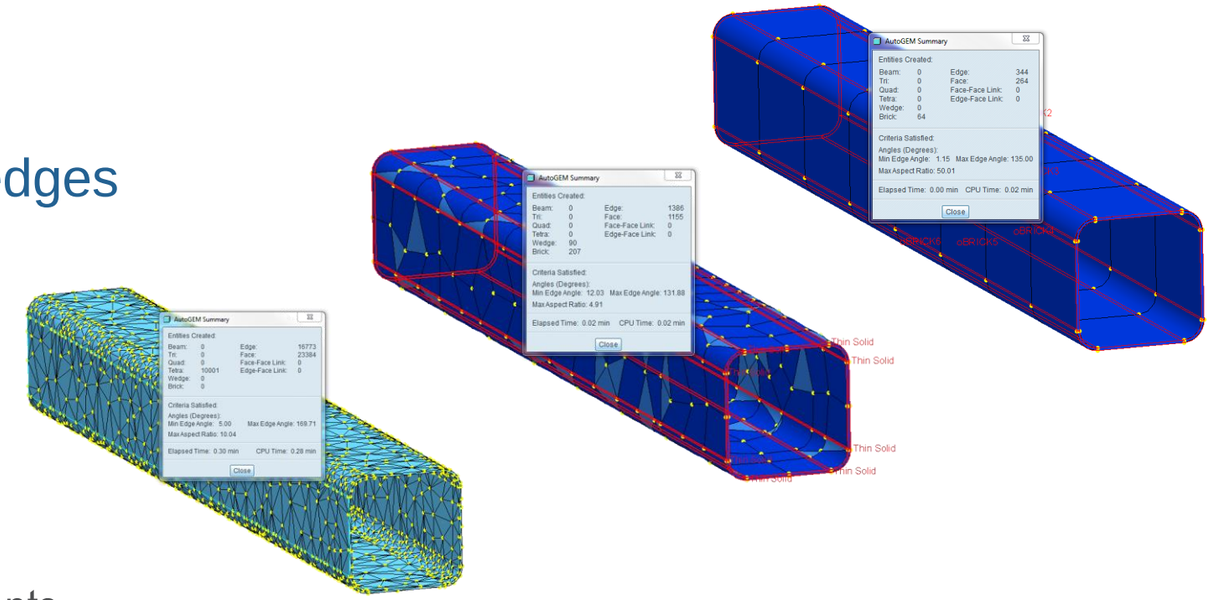
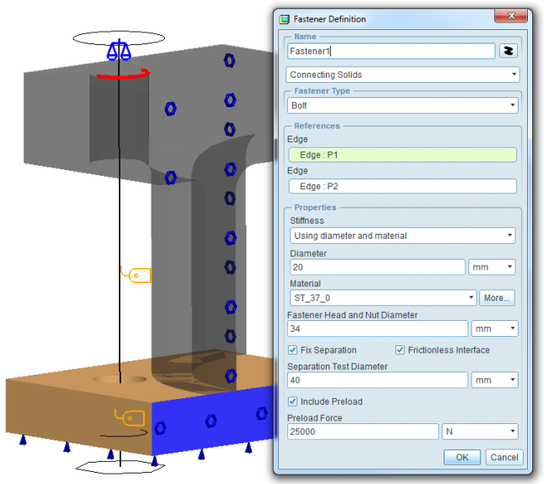
- Ability to mesh thin regions with bricks and wedges
- Ability to mesh prismatic regions with bricks and wedges
- Mapped meshing
- Increased solver Memory
- Enhanced modeling of Fasteners:
  - More accurate modeling of interface between bolted components
  - Modeling of bending and torsion effects
  - New measure calculations





