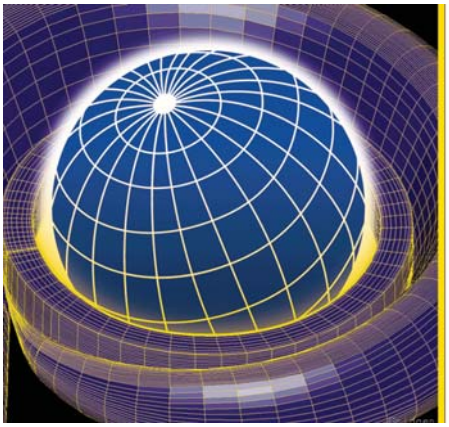

Focal Point

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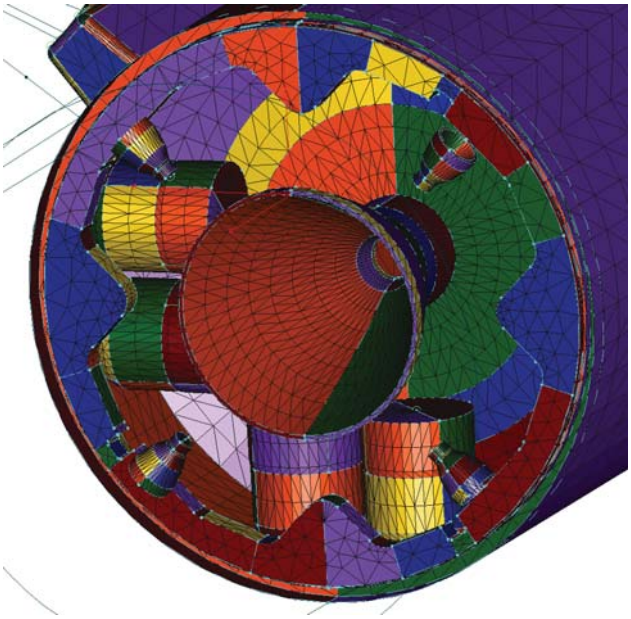
Spring 2004
The Newsletter for Gridgen Users

Grid Generation Using Gridgen for Radar Cross Section (RCS) Predictions

Article by Brian E. McGrath and Gary I. Appelbaum, Johns Hopkins University Applied Physics Laboratory

The John Hopkins University Applied Physics Laboratory (JHU/APL) has been working with the U.S. Navy, U. S. Air Force, and Missile Defense Agency (MDA) in the development, testing, and evaluation of the Ballistic Missile Defense System (BMDS). Elements of the BMDS in which JHU/APL has been closely involved are the Boost Phase, Midcourse Phase, and Targets and Countermeasures (TC) mission areas. JHU/APL's involvement and contribution is multi-faceted and multi-disciplinary. However, this article focuses on the contributions to the BMDS in the area of Radar Cross Section (RCS) definition and prediction of various missile configurations. The RCS is a measure of missile or vehicle radar reflectivity within the radar frequency range. The magnitude of the RCS is a function of geometry, frequency, and the aspect and evaluation angles and indicates whether a vehicle is detectable and/or trackable using radar. JHU/APL is currently helping to define and predict the RCS of various threats, threat surrogates, and target missiles as defined by MDA. Definition and prediction of the RCS characteristics of these various missiles aid in the overall development of the mission and system requirements within each element of the BMDS and ultimately the deployment of the BMDS. Accurate and timely definition and prediction of the RCS characteristics for these various missiles is paramount to the successful deployment of the BMDS.



RCS surface grid of the SM3 third stage aft end. Shown are the various domains as created during grid construction. Before the grid is output domains are joined to form common parts.

