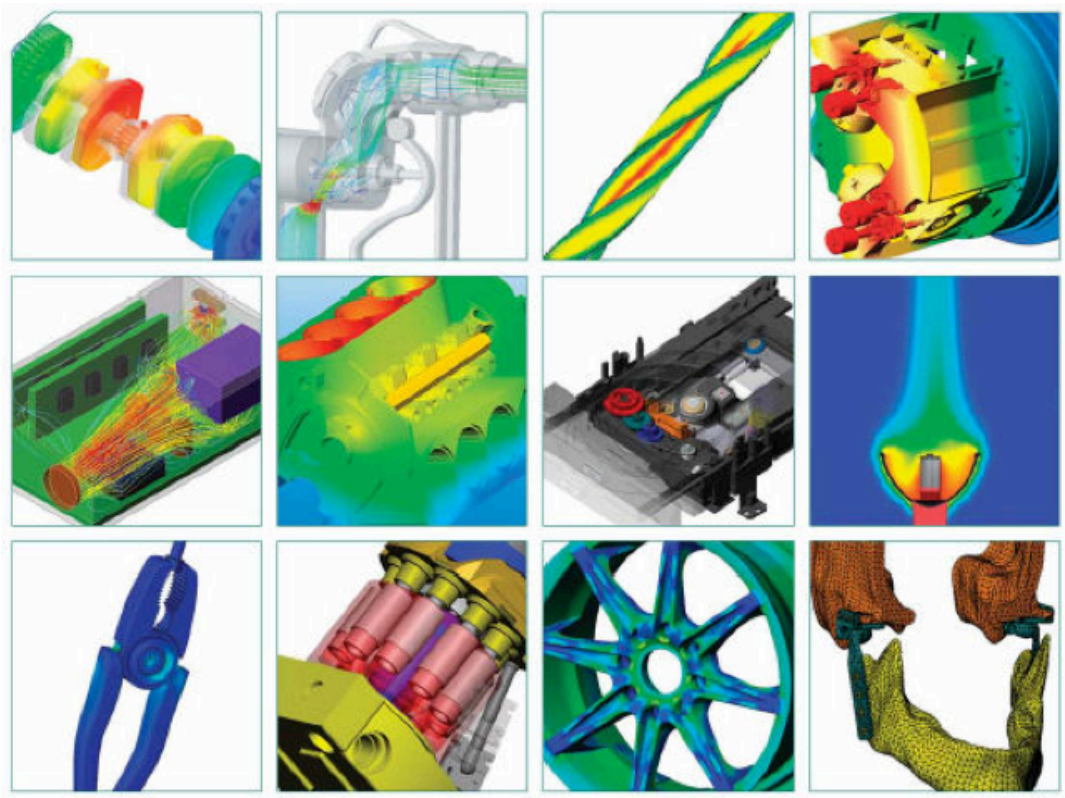
SIMULATION BUYER'S GUIDE

HAWK RIDGE SYSTEMS

Selection of analysis software can often be a daunting task. For any given situation there are multiple software products, technologies, and underlying strategies that can be considered to increase product performance and design efficiency. Each software product comes with its own set of limitations, assumptions, and methodologies that may or may not be appropriate for a problem.

Software providers don't make the task much easier, normally providing a list of capabilities that is heavy on technical jargon. Finding a resource that provides clear, concise information about what is actually possible in each tool set, and what the differences between options really mean to you as an engineer or designer can often be more challenging than completing the analysis itself.

This Hawk Ridge Systems Simulation Buyer's Guide aims to cut through all the clutter and jargon and present clear, actionable decision points to help you select what software is right for your application. We provide a range of software solutions available from SOLIDWORKS and Dassault Systèmes that help address different types of analysis problems, and identify the pros, cons, assumptions and limitations of each method.



Our Analysis Philosophy

At Hawk Ridge Systems and SOLIDWORKS, we believe that analysis should be accessible, accurate, and powerful, and in the hands of every engineer or designer who wants to use it.

We are mindful of three central philosophies:

- Simulation tools should be powerful, yet easy to use. Workflows should be clean, logical, and familiar to existing SOLIDWORKS users.
- Simulation tools should be integrated into the CAD environment. Changes that you make to the design should instantly be ready to be analyzed.
- We are a single source solution for everything you might need. We support, train, and implement everything that we sell, and we can help you with consulting assistance if you're not ready to buy the software. Whether your problem is related to CAD or analysis, Hawk Ridge Systems and SOLIDWORKS can help.

Hawk Ridge Systems has actively sought out a range of analysis tools for our customers to provide the most complete suite of analysis offerings – from simple and free analysis tools to highly competent multiphysics tools like SIMULIA Abaqus – to make sure we can provide our customers with analysis solutions to meet their needs.

Which Analysis Type Do I Need?

The nature of the engineering problem you are trying to solve determines the methodology that will make the most sense.

We characterize applicable engineering problems into one of six categories, and then discuss the approaches applicable to each category in detail. Skip to the section that corresponds to the analysis scenario you're trying to resolve.

Engineering Problem	Definition	Page
Static Structural Analysis	Response of components and structures subjected to mechanical loads (forces, pressures, torques, etc.) that are statically applied. Includes linear and nonlinear stress analysis, assessments of fatigue life, etc.	3
Dynamic Structural Analysis	Response of components and structures subjected to forces and accelerations that vary with respect to time. Examples include shock and vibration analysis, modal frequency extraction, and motion analysis.	8
Thermal Analysis	Investigation of how heat flows through components and environments, and how different heating or cooling strategies affect the thermal performance of a device. Consideration of thermal expansion and thermal stress.	13
Fluid Flow Analysis	Assessment of how gas or liquid flow moves around or through an object of interest – investigation of aerodynamic drag, lift, pressure drop in pipe and valve systems, performance of pumps and impellers.	16
Plastic Injection Molding Analysis	Simulation of the injection molding analysis process to help predict and correct potential defects including surface finish issues, sink marks and warp.	18
Optimization and Automation Tools	Tools to optimize the analysis procedure, automatically generating and executing analysis projects to explore the effect of different conditions on the results of the analysis, and adjustment of model geometry and assembly layouts to optimize model performance.	21

Section 1 – Static Structural Analysis

What does it do?

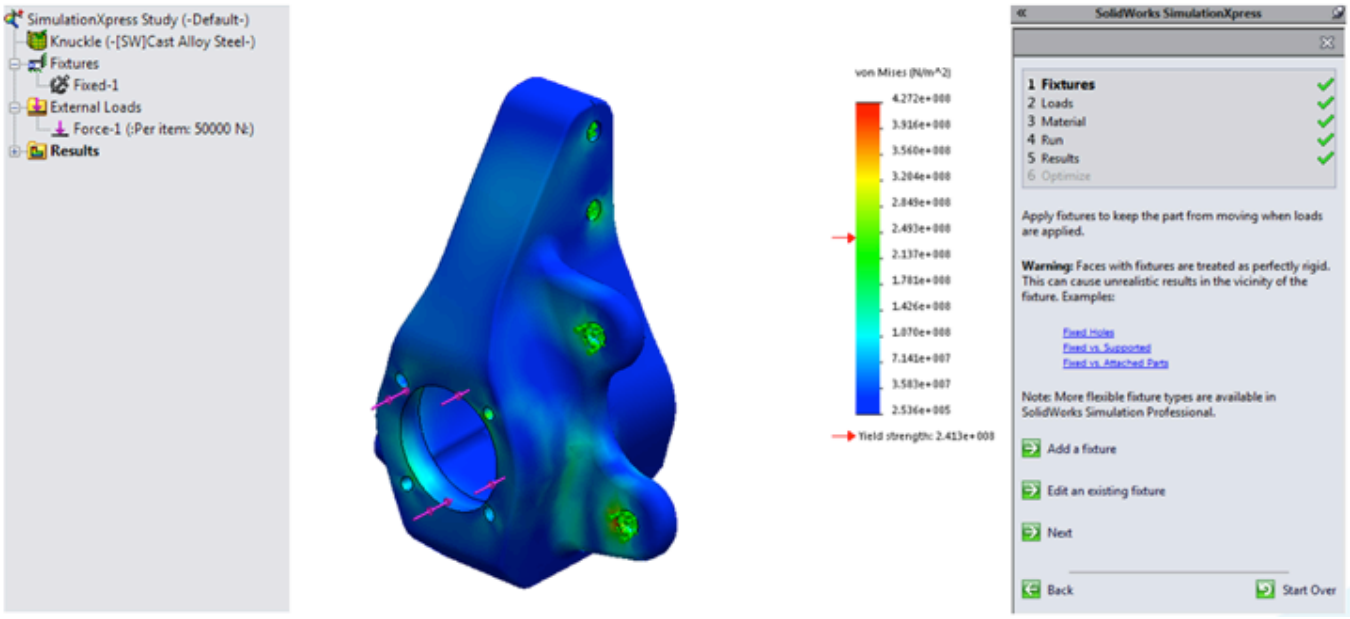
When your product (or a part of your product) is subjected to a mechanical load it needs to resist during the course of its life, static structural analysis can help predict whether the product is likely to fail, evaluate how far it will deform, and determine how much stress is present in the material. Additionally, we can consider the fatigue life due to repeated application of the loading, or potential of failure due to buckling.

