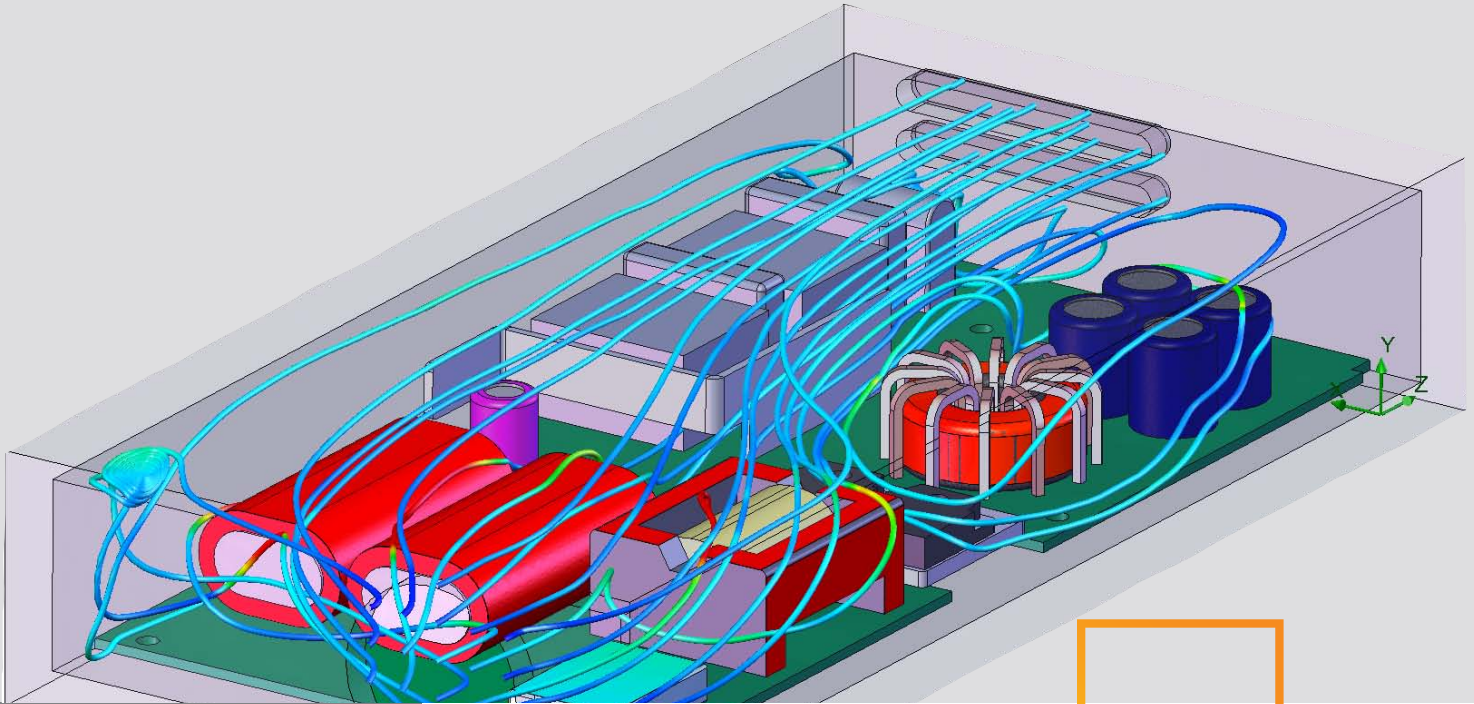


# Analysis Guide for Electronics/Electrical Product Designers



## SUMMARY

In this paper we outline the key design performance issues facing electronics and electrical product manufacturers and identify the benefits of using SolidWorks® Simulation software for electronics and electrical product design. The paper outlines the types of analyses that SolidWorks Simulation software can perform and proves why these analyses are critical to electrical and electronic product engineering.

## Introduction

Analysis and simulation software has become an indispensable tool for the development, certification, and success of electronics and electrical products. In addition to having to meet federal requirements, such as standards regulating electromagnetic compatibility (EMC) and product safety, electronics and electrical products manufacturers must meet various industry standards, such as the Bellcore standard for telecommunications equipment and standards governing the reliability of printed circuit boards (e.g., all PCBs must be able to withstand 21 pounds of load in the center). Combined with customer and market demand for smaller, more compact, and lighter products, these requirements create competitive pressures that make flawless, reliable development of electronics and electrical products an absolute necessity.