JHU/APL has been using a Computational Electromagnetic (CEM) code, named Xpatch, for the past eight to ten years. Xpatch is a high frequency radar signature code based on the Shooting and Bouncing Ray (SBR) technique. Computations with Xpatch require only a surface geometry definition in the form of triangular facets or triangular grid cells, i.e. an unstructured grid. Xpatch computations do not need a volume grid. The surface grid generation is where Gridgen has become an integral and useful instrument in the RCS computational process. While surface grid generation is a seemingly simple task, capturing the proper physics for an RCS computation presents a number of challenges in the surface geometry definition. The greatest challenge is the level of surface detail that may be required to produce an accurate RCS computation. Shape, size,

(Continued on page 2)

Gridgen
Reliable CFD Meshing

Focal Point is a publication of Pointwise, Inc. It is for Gridgen users and people interested in learning more about Gridgen and numerical grid generation. It includes information about the latest release of Gridgen, future development plans, and tips on how to get the most out of Gridgen while saving time in grid generation.

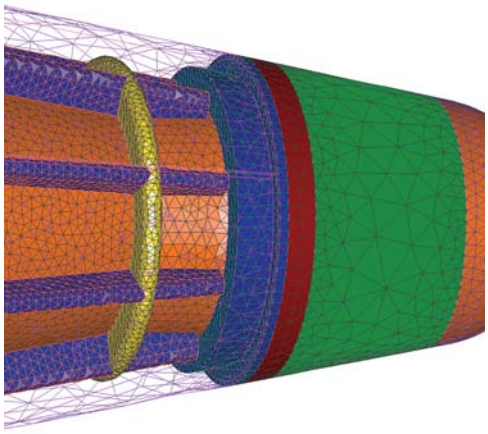
Inside this issue:

Radar Cross Section (RCS) Predictions cont.

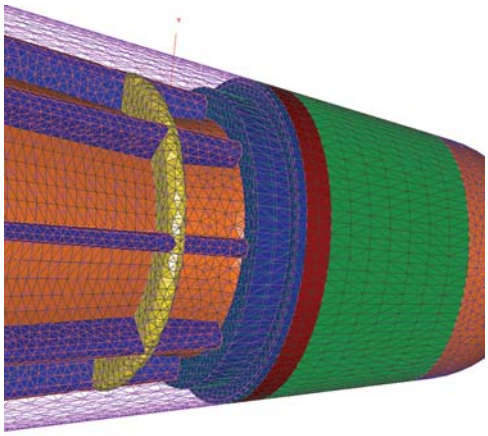
(Continued from page 1)

and surface of a given vehicle configuration are directly related to the RCS characteristics through the radar frequency or wavelength. As the radar frequency increases, the corresponding wavelength decreases. Wavelength is directly related to the size and level of surface detail required to capture the proper physics. Typically, in order to best capture the proper physics, details as small as one quarter of a wavelength need to be included. As an example, for L-band radar (1 to 2 GHz), the wavelength is between 12 to 6 inches, so details between the sizes of 3 to 1.5 inches should be included in the surface model. While for X-band radar (8 to 12.5 GHz), the wavelength is between 1.5 to 1 inches and details between the sizes of 0.375 to .25 inches should be included in the surface model. The amount of detail to be included continues to increase as the radar frequency increases into the Ku (12.5 to 18 GHz) and Ka (26.5 to 40 GHz) bands. One can see quickly that in some instances the amount of geometric detail needed can be quite significant and daunting. This geometric requirement makes the surface grid definition for RCS computations quite challenging. In addition, consideration based on the amount of time necessary for a given RCS computation is necessary. As geometric detail increases, so does the number of triangular facets and computational time needed to get a solution. However, there is a middle ground between the recommended and actual amount of geometric detail needed, and thus the length of computation time. The middle ground is defined and developed through practical experience and engineering judgment.

There are numerous application areas where Gridgen has enhanced efforts in the surface grid generation for RCS computations. Gridgen provides the necessary tools for unstructured surface grid generation of the various missile configurations. Computer Aided Design (CAD) tools are used to construct and define the surface geometry. Typically, transferring geometry to Gridgen is through the Native CAD Readers or Initial Graphics Exchange Specifications (IGES) files. The underlying geometry database is cleaned up and modified using Gridgen database commands. Flexibility during creation of connectors provides the necessary options to develop the surface grid. At this point, consideration based on wavelength requirements is given to how much geometric detail needs to be included or not. Gridgen easily allows one to ignore or grid over geometric details that are deemed unnecessary without having to remove them from the database. Then at a later point in time, if the wavelength requirements change and require more detail, the additional detail can be added easily and quickly.