PTC Creo Simulate 2.0 Enhancements

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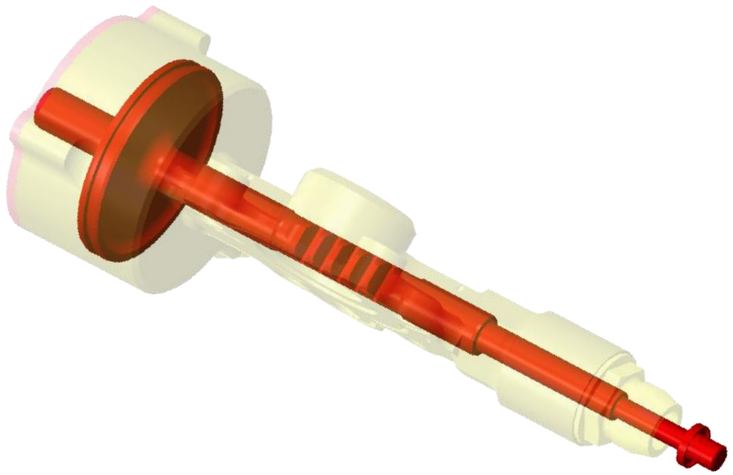
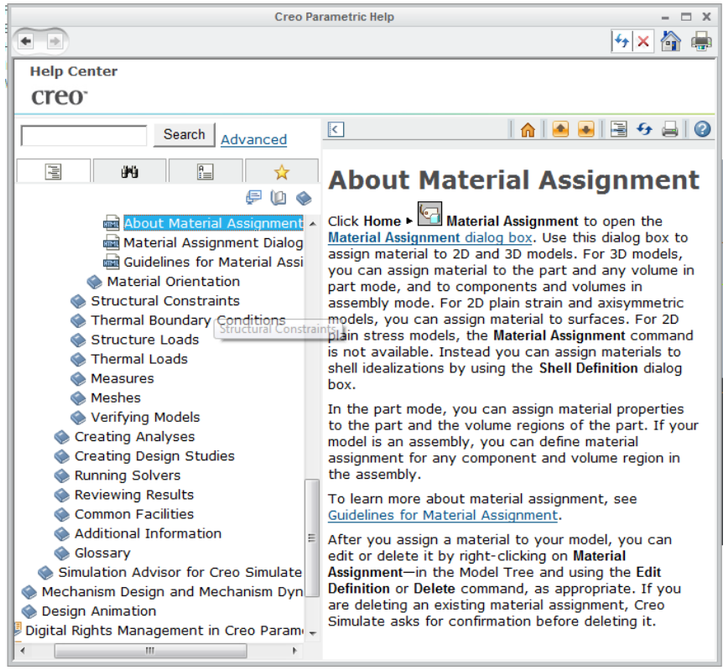
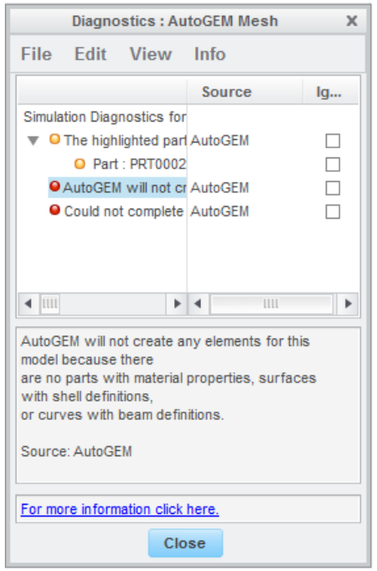
- Lightweight Assembly Representations in PTC Creo Simulate
- Online Help Links in Diagnostics
- Speedup of Dynamic Analysis Calculations
- General Performance Tuning







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PTC Creo Simulate 3.0 Enhancements

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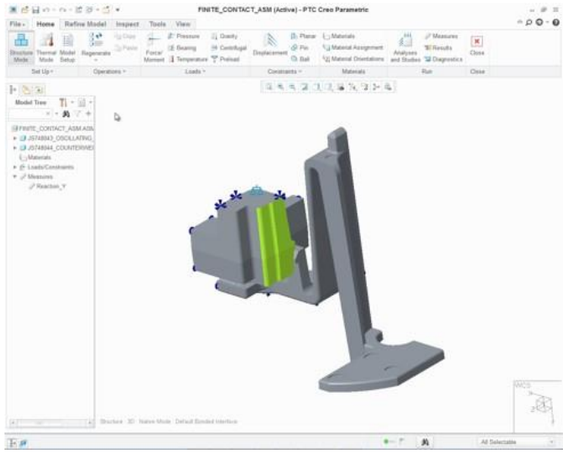
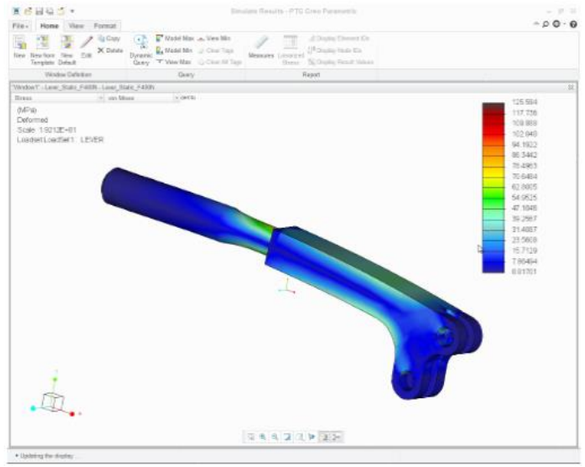
One of the most exciting releases of PTC Creo Simulate – Over 30 Enhancements

- Simulation Definition
  - **Sliding Contact with Friction**
  - **Fracture Mechanics**
  - Fastener Preload
  - Split Surface
  - Support of Ball Planar and Pin Constraints in LDA
  - Weighted Links in 2D
- Usability
  - **Support Multi-CAD in Creo Simulate**
  - Support Models with Failed Features
  - Improved Object Display
  - **Diagnostic Enhancements**
  - Analysis Node in Model Tree
  - Unicode Support
- Fatigue Advisor
  - Multiple Load Sets
- Results
  - **Updated Results Window**
  - Enhanced Linearized Stress

