



“We believe in HEEDS and have seen tremendous benefit as we’ve applied it on several internal programs with great success. HEEDS integrates well with our internal tools, as well as with the MSC products we represent and use. Because of our confidence in this technology, we have committed to reselling it and working closely with Red Cedar Technology to share it both with our customers and prospects.”

Mark Palmieri
Pratt & Miller Engineering

Pratt & Miller Uses HEEDS MDO to Reduce Design Time and Lap Time

Pratt & Miller Engineering has evolved from a small business focused on designing and building race cars into an international engineering powerhouse. Today, Pratt & Miller is recognized around the world as a formidable force in both motorsports and high-level engineering.

After evaluating multiple optimization tools, Pratt & Miller concluded that HEEDS MDO, and its SHERPA algorithm, is the only optimization technology that can solve their highly constrained models. According to Pratt and Miller’s Jesper Slattengren, “The SHERPA algorithm is currently superior to anything else that exists on the commercial market.” The use of HEEDS MDO software has enabled Pratt & Miller to reduce both design time for its engineers and lap time for its drivers.

Pratt & Miller’s Challenges before Using HEEDS

Pratt & Miller’s typical automotive optimization studies are set up as nearly over-constrained problems. They usually need to minimize or maximize only one or two objectives, but often need to satisfy up to 50 constraints. Prior to using HEEDS MDO, Pratt and Miller would plan for 4-12 man-weeks to find a solution for their typical problem. This was in addition to the time required to generate the baseline model using a combination of engineering intelligence and DOE methods. Using HEEDS MDO and parallel processing, this time is typically reduced to 1-2 weeks.

How HEEDS Has Changed the Design Process at Pratt & Miller

In the past, Pratt & Miller structured simulation investigations primarily around DOE studies performed using Adams/Insight. However, an assumption of the model order had to be set before the simulations were started, and the response surface did not always conform to that order, resulting in a poor fit. When designing new vehicles from the ground up, the parameter variations can be very large, and even a cubic model doesn’t fit very well to the actual response surface. HEEDS MDO removes this problem. HEEDS operates on the actual response values and determines how the simulation should progress. It is very easy to exclude failed simulations from the optimization process in HEEDS. The other problem with DOE simulations was the large number of evaluations.



“Pratt & Miller has evaluated multiple optimization tools and HEEDS MDO, with the SHERPA algorithm, is the only one that can solve our highly constrained models.”

Jesper Slattengren
Pratt & Miller Engineering

Pratt & Miller often ended up doing 21,000 evaluations for a cubic model and 1,500 evaluations for a quadratic model. According to Slattengren, “Using HEEDS MDO with SHERPA, we can find a good solution in 400 evaluations, and often less. HEEDS allows us to study the progress of the optimization while it is running. We can stop the simulation at any point when the results are close enough to the desired target. We can also extend the run beyond the initial number of runs without any loss of optimization progress.”

Finally, Pratt & Miller struggled to manage multiple simulations. In a typical scenario, they would conduct 6 to 14 different simulations for each model, and the optimal design was dependent on all of the simulations. This required 6 to 14 different DOEs with the same factors and different responses. It also required a polynomial optimization method that could work over the combined response surfaces from all the DOEs. Incorporating HEEDS into the design process has completely eliminated this problem.

Specific Problems Pratt & Miller Has Solved with HEEDS

Optimizing chassis components for military vehicles

HEEDS MDO is used daily at Pratt & Miller to optimize chassis component parameters to meet specified military requirements for heavy vehicles. These include spring and damper parameters, anti-roll bar dimensions and suspension geometry points. Among the constraints are under-steer gradient, ride-quality measures and spring and damper balance. Typical problems include up to 50 factors and as many constraints. Using MSC Adams with HEEDS MDO parallel processing, Pratt & Miller is able to produce reliable results overnight.

Optimizing gear ratios for race cars at Nürburgring

Pratt & Miller uses HEEDS MDO to optimize gear ratios for sports cars at Nürburgring and other tracks. A limited number of gear combinations can be used in a gearbox, and the ease of specifying discrete sets of allowed values in HEEDS makes this a breeze. Using an in-house lap-time simulator, with MATLAB as pre- and post-processor wrapped around HEEDS, makes the simulations easy to set up.

Correlating kinematic and compliant test data for open-wheel race cars

Because ball joints are used in all connections in race car suspensions, it is easy to assume that the suspension behavior is kinematic. This is not the case. Suspension part compliance can be analyzed using FEA tools, but ball joints are not easily analyzed this way. Instead they are modeled as non-linear bushings whose parameters can be optimized using HEEDS MDO. The resulting simulation model is used to better predict track performance and car setup for specific tracks.