Static structural analysis is the most common type of mechanical analysis performed in industry today.

Options:

SOLIDWORKS – SimulationXpress

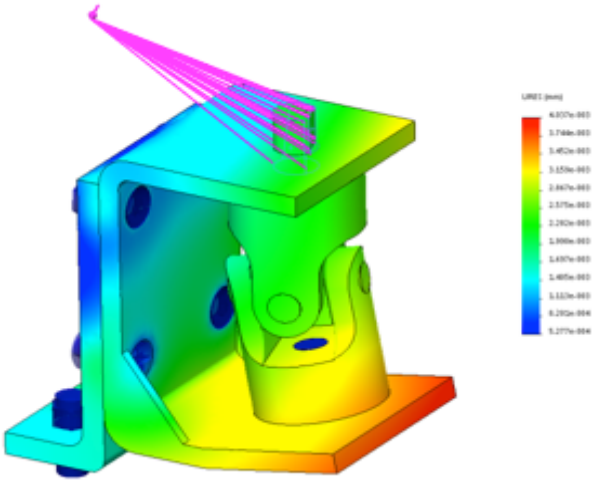
Every single installation of SOLIDWORKS® includes the SimulationXpress analysis wizard. This allows you to run a stress analysis with limited loading and restraint options on a single-body part file (no assemblies or multibody part files). This tool has guided workflows to lead you through the analysis process. While it uses the same underlying analysis engine as other SOLIDWORKS Simulation tools, the limited conditions and controls that can be added to the analysis make it useful for first pass and early-stage analysis only.



SimulationXpress setup and result example

SOLIDWORKS Premium – Static Analysis

Our top level SOLIDWORKS CAD package, SOLIDWORKS Premium, allows complete linear static stress analysis of parts and assemblies within the SOLIDWORKS window. It allows you to analyze stress developed from static forces, pressures, torques, self-weight, thermal expansion/contraction, and remote and distributed loading. Contact interactions between parts in an assembly can be assessed, along with connector elements like bolts, pins and springs. Parts within an assembly can be modeled as solids, shells (thin components/sheet metal) or beams (e.g. structural framework). These three model types can easily be combined in the same analysis. Static analysis of this type is normally used to determine whether a model is likely to fail due to material yield, as only the linear portion of the stress/strain curve is accurately modeled.



Assembly-level stress analysis with bolts and remote load

SOLIDWORKS Simulation Professional

SOLIDWORKS Simulation Professional is available as either an upgrade to a SOLIDWORKS Premium license or as a standalone license. It includes the static stress analysis capability of SOLIDWORKS Premium, but extends the analysis capability to include other potential modes of failure, such as buckling on slender structures under compressive load, and high-cycle fatigue failure due to repeated application of a static load.

Fatigue prediction on a bicycle crank

Capabilities are also included that add productivity tools to the static analysis type:

- **Submodeling** – allows you to perform analysis on a small portion of a large model, while still taking into account the overall stress and distortion of the large model
- **Trend Tracker** – keeps a record of your analysis history, allowing you to record iterations of a model
- **Optimization** – allows you to automatically adjust model parameters to modify the shape of components to more efficiently meet design requirements, and optimize the model shape

SOLIDWORKS Simulation Premium

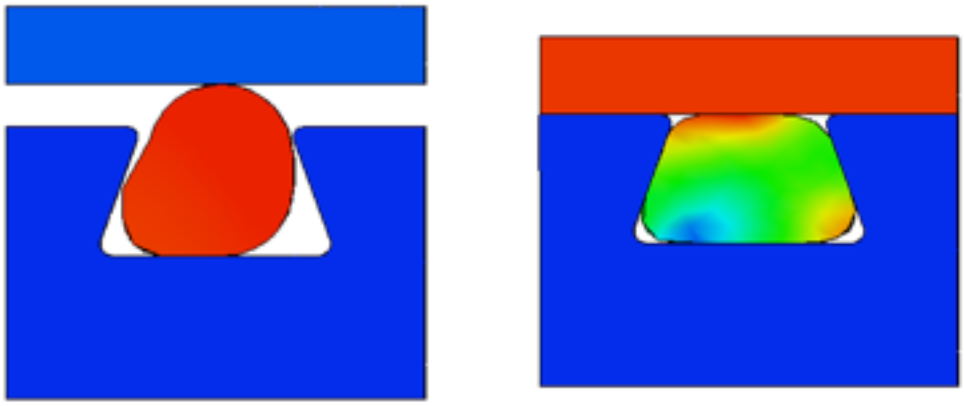
With SOLIDWORKS Simulation Premium, you get all the analysis capabilities in the previous two packages but are also able to include nonlinear conditions in the analysis. This makes for a more accurate and comprehensive analysis when linear analysis assumptions are not met.

Linear static analysis makes three key analysis assumptions:

- Deformation of parts under load is assumed to be small – i.e. the shape (and stiffness matrix) of the part doesn't change significantly when loaded
- Material stress/strain behavior is assumed to be linear
- Loading is assumed to be statically applied – no dynamic or time-dependent effects

With nonlinear static analysis in Simulation Premium, you can overcome the first two of these assumptions. Linear and nonlinear dynamic analysis is also available to overcome the third (see Dynamic Structural Analysis section).

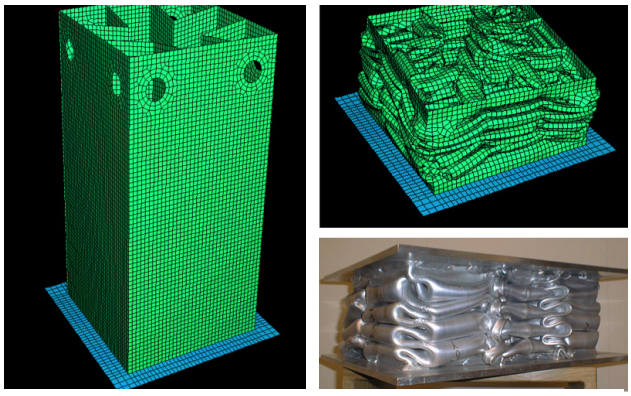
In nonlinear analysis, the effect of large deformations and shape change is captured automatically through an iterative analysis procedure. A variety of material models are available, including plasticity models for analyzing post-yield behavior, hyperelastic models for assessing performance of rubber and elastomers, and viscoelastic materials.