Unstructured RCS surface grid of a missile nose configuration.



Best fit unstructured RCS surface grid of the same missile nose configuration.

The maximum and minimum facet or grid cell sizes are based on the radar frequency or wavelength. Prior to implementing Gridgen in our RCS computations process, the grid generation tools used did not provide the necessary control over the maximum and minimum facet size. In many cases we needed to better control the facet size. Often details are defined using a structured grid and then simply converting to unstructured grid through the best fit option. Older versions of Gridgen provided an output format that was nearly compatible with the requirements the Xpatch code. Only minimal changes were required to ensure complete compatibility. As our use of Gridgen increased, Pointwise accommodated our request to provide a version with an output option completely compatible with Xpatch input requirements.

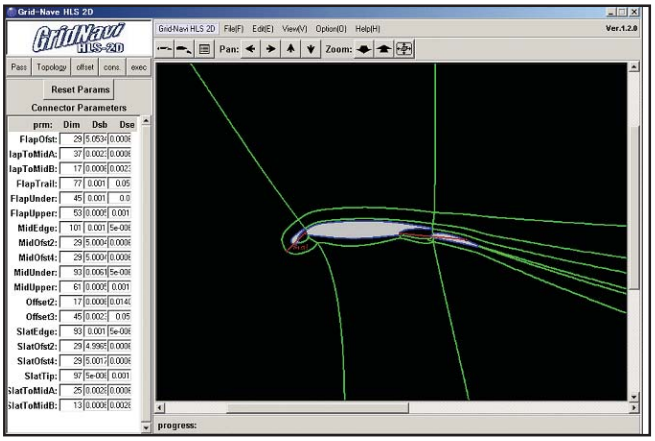
Over the past several years, JHU/APL has successfully used Gridgen to construct Xpatch surface grids for many missile configurations. The following missile configurations have been gridded using Gridgen: Lance, Aries, Hera, Terrier/Lynx, and STARS target missiles; Standard Missile 2 (SM2) Block IVA and Standard Missile3 (SM3)/LEAP interceptor missiles; and various other MDA conceptual threat missiles. The employment of Gridgen in the RCS computational process helped to greatly increase the fidelity of the predicted results, reduce the amount of time needed to define the surface grid, and to provide much more timely computational predictions to our customers. The increased productivity developed in the RCS computational process, which Gridgen has been a major factor in, has lead to additional work from our current customers, and is providing a steppingstone in the development of new customers as well.

If you have a Gridgen project and would like to share your successes, let us know. We welcome story ideas and accept articles. Please send your ideas to Heather McCoy at FocalPoint@pointwise.com

Innovative Automatic Grid Generating System for High-lift System of Aircraft

Courtesy of Japan Aerospace Exploration Agency/Dr. Yuichi Matuso

Japan Aerospace Exploration Agency (JAXA), a long time client of VINAS Co., Ltd. (VINAS), Gridgen's distributor in Japan, has developed GridNAVI-HLS, an add-on utility program to Gridgen. GridNAVI-HLS is programmed using the GridgenGlyph scripting language capability, and is used for semi-automatic mesh generation around a high-lift-wing-system of a typical modern commercial aircraft. JAXA has been working on developing this program to improve the efficiency of CFD work, to streamline the analysis cycle, and to promote sharing of grid generation know-how.



GridNAVI-HLS automatically generates grids for high-lift configurations.

JAXA entered into a contract with VINAS to commercialize GridNAVI-HLS. High quality mesh generation is essential for accurate flow analysis in aircraft engineering. GridNAVI-HLS is capable of quickly generating high quality meshes for CFD analysis of the high lift system with complicated geometry.

Features of GridNAVI-HLS include:

1. Easy to understand user-interface.
2. User-friendly menu for design parameter entry that enables even CFD beginners to generate high quality hexahedral mesh in shorter time.
3. Hexahedral mesh generation suitable for high quality CFD analysis.

JAXA initially developed the 2D version of GridNAVI-HLS. Vinas currently sells the 2D version. Based on JAXA's development achievement, VINAS has commercialized the 3D version, whose release is being prepared as of May 2004.