**FIGURE 1:** THE USE OF CFD MAKES IT POSSIBLE TO ELIMINATE EXPENSIVE PHYSICAL PROTOTYPES, AND FIND SERIOUS FLAWS MUCH EARLIER IN THE DESIGN PROCESS.

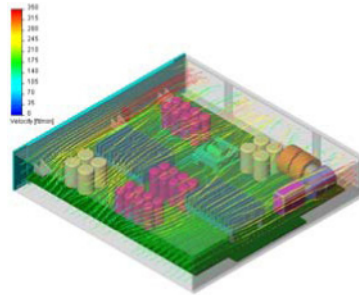
Today's electronics/electrical product manufacturers use analysis software to simulate and assess the performance of a variety of product designs, including consumer electronics, appliances, sophisticated instrumentation, electronics components, printed circuit boards, RF equipment, motors, drives, electrical controls, micro electromechanical systems (MEMS), optical networking equipment, electronics packaging, and semiconductors. Analysis software enables engineers to simulate design performance and identify and address potential design problems before prototyping and production.

### **Analysis at the forefront of electronics and electrical product development**

Whether designing miniaturized electromechanical systems, wireless telecommunications products, or electronics packaging, engineers who develop electronics/electrical products face two common challenges: time and space. No matter what the final product, engineers designing products in this area are being asked to make products smaller and get them to market faster.

Working in this type of environment, engineers have little time to produce multiple prototypes and use trial and error to gain a better understanding of the physical behavior of their designs. Yet, that information is vital for producing innovative, high-quality products.

Analysis tools help electronics/electrical product designers understand the physical behavior of their designs quickly without resorting to expensive prototypes and physical tests that extend the product design cycle. Consider the Bellcore network equipment requirements in the telecommunications industry as just one example.



**FIGURE 2:** COMPUTATIONAL FLOW DYNAMICS (CFD) ANALYSIS IS USEFUL FOR UNDERSTANDING THE EFFECT OF AIR FLOW ON TEMPERATURE DISTRIBUTION IN ELECTRIC COMPONENTS, SUCH AS THE PRINTED CIRCUIT BOARD SHOWN HERE.

Established by telephone utilities to ensure reliable telephone service during times of natural disaster, such as an earthquake, the Bellcore standards require that telecommunications products continue to perform under certain physical conditions—high temperatures, high humidity levels, and episodes of structural vibration—as well as meet other provisions, such as electromagnetic compatibility (EMC) standards.

All manufacturers of electronics/electrical products can benefit from analysis and simulation technology because it helps engineers to understand the physical behavior and limitations of their designs without expending the time and effort required to develop multiple prototypes.

### Application areas

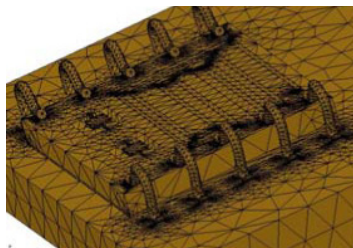
- Electronics Packaging: housings, enclosures, consoles, racks
- Printed Circuit Boards: semiconductors, heat sinks, MEMS
- Cooling Systems: fans, motors, air flows
- RF Equipment: antennas, transmitters, switches
- Wireless/Telecommunications Devices: cellular telephones, radios, routers
- Optical Networking Equipment: amplifiers, switches, relays
- Electrical Components: automotive, transistors, capacitors, switches
- Office and IT Equipment: computers, servers, printers, copiers
- Appliances: washers, dryers, refrigerators, stoves
- Consumer Electronics: laptops, PDAs, stereos, DVD players, digital cameras



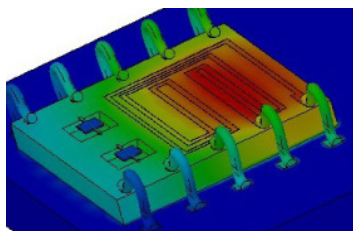
**FIGURE 3:** ANALYSIS HELPS ENGINEERS CREATE EFFECTIVE DESIGNS FOR ELECTRONICS PACKAGING. BALDOR ELECTRIC COMPANY USES SOLIDWORKS ANALYSIS SOFTWARE TO MAKE SURE THE DIE-CAST HEAT SINKS THAT IT PRODUCES FOR ITS VARIABLE-SPEED DRIVES PERFORM AT AN OPTIMAL LEVEL.