Nonlinear analysis of an O-ring compressed in a groove

SIMULIA Abaqus/CAE

SIMULIA Abaqus/CAE is a dedicated analyst-level package that can address very complex and advanced analysis cases. Unlike our SOLIDWORKS analysis packages, it runs as a separate application outside of the SOLIDWORKS CAD window (although an associative connector is available). Abaqus specializes in highly nonlinear analysis situations, and can offer a solution to problems that are too complex for SOLIDWORKS Simulation Premium. This tool offers an enormous range of capabilities, but there are three static analysis cases that commonly require the usage of a tool of this type:



Abaqus crushing analysis of a metal structure

- **Very large distortion** – situations with very large amounts of nonlinear deformation, or complex crushing/crimping behavior
- **Complex contact** – situations with many contact interactions; Abaqus' general contact capability offers the most robust and efficient contact solver available in the industry
- **Pre-load/load stepping behavior** – situations where the response to a stepped loading condition needs to be evaluated – for example, a member is pre-tensioned, then a bending load is applied as a secondary step

Abaqus offers a wide range of mesh types, material models, and analysis methodologies, and is an ideal solution for situations that are outside the capabilities of the SOLIDWORKS Simulation suite of tools.

Decision Points

When making a decision about which solution is needed for your specific situation, ask yourself these questions:

Is yield the only failure mode I need to consider?

While material yield is often the first thing we look at when considering a stress analysis, it is just one of a number of ways that a product might potentially fail. Many products could be just as likely to fail due to fatigue, or collapse due to buckling. If you're not testing for these failure modes, you're missing important failure mechanisms, which could lead to product reliability and safety issues.

> If yield is the only mode you need to consider – Choose **SOLIDWORKS Premium.**
>
> If you'd like to also consider buckling, fatigue, and get some additional productivity and analysis tools thrown in – Choose **SOLIDWORKS Simulation Professional.**

Is my situation nonlinear?

Does the material exceed its yield strength or permanently deform under load? Are you working with soft plastics, rubbers or elastomers? Does your object deform enough to see with the naked eye when under load? If your answer to ANY of these questions is yes – you're looking at a potential situation that will require nonlinear analysis to make an accurate assessment.

> If you answered no to all the questions above – Choose **SOLIDWORKS Premium** or **SOLIDWORKS Simulation Professional.**
>
> If you answered yes to any of these questions – Choose **SOLIDWORKS Simulation Premium.**

How complex is my nonlinear analysis?

For situations that have very large amounts of distortion under load, or large numbers of contact interactions, or that involve pre-stress behavior, the SIMULIA Abaqus solver might be required to accurately resolve your situation. The assessment of what sort of situations require this sort of analysis can be a difficult one to make, so feel free to reach out to your local Hawk Ridge Systems representative. We'll be happy to review your case situation to make an appropriate recommendation and help you build an Abaqus implementation that meets your needs.

For complex nonlinear analysis situations – Choose **SIMULIA Abaqus CAE.**

Summary

Product	Key Benefits	Key Limitations
SimulationXpress (every license of SOLIDWORKS)	• Analysis capability in every license of SOLIDWORKS • Uses the same solver technology as other SOLIDWORKS Simulation tools	• Limited to parts only • Very limited input conditions • Suitable for first pass analysis only
Linear Static Analysis (SOLIDWORKS Premium)	• Comprehensive range of static analysis tools and controls available • Completely integrated into the SOLIDWORKS CAD environment	• Static loading only • Small deformations only • Linear material models only
SOLIDWORKS Simulation Professional	• Adds testing for additional modes of failure, fatigue, and frequency • Provides a number of additional analysis tools at a great value price	• Subject to the same linear assumptions as a static analysis • Buckling assessment is linear
SOLIDWORKS Simulation Premium	• Overcomes all of the limitations of static analysis • Complex post yield, large deformation behavior	• Can be limited in very high distortion situations • Issues with large numbers of nonlinear contacts
SIMULIA Abaqus CAE	• Highly accurate, robust, and powerful solver • Most robust contact algorithms available • Assesses complex scenarios beyond the capability of other solvers	• Not integrated within the SOLIDWORKS window • Analyst-level interface and workflows

Section 2 - Dynamic Structural Analysis

What does it do?

Dynamic analysis allows you to evaluate how things move over time – from simple rigid body motion of a mechanism to nonlinear dynamic analysis of a crash test. Time-varying loading is applied to models and the subsequent response of the system is captured dynamically. Dynamic stress analysis can mimic real-life testing performed on shock or vibration testing equipment.

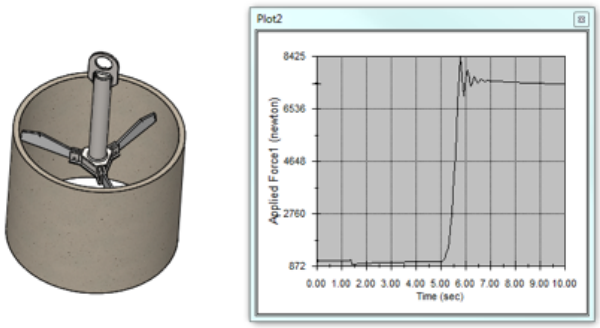
Typical outputs from different types of dynamic analysis include forces/torques needed to drive mechanisms, resonant frequencies of a structure, and accelerations, displacements and dynamic stresses from shock or vibration testing.

If you're interested in how your system responds to dynamic loading, one of these tools will be a fit for your situation.

Options:

Motion Analysis – SOLIDWORKS Premium

SOLIDWORKS Premium includes SOLIDWORKS Motion, which is a kinematic motion analysis tool. All bodies in the model are assumed to be rigid (no deformation), and the program utilizes existing SOLIDWORKS mates to identify how parts interact with one another. Forces, torques, or driven motion are applied to components in an assembly. Based on their relationships with other parts and 3-D contact, you'll see how they move in 3D space, the forces and torques required to drive them, and the loading on joints and connections. Forces on key components at certain time points during the analysis can be exported to a static stress analysis to assess component strength.



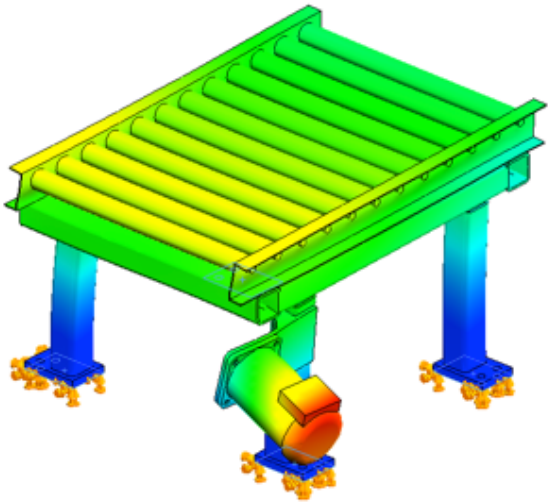
Motion analysis of a pipe lifting mechanism, with applied force result

Motion analysis in SOLIDWORKS Premium is defined by time-based key-frames. Event-based key-frames, which allow you to sequence tasks and trigger actions by the completion of a previous task or sensor activation, are available as part of Event-Based Motion in SOLIDWORKS Simulation Professional.

SOLIDWORKS Simulation Professional

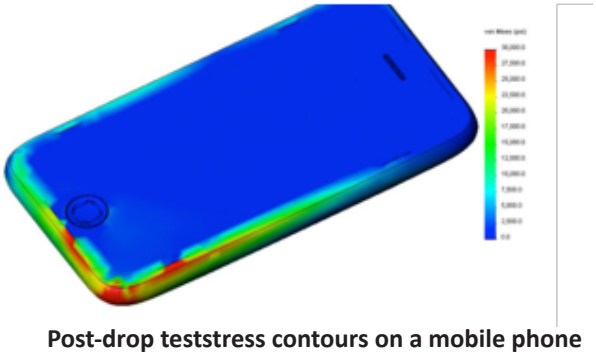
The Simulation Professional package contains three analysis modules that feature different types of time-dependent analysis, with very different capabilities and applications.