Gridgen User Group Meeting 2004

The inaugural Gridgen User Group Meeting was held April 5-6. 2004 at the Renaissance Worthington Hotel in downtown Fort Worth, Texas. The meeting included special Gridgen training seminars, presentations by Pointwise staff on new Gridgen developments, user presentations, and exhibits by our partners. It was a great opportunity for Computational Fluid Dynamics (CFD) users to learn about the latest Gridgen features, get a glimpse of future developments, and network with other CFD experts from around the world. Participants came from all over the globe, including Japan, Germany, United Kingdom, and many U.S. States.

Special Gridgen training seminars were scheduled on Monday, April 5. The morning session, Gridgen V15 New Features, covered features in the latest Gridgen release. The afternoon training session, Gridgen Tips and Tricks, was an overview of many helpful Gridgen V15 techniques used by experts to achieve the most efficient use of the software.

Tuesday's sessions included presentations from the Gridgen user community and from Pointwise staff. Additionally, Prof. David Whitfield from the University of Tennessee at Chattanooga gave the keynote address.

The meeting was such a great success, that Pointwise will host a Gridgen User Group Meeting again in Spring 2005. We will look forward to seeing everyone there!

Gridgen Training 2004

Jul 13-15
Sep 14-16
Nov 9-11

Additionally there will be a one day on demand Version 15 training class scheduled independently of the regularly scheduled training classes. Please check www.pointwise.com/support/ to register or for more information.

Pointwise Consulting Services

Whether you are looking for help in generating a particularly difficult grid, need help during peak load periods, are just looking to get a quick start on a project, or want custom software development, Pointwise is ready to give you a hand. With over 30 years experience developing and supporting 3D grid generation software and applying it to demanding industrial applications, we have the expertise to get your job done right.

Call 1-888-GRIDGEN for more information.

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Gridgen Product News

PAGE 4

There have been three maintenance releases (MRs) of Gridgen Version 15 since the last Focal Point, so there's a lot of new stuff to tell you about. Most importantly, you're going to want to get the latest MR right away because an insidious bug was fixed that considerably slowed Gridgen (.gg) file import.

On the CAD side of things, Gridgen's Native CAD Readers now support Unigraphics. A utility script was added for importing data from the Kreila pump design program and automatically building a database.

A right-click menu was added to the layer manager that provides quick access to setting the current layer, toggling a layer on/off, isolating a layer, and setting a layer's description.

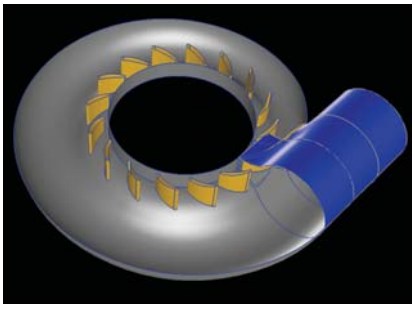
Graphical feedback was added to the consolidated Merge Entities command. The feedback makes it easy to find and fix mesh gaps caused by CAD gaps. A new merge command, Replace Connector, was added for those of you who want to choose which connector to keep when two are merged.

Interfaces were added for two new CFD codes: the unstructured version of WIND and STAR CCM+. Double precision options were added to both the Cobalt and NSAERO interfaces.

Unstructured domains, especially those domains that span multiple database surfaces or have been joined, now respond more robustly to changes to their connectors. Wherever possible, connector grid point changes are blended smoothly into the unstructured domain.

Native CAD Readers Save Time - Lots of Time

One of our customers reported that by reading a native CAD file directly (instead of using IGES), the geometry preparation time dropped from 4 days to less than an hour – a 32X reduction. Gridgen's Native CAD Readers for CATIA, Pro/E, Unigraphics, and STEP bypass the translation errors inherent in writing and reading a neutral file by reading your CAD directly from its native file. While you get the benefits of reduced geometry prep, your designers also have their workload reduced because they don't have to export a neutral file for you. And Gridgen's NCRs don't tie up one of your valuable CAD licenses, either – all that's needed is the native CAD file. Interested? Try an NCR for yourself. Request one at www.pointwise.com/native.



The geometry for this hydraulic turbine's spiral casing was imported into Gridgen from a native Unigraphics file.