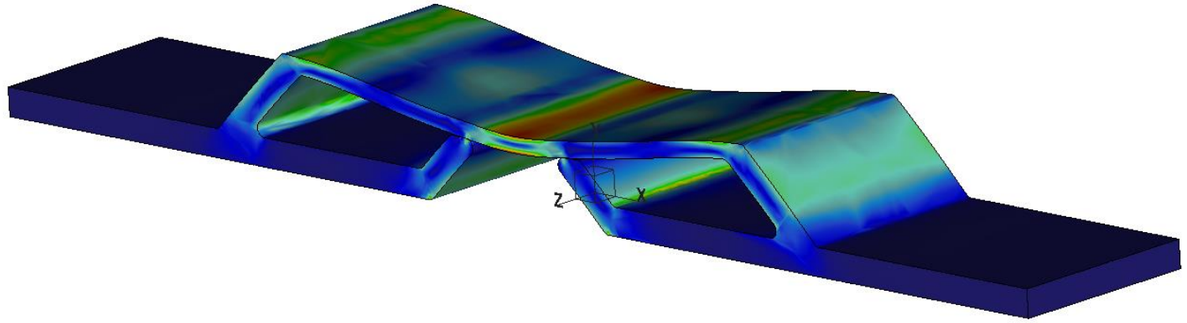


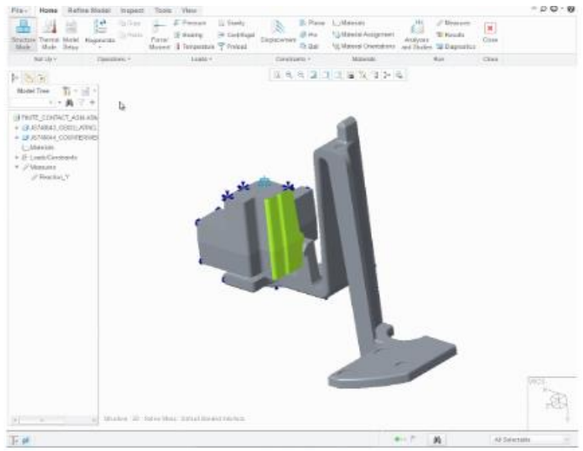


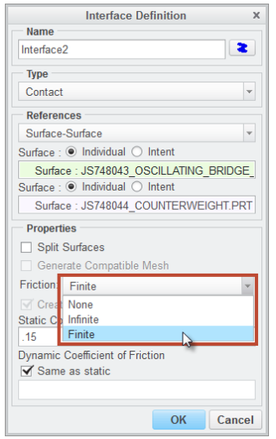
Sliding Contact with Friction

Capabilities

- Users can apply a finite friction contact interface between two surfaces or components
  - Applies for both 2D and 3D Models
  - Performs a nonlinear large displacement analysis
  - Requires Simulate Advanced License
- Users are able to specify define different values for Static and Dynamic coefficients
- Maximum Tangential Traction per contact interface is calculated as an automatic measure – in addition to normal force, contact area and the slippage coefficients
  - <INTERFACE#>_tang_force







Benefits

- Determine if sliding has occurred between components
- Determine the tangential force load transferred across each interface
- Improved analysis results