Frequency Analysis – also called modal analysis, this tool gives basic information about how a model will respond to vibration. It identifies the resonant frequencies and mode shapes of a product, indicating at which vibrational frequency the object would see an uncontrolled, resonant response. From a design perspective, if the resonant frequencies identified by the study match up with a driving frequency the object would be subjected to in the real world, this identifies a potential issue that will need to be designed away from. Frequency analysis gives no information about response to a forced vibration.



Resonant frequency mode shape of conveyor frame

Drop Test Analysis – this tool provides a complex nonlinear, dynamic analysis, utilizing an explicit solution method, but with limited control over input conditions. The Drop Test module allows you to analyze a situation where an object is dropped from a given height onto a flat surface. The angle and flexibility of the surface can be manipulated, realistic contact interactions between components can be addressed, and both linear elastic and nonlinear plasticity material models can be used. Stresses and accelerations in the dropped part can be monitored to make predictions of failure. This is a great tool for consumer products or anything else that has to meet a drop testing requirement.



Post-drop teststress contours on a mobile phone

Event-Based Motion – a counterpart to the Motion analysis tool in SOLIDWORKS Premium, this tool allows the definition of actions based on the completion of prior events or sensor activation. This tool is commonly used for sequencing of tasks in production machinery, and simulation of machines controlled by PLCs and other electromechanical systems.

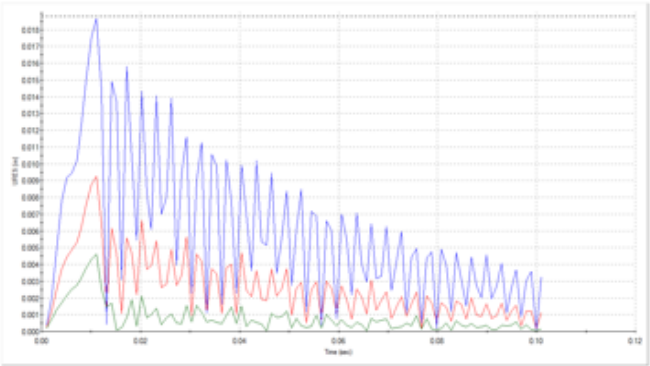
SOLIDWORKS Simulation Premium

This package unlocks the full dynamic analysis capability of SOLIDWORKS Simulation, and provides both linear and nonlinear dynamic analysis capabilities. Linear dynamic analysis is the most commonly used package, and is frequently used as a virtual representation of real life testing performed on shock testing or vibration testing equipment. As this testing is often time-consuming and expensive in the real world, being able to quickly iterate through different virtual testing scenarios has significant benefit. Most testing of this type replicates the product of interest being mounted to a tester and being subjected to a shock or vibration pattern.

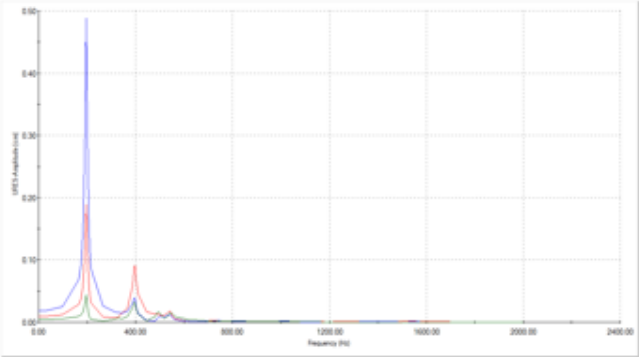
Linear dynamic analysis is available in 3 main formats:

- Time-history – loading that changes with time; typically used to represent shock or impact testing
- Harmonic – loading that changes with frequency; usually used for vibration testing; determining amplitudes of vibration for different frequencies
- Random Vibration – representations of vibration loading that is difficult to explicitly quantify, such as ship-board, transport, or aircraft vibration patterns

Linear dynamic analysis includes only bonded contact. Nonlinear dynamic analysis is required for more advanced contact.



Displacement vs. time plot from a time-history dynamic analysis



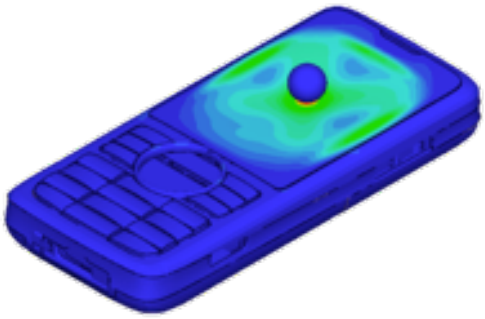
Displacement vs. frequency plot from a harmonic dynamic analysis

Nonlinear dynamic analysis can also be conducted incorporating complex contact and material models, but is performed with an implicit solution technique which means that it can be of limited use in practice for anything but very simple models.

SIMULIA Abaqus/CAE

This tool provides a more complex analysis toolset, including both implicit and explicit solvers. The explicit solver is particularly well-suited to fast developing events, such as collisions or impacts. Abaqus is commonly used in industry to evaluate impact and crash testing, and can incorporate a mixture of rigid body dynamics and deformable elements to maximize the efficiency of the analysis process.

Abaqus can also help to evaluate scenarios where there is significant relative motion of components within an assembly, something that can be challenging to represent in a linear dynamic analysis in SOLIDWORKS Simulation Premium.



Ball drop test on mobile phone screen

Crash test on vehicle in SIMULIA Abaqus

Decision Points

Some of the key questions to ask yourself so you can select the right dynamic analysis tool are:

Do you need to evaluate how parts in an assembly move relative to each other?

Motion analysis provides answers about how parts in an assembly move, based on their relationships and contact, and the forces needed to drive them. Dynamic analysis in SOLIDWORKS Simulation Premium is generally based around the response of a combined assembly to an external vibration or impact, as in a shaker table test.

> If relative movement within an assembly is important – Choose **SOLIDWORKS Motion** in **SOLIDWORKS Premium** or **SOLIDWORKS Simulation Professional**, or choose **SIMULIA Abaqus/CAE** if you need to do crash or collision testing.
>
> If you need to evaluate the response of an object to an external excitation – Choose Frequency analysis in **Simulation Professional** or Dynamic analysis in **Simulation Premium.**

Do you need to understand the stresses/acceleration from forced vibration, or does knowing the resonant frequencies to avoid give you enough information?

Frequency analysis can help you understand the dangerous vibratory frequencies that might cause an issue in real life, but doesn't give any indication of the amplitude or stress induced by the vibration. Linear dynamic analysis will provide that information.

> If you only need to know the frequencies to avoid and design away from – Choose Frequency analysis in **Simulation Professional.**
>
> If you need amplitudes of displacement or stress – Use a harmonic, time-history, or random vibration analysis in **SOLIDWORKS Simulation Premium.**

If you are considering a drop or collision test, is the collision between the object of interest and the ground, or some other situation?

The drop test in SOLIDWORKS Simulation Professional uses a sophisticated analysis routine, but the conditions that can be assessed are limited – basically an interaction between the object of interest and a flat ground plane only. For anything more complicated than that, some simple applications may be handled with a nonlinear dynamic analysis in SOLIDWORKS Simulation Premium, but otherwise SIMULIA Abaqus CAE is most likely the tool of choice.

> For a drop test between the object of interest and the ground – Choose **SOLIDWORKS Simulation Professional**.
>
> For any other type of drop, collision or crash test – Choose **SIMULIA Abaqus CAE** for most scenarios.

