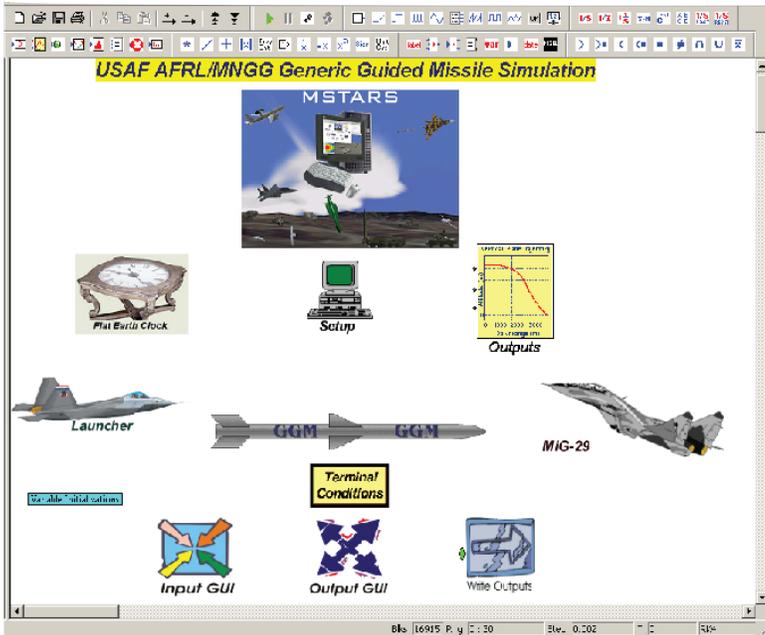


Air Force Research Laboratory Munitions Directorate

Air Force Uses Embed to Simulate Dynamic 6-DOF Munitions Systems



Top level of MSTARS flight dynamics and weapons diagram.

"[Embed] was the appropriate solution. It offered the power, reliability, and extensibility that we required. Without [Embed], we could never have come this far, so quickly."

Larry Lewis
Chief Architect of MSTARS
Eglin Air Force Base

Using Embed (formerly called VisSim Embedded), the Air Force Research Laboratory Munitions Directorate at Eglin Air Force Base in Florida developed a high-fidelity 6-degree-of-freedom (6-DOF) modeling system, named MSTARS, that simulates the flight dynamics and performance of a state-of-the-art weapons system. MSTARS, which stands for Munitions Simulation Tools and Resources, allows engineers to rapidly prototype advanced concepts in guided bombs and missiles, as well as evaluate the performance of new technologies.

Embed-Based Munitions Subsystems

MSTARS comprises a library of Embed-based munitions subsystems representing accelerometers, rate gyros, autopilots, seekers, inertial navigation systems, control surfaces, and air vehicles with complete 6-DOF flight dynamics. Simplified models of launch aircraft and threat targets are also incorporated into the components library. With over 70 models and DLLs in the library, engineers have been able to develop numerous air-to-air and air-to-ground 6-DOF simulation scenarios.

According to Larry Lewis, munition fly-out team leader and chief architect of the MSTARS modeling system, numerous Embed features were essential in building the MSTARS modeling system. "Embed blocks allowed us to build a truly reusable library of components," said Lewis. "And path aliases tied



INDUSTRY

Defense/Aerospace

CHALLENGE

Develop a high-fidelity 6-DOF modeling system to simulate flight dynamics and weapons systems performance

SOLUTION

Use Embed to rapidly prototype advanced concepts in guided bombs and missiles, as well as evaluate the performance of new technologies

BENEFITS

- Modular approach to system development saved time during design and debugging phases
- Easy to test the effectiveness of subsystem components
- Reuse of legacy code

to the embed blocks let us easily specify and modify complete simulation configurations, eliminating the use of lengthy file specifications." Lewis emphasized that this modular approach to system design not only saved valuable time during the design and debugging phases, but also allowed engineers to quickly test the effectiveness of new subsystem component designs. "Whenever we came up with a new design, we just changed a single file name to swap a new component into the simulation."

```

simulation_int_pilot_code.f95 - Visual Studio - [F:\mstars\1.0\mstars\public\embed\pilot_code.f95]
File Edit View Tools Windows Help
Real*8 Angles(3) Roll, Pitch, and Yaw Angles - radians
Real*8 Q_Vector(4) Initial Customized Vector
Real*8 Dn_Factor(1)
Real*8 half_roll, half_pitch, half_yaw
Real*8 sr, cr, sp, cp, sy, cy

-----
Compute angles and cosines :: half_angles...

half_yaw = Angles(3) / 2.0D0
half_pitch = Angles(2) / 2.0D0
half_roll = Angles(1) / 2.0D0

sr = d*sin ( half_roll )
cr = d*cos ( half_roll )
sp = d*sin ( half_pitch )
cp = d*cos ( half_pitch )
sy = d*sin ( half_yaw )
cy = d*cos ( half_yaw )

```

Reuse of Legacy Code

Reuse of legacy code written in Fortran and Ada was facilitated by Embed's DLL capability, as was the creation of new models and special utilities. "Our ability to reuse existing code and create special-purpose code via DLLs shaved months off our development schedule," said Lewis. New DLLs, written in C++, Fortran, and Ada, are continually being added to the library.

Multi-Rate Simulations

In large model design, the dynamics of the system generally demands multi-rate simulation. In the MSTARs modeling system, discrete transfer functions, unit delays, and automatic DLLs were used to achieve different rates. This allowed the engineers to dramatically reduce computation time and speed up the simulation.

Culmination of Yearlong Effort

The current MSTARs modeling system is a culmination of a yearlong effort by Lewis, which started when he created a prototype 6-DOF simulation using Embed. "We had been using another modeling system, but it was slow and relatively inflexible," said Lewis. After looking at numerous simulation packages, Lewis decided that Embed best suited his needs, particularly in the areas of multi-rate simulation and interoperability with existing code. "It was a scary prospect to re-do our previous work, but with [Embed], we accomplished more in one year than we had in the previous three. [Embed] was the appropriate solution."

The VisSim™ product line has been renamed to Embed™ and Embed SE™



For more information

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