Simulation Definition

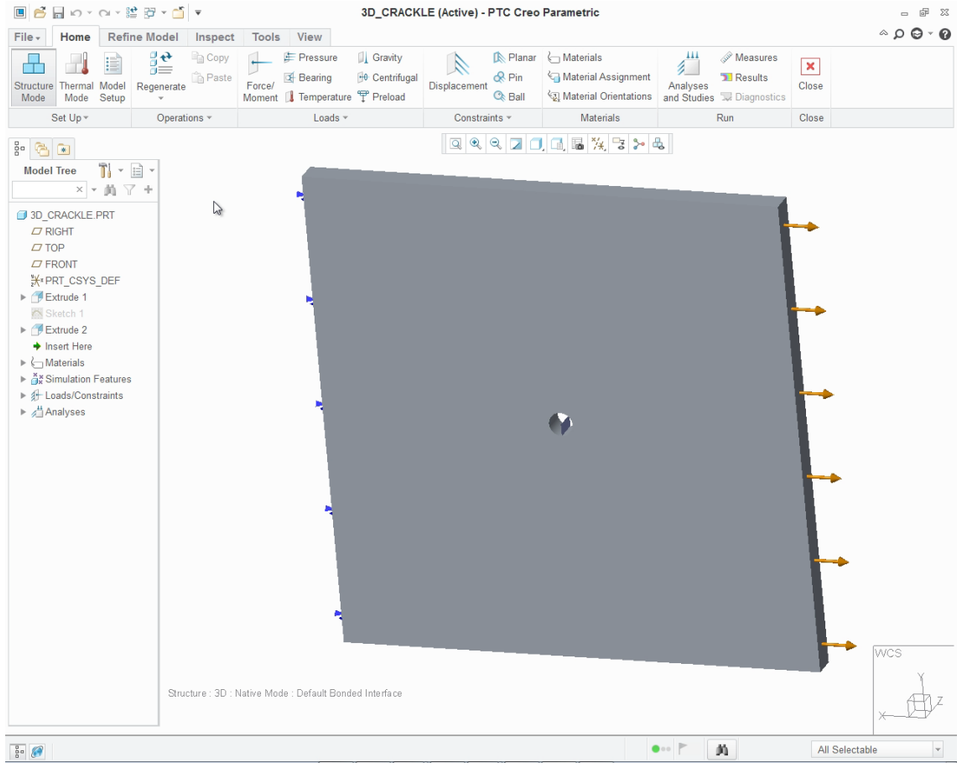
Fracture Mechanics

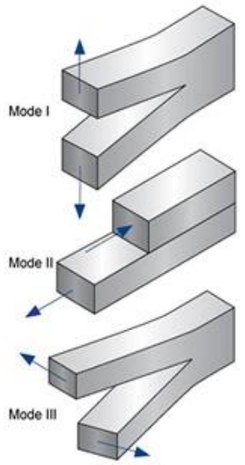
Capabilities

- New Crack Idealization available in both Structure and Thermal modes
  - Select curve references for 2D models and individual surfaces for 3D models
- Simulate checks are introduced to evaluate if there is a crack that cuts through the entire model.
  - If so, a warning appears in the Diagnostics dialog box for the analysis.
- New measure - Stress Intensity Factor
  - Mode I (Opening) for 2D models
  - Mode II (Sliding) for 2D models
  - Mode III (Tearing) for 3D models

Benefits

- Determine if initial cracks in your model will grow under specified loading conditions
- More predictable results

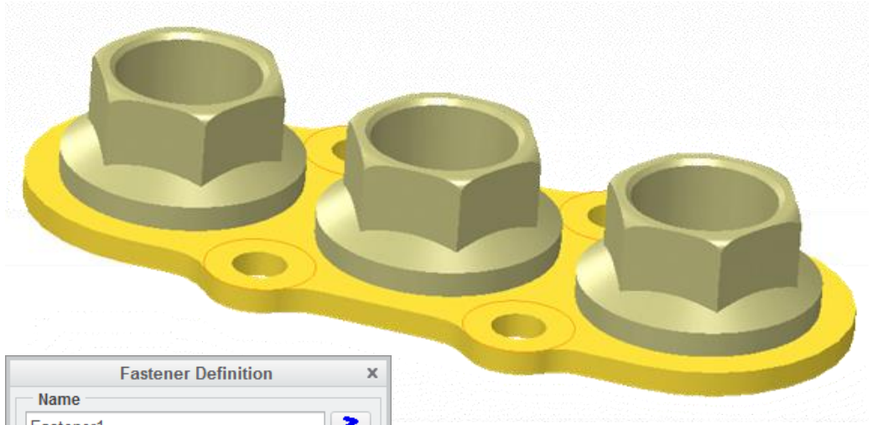


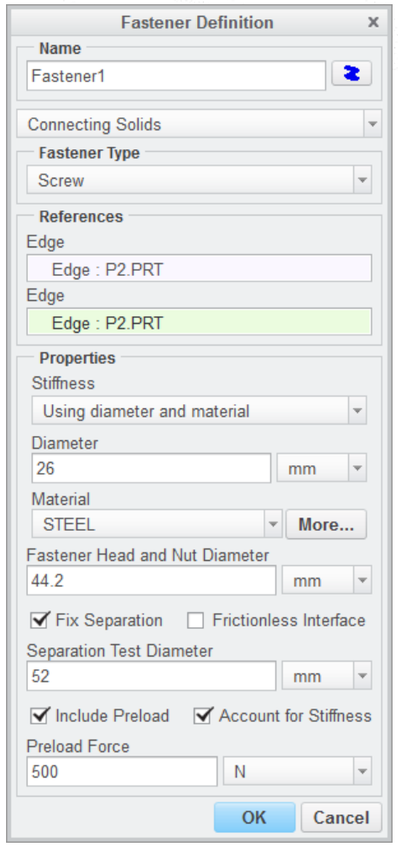


Fastener Preload

Capabilities

- More accurate preload modeling
  - Requires Simulate Advanced License
- Account for the stiffness of the structure
- Automatically iterate with scaled loads to achieve fastener preloads at target values





Benefits

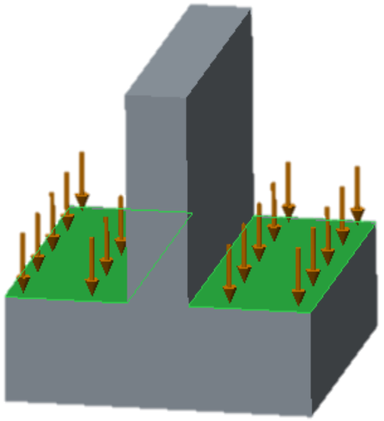
- Preload force is applied to the deformed model providing more predictable results
- Reduces the need for users to manually calculate and scale the preload force