Summary

Product	Key Benefits	Key Limitations
SOLIDWORKS Premium – Event-based motion in Simulation Professional (SOLIDWORKS Motion)	• Get driving forces and torques for an assembly accounting for gravity, friction, inertia • Re-uses existing mates and relationships from the SOLIDWORKS model	• Rigid, non-deformable parts in analysis only • No stress analysis (although some information can be exported to stress analysis)
SOLIDWORKS Simulation Professional (Drop Testing)	• Sophisticated implicit solver routine • Incorporates nonlinear materials and non-bonded contact	• Suitable for a single case – drop onto flat floor • Limited element choices can make thin or detailed geometry difficult to assess
SOLIDWORKS Simulation Professional (Frequency Analysis)	• Fast, robust solver reports resonant modes quickly • Visual feedback of mode shapes helps design to improve performance	• No indication of stresses or amplitude of vibration
SOLIDWORKS Simulation Premium (Linear Dynamic Analysis)	• Efficient analysis routine that closely mimics expensive real-life shock and vibration testing • Performs analysis to satisfy many common dynamic testing standards • Provides stress and amplitude information across the time or frequency domain	• No nonlinear contact or material effects considered • Not suitable for assessing rigidly moving parts within an assembly
SOLIDWORKS Simulation Premium (Nonlinear Dynamic Analysis)	• Allows for complex material, geometric and contact nonlinearity vs time	• Allows for complex material, geometric and contact nonlinearity vs time
SIMULIA Abaqus CAE	• Explicit solver technology provides best-in-class solutions for highly dynamic events • Commonly used by major manufacturers for crash and collision testing	• Not integrated within the SOLIDWORKS window • Analyst-level interface and workflows

Section 3 - Thermal Analysis

What does it do?

Thermal analysis is the study of how heat energy flows through and around a product, and is typically used to optimize heating and cooling processes.

Consideration of heat transfer typically takes into account three mechanisms:

- **Conduction** – Heat transferred through a solid object. Conduction is the reason why the metal handle of a frying pan on a gas stove feels hot.
- **Radiation** – Heat transferred from a hot object to a cold object without needing airflow or a medium in between. This effect is most significant in places where the temperature difference is particularly high. An example is how we feel heat from the sun despite being separated from it by millions of miles.
- **Convection** – Heat transferred from a hot object to a cooler gas or liquid flow (or vice versa). A manifestation of the effect of convection is when your skin feels colder in a breeze than it does in still air of the same temperature.

Thermal analysis is becoming more and more prevalent, especially in the electronic and high tech industries. Industry trends are driving products that have more and more power in smaller boxes, so optimized cooling solutions need to be developed. Information about how the temperature profiles change over time, and how the temperature change might influence thermal expansion and stress, is often important.

Options:

SOLIDWORKS features two analysis packages that perform thermal analysis. Both approaches offer steady-state and transient analysis. In both packages, thermal results across the model can be exported to a static stress analysis for prediction of thermal expansion and thermal stress. However, they differ in how they assess convective heat transfer. Note that thermal expansion and stress analysis based on a global constant temperature change doesn't require thermal software – it is possible in SOLIDWORKS Premium.

SOLIDWORKS Simulation Professional

This package is a finite element analysis (FEA) based tool that meshes and analyzes the solid portions of the model only. It allows us to assess all three mechanisms of heat transfer, conduction, convection and radiation, but while conduction and radiation are analyzed explicitly, convection is evaluated by estimating a convection coefficient – also known as a thin film coefficient or heat transfer coefficient. In reality, the convective rate across a surface or product is variable, dependent on the fluid, the fluid velocity, and the shape of the object. For situations where the flow is predictable, like in natural convection situations, assuming a convection coefficient is a reasonable assumption. However, as the fluid starts moving quickly, or if we need to consider heat exchange from solid to fluid to another solid, it can be hard to develop accurate assumptions of the convective heat transfer.

SOLIDWORKS Flow Simulation

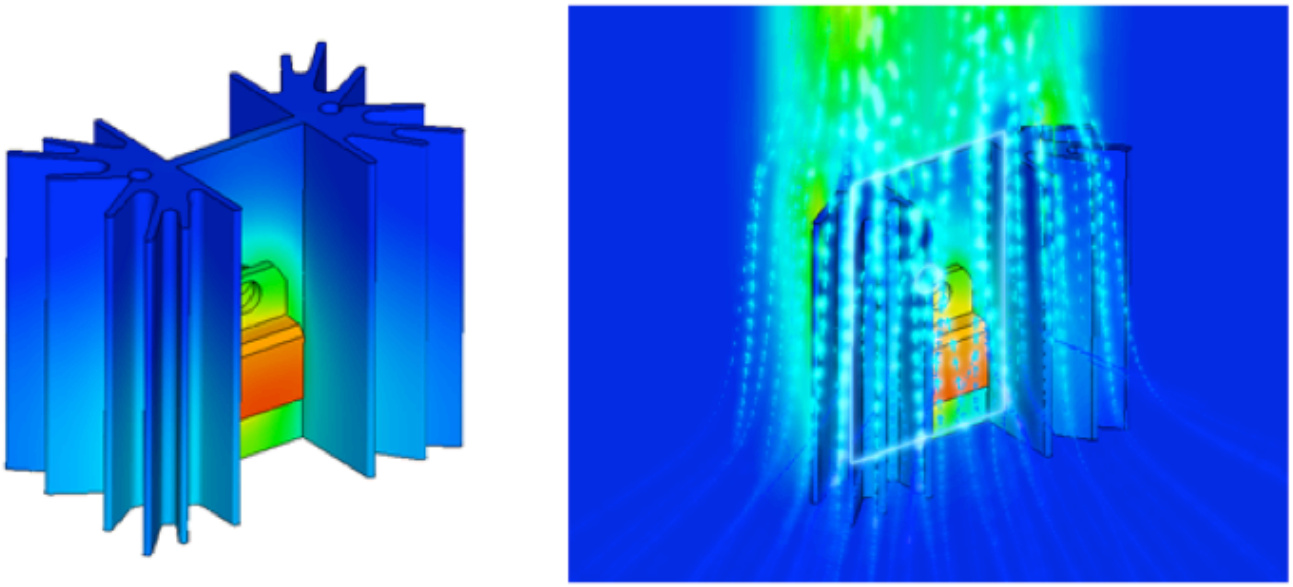
This comprehensive computational fluid dynamics (CFD) tool provides a realistic and accurate assessment of all three mechanisms of heat transfer. Conduction and radiation are modeled explicitly, and the movement of surrounding or internal fluid is accurately analyzed to predict the convective heat transfer. Fluid flow and heat transfer characteristics are solved simultaneously to give a prediction of solid and fluid temperature for a variety of common applications. Conjugate heat transfer incorporating conductive, convective and radiative heating between multiple solid and fluid regions can easily be assessed. While complete thermal analysis can be performed in the baseline thermal analysis tool, there are two add-on modules that provide deeper resolution and enhanced accuracy for certain types of components in two industry sectors:

SOLIDWORKS Flow Simulation – Electronic Cooling Module

Provides enhanced models for thermal assessment of ICs/chips, PCBs, heat pipes, and allows for joule heating from electrical current/voltage. This provides deeper accuracy and resolution for common electronic components, particularly in the application of two-resistor thermal models for chips/ICs and calculation of PCB conductivity from layer composition.

SOLIDWORKS Flow Simulation – HVAC and Advanced Radiation Module

Provides a discrete-ordinate (DO) radiation model for partially transparent materials like glass, commonly used in LED lighting applications, and thermal comfort parameters for the HVAC industry. The advanced radiation capabilities provide more accurate results in situations where radiation through glass or clear plastic is important, and comfort parameters allow HVAC engineers to predict the comfort of inhabitants in design spaces.



Side by side thermal results from FEA (left) and CFD (right). In FEA only the solids are considered, but in CFD fluids are calculated and presented in results.

Decision Points

Some of the key questions to ask yourself so you can select the right thermal analysis tool are:

How accurate do I need my thermal analysis to be?

Even in the most controlled situation, the convective coefficient assessment used by Simulation Professional is an approximation. It will provide some level of useful information, and allow for comparison of different design options, but for detailed and accurate analysis Flow Simulation provides higher quality results for all situations.

For first pass thermal analysis – Choose **SOLIDWORKS Simulation Professional.**

For accurate thermal assessment of many situations – Choose **SOLIDWORKS Flow Simulation.**

Do I have moving fluid flow (forced cooling), complex geometries, or heat transfer between multiple fluid streams?

