MSC Apex | Generative Design

Automated lightweight design optimisation

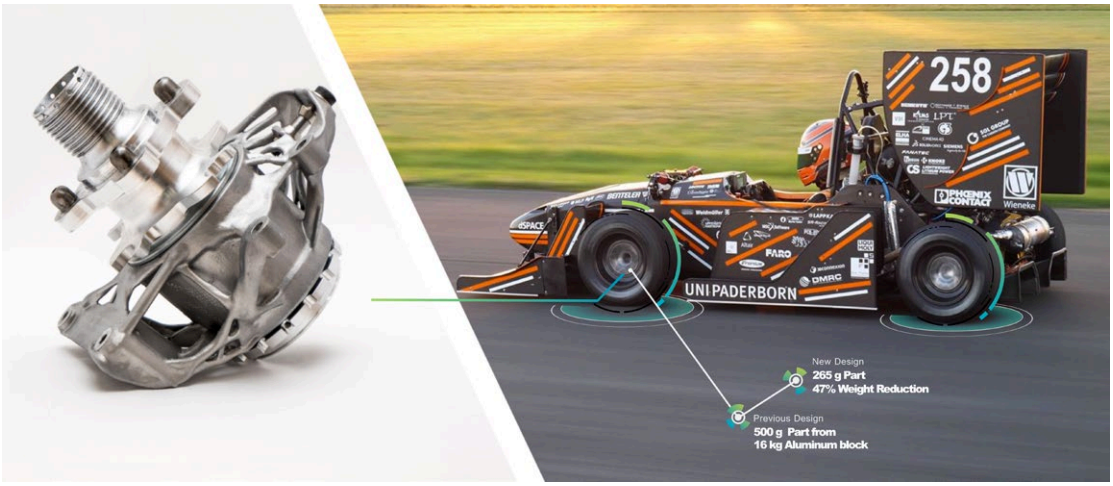
MSC Apex Generative Design is the fully automated generative design solution built on the intuitive CAE environment of MSC Apex. It exploits its easy-to-use and easy-to-learn features while employing an innovative generative design engine in the background. This combination of advantages dramatically decreases the effort required in the design optimisation workflow.

MSC Apex Generative Design is designed specifically to generate the detailed and highly complex structures that only additive processes can manufacture. The innovative, stress-based algorithm derives distinct geometries by minimising mass, creating geometries that are truly unimaginable by the human mind.

- Automated design: Almost automatically generate multiple smoothed design candidates that all satisfy the design criteria while minimising the weight.
- Simplicity: No expert knowledge required for conducting optimisations through a high user-focused software design.
- Import and validation: Import existing geometries or mesh, find optimised design candidates, and perform design validation – all inside a single CAE environment.
- Direct output: Export geometry that can be directly manufactured and used immediately without manual rework.
- One process: Import the resulting geometries in Simufact Additive or Digimat-AM to achieve cost-efficient first-time-right result for every part and validate them with MSC Nastran or MSC Apex Structures.

Productivity gains

A race car's wheel carrier with 9 load cases was optimised within 6 hours instead of usually more than 1.5 weeks of work. The optimisation's result is an already smoothed geometrically and mechanically correct design that is ready for manufacturing. By cutting the weight through the optimisation to almost 50%, production runtime and costs were significantly reduced. Through a production with additive manufacturing, scrap can be significantly reduced which increases the overall sustainability of the car.



Capabilities

- Import CAD files
- Direct and fast creation of (multiple) optimisation model(s)
- Automated optimisation process of linear static load cases
- Integrated smoothing for clean surfaces & perfectly shaped transitions between struts and shell structure
- Significant weight reduction through a stress-based algorithm
- Generative design studies to create a variety of results in a short time
- Directly transfer the result to native CAD format based on NURBS
- Solving on CPU, Nvidia GPUs and remotely on Windows
- - Local coordinate systems, pressure, gravity
- - Simulation of isotropic and non-isotropic material (3D transversely isotropic and 3D orthotropic material)

Benefits

- New, innovative design mindset – no manual construction necessary
- Easy-to-use software does not require an extensive training period
- Cost savings through a much more efficient process of product design.
- Multiple design candidates generated based on optimisation settings
- Direct and feasible part design output
- Generated results are tailored for a direct AM production and utilise the technology's potentials
- Interoperability for mechanical integrity validation and manufacturability
- Generation of highly complex, organic shaped lightweight designs for reduced production and operation costs.
- Leaner production and more efficient parts increase the company's sustainability.