Simulation Definition

Productivity Improvements

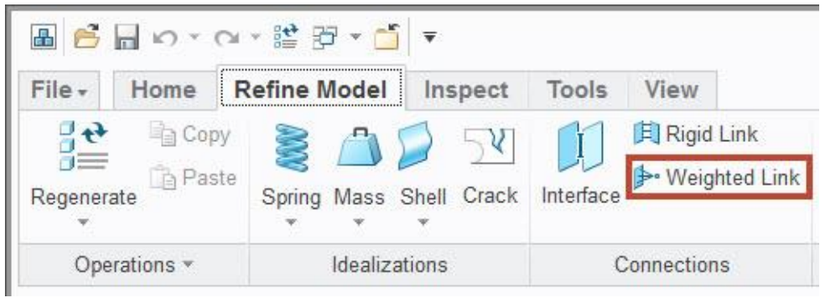
Capabilities

- New Simulation Feature type: Split Surface
  - Functionality also available in Creo Parametric
  - Creates new surface from a single contour of multi-contour surface
  - Similar to Surface Region
- Ball, Planar, Pin Constraints in LDA
  - Extending capability that is available in SDA
- Weighted links for 2D analyses
  - Extending capability available in 3D mode



Benefits

- Enables the ability to apply different loads/constraints to the model without the need to remodel the geometry
- Extends functionality to other areas of PTC Creo Simulate providing flexibility for users



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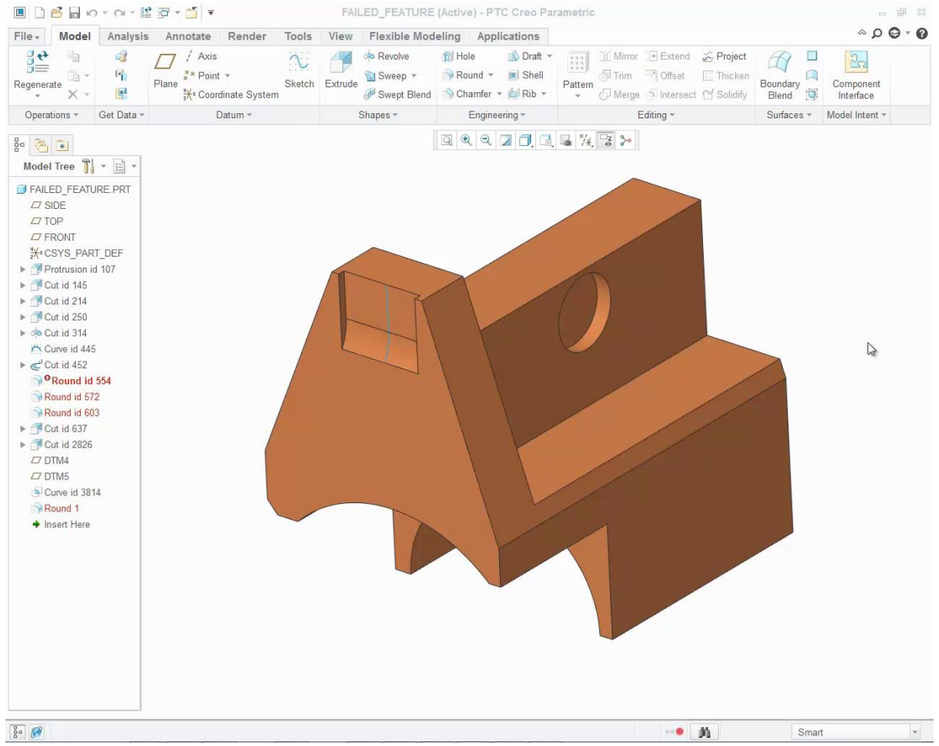
Support Models with Failed Features

Capabilities

- Users will now have the ability to define, modify and analyze models containing failed features
  - As with PMA, all failed features will be shown in Red in the model tree
- Users will be presented with a warning message indicating the model has failed to regenerate
  - Traffic light shows red at the bottom of the screen
- Users will be limited to running analyses or standard design studies
  - Sensitivity or optimization design studies will not be available if the model has failed features



Benefits

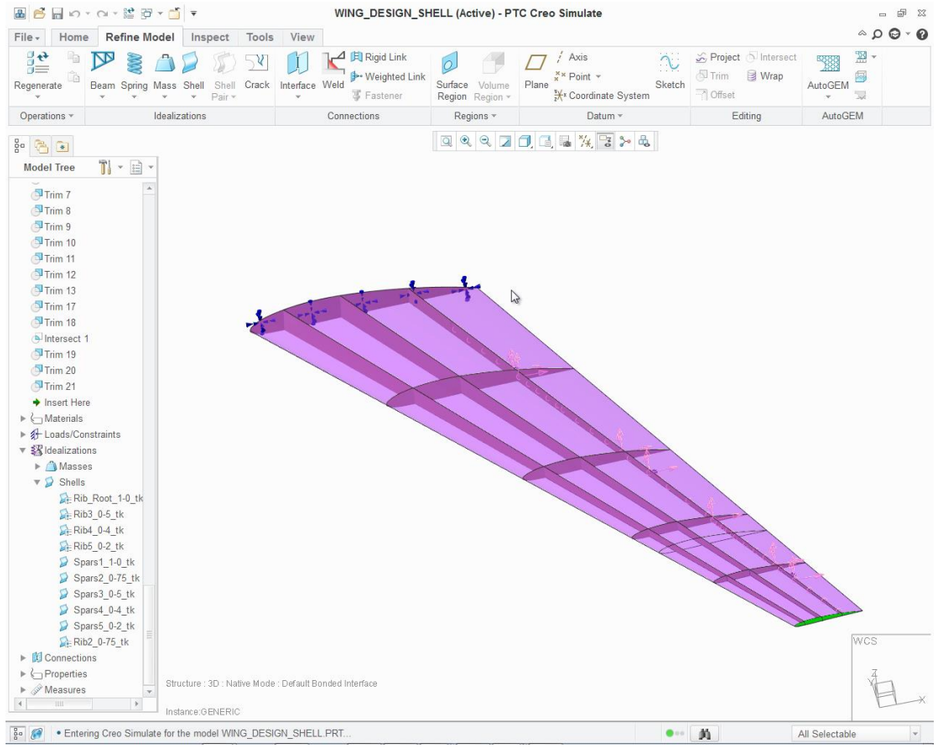
- Improved productivity and user experience
- Users do not need to resolve failed features to access PTC Creo Simulate