### Scope of analysis

- Design verification/validation: Will this design work? Will this design behave the way I think it will?
- Relative merit: Which of these candidate designs is the best? How can I weed out and eliminate poor-functioning designs?
- Miniaturization: What's the impact of physical phenomena when I make this smaller?
- Proof of concept: Testing radical new concepts without producing prototypes.
- Durability and reliability: Fatigue/failure analysis, drop tests, shake simulations.
- Fulfilling industry/regulatory standards: Bellcore, Federal Communications Commission (FCC), EMC/EMI compliance.



**FIGURE 4:** DELPHI PACKARD ELECTRIC SYSTEMS, A LEADING SUPPLIER OF AUTOMOTIVE ELECTRONICS COMPONENTS, USES SOLIDWORKS SIMULATION ANALYSIS SOFTWARE TO OPTIMIZE DESIGNS, SUCH AS THESE TWO CAST ALUMINUM PLATES WITH ELASTOMER-BONDED SURFACES.



**FIGURE 5:** SIZE IS NO OBJECT WHEN IT COMES TO ANALYSIS. EVEN SMALL SEMICONDUCTOR CHIPS CAN BE MESHED (ABOVE) AND ANALYZED (BELOW).

### Tight integration with 3D CAD

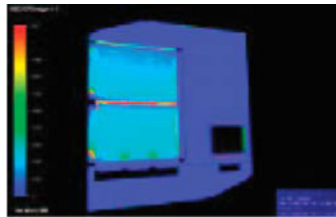
SolidWorks Simulation analysis software is tightly integrated with all major CAD systems and is directly integrated with the SolidWorks CAD system, the standard for 3D design. This means that engineers can use SolidWorks Simulation analysis software directly on the CAD model and do not need to remodel designs to take advantage of analysis technology.

### “What if” studies

Designing an electronics/electrical product presents unique engineering challenges. What are the loads and operating conditions? Is temperature an important consideration? Does the cooling system perform adequately? Are there electromagnetic and vibration issues?

Using analysis to conduct “what if” studies—what if I tried this material, or what if I used this type of mechanism—can help engineers identify the best material and mechanical design for a particular function. Using a computational model and analysis software to perform “what if” evaluations saves time and money and can help to improve design performance.

By coupling analysis studies with Configuration Management, the designer can quickly converge on the best-form design solution over many degrees of freedom.



**FIGURE 6:** TALITY, THE WORLD’S LARGEST INDEPENDENT ELECTRONICS DESIGN PROVIDER, USES SOLIDWORKS STRUCTURAL, THERMAL, AND FLUID-FLOW CAPABILITIES TO OPTIMIZE ELECTRONIC PACKAGING DESIGNS.

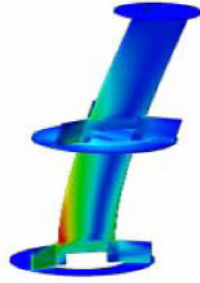
### Powerful analysis types—thermal, vibration, fluid-flow, nonlinear

Reliability, temperature management, and miniaturization are key requirements for electronics and electrical product designs. Companies that use analysis to manage heat, validate miniaturized concepts, and build in reliability at the initial design stage have an advantage over competitors. SolidWorks Simulation analysis software helps to ensure that these considerations are addressed early in the product development cycle, enabling manufacturers to accelerate time-to-market and reduce development costs while producing higher quality products with fewer warranty issues. Using a range of analysis technologies, SolidWorks Simulation software helps engineers to ensure that a product’s behavior will be within design limits, reliable, and free of the risk of thermal, electromagnetic, or stress-induced failures.



**FIGURE 7:** KRYOTECH, INC. LEVERAGES SOLIDWORKS SIMULATION THERMAL AND FLUID-FLOW CAPABILITIES IN THE DESIGN OF ITS INNOVATIVE COOLING SYSTEMS FOR PERSONAL COMPUTERS.