MSC Apex | Modeler

Direct modeling and CAD-and-Mesh solution

MSC Apex Modeler is a CAE specific direct modeling and CAD-and-Mesh solution that streamlines CAD clean-up, mesh creation and attributes setting workflow. The solution features sophisticated and interactive tools that are easy to use and easy to learn.

- Smart tools: MSC Apex features a complete set of direct modeling tools to make geometry clean-up and idealization steps in an extremely fast and efficient manner. Simply select the entities of interest and push/pull or drag to implement any modifications. Such tools allow users to clean up geometry without any prerequisite experience and can reduce the number of user operations by a factor of 10.

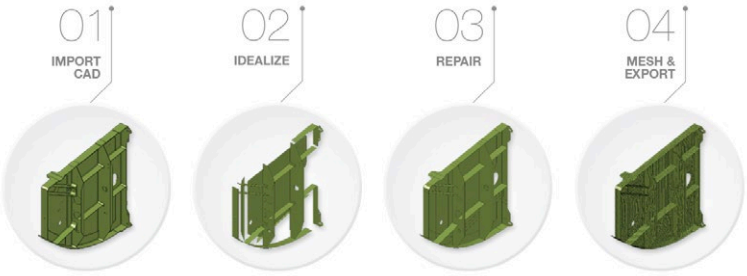
- Product workflows: MSC Apex has also been architected with smart FEA/CAE workflows in mind. A representative example is the smart mid-surfacing capabilities that enable the fast converging of 3D FEA models to 2D models. Users can easily achieve 10x productivity gains in a typical CAD to analysis-ready FEA workflow by employing the workflows provided by MSC Apex.

- Underlying technologies: MSC Apex incorporates a generative framework to enable full associativity between the geometry and analysis data. Once the 'upstream' object has modifications, the change will be synchronized to 'downstream' objects automatically, including mesh, attributes, and even simulation results. This Direct-modeling is unique in the CAE industry and provides a tremendous user experience benefits.

- Easy to use, easy to learn: MSC Apex is designed to have multi-purpose tools to make the application easy to use. It also features numerous learning aids such as tutorials, video-based documentation, workflow, and at-mouse instructions which promotes single day productivity

Productivity gains

Geometry creation and meshing of this aerospace bulkhead required 50 hours with conventional CAE tools. In MSC Apex Modeler, the process only took 5.5 hours and required little effort to extract mid-surfaces, connect separate surfaces, mesh, and assign thicknesses and offsets.



	Today's Workflow	MSC Apex Workflow
Expertise Required	High	Low
Analysis geometry creation	35h	3h
Mesh creation	3h	2h
Property Assignments	12h	0.5h
Complete entire scenario	50h	5.5h

Capabilities

Sketching

- Sketch lines, squares, circles, ellipsoids, fillets, chamfers, and high-order geometries
- Project, split, and edit existing sketches

Geometry edits with direct modeling

- Identify features and automatic defeature
- Interactively edit solids and surfaces with Push/Pull or Vertex/Edge drag
- Split and fill surfaces
- Add/Remove and Suppress/Un-suppress vertices or edges
- Support automatic part replacement in an assembly

Midsurface creation and repair tools

- Extract mid-surfaces by auto offset, constant thickness, distance offset, or tapered methods
- Incrementally build mid-surfaces of uniform or non-uniform thickness for planar or curved solids

Geometry extraction from orphan mesh

- Generate, modify and re-use/re-mesh faceted and 'real' NURBS geometry from legacy FEA models
- Modify and update facet geometry zones with user control
- Recognize 2D and 3D features for subsequent geometry edits
- Export retrieved geometry to widely used file format

Meshing and mesh editing

- Mesh curves, surfaces, and solids, available element types: Beam, Quad, Tria, Tet, Hex
- Regenerate meshes automatically as geometry is modified
- Refine meshes with Feature Base Meshing, mesh Seeding and mesh control curve
- Construct Hard Points to facilitate part connection
- Mesh surfaces via paver, 4 side map, or 4+ side map mesh methods
- Visually inspect element quality

Model attribution

- Material Creation and Assignment
- Behavior Creation and Assignment
- Automatic creation of thickness and offset properties for uniform and non-uniform cross sections
- Definition of interaction tools, including Ties and Discrete Connectors
- Definition of gravity load, point load, enforced motion, constraints, and press load

Interoperability with gold-standard solvers

- Continuously extended import, export and MSC Nastran-generated data support
- "Abstraction" concept for closer Apex/MSC Nastran integration
- Support access to Adams/Car model/results data for post-processing
- Enable Geometry association and loads mapping between Adams/Car result data and structural FEA model in a single environment

Productive post-processing

- Embed image/movie capture function in GUI
- Enable multi-view result exploration environment

Automation via Python-based API

- Allow user-defined tools to automate repetitive work and develop in-house workflow
- Provide full IDE support
- Support Macro record and reply without coding

MSC Apex | Structures

Computational parts based structural analysis

MSC Apex Structures is an integrated module of a Finite Element Analysis solver, which provides users access to linear (and very soon, nonlinear) structural analysis. Currently, Apex supports four types of linear analysis, including linear statics, linear buckling, normal modes, and frequency response analysis.