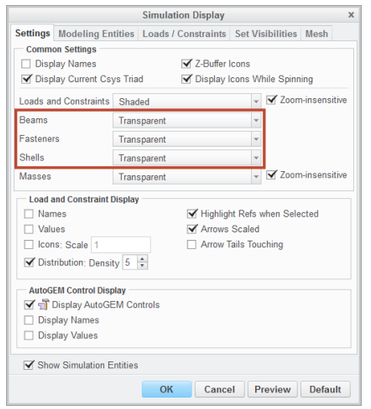
Usability / User Experience

Improved Object Display

Capabilities

- Idealizations
  - Shells
    - Thickness displayed when user selects the shell
  - Beams
- Connections
  - Fasteners
- Objects will be shown as transparent
  - Users can change the display to wireframe or solid via the Simulation Display dialog





Benefits

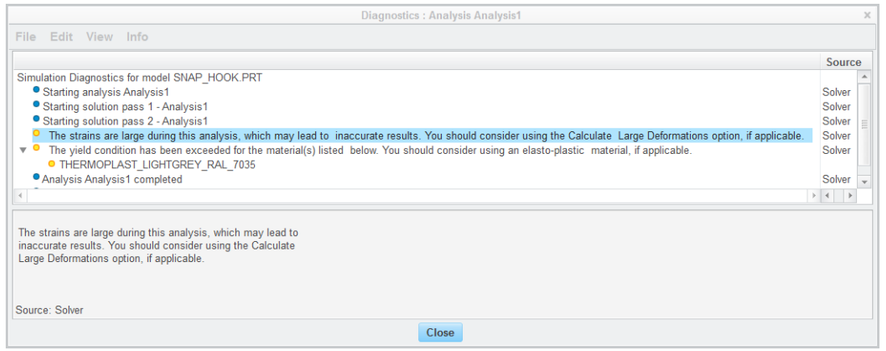
- Improved visualization
- Improved productivity and user experience

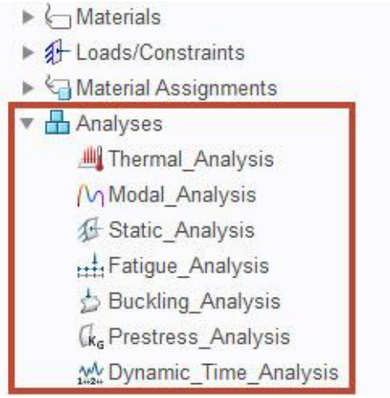
Usability / User Experience

Productivity Improvements

Capabilities

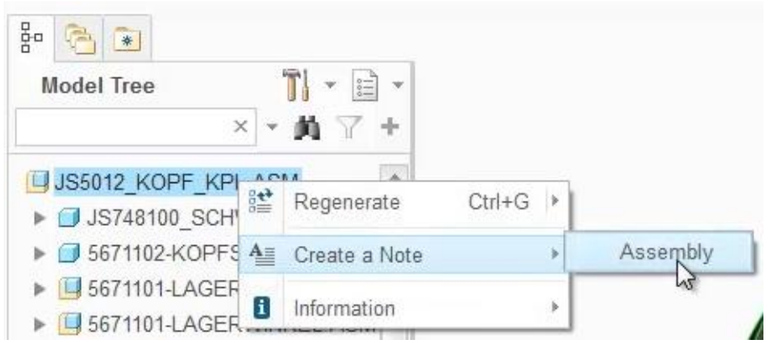
- Diagnostics enhancements
  - Warning when nonlinear effects may be important
  - Warning when properties vary widely – typo / wrong units?
- Analyses as nodes of Model Tree
  - Set the Tree Filters Option to display Structure and Thermal entities together
- Updated Material Orientation, Note UI
  - Same as PMA – does not require users to specify placement
- Unicode support
  - Multi-language support for entity names





Benefits

- Provide users tips on improving their results
- Easy display of Analyses saved in the model
- Productivity Improvements