In all of these situations, Flow Simulation is the only approach that can provide the accuracy most users require.

If yes to any of the questions above – Choose **SOLIDWORKS Flow Simulation.**

Summary

Product	Key Benefits	Key Limitations
SOLIDWORKS Simulation Professional (Thermal FEA)	• Provide fast results for thermal analysis for comparison of design options • Steady-state and transient analysis, with interface to export thermal information to stress analysis	• Convection is based on assumption of heat transfer coefficient • Accuracy can be limited based on this assumption
SOLIDWORKS Flow Simulation (CFD)	• Convection, conduction, and radiation are modeled explicitly, leading to highly accurate heat transfer calculations • Ideal combination of ease of use and power allow concurrent engineering processes for all engineers and designers • Steady-state and transient analysis, with interface to export thermal information to stress analysis	• Slightly more involved calculation process than FEA • Unable to model phase change or moving geometry

Section 4 - Fluid Flow Analysis

What does it do?

Fluid flow analysis is the study of how gas or liquid flows around or through an assembly or part of interest. It can be used for the investigation of aerodynamic drag and lift, or the assessment of pressure drop through pipe and valve systems. Other usages include prediction of cavitation, flow through filters, optimization of intake manifolds and exhaust systems, and performance of rotating components like pumps and impellers.

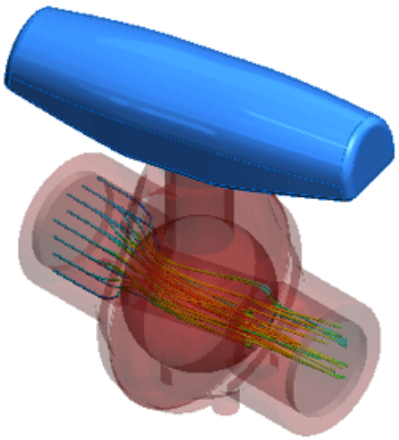
Many fluid flow situations also involve heat transfer as discussed above; in SOLIDWORKS Flow Simulation heat transfer and fluid flow calculations are performed simultaneously.

Options:

FloXpress (every license of SOLIDWORKS)

Every license of SOLIDWORKS includes FloXpress. This is a very limited, first pass CFD tool that will enable users to run an internal flow analysis, with one inlet and one outlet, with either air or water, with no heat transfer. Flow patterns can be visualized by viewing flow streamlines, colored by velocity value, and no other numerical outputs are available. While the software uses the SOLIDWORKS Flow Simulation solver, no adjustment to meshing or solver inputs is available.

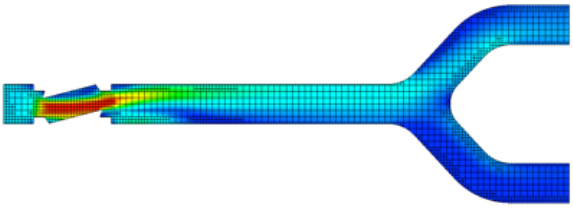
FloXpress is a first pass for simple visualization of flow streamlines around or through a model, but doesn't provide sufficient numerical information for most real engineering problems.



Typical result output from FloXpress

SOLIDWORKS Flow Simulation

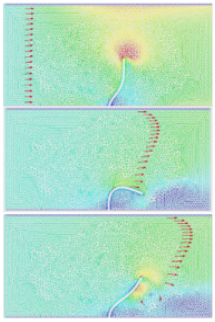
SOLIDWORKS Flow Simulation is a computational fluid dynamics package that is completely integrated into the SOLIDWORKS environment. Flow Simulation can address a wide range of fluid flow applications, including both internal and external situations, gas and liquid flow, particle tracking, porous media, and assessment of performance of rotating equipment like pumps and blowers. It uses a finite-volume analysis method, using the Navier-Stokes fluid flow equations, with conservation of energy, momentum and mass, and a modified k-epsilon turbulence model. The software is optimized to provide accurate results in a wide range of analysis applications, has incredibly robust solver technology, and is the best value CFD tool on the market today. Pressure and thermal information can be exported from the flow analysis to a stress analysis in SOLIDWORKS Simulation to evaluate the stress caused by fluid loading.



Flow prediction through a valve and split pipe

SIMULIA Abaqus/CAE

This analyst-level simulation package includes a CFD solver which is most often used to facilitate multi-physics analysis situations that are limitations of the SOLIDWORKS Flow Simulation package. It allows users to run a coupled fluid-flow/stress analysis (fluid-structure interaction – FSI) to assess situations where flow causes significant deformation of a part (e.g., flexible valves). It also features coupled euler-lagrangian (CEL) and smooth particle hydrodynamics (SPH) technology that allows analysis of free surfaces of fluids, for applications such as fluid sloshing or tank emptying.



FSI analysis of a flexible flap in a background wind

Decision Points

Some of the key questions to ask yourself so you can select the right fluid flow analysis tool are:

Do you need numerical results from your fluid flow simulation?

If you need anything more than visual representations of flow streams, the information provided by FloXpress will likely be too limited to provide a complete picture.

I need numeric results – Choose **SOLIDWORKS Flow Simulation.**

I'm ok with visual results only, with limited input and output conditions – Choose **SOLIDWORKS FloXpress** (every license of **SOLIDWORKS**).

Do you need to see movement in your model caused by fluid flow or free surfaces of fluids?

In many situations, approximations can be made to represent what is happening in the model with SOLIDWORKS Flow Simulation, but in order to directly analyze these complex physics, SIMULIA Abaqus CAE will be required.

If you need to see complex FSI or free surface physics – Choose **SIMULIA Abaqus/CAE.**

If you don't have any of these elements in your situation – Choose **SOLIDWORKS Flow Simulation.**

Summary

Product	Key Benefits	Key Limitations
SOLIDWORKS FloXpress (every license of SOLIDWORKS)	• No cost CFD software for all SOLIDWORKS users • Visual representation of flow streams through a model	• Very limited analysis conditions – one inlet, one outlet, air or water • No heat transfer analysis
SOLIDWORKS Flow Simulation (CFD)	• Wide range of fluid flow applications and analysis conditions • Robust solvers and structured workflows mean all engineers can get accurate CFD results with ease	• Unable to model free surfaces or moving geometry (other than rotation)
SIMULIA Abaqus/CAE	• Analysis of complex multiphysics scenarios such as fluid-structure interaction and free surfaces • Choice of CFD strategies available – CFD, CEL, SPH	• Not integrated within the SOLIDWORKS window • Analyst-level interface and workflows

Section 5 - Plastics Injection Molding Analysis

What does it do?

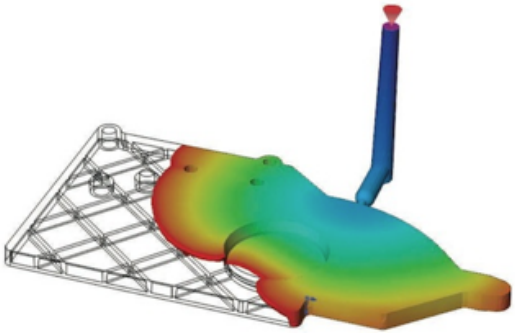
Injection molding analysis is fundamentally different in its intent from all the other analysis techniques mentioned here. Most of the other tools discussed are focused on proving a product is able to perform its required operation in the real world, whereas plastic injection molding is focused on analyzing the manufacturing process to make plastic parts – and to identify and correct defects with that process.
This type of software analyzes the injection of molten plastic into a heated tool, and provides an animation of how the mold will fill, the pressure required to fill and pack the model, and how the plastic will cool. It can be used to predict defects including sink marks, weld lines, air traps, warping, and surface finish issues.

Options:

There are three types of plastic injection molding software available under the SOLIDWORKS Plastics banner: Plastics Professional, Plastics Premium, and Plastics Advanced.

