



RAMDO® Solutions is a software development and consulting services company focused on developing tools that account for variability in simulation inputs.



WHAT DOES RAMDO DO?

RAMDO software works in conjunction with computer simulations and allows it to take into account the variability of input parameters that can have an effect on a design or system. RAMDO's **enhanced analysis** provides engineers with an understanding of how variability affects their simulation results, which leads to **more-reliable, better-optimized, safer, and less-expensive solutions**.

WHY IS RAMDO NEEDED?

Uncertainty and variability in design is everywhere, especially in material properties, load variabilities, operating environments and conditions, and the manufacturing process.

Currently, engineers have many tools to help them model products and systems and simulate how they will perform in operating conditions. But these simulations only tell part of the story because they assume a set of non-varying input parameters, producing a single solution. Imagine if these simulations could be **more detailed**, showing not only exactly where designs and applications would fail, but how engineers could optimize them with a known probability level and providing a more reliable solution.

That's where RAMDO can help. By **incorporating RAMDO software into your modeling and simulation process**, engineers will see how their designs will react for the given input variability.

HOW IS RAMDO DIFFERENT?

RAMDO works in conjunction with simulation models, allowing engineers to incorporate input variability. By taking into account input parameter variabilities in simulation analysis, RAMDO shows how sensitive the designs are to variability in input parameters.

RAMDO's three distinctive tools allow engineers to better analyze designs for systems and products:

- **Uncertainty Quantification (UQ)**—accounts for input variability and generates an output distribution, which is used to calculate how likely particular outcomes might occur.
- **Reliability-Based Design Optimization (RBDO)**—a specific type of design optimization that accounts for input variability and generates a reliable design at minimum cost.
- **Verification & Validity (V&V)**—a tool that allows engineers to statistically verify and validate their simulation models, even with limited output test data.

RAMDO's accuracy and efficiency comes from these RAMDO-developed, proprietary technologies:

- **Dynamic Kriging™**—a surrogate modeling method used to make UQ and RBDO computationally affordable.
- **Variance Window™**—a method that accurately hones in on a particular region of input parameters variation, minimizing the number of simulation model runs required to achieve accurate results.

WHY RAMDO?

Many simulation solvers use input parameters (not accounting for their variability) and produce a single solution. RAMDO on the other hand, **allows engineers to understand and take into account the variability of their input parameters** (dimensions, material properties, loads, etc.), produces an output distribution, and provides a sensitivity analysis of input variability to outputs. RAMDO's unique capabilities include a highly accurate and efficient calculation of these solutions.

Compared to other similar software tools, RAMDO is **computationally affordable and user friendly**.

Benefits include:

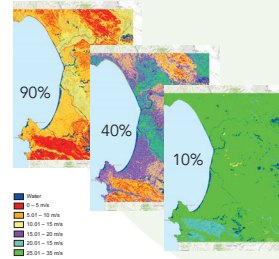
- increased product reliability and safety
- reduced weight, noise, and cost
- knowledge of how variability affects products and systems

WHAT IS RAMDO'S COMPATIBILITY?

RAMDO software **can be used with any simulation solver** for any discipline, including:

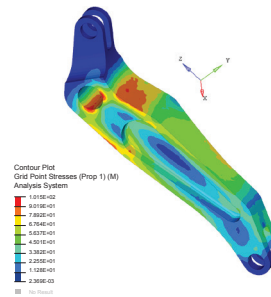
- Finite Element Analysis (FEA)
- Computation Fluid Dynamics (CFD)
- Multibody Dynamics (MBD)
- Electromagnetic Simulation (EM)
- Casting Simulation
- Terramechanics and Dynamics Simulations

APPLICATION EXAMPLES



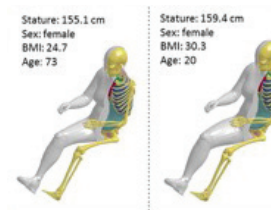
Predictive Speed Maps (UQ)

RAMDO software takes into account input variability, such as soil type, slope, and elevation to produce predictive speed and mobility maps at any selected level of probability.



Durability of Suspension Part (RBDO)

RAMDO software takes into account input variabilities, such as dimensional tolerances and fatigue material properties to illustrate the optimal part design, including improved reliability, reduced weight, and increased product life.



Passenger Restraint Designs (UQ)

RAMDO software takes into account input variabilities, such as age, stature, BMI, and gender in their designs of passenger restraint systems, ultimately protecting more human lives.

"Only RAMDO can solve our extended design variable and random parameter correlations with the other commercial software we are using."

Jongguk Choe
 Research Engineer
 LG Electronics, Inc.

"The special technology RAMDO developed to do RBDO is a valuable tool for our use, and we support efforts to bring this technology to the commercial market."

David A. Lamb, Ph.D.
 Senior Research
 Computer Scientist
 U.S. Army

"RAMDO has the best RBDO algorithm to obtain accurate solutions."

Kwang-Hyeon Hwang
 Noise & Vibration CAE Team
 Senior Research Engineer
 Hyundai Motor Company