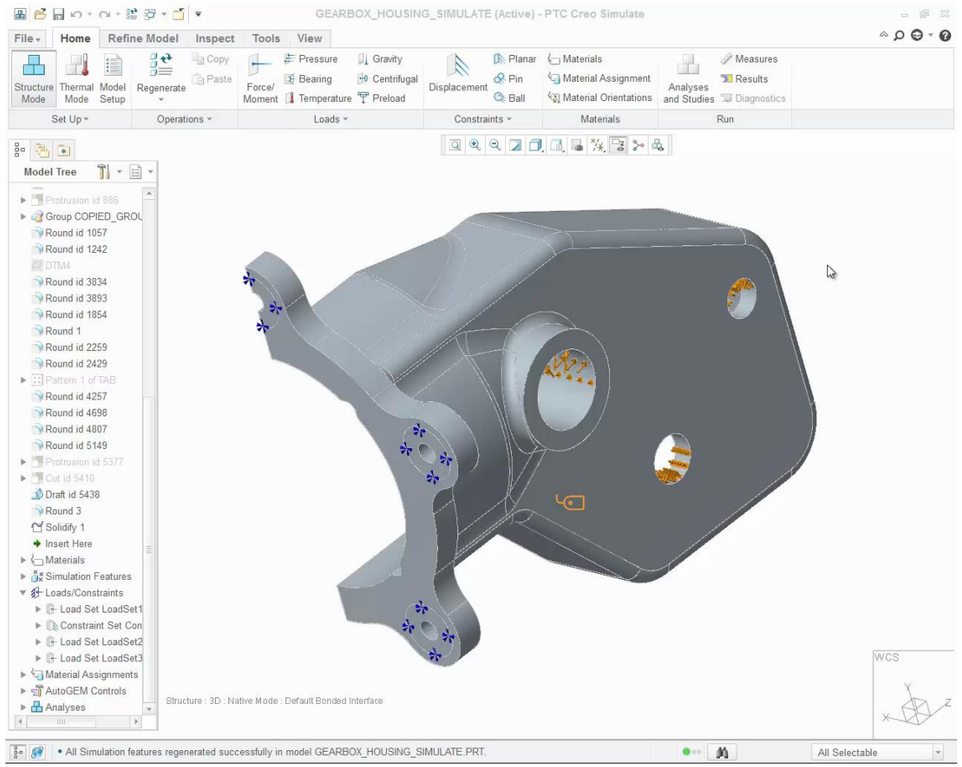


Fatigue Advisor

Multiple Load Sets

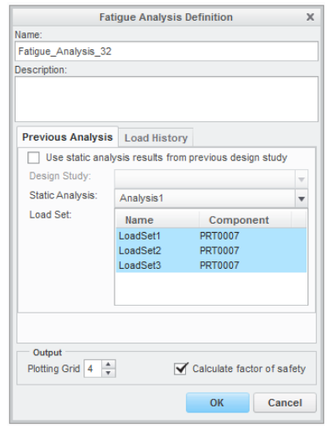
Capabilities

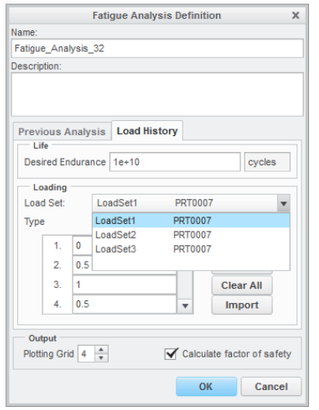
- Multi-load effects with independent histories
- Use of the latest solver from nCode with updated models



Benefits

- Users can properly group loads logically in their model and use them for the fatigue analysis
- Select which load groups to include in the analysis





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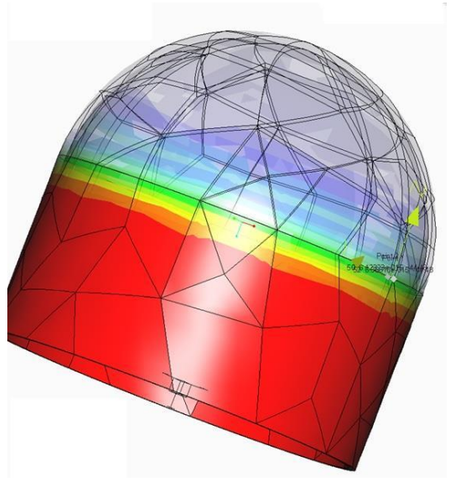
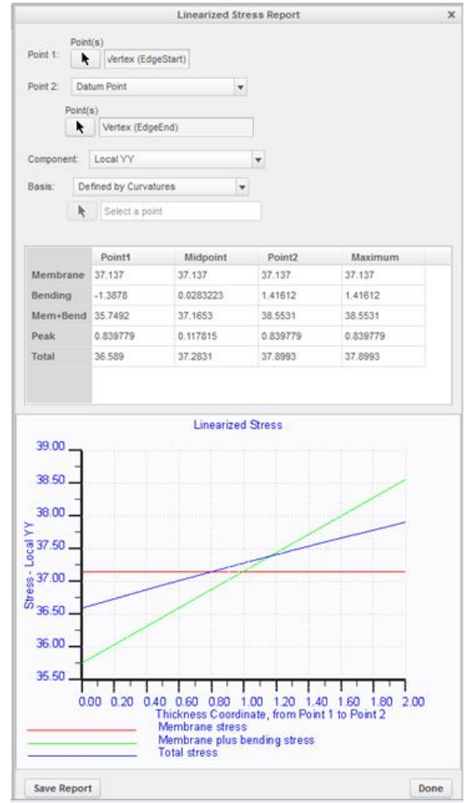
Linearized Stress Results

