OPTIMIZATION TECHNOLOGIES

Maximizing Performance and Cost Effectiveness

Highlights

Why is optimization important?

- While analysis answers the question "what will be the outcome if I do …" optimization answers the question "what should I do to get the best outcome".
- It often identifies high performing, non-intuitive solutions.
- It can be used to quantify the tradeoffs that typically exist between multiple objectives (ex. cost and performance).
- It aids designers and decision makers in understanding the nature of their problem and provides a mathematical basis for the decisions they make.
- For large scale systems, the performance gains achieved from optimization can be significant, as can the cost savings.

What are the objectives for developing this capability?

- To provide our customers with a rich set of highly functional optimization capabilities.
- To provide our analysts with the means of supplying decision makers with high quality, defensible results.

What are the research areas?

- There are many optimization techniques and each has strengths and weaknesses. Deciding which technique to use for different problems is a difficult question.
- The majority of the problems we deal with have a high degree of uncertainty. Techniques for uncertainty quantification are being actively researched.
- Understanding the results of an optimization is critical and can be difficult. Research is ongoing to develop methods of effectively conveying optimization results to decision makers.
- All optimization techniques require repeated evaluation of a model, and such evaluations can be expensive. Research is ongoing to explore distributed optimization techniques.

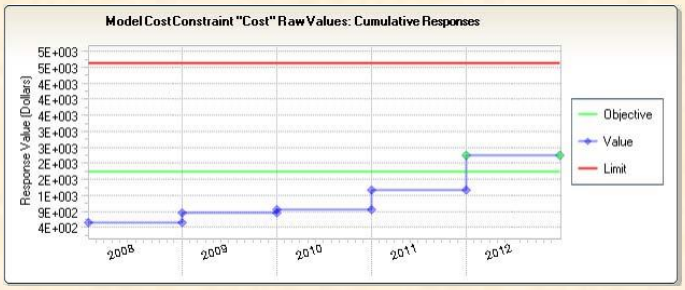
Human Performance Overview

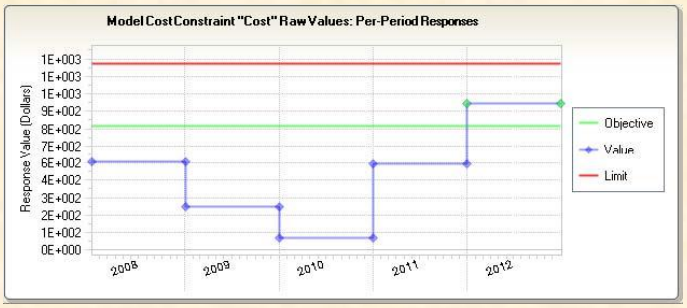
Optimization is the process of varying input parameters to a model with the ultimate goal of achieving improved performance with respect to some objectives.

In most problems of interest, there are multiple objectives that must be simultaneously optimized and multiple constraints that must be respected. This is the job of any optimization algorithm.

In addition to having multiple objectives and constraints, many of the problems we deal with involve discrete decision spaces. That is, there is a limited selection of possible choices that can be made and the task is to choose from amongst them. Problems such as this present particular difficulties for optimization algorithms.

We have developed a number of applications that have been successfully demonstrated on these large scale and difficult problems.





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Key Features

Current Capabilities

- Pro-Opta: a reliability analysis and optimization tool that among other things can conduct performance and spare parts optimization.
- TMO: an optimization tool designed to optimize technology management strategies over time but that can be used for a wide variety of time-based decision support problems.
- MILP: Some optimization problems solved in this center have been analyzed using a mixed-integer linear programming formulation and solver.

Example Applications

- Resource allocation
- Maintenance strategies
- Technology management roadmaps
- Spares inventories
- Design for manufacture, sustainment, and availability
- Investment strategies

Key Benefits

Improved Performance

- Optimization can provide solutions to problems that maximize performance with respect to multiple objectives.
- Systems will function more effectively and cost less.

Improved Understanding

- Optimization results can illuminate the relationships between input variables and outputs.
- It can be used to quantify the trade-offs between objectives.

Defensible Decisions

- Decision makers often find it valuable to have optimization results to show when defending their actions.
- Results such as these demonstrate that due-diligence was exercised in making a decision.
- A single analysis is typically all that is necessary to demonstrate the inferiority of other choices that could have been made.

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