SOLIDWORKS Plastics Professional

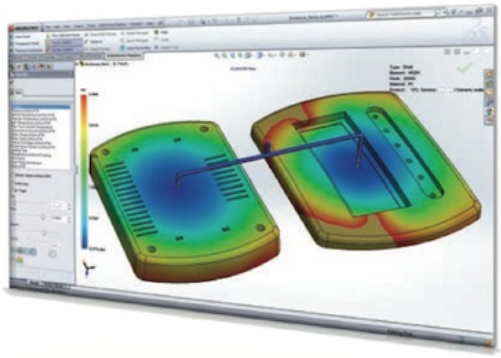
This package provides plastic part designers with the tools to ensure early in the design process that their parts can effectively be filled without defects. It simulates the mold-filling portion of the injection molding process, and can help identify defects like sink marks, air traps, weld lines. It also allows designers to explore the effect of different gate locations on final part results.



Mold filling process for a single part

SOLIDWORKS Plastics Premium

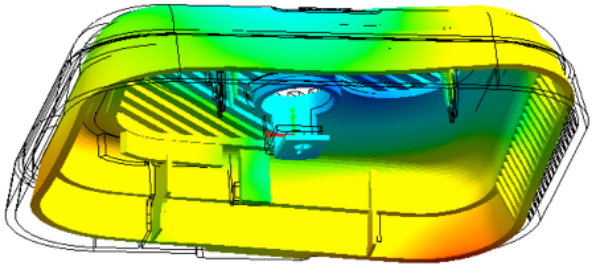
SOLIDWORKS Plastics Premium gives designers or builders of injection molds an accurate, easy-to-use way to optimize. Multi-cavity layouts can be modeled, and the fill and pack phases of the injection molding process are analyzed. Sprue and runner systems and family molds can be optimized using runner-balancing processes. Advanced injection molding techniques, including fiber-reinforced plastics, insert-overmolding, co-injection, and gas-assisted injection can be simulated.



Multi-cavity family mold filling process

SOLIDWORKS Plastics Advanced

SOLIDWORKS Plastics Advanced gives you complete understanding of your tool design and the molding process, allowing you to model cooling systems and analyze warp. A virtual representation of the mold tool – complete with cooling channels and runner systems – can be analyzed, and part distortion and warpage due to molded-in stress and thermal quenching can be assessed.



Exaggerated plot of warp prediction

Decision Points

Some of the key questions to ask yourself so you can select the right plastic injection analysis tool are:

Are you only a part designer, or are you also involved in designing the tool and multi-cavity layouts?

As a general rule, SOLIDWORKS Plastics Professional provides enough functionality for most part designers, whereas design of the tool layout incorporates functions included in SOLIDWORKS Plastics Premium and Advanced.

> If you're a part designer only – Choose **SOLIDWORKS Plastics Professional.**
>
> If you're also involved in the design of the tool – Choose **SOLIDWORKS Plastics Premium** or **Advanced.**

Does your process involve insert overmolding, coinjection, gas-assisted injection molding, or other advanced molding techniques?

> If not – Choose **SOLIDWORKS Plastics Professional.**
>
> If so – Choose **SOLIDWORKS Plastics Premium.**

Are you concerned with part warpage, or design of cooling systems within the mold tool?

While some result parameters in lower level packages can give clues as to where warp might occur, for a realistic prediction of part warp, SOLIDWORKS Plastics Advanced is required.

> If you need to assess warp or design cooling systems – Choose **SOLIDWORKS Plastics Advanced.**
>
> If not – Choose **SOLIDWORKS Plastics Professional** or **Premium.**

Summary

Product	Key Benefits	Key Limitations
SOLIDWORKS Plastics Professional	• Integrated plastic injection molding analysis in the SOLIDWORKS window • Early prediction of mold filling defects	• Single mold cavity only • No advanced molding techniques like overmolding
SOLIDWORKS Plastics Premium	• Prediction of filling and packing parameters for multi-cavity tool layouts • Assessment of coinjection and insert molding behavior	• Simple assumption for mold cooling – no direct modeling of cooling systems
SOLIDWORKS Plastics Advanced	• Detailed analysis of cooling system performance • Realistic approximation of real life warpage from molding conditions	• Longer solution times for cooling/warping analysis

Section 6 - Optimization and Automation Tools

Optimization and automation tools are used in order to enhance the power of simulation tools. By automating the repetition of analysis studies, and by intelligently selecting variations of the model to optimize a design, you can evaluate a wide range of design alternatives and generate large amounts of data about the performance of an object, with minimal user input.

Each of the analysis packages available with SOLIDWORKS and SIMULIA feature their own automation and optimization tools. This is a simple summary of their capabilities.

Design Studies – SOLIDWORKS

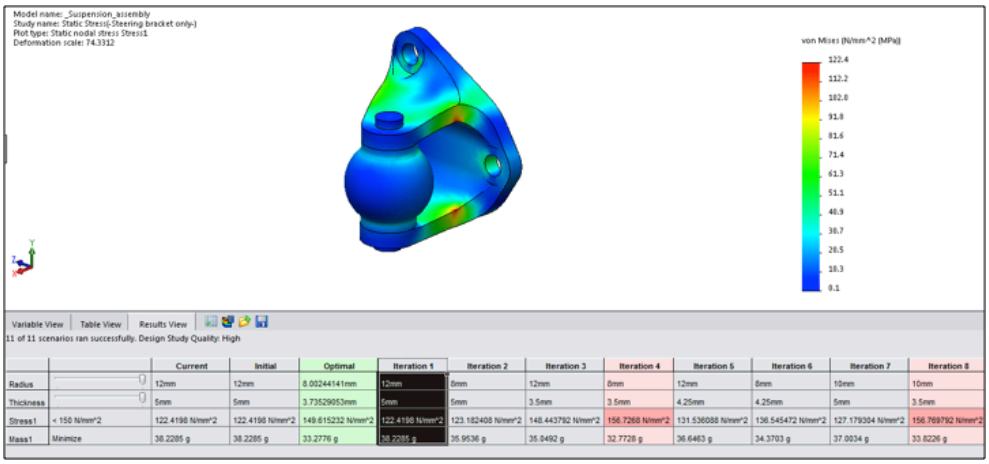
Every license of SOLIDWORKS features the ability to run design scenarios – to specify a range of model parameters and dimensions that can be adjusted, and to see how variation of those parameters adjust outputs that can be measured by SOLIDWORKS – mass properties, section properties, dimensional clearances etc..

Design Studies – SOLIDWORKS Premium

Using the static stress analysis capabilities of SOLIDWORKS Premium, design studies can be used to automatically run stress analysis with varying parameters. Multiple parameters such as model dimensions and simulation inputs like loads pressures can be modified in a single study. The user defines which values of the input parameters will be run, and results from all analysis runs are presented in a tabular format.

Optimization – SOLIDWORKS Simulation Professional

Simulation Professional introduces an optimization routine that allows the software to automatically adjust model dimensions and input conditions to meet a certain design goal, while meeting design constraints. For example, the thickness and width of a plate could be modified to produce the part with the lowest weight, which has a stress level below the yield stress of the material. The key difference between optimization and design studies is that optimization automatically selects the variations of the model it will run, whereas in the design study each variation needs to be defined by the user.