Capabilities

- Location selected on geometry, not tied to plotting grid
- Powerful, automatic methods to select direction of cross-section and basis
- Clear, graphical display of components
  - **Membrane** - Overall average stress
  - **Bending** - The difference in the stress from the inside point to the outside point
  - **Mem+Bend** - The sum of the **Membrane** and **Bending** numbers
  - **Peak** - The highest stress found along the line





Benefits

- Improved productivity and user experience
- Easily selection of reference on the model

Retirement of Independent Mode

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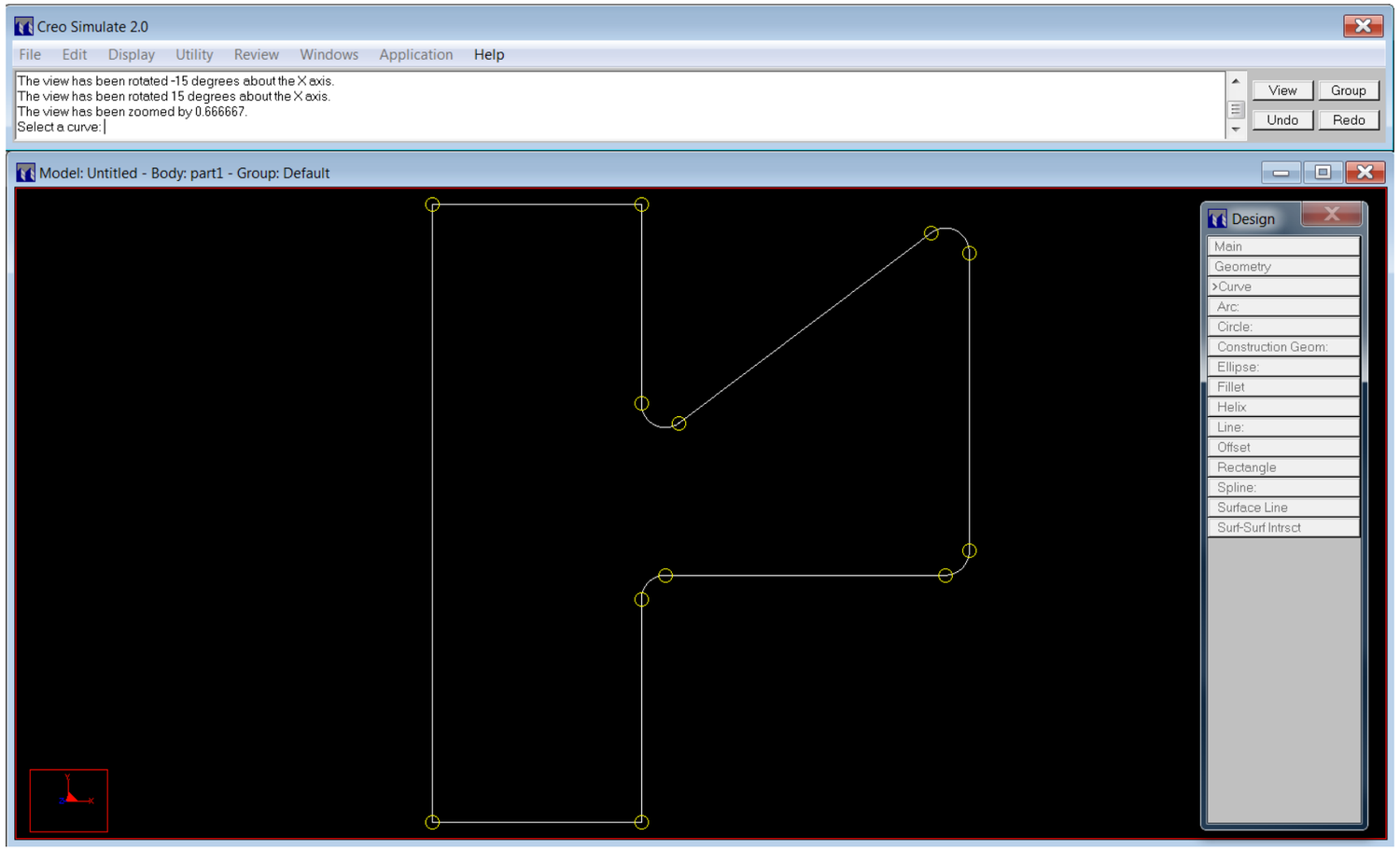
Tech Support Bulletin – May 6th, 2012

- Independent Mode of PTC Creo Simulate will no longer be available with PTC Creo 3.0
  - All the core capabilities have been successfully implemented into PTC Creo Simulate 3.0



Agenda

PTC Creo Simulation - Product Strategy

A Look Back: Highlights from Previous Releases

PTC Creo Simulate 3.0 - Enhancements

PTC Creo Simulate - Future Directions

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