

THE WORLD'S FASTEST, MOST COMPREHENSIVE OPTIMIZATION SOFTWARE

HEEDS

Design to Win. *Faster.*

PROFESSIONAL EDITION



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TECHNOLOGY

HEEDS

PROFESSIONAL EDITION

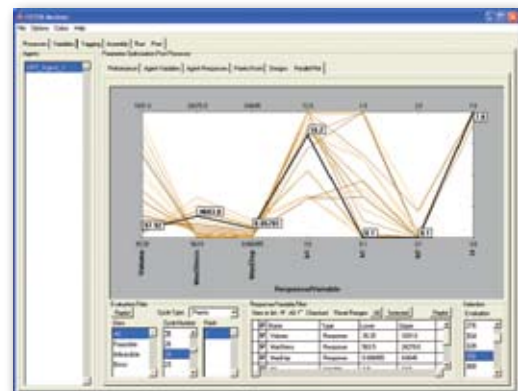
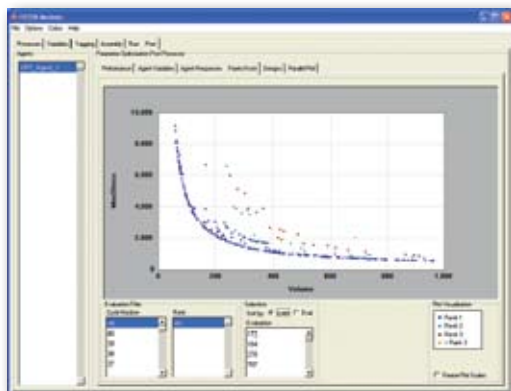
Design to Win. *Faster.*

HEEDS™ (Hierarchical Evolutionary Engineering Design System) Professional is an intuitive and powerful software package that interfaces with all of the popular CAE applications to automate and expedite the design optimization process. It intelligently conducts a broad, efficient search for optimized designs, often in a fraction of the time it would take to perform a handful of manual design iterations.

Whether you need to improve the design of a simple engineered system or solve multidisciplinary problems, HEEDS Professional is flexible and powerful enough to rapidly identify the parameter values, or attributes, that satisfy your design criteria.

Benefits of Using HEEDS Professional

- Discover innovative designs, faster
- Significantly reduce development costs
- Leverage existing CAE tools, hardware and talent
- Satisfy multiple, even conflicting, design criteria



Obtain a greater understanding of your design space, including tradeoffs among competing objectives, and relationships among variables and objectives, through extensive graphical and tabular views of your design study results.

Be more productive and lower your costs

HEEDS Professional guides the development of products that are higher performing, safer, lighter and less expensive.

Design Optimization

Within HEEDS Professional, engineers can easily define design parameters and multi-disciplinary design goals, and choose analysis tools to judge a design's performance. Then, HEEDS performs design iterations automatically while searching for design parameter values that simultaneously meet all targets and criteria.

Using advanced proprietary optimization algorithms and intelligent strategies, HEEDS Professional effectively searches even the most complicated design spaces, so you discover better designs, faster.

Optimization algorithms

- SHERPA
- Multi-objective SHERPA
- Genetic algorithm
- Quadratic programming
- Simulated annealing
- Response surface
- Multi-start local search

Design of Experiments (DOE)

When it's important to predict design sensitivities, or gain a clearer understanding of your design space, a HEEDS Professional design of experiments (DOE) study is often the ideal approach. It allows you to extract a great deal of useful information quickly, with the least computational or experimental effort possible. In a HEEDS DOE study, your CAE model is automatically evaluated multiple times with the design variables set to different values in each run.

DOE sampling methods

- Full factorial designs (two-level and three-level)
- Fractional factorial designs (two-level and three-level)
- Taguchi orthogonal arrays
- Plackett-Burman designs
- Latin hypercube designs
- Central composite designs
- D-optimal designs
- Taguchi robust design arrays
- User-defined arrays
- User-defined response data

Easily predict design sensitivities

A HEEDS DOE study helps you identify, and focus on, the variables that affect your design the most. Variables that are not important can then be ignored or set to values that are most convenient or least costly. This allows you to control quality more effectively while lowering cost.