- **Thermal** analysis is critically important in electronics and electrical product design. Managing temperature, whether it's on a printed circuit board, within a semiconductor, or inside a computer housing, is one of the primary design challenges an engineer must overcome. SolidWorks Simulation analysis software can perform steady-state or transient thermal analysis on parts or assemblies. After meshing the design, the designer sets any relevant constraints, then sets power or heat flux conditions associated with a geometrical feature of the model. Because component material properties include thermal conductivity, coefficient of thermal expansion, and heat capacity, the designer gets a realistic prediction of temperature distributions under prescribed loads and operating conditions.
- **Vibration** analysis is used in the design of many types of electronics and electrical products, especially components used in moving systems, such as airplanes, automobiles, and handheld consumer electronics. Reliable performance in a dynamic environment requires an understanding of the natural frequencies at which a component or assembly will vibrate and the impact of any stresses or deflection that may occur. Using SolidWorks Simulation analysis software, an engineer can simulate the natural frequencies of a part or assembly and use this information to modify the design or materials used to avoid resonance and deflection in certain areas or improve performance. Random vibration analysis can also help engineers stiffen electrical systems that are designed to survive earthquakes and represent a more cost-effective approach than conducting physical shake tests. Analysis can be used to minimize frequency and vibration, as in the case of sensitive instrumentation, or control it with a high degree of precision, such as the silicon cantilevers used in most accelerometers.



**FIGURE 8:** EMS WIRELESS, A LEADING MANUFACTURER OF CELLULAR TELEPHONE BASE STATION ANTENNAS, USED SOLIDWORKS SIMULATION ANALYSIS SOFTWARE TO STACK TWO ANTENNAS IN A FLAG POLE DESIGN, FOR COMMUNITIES WITH STRINGENT ZONING REQUIREMENTS, THAT IS CAPABLE OF SUSTAINING WIND LOADS IN EXCESS OF 100 MPH.

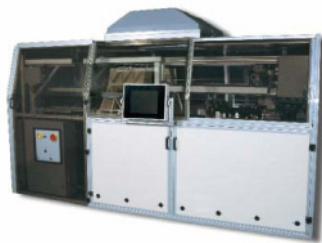
- **Fluid-flow** analysis is important across a range of electronics and electrical product applications, primarily as a means for evaluating the effectiveness of cooling systems and heat sinks. In the case of a cooling system, such as a computer fan, engineers can use fluid-flow analysis to evaluate the effectiveness of a cooling system design as well as investigate the effects of design modifications. In the case of a printed circuit board, engineers can use fluid-flow analysis to analyze the effectiveness of thermal dissipation in heat sinks. Whatever a manufacturer's cooling system or heat temperature management needs, SolidWorks Flow Simulation offers high-powered computational flow dynamics (CFD) analysis for understanding the impact of fluid flow on temperature in electrical systems.
- **Nonlinear** analysis gives electronics and electrical product designers the ability to evaluate product performance within a complex, 3D simulated environment, giving them a far more accurate determination of the different factors that may cause a device to fail. Nonlinear analysis tools are effective for analyzing static and dynamic problems with geometric and material nonlinearity, hyperelasticity, creep, thermoplasticity and viscoelasticity. SolidWorks Simulation Premium nonlinear analysis software can also analyze nonlinear contact problems involving surface interactions of models with or without friction. Such capabilities are valuable for solving contact problems arising from miniaturized connection systems on printed circuit boards.



**FIGURE 9:** SAMTEC, WHICH PRODUCES CONNECTORS THAT TERMINATE LAND GRID ARRAY DEVICES (LGAS) TO A PRINTED CIRCUIT BOARD, USED SOLIDWORKS SIMULATION NONLINEAR ANALYSIS CAPABILITIES TO REDUCE PRESSURE AND DEFLECTION ON THE BOARD TO ACCOMMODATE A HIGH CONCENTRATION OF CONNECTIONS (600) IN A VERY SMALL AREA (ONE SQUARE INCH).

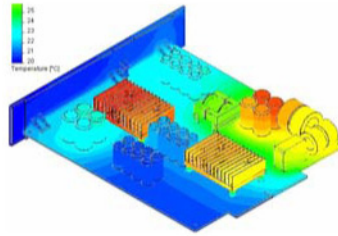
### Assembly analysis

Most designers of electronic and electrical products need to do more than analyze single components and can benefit from robust assembly analysis capabilities. Electronic and electrical systems generally require a mix of components and a wide range of attachment, interconnection, and encapsulation/protection methods. These assemblies, often referred to generically as electronics packaging, can be affected by heat, pressure, vibration, impacts, and electromagnetic fields at both the component and assembly levels.



