IRONCAD
## FASTEST AND EASIEST WAY TO 3D

**Truly Integrated
Multi-Physics**

IronCAD Integrated Multi-Physics Solution

IronCAD is pleased to exclusively announce the completely integrated Multi-Physics solution for IronCAD. "Multi-Physics for IronCAD" (MPIC) is the newest generation of integrated CAD/FEA for general entry level to advanced design simulations.

MPIC focuses on ease of use for CAD users and provides fully coupled multiphysics with stress, thermal, and electrostatic which includes the following analysis types:

- Static/Steady State
- Dynamic/Transient Response
- Modal/Vibration Modes
- Instability Buckling
- Frequency Domain
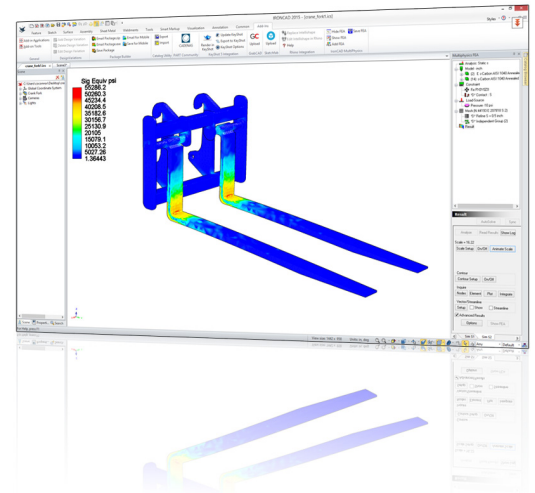
As part of the IronCAD Gold Partner Program, MPIC is included with full product capabilities with the standard IRONCAD solution for 30-days then extends as a node-limited version allowing you the ability to experiment with your designs. Even though the extended version is node-limited, MPIC's technology using SefeaTM (Strain-Enriched Finite Element Analysis) gives you extended capabilities to test your products at a lower mesh level. SefeaTM is the newest enriched finite element formulation developed specifically for low-order 4-node tetrahedron elements commonly used in CAD simulation. It achieves the same accuracy as 2nd-order elements, but is more robust, without mid-side-node noise, and requires much less computing cost.

Seamlessly integrated, simply add a multi-physics analysis to your IRONCAD model. Add material, forces, constraints, and hit the AutoSolve to quickly mesh and return your analysis results. Make modifications on the IRONCAD model and associativity will allow you to simply update and re-solve your analysis in seconds.

Beyond the included version, options to purchase full accuracy levels, advance versions, and add-on functionality are available.

- MPIC Basic includes full mesh quality controls with static/steady state and natural modal vibration extraction for product assembly analysis.
- MPIC Advance provides additional large deformation and large rotation abilities, as well as advanced nonlinear modeling ability of nonlinear elastic, plastic, hyperelastic/foam materials with fully runtime coupled nonlinear material dependency.
- MPIC Advanced Dynamic Add-on adds advanced Stress Stiffened Modal analysis, Arc-Length Nonlinear Buckling, Frequency Domain analysis, and Fatigue analysis for advanced analysis options.
- MPIC Fluid Add-on expands the fluid dynamic physics to the existing stress, thermal and electrical and works seamlessly to investigate flow physics impact with ease.

MPIC is an advanced multithread FEA design application with fast solver technology that can process large models with millions of equations in minutes. MPIC is developed and designed specifically for CAD design simulation by AMPS Technologies Company.

3D Technical Specifications

Unique Methodologies

- Innovative Part Design, Intuitive feature history with flexible design intent
- 3D Dynamic Modeling, Mixed feature based and direct editing design
- Single scene part and assembly environment
- IntelliShape™ Handled based design editing
- IntelliShape Modeling Intelligence, Advanced modeling settings connected to features
- SmartSnap™ Technology enabling automatic catching to existing geometry
- SmartAssembly® Technology for automatic positioning, sizing, and orientation of parts, and assemblies
- DesignVariation™ parametric and property configurations at any part, feature, and assembly level
- TriBall® advance positioning and operation tool
- Catalog based design environment for drag and drop design
- IntelliStretch™ dynamic resizing for assemblies/parts
- Dual Kernel Support and Kernel collaboration (ACIS and Parasolid)
- Support both top-down and bottom-up design process

CAD Interoperability

- Native file translators to and from nearly all mechanical CAD products and graphical applications on the market today: CATIA® V4 & V5, SolidWorks®, CREO®, IPT & IAM (Autodesk Inventor®), Unigraphics®, IGES, STEP, X_T (Parasolid®), SAT (ACIS®), VRML, STL, DWG, DXF™, EXB (CAXA DRAFT), TIFF, JPG, PNG, TGA, BMP, EPS, HSF (Hoops), 3DS (3D Studio), POV-Ray, Raw, Romulus, TrueSpace, OBJ (Wavefront), 3D PDF
- Supported standards: ANSI, DIN, ISO,JIS, and GB

