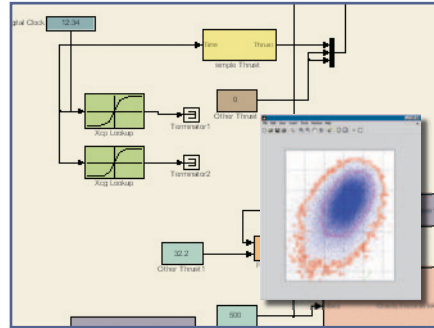


TYBRIN Accurately Predicts Debris Fallout from Missile Tests Using MathWorks Tools

Test ranges require precise analysis to determine when and where they can safely test missiles. Defense contractors that recommend tests need to quickly assess potential risk.

Using MathWorks tools, TYBRIN Corporation rewrote their legacy analysis and modeling programs to provide faster and more detailed recommendations for a recent NASA flight test project.

“Our analysis and modeling tools were based on custom Fortran,” says Cary Owens, program manager and missile flight test safety engineer at TYBRIN Corporation. “MathWorks tools increased our computational speed and provided a unified environment for modeling trajectories, simulating impact risk, and visually assessing the results.”



Model of missile launch with map of debris field containing risk contours.

displays. Therefore, TYBRIN needed a tool that enabled them to choose an appropriate map projection and put risk contours on maps.

Finally, since their legacy modeling tool was difficult to update for new missile designs, they needed more comprehensive modeling capabilities that enabled them to create six-degrees-of-freedom models.

THE SOLUTION

In just one week, TYBRIN recreated the functionality of their legacy risk analysis and modeling tools with MATLAB®, Simulink®, the Mapping Toolbox, and the Aerospace Blockset after attending MathWorks training.

“With our new tools, we completed a proof of concept that proved its capabilities,” explains Owens. “We rebid our project with our new tools and won.”

TYBRIN used the tools to model and analyze the failure modes of upper-atmospheric, unguided research rockets for NASA. Engineers used the Aerospace Blockset to create three-degrees-of-freedom and six-degrees-of-freedom missile models to handle core transformations for simulating a missile launch.

THE CHALLENGE

To improve computational speed of models and increase risk analysis capabilities with custom visualization

THE SOLUTION

Use Simulink and the Aerospace Blockset to improve the computational performance of models and MATLAB and the Mapping Toolbox to improve the visualization of results

THE RESULTS

- Computational time reduced from two days to two hours
- CMM Level III certification maintained
- Productivity increased with unified development and visualization environment

THE CHALLENGE

TYBRIN sought to improve the computational speed and functionality of their legacy analysis and modeling tools to respond more quickly to customer requests.

“Our analysis is critical for test ranges where customers must determine when and where they can launch test missiles,” says Owens.

Their debris impact risk analysis tool, which assesses the potential effect of debris on population and property from missile tests, lacked the performance capabilities to provide results quickly.

“We deal with millions of data points,” explains Owens. “Each point has to be filtered on kinetic energy and mass, which takes up to two days to compute.”

Owens and his team also wanted to provide their customers with improved map

“With our legacy programs, it took us eight to 12 months to complete a project. With MathWorks tools, we completed a similar project in just four weeks.”

Cary Owens, TYBRIN Corporation

“Before, we used a general transformation program that was written in C, using output from a Fortran model with Perl scripts,” explains Owens. “With the Aerospace Blockset, I started with the ground and modeled the entire flight up to the point of impact. We simply could not do that before with our legacy tools.”

Using the Aerospace Blockset, TYBRIN altered launch elevations and adjusted the motor placement on the back end of the missile to determine where it would travel. Using Simulink, they ran 2,000 Monte Carlo simulations to capture all of the potential destructive actions, including missile detonations and early terminations. They then propagated the debris to the ground using three-degrees-of-freedom models, recording the impact points.

TYBRIN then analyzed the debris catalog with MATLAB and the Mapping Toolbox, determining the probability of impact by constructing a data grid and accumulating results for each grid cell. Using the spatial grid manipulation capabilities in the Mapping Toolbox, they converted latitude and longitude points, computed distance, analyzed data, and produced risk contours.

“The Mapping Toolbox made it easier for our customer to quickly determine the high-risk areas by simply looking at the colors,” says Owens. “The spatial grid display and analysis functions also gave us the flexibility to present our data in many ways and handle the complex distance computations.”

Owens plans to use the **geostruct** data type in the Mapping Toolbox to organize data for improved visualization.

By providing faster analysis and quicker response to ad-hoc requests, TYBRIN enabled NASA to meet their launch date

to test a missile at the U.S. Army Kwajalein Atoll’s Ronald Reagan Ballistic Missile Test Site in the Pacific Ocean.

THE RESULTS

- **Computational time reduced from two days to two hours.** “Using the algorithms developed in MATLAB and the Mapping Toolbox reduced our computational time from two days to two hours,” explains Owens. “The results were identical, but the speed increase was shocking. It absolutely flew!”
- **CMM Level III certification maintained.** Using MathWorks tools, TYBRIN has reused models to maintain the Capability Maturity Model for Software (CMM) Level III certification, which judges the maturity of the software processes of an organization. “A lot of CMM implementation deals with documentation, and since Simulink models are self-documenting, much of that work is already done,” says Owens.
- **Productivity increased with unified development and visualization environment.** “By programming and visualizing everything using MathWorks tools, we have increased our productivity, so we can now focus more on our analysis efforts instead of programming,” Owens notes.

To learn more about TYBRIN Corporation, visit www.tybrin.com

APPLICATION AREAS

- Aerospace and defense
- Geospatial data analysis
- Model-based design
- Modeling and analysis

PRODUCTS USED

- MATLAB
- Simulink
- Mapping Toolbox
- Aerospace Blockset

www.mathworks.com