Clearly understand your design space

The results of a HEEDS DOE sampling process can be used to generate an approximate model of your system, often called a response surface model (RSM). These models are very convenient for

- Visualizing your design space
- Examining the relationships among variables and their effects on key responses
- Quickly evaluating different designs without performing additional expensive CAE evaluations or experiments

HEEDS Professional offers a broad range of DOE sampling methods and post-processing features. Also, if you're not an expert at DOE, HEEDS' unique DOE wizard can guide you through the definition of your problem, ensuring that you obtain the information you need.

Process Automation

The HEEDS Professional process integration module makes you more productive by capturing and automating your existing processes. With HEEDS, your data flows

automatically between CAD, meshing tools, simulation tools, in-house proprietary codes and cost models, eliminating tedious manual data transfer and costly errors. After a process is captured and validated, it can be used over and over by engineers throughout your organization.

HEEDS Professional process automation features include:

- Direct portals to common CAE tools for data extraction
- Automated execution of multiple simulation and analysis tools within a design evaluation process
- Integration and sharing of data among separate simulations
- Support for parallel processing on networks, clusters, and multiprocessors

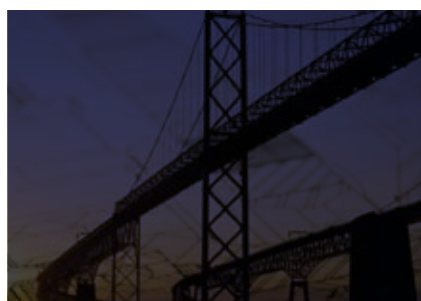
Quality Design Tools

Finite geometric tolerances, variations in material properties, and uncertainty in loading conditions will cause any manufactured part to perform slightly differently in service. However, the performance of a robust and reliable design will not change much with these expected variations and remains above an acceptable level at all times. To evaluate the robustness and reliability of a design, its variables and system inputs are made stochastic – they are defined in terms of both a mean value and a statistical distribution function. The resulting system performance characteristics are then measured in terms of a mean value and its variance.

With HEEDS Professional, stochastic variations can be assigned to all design variables as well as fixed system parameters so that a stochastic simulation can be performed, helping you achieve designs that meet the highest quality standards for robustness and reliability.

Quality design capabilities

- Taguchi robust design arrays
- Structured sampling
- Random (Monte Carlo) sampling



How HEEDS Optimization Works

HEEDS Professional works the way you do. It captures and automates your current design workflow, based on the design and analysis tools you prefer to use. Then, it automatically explores the design space to quickly identify solutions that meet all of your performance and cost goals.

HEEDS optimization begins within your preferred modeling and analysis tools, where you create and execute the analysis models needed to fully evaluate the performance of a baseline design. The input and output files generated during each step in the model creation and analysis contain the data that HEEDS will use as a starting point for its optimization process.

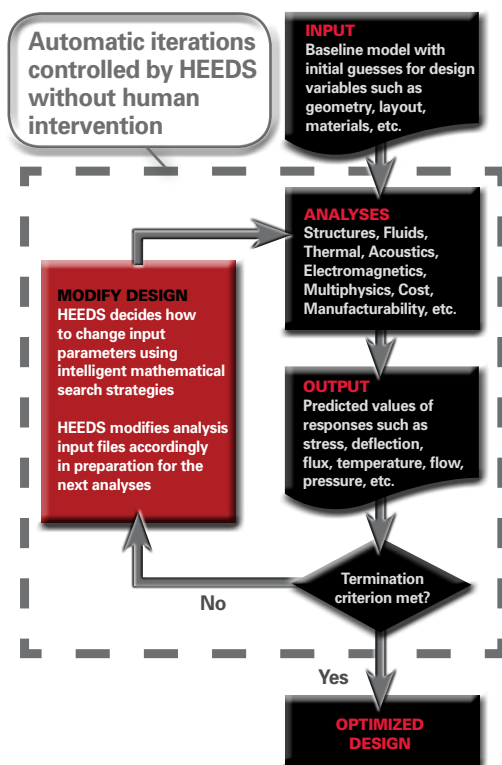
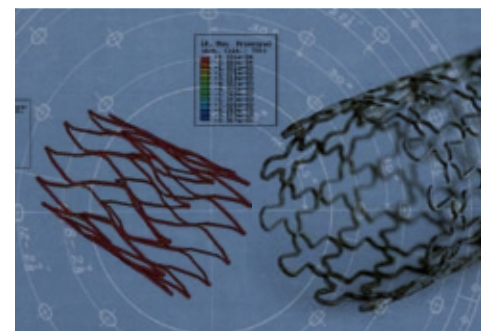
Next, within the HEEDS Modeler, you