Part Modeling

- Feature based, parameterized solid modeling
- Scene Browser dynamic design tree (e.g. re-order, drag & drop, etc.)
- Property Browser direct input and context based actions
- Quick Access contextual pop-up hotkey commands for in-place design creation
- In-place editing of features, parts, and faces.
- History Independent referencing to part geometry
- Integrated sketching with dynamic optional constraints

- Extrudes, revolves, feature patterns, holes, etc.
- Advanced 3D operations, e.g. lofting, sweeping, complex blending, chamfering, etc.
- Advanced shelling, trim operations, and Boolean operations
- Catalog based functional features, e.g. Custom Holes, Fasteners, Gears, Bearing, etc.
- Direct Face modification support for native features and imported data.
- Support for creating 3D models from existing 2D data, e.g. 2D-to-3D extrusion, etc.
- Multiple design variations with Configuration Management support

Assembly Modeling

- Flexible Assemble and Disassemble support
- Complete range of mating conditions, snap-to-fit SmartAssembly® Technology
- Cross parent constraint relation support
- Real-time Collision Detection and Interference Checking
- Multiple sub-assembly support
- Easily design-in-the-context of an assembly
- Easy designing and changing of parts and subassemblies from within an assembly
- Mirrored components to create new parts and assemblies based on existing designs
- Multiple assembly design variations with Configuration Management for easy "what if" design scenarios
- Statistical analysis support for mass, center of gravity, and moments of inertia

Communication

- Photo-Realistic real-time realistic settings with Image export
- Advance Photo-Realistic Rendering Engine
- Drag and Drop color and image capabilities
- Drag and Drop animation support
- Key Frame animation manipulation and advance animation positioning with TriBall

Multi-Physics Technical Specifications

Finite Element Pre-/Post-Processing

- Complete on-line documentation with direct immediate context-sensitive help
- Intuitive, friendly and familiar office-tool menu/dialog GUI design
- Extensive interactive inquiry, integral, and history plotting abilities
- Fast result animation with pause, forward. backward, auto stepping controls
- Interactive real-time cutting plane and result contouring with cut-planes integration option.
- Vector, streamline, deformation animation and display/plot
- Automatic AVI movie and bitmap generation
- Model Database (MDB) Library for advanced user result inquiry/processing
- Interactive contour slide-bar control for dynamic contouring range slicing to easily identify critical peak results
- Dynamic streamline slide-bar controls to quickly understand the physic of heat flow, flow line, and many 3D physics
- Fast and robust automatic CAD to finite element meshing with intelligent automatic refinement for general users.
- Conveniently automatically generates Analysis Report for overall model description and result analysis in an easy to understand HTML report of text and graphics.

Finite Element Features

- **Continuum Stress**
  - Static/Steady State Linear/Nonlinear
  - Dynamic/Transient
  - Natural frequency/Modal
  - Harmonic response
  - Buckling
    - Euler linear, Nonlinear in-situ, Collapse searching
  - Automatic contact without any legacy user intervention
  - Local coordinate for convenient load and boundary condition definition
- **Thermal**
  - Steady-state
  - Transient
  - Conduction
  - Convection
  - Radiation
  - Joule-heating, viscous heating, plastic work and contact frictional thermal coupling

- **Electrical**
  - Current-voltage
  - Dielectric-potential
  - LSFEA formulation without any spurious mode, directly coupled with stress/thermal/fluid physics
  - Joule thermal/stress coupling
- **Fluid flow**
  - Newtonian/Non-Newtonian incompressible flow
  - Conjugated thermal flow with directly coupled stress deformation effect
  - Advanced conserving optimal LSFEA fluid formulation without any numerical any numerical stabilization such as artificial viscosity or streamline upwinding.
  - Advanced boundary conditions for inflow, outflow, and spinning/rotational flow controls for convenient general fluid analysis and special pump/impeller design application.
- **Fully Integrated Multi-physics**
  - Fully coupled thermal, stress, and electrical physics in a unified Sefea element formulation
  - Thermal/Electric/Joule heating/Fluid/Solid/Thermal

Advanced Nonlinear Capabilities

- **Geometric**
  - Robust strain rate based formulation
  - Large deformation and rotation with robust co-rotational framework
  - Total Lagrangian and Updated Lagrangian method
  - Stress stiffening and spin softening nonlinear effect
  - Arc-length load tracing for posting buckling load softening applications
  - Moving Least-Squares (MLS) energy-based tying for general and flexible CAD bodies tying and for quick gluing of solid, face, edge and vertex to each other.
  - Robust general contact with friction
    - General surface-to-surface with automatic contact detection
    - Rigid/Semi-Rigid wall, Moving wall
- **Material**
  - Elastoplastic with isotropic and kinematic hardening
  - Incompressible rubber hyperelasticity
  - Hyperelastic foam
  - Viscoelastoplasticity
  - Mohr-Coulomb geological
  - All properties are run-time multiphysics state dependent and also on time/step scaling.

Multi-Physics Technical Specifications (cont.)