MSC Apex Structures is a package with an intuitive user interface for scenario definition, analysis readiness check, and integrated solver. The integration of the user interface with solvers gives users a unique ability to validate and solve FEA models interactively and incrementally. This Incremental Validation and Solution philosophy is a creative and intelligent revolution to the very time-consuming traditional FEA workflow where pre/post processor and solver are separate.

With continuously extended supports of “MSC Apex - MSC Nastran - MSC Apex” workflow, users can pick the best scenario according to different design stages and tasks:

Scenario 1 – External MSC Nastran solution

Many existing MSC Nastran uses will determine to use MSC Nastran as an external solver, due to their in-house process and/or client requirements.

Scenario 2 – Integrated MSC Apex Structures solution to support external MSC Nastran solution

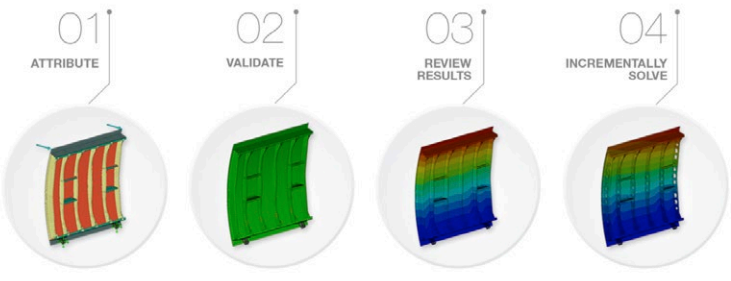
The integrated solver can be used for incremental building and validation of FEA models as they are developed. Once verified as working representations, the run-ready FEA models can be solved externally with MSC Nastran, for subsequent result exploration through MSC Apex.

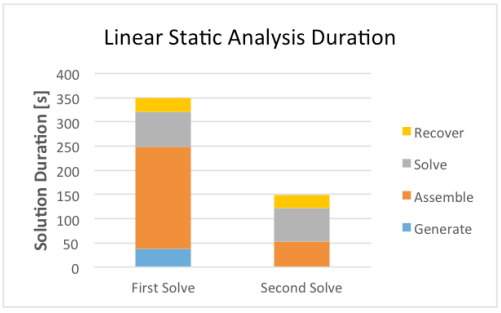
Scenario 3 – Embedded MSC Apex Structures solution

In the case where an MSC Nastran solution is not mandatory, the user can take advantage of the full capability of the embedded MSC Apex solver.

Productivity gains

Computational Parts technology was used to perform an incremental analysis of this landing gear door assembly. After modifying one part of the assembly, an incremental or subsequent analysis completed 2.5x faster than its first solve.



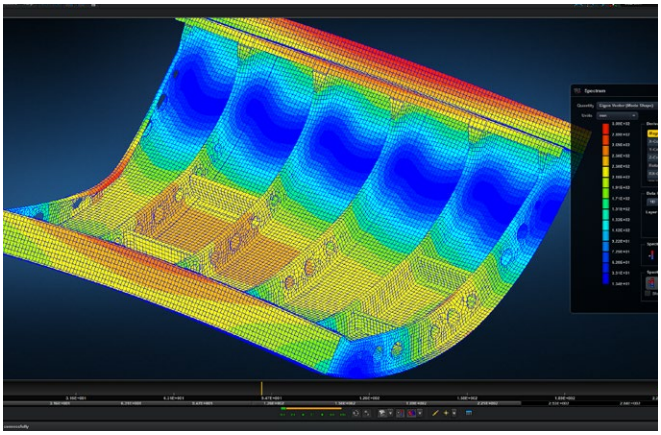


Capabilities

Linear structural analysis

Offer 4 types of linear simulations

- Linear Statics Analysis
- Linear Buckling Analysis
- Normal Modes Analysis
- Frequency Response Analysis



Incremental validation and solving

- Automatic Analysis Readiness check that covers geometry integrity, mesh quality, materials properties, loads and constraints, interactions, and simulation settings
- Manage multiple scenarios (model representations, output requests, analysis type)
- Context-specific calculation (Part, Sub-assembly, Assembly)

Generative framework

- Quickly update simulation results when “upstream” objects are modified