- Capture the modeling and analysis process that HEEDS will automatically repeat to evaluate potential designs.
- Identify the project variables that will be varied and the responses of interest.
- Define the constraints that specify whether a response should be greater than or less than a particular value.
- Define the objectives that specify whether a response should be maximized or minimized.

HEEDS begins its search by selecting values for the project variables within the ranges you have specified. It creates new model input files containing these values, and evaluates each design with the same analysis software tools that produced the baseline input and output files. After each evaluation, HEEDS automatically extracts the corresponding response values from the output files.

As the search progresses, HEEDS uses an intelligent mathematical process to discover relationships among variables and responses, and leverages this knowledge to identify higher-performing designs, until it converges on the optimal solution.

Other HEEDS design studies, such as Design of Experiments or Reliability and Robustness studies, are performed in a very similar manner. The primary difference is in the definition of the sampling methods and in the post-processing of the results.



Parallel Execution of a Design Study

In order to speed up an optimization, DOE, or reliability design study, HEEDS Professional can perform multiple design evaluations simultaneously on multiple processors.

Each of these evaluations may involve multiple steps (analyses) and require the use of several different CAE tools. For example, one evaluation may involve the use of a CAD model to create a new geometry, a Mesher to generate a new finite element mesh, a Pre-processor to generate a complete finite element model, a CAE Solver to perform the finite element analysis, and a spreadsheet-based cost model. Each of these steps within a design evaluation may utilize a different software package whose

license exists on a different machine. Hence, for a single design evaluation it may be necessary for data to flow to several different machines and different CAD/CAE tools.

This is all handled automatically within the optional HEEDS MPD (multi-processor design) module. Each set of analyses can be performed on the same set of machines or on a different set of machines, to account for the case in which software licenses are available on different machines. The HEEDS MPD module has its own queuing process, but it can also interface with third-party grid software such as LSF and PBS-pro.

The HEEDS™ Advantage

HEEDS' proprietary optimization search strategies are the most efficient and robust available, shortening design time from weeks to days. And, shorter design time translates into reduced product development costs.

At the same time, HEEDS provides a more thorough search with the potential to yield truly innovative design alternatives that satisfy multiple, even conflicting, criteria.

Finally, HEEDS easily integrates with your existing CAE tools, hardware, and talent, maximizing the investment you've made in these resources.

Whether you need to improve the design of a simple engineered system or solve multidisciplinary design problems, HEEDS is flexible and powerful enough to identify the parameter values, or attributes, that satisfy your design criteria.

Leverage the Power of HEEDS' Exclusive Search Strategies

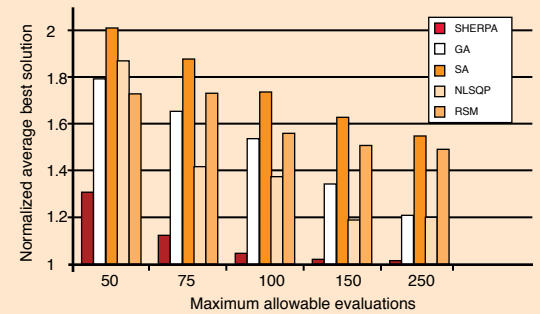
SHERPA: *Simultaneous Hybrid Exploration that is Robust, Progressive, and Adaptive*

- Finds better solutions the first time, without iterating to identify the best method or the best tuning parameters for your problem
- Enables non-experts to successfully apply automated optimization the first time
- Performs direct optimization based on actual model evaluations, rather than using approximate response surface models
- Uses multiple strategies concurrently to more effectively and efficiently search even the most complex design spaces
- Adapts itself to each problem, eliminating the need for user-specified tuning parameters
- Achieves both global and local search simultaneously