- **Element**
- Proprietary SefeaTM (Strain Enriched FEA) formulation using low-order triangle and tetrahedron element to achieve 2nd order accuracy and robustness, without the mid-side-node noise, and require much less computing cost
- Unified SefeaTM (Strain Enriched FEA) formulation for 2D/3D/Shell/rod/planar/axisymmetric multi-physics with fully coupled stress, thermal, fluid and electromagnetic physics in an integrated formulation.
- Sefea is currently the only accurate method for low-order tetra elements in CAE simulation.
- Least-Squared Eulerian fluid and electromagnetic formulation.

Fast Solution Methods

- **Iterative**
- Large capacity pre-conditioned conjugate gradient (PCGLSS) interactive solver solving millions of equations in minutes
- BiCG, TFQMR and GMRES options
- **Direct**
- Fast sparse direct with out-of-core ability
- Automatic system singularity check and failure recovery for load stepping refinement
- **Eigensolvers**
- Fast sparse Lanczos eigensolver for buckling and modal eigen value extraction
- Subspace Iterative method with Sturm sequence check

Versatile Boundary Conditions

- Automatic load marching, step restart and refinement control designed for realistic nonlinear analysis.
- Extensive load and boundary conditions
  - Point force, Line load, surface traction
  - Global/Local pressure
  - Surface flux/Charge/Source term
  - Rigid body rotation/translation
  - Prescribed unknown
  - Convective/Radiative thermal flux
  - Nodal stiffness/Mass/Damping
  - Advanced Tie/Glue with direct specification on solid model
  - Single/Multiple constraint equations
- All boundary conditions are time/step scalable and with active/inactive duration control;
- All load types can be scaled by automatic arc-length automatic load marching for post-buckling and softening analysis

- User defined local coordinate system applicable to all boundary conditions
- Cylindrical, Spherical, and geometry normal local coordinate system for flexible load/constraint specification

Software Engineering

- Multi-thread, object-oriented modules developed with the best software engineering design
- Easily run on notebooks, inexpensive desktops, and fast multi-core/multi-CPU workstations.

About AMPS

AMPS (Advanced Multi-Physics Simulation) Technologies Company was established in 2003 with a main goal to provide new generation FEA to deliver advanced office-tool style finite element software based on best software engineering design and the most up-to-date FE technology.

AMPS Technologies has pioneered SefeaTM (Strain-Enriched FEA) formulation and LSFEA (least-Squares FEA) technology in commercial applications with leading academic and national laboratory researchers and has expanded the technology to stress, thermal, fluid and electromagnetic applications using a consistent framework. As such, AMPS is the only product on the market with the accuracy, reliability, and true multiphysics abilities in CAD-centric analysis when automatically generated low order tetra elements are the favored options.

AMPS Technologies has been shipping AMPS to customers such as Canon, Casio, Hitachi, IBM, Mitsubishi, Olympus, Sharp, Sony, Toshiba, Bridgestone-Firestone, and many prestigious universities for multi-physics simulation. These elite customers have helped drive AMPS product development even further.

Options are available to purchase licensed versions of the functionality to meet your design needs. For purchasing options, please contact at 1-800-339-7304 (sales@ironcad.com) or your local reseller (http://www.ironcad.com/index.php/how-to-buy/locate-a-reseller).

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Multi-Physics for IronCAD
Package Configurations

Features		Multi-Physics Package Options				
Group	Feature	Starter (Free)	Basic	Advance	Dynamic Add-on	Fluid Add-on
Physics						
	Stress	■	■	■		
	Thermal	■	■	■		
	Electro	■		■		
	Fluid	■				■
Mesh						
	3D, Shell, 2D (Plane Stress/Strain, Axisymmetric)	2000 Node Limited	■	■		
Analysis Type						
	Static/Steady-state	■	■	■		
	Dynamic/Transient	■		■	■	
	Modal Vibration Modes	■	■	■		
	Modal w/ Stress Stiffening	■			■	
	Buckling	■		■	■	
	Frequency Domain Response	■			■	
Material						
	Elastic Isotropic	■	■	■		
	Thermal Isotropic	■	■	■		
	Nonlinear Elastic/Anisotropic	■		■		
	Elastoplastic with kinematic/isotropic hardening	■		■		
	Anisotropic Thermal/Electrical	■		■		
	Hyperelastic Rubber/Foam	■		■		
	Mohr Coulomb Plasticity	■		■		
Other						
	Non-linear/Large Deformation	■		■		
	Tie/Glue (body, face, edge, vertices)	■	■	■		
	Contact	■		■	■	
	Rigid/Semi-Rigid/Moving Wall	■		■	■	
	Centrifugal/Rotating Systems	■	■	■		
	Spinning/Forced Fluid Rotation	■				■
	Arc-length Load Marching/Nonlinear Buckling	■		■		
	Analysis Report	■	■	■		
Solver						
	Sparse Direct, PCGLSS Iterative	■	■	■		
	Multiple CPU (over 2) and over 8 threads	■	■	■		

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