**FIGURE 10:** DAMPING VIBRATION IS A COMMON NEED IN ELECTRONICS/ELECTRICAL PRODUCT DESIGN, ESPECIALLY WITH MOTION-SENSITIVE INSTRUMENTATION AND EQUIPMENT. SONORAN SCANNERS USED SOLIDWORKS SIMULATION TO ANALYZE FREQUENCY RESPONSE AND STRUCTURAL STABILITY ON THE DESIGN OF ITS CACTUSSETTER COMPUTER-TO-PLATE PRODUCTION SYSTEM.

SolidWorks analysis software enables engineers to simulate all of these behaviors by allowing for the analysis of small or large CAD assemblies. The software allows engineers to assign different materials to different parts of the assembly and specify how the components will interact with each other. SolidWorks Simulation assembly gap/contact analysis allows you to simulate various real-life conditions for electrical components.



**FIGURE 11:** SOLIDWORKS ASSEMBLY ANALYSIS CAPABILITIES ENABLE ENGINEERS TO ANALYZE TEMPERATURE DISTRIBUTION FOR AN ENTIRE ASSEMBLY, SUCH AS THE STEADY-STATE THERMAL ANALYSIS OF A PRINTED CIRCUIT BOARD, SHOWN HERE.

An example of where assembly analysis can benefit the design of an electronics/electrical assembly is a printed circuit board. Many of the components on the board, such as capacitors, produce heat. SolidWorks Simulation assembly analysis capabilities enable engineers to analyze temperature distribution for the entire assembly, so they can optimize designs for corresponding heat sinks and packaging in such a way as to dissipate the maximum amount of heat using the least amount of material. SolidWorks Simulation analysis tools enable analysis of electronics and electrical products at the component, assembly, and system levels.

### 3D visualization

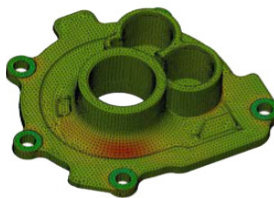
- 3D visualization provides a designer with a first check of design intent, proper operation, and aesthetics as the project develops.
- 3D CAD enables the designer to view a product design from all angles and examine the internal parts of the product throughout the design process. This gives designers a clear and accurate review of parts and assemblies early in the design cycle.
- 3D visualization reduces communication and fabrication errors, saving development time by more effectively conveying design information so that designers can find problems early in the design cycle. Designers can view the product from all sides and look inside by hiding the outer enclosure or other parts.
- 3D animations of simulations allow you to see how electronics and electrical products function in the real world.
- Section plots allow you to see simulation results inside the part and not just on the surface.



**FIGURE 12:** A LEADING PRODUCER OF INDUSTRIAL MANUFACTURING EQUIPMENT, TECO-WESTINGHOUSE USES SOLIDWORKS SOFTWARE TO TEST DESIGNS FOR STRESS, DISPLACEMENT, FREQUENCY, BUCKLING, HEAT TRANSFER, DYNAMIC RESPONSE, AND NONLINEAR ANALYSIS UNDER REAL-WORLD OPERATING CONDITIONS.

### Design communication and collaboration tools

- Design collaboration has become an increasingly important part of the product development process, enabling designers to share designs easily with anyone, anywhere.
- Collaboration tools offer new ways for product designers to work more effectively with other members of the development team. The ability to share design resources over the Internet benefits all product designers, from independent consultants to engineers in large multinational corporations.
- SolidWorks Simulation analysis tools allow designers to share analysis results in various formats such as:
  - HTML reports of analysis results
  - VRML files
  - AVI files
- SolidWorks Simulation allows users to publish SolidWorks eDrawings® for analysis results.



**FIGURE 13:** VYNCOLIT, BASED IN GENT, BELGIUM, USES SOLIDWORKS TO CHECK THE PERFORMANCE OF COMPONENTS MADE OUT OF PHENOLICS MATERIAL. PHENOLICS MATERIALS HAVE A NUMBER OF PHYSICAL PROPERTIES THAT MAKE THEM IDEAL FOR MANY APPLICATIONS, WHICH HAVE TRADITIONALLY BEEN SERVED BY METAL OR THERMOPLASTICS, IN INDUSTRIES SUCH AS ELECTRONICS AND AUTOMOTIVE.

## Conclusion

Analysis tools help electronics and electrical product designers understand the physical behavior of their designs quickly without resorting to expensive prototypes and physical tests that extend the product design cycle. SolidWorks Simulation software offers powerful thermal, vibration, fluid-flow, nonlinear, and electromagnetic analysis capabilities, in addition to robust assembly analysis features, to help design quality products that will meet stricter industry and market requirements.



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