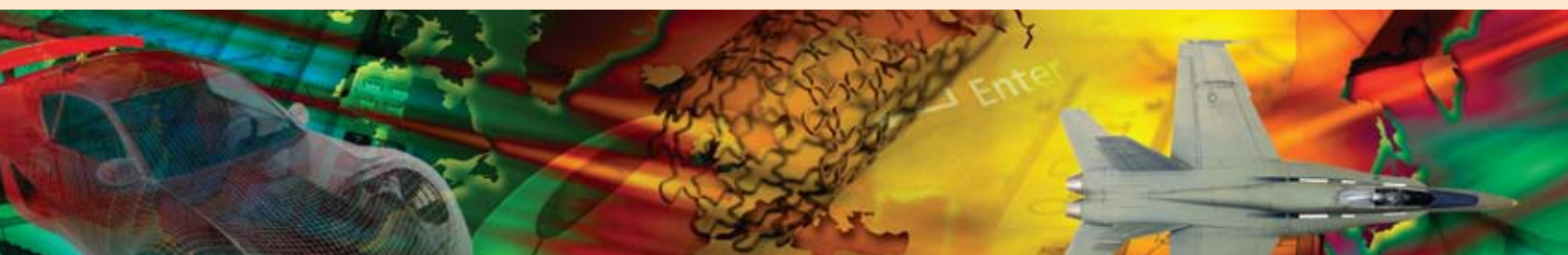
MO-SHERPA: *Multi-Objective SHERPA*

- Performs multi-objective Pareto search using a modified version of the SHERPA algorithm
- Handles multiple objectives independently to provide a set of optimized solutions that represent trade-offs among the objectives
- Uses multiple search strategies simultaneously to more effectively explore the Pareto front
- Contains no tuning parameters, making it simple for non-experts to achieve success every time

Effectiveness and Efficiency of Search (Goal=1)



On average, SHERPA requires significantly fewer model evaluations than other leading methods do to identify optimized designs. This efficiency can save days or even weeks of CPU time during common engineering optimization studies. The results shown here are typical. SHERPA finds the optimal solution (a value of 1 in this case) within about 125 evaluations in nearly every run. The next best algorithm for this problem requires approximately 350 evaluations to consistently achieve the same level of optimization. Other methods are even less efficient for this problem.



How Engineers are Using HEEDS™ Professional Edition

Aerospace

- Composite wings
- Turbine blades
- Landing gear
- Wing profile design
- Sensors
- Fuselage structures
- Composite joint layout
- Rocket propulsion

Automotive

- Body and chassis
- Suspension systems
- Crashworthiness (frontal, rear, side, roll-over)
- Hybrid electric powertrains
- Bushings
- System and component crash and NVH
- Armored vehicles
- Seat systems
- Exhaust systems
- Electromagnetic sensors
- Pistons, rings and gears
- Heating and cooling systems
- Bumper systems

Biomedical

- Orthopedic implants
- Vascular stents
- Surgical devices
- Biomaterials modeling
- Human body model calibration

- Consumer products
- Press fits
- Racing head and neck support (HANS)

Durable Goods

- Plastic and metallic containers
- Food manufacturing equipment
- Golf clubs and balls
- Shoe design
- Transport equipment
- Packaging

Materials

- Composite layout design
- Material selection
- Material model calibration
- Material property optimization
- Material identification
- Redesign for material conversion

Manufacturing and Processing

- Injection molding
- Stamping
- Forging
- Hydroforming
- Weld design
- Chemical processing

HEEDS Helps You Make Intelligent Business Decisions

Although HEEDS optimization technology is most typically used by engineers to make design decisions, its power and flexibility can just as easily be applied to other disciplines. It is, at its essence, a decision-making optimization tool.

For any application in which predictive models are available, HEEDS can help you rapidly identify and rank the feasible options, so you can easily optimize your solution and make more intelligent decisions. Common applications include cost analysis, financial forecasting, supply chain management, drug discovery, scheduling, and more.

If you'd like to learn more about how HEEDS can help you optimize your business decisions, please contact us at info@redcedartech.com.

Platforms

HEEDS Professional is supported on 32-bit and 64-bit Windows, Linux and Unix systems.



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