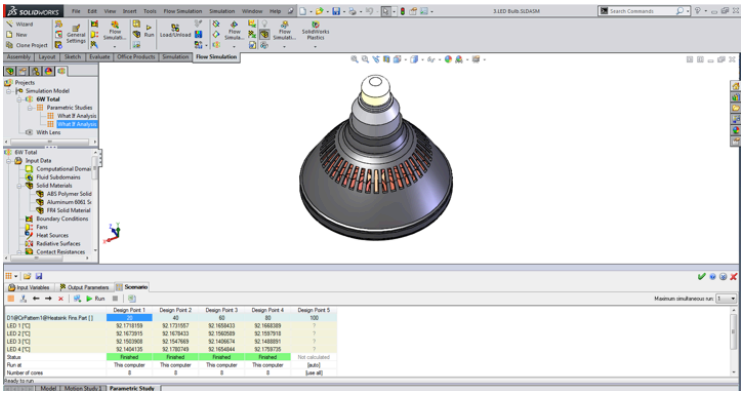


		Current	Initial	Optimal	Iteration 1	Iteration 2	Iteration 3	Iteration 4	Iteration 5	Iteration 6	Iteration 7	Iteration 8
Radius		12mm	12mm	8.00244141mm	12mm	8mm	12mm	8mm	12mm	8mm	10mm	10mm
Thickness		5mm	5mm	3.73529053mm	5mm	5mm	3.5mm	3.5mm	4.25mm	4.25mm	5mm	3.5mm
Stress1	< 150 N/mm^2	122.4198 N/mm^2	122.4198 N/mm^2	149.615232 N/mm^2	122.4198 N/mm^2	123.182408 N/mm^2	148.443792 N/mm^2	156.7268 N/mm^2	131.536088 N/mm^2	136.545472 N/mm^2	127.179304 N/mm^2	156.769792 N/mm^2
Mass1	Minimize	38.2285 g	38.2285 g	33.2776 g	38.2285 g	35.9536 g	35.9492 g	32.7728 g	36.6463 g	34.3703 g	37.0034 g	33.8226 g

Example of SOLIDWORKS Optimization interface

Parametric Studies – SOLIDWORKS Flow Simulation

SOLIDWORKS Flow Simulation provides two model automation routines. Firstly, a single-factor optimization routine, where one model parameter or flow simulation input can be modified to meet a certain design goal. Secondly, a "What If" analysis allows multiple factors to be specified, and a table of analysis variations to be run automatically, and results tabulated and summarized.



Parametric Study exploring the effect of the number of heat sink fins in an LED lighting application

iSight – available for SIMULIA Abaqus

iSight is an incredibly flexible and powerful automation routine that can make adjustments to SIMULIA Abaqus models automatically, and also make adjustments to other analysis and CAD tools, as well as invoking mathematical routines, incorporating scripting, and applying a variety of optimization strategies.

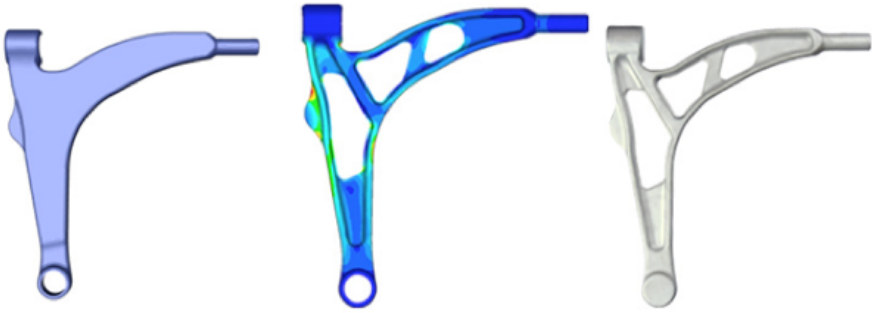
Simple example of an iSight worfklow, incorporating Abaqus analysis, Matlab calculations, and result reporting to Excel

Tosca – available for SIMULIA Abaqus

Tosca is a shape, structure and topology optimization analysis tool that can be integrated with SIMULIA Abaqus studies, along with other FEA analysis tools.

The Topology Optimization routines in Tosca are able to change the form of a part in a non-parametric fashion to optimize the physical shape of a component to most efficiently carry the required loading. Parts being optimized can be subjected to multiple loading cases and the optimal solution to all these loading cases be developed.

Shape and structure optimization can add some parametric control to the scenario, ultimately providing the best of both worlds for a complete optimization solution.



Topology Optimization of a wishbone – from design space, through the optimization and stress analysis process to a finished part

Summary

Product	Key Benefits
SOLIDWORKS	• Provides no-cost first pass stress and flow analysis tools to provide basic information about model behavior • These simple tools will likely not provide enough information to make sound design decisions
SOLIDWORKS Premium	• Comprehensive linear static stress analysis functionality, with a range of modeling strategies and analysis features available • Considers only one mode of failure (material yield)
SOLIDWORKS Simulation Professional	• Our best value analysis package allows a user to check against many modes of failure at a competitive price • Includes fatigue, frequency, buckling, optimization and FEA thermal analysis
SOLIDWORKS Simulation Premium	• Our top-level SOLIDWORKS analysis package unlocks the ability to run nonlinear or dynamic analysis • Dynamic analysis provides a realistic analog to expensive real-life shock or vibration analysis
SOLIDWORKS Flow Simulation	• The most powerful CFD software available on the market today at its price point • World-class ease of use and high levels of model accuracy allow engineers and designers to assess heat transfer and fluid flow performance in a wide range of applications • Add on modules available to provide deeper detail in electronics and HVAC industries
SOLIDWORKS Plastics	• Injection molding analysis simulation to detect and correct potential manufacturing defects early in the design process • 3 packages available with variable levels of capability
SIMULIA Abaqus	• Analyst-level simulation tool that can be applied to an incredible range of complex applications • A next-level tool for situations that SOLIDWORKS packages are unable to address • Industry-leading contact, multiphysics, and explicit solver technology

Conclusion

The information presented here represents a simple summary of some of the key decision points that can go into selecting between the different types of analysis available from Hawk Ridge Systems and SOLIDWORKS. However, it's impossible to fully describe all the capabilities of all the analysis tools on offer.

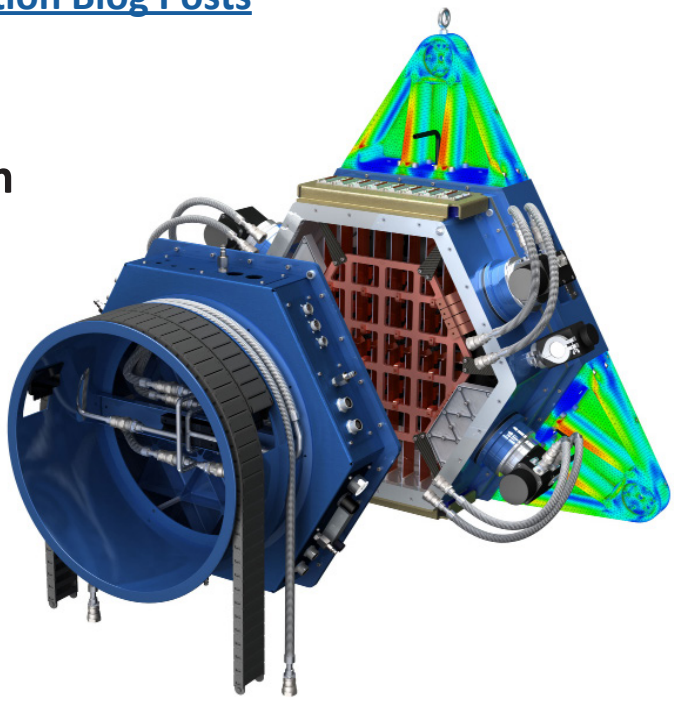
While we hope the information here provides some useful information in making your design decision, more information can be found on the Simulation pages of our website at www.hawkridgesys.com. Please don't hesitate to contact us or your local Hawk Ridge Systems account representative to discuss your application in more detail.

Learn more about SOLIDWORKS Simulation from these Hawk Ridge Systems channels:

- **SOLIDWORKS Simulation Product Page**
- **SOLIDWORKS Simulation Video Tutorials**
- **SOLIDWORKS Simulation Blog Posts**

Get in touch with us!

info@hawkridgesys.com



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Hawk Ridge Systems is a global leader in engineering design and manufacturing solutions. Innovative 3D software applications include SOLIDWORKS 3D CAD design, CAMWorks manufacturing software and 3D Printing solutions.

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