Rapid Design Exploration & Optimization Interactive Gimbal Design (RaDEO-IGD)

Project Overview

The basic concept of the RaDEO-IGD program, titled "Development of an Adaptive Modeling Language (AML) for Knowledge-Based Engineering with Application to Interactive Gimbal Design (IGD)", is the development of a system that will allow for the efficient integration of overall gimbal system requirements, sensor models, optical designs, mechanical designs, structural analyses, stabilization models and manufacturing processes. The IGD system will capture previous successful gimbal designs and have available a database of gimbal sub-components to aid in the design of new gimbals. The IGD System will offer a significant productivity increase in the ability to design and evaluate gimbal systems. The design, analysis, and manufacturing of gimbals and integrated optical systems (e.g.: TADS/PNVS shown above) is a complex, highly interactive, and time-consuming process that contributes significantly to the overall product cost of electro-optical systems. This task must address cost, technical performance, customer's vehicle specification considerations, weight, dynamic performance, accuracy, environment and a host of other aspects in order to bring about an effective design. Significantly contributing to this design process is the use of commercial-off-the-shelf items (bearings, gyros, resolvers, and torquers) whose operational and physical properties, environmental limits and interfacing requirements are critical to the design process. The IGD program requires the integration of software products: AML, Pro/E, PATRAN, NASTRAN, Matrix-X, ACCOS-V, FEM/SINDA, M-Vision, Oracle, DADS, and PV-Wave.

Technology Objective

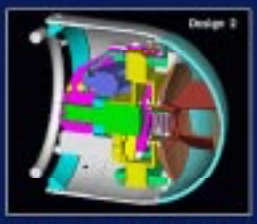
- Development/Enhancement of an Adaptive Modeling Language for Knowledge-Based-Engineering that will allow industries to capture their design/analysis processes and associated knowledge.
- Develop an Interactive Gimbal Design system based on AML Class/Objects that will capture the gimbal design process followed at Lockheed Martin. The IGD structure will allow for a creative design environment and capture the knowledge of that creativity.
- Develop an electro-mechanical, standardized gimbal sub-component database that will be integrated into the IGD system.

Value

The development of the IGD system will make a significant impact in Lockheed Martin's ability to perform both conceptual and detailed design. The figure (top-right) shows present data for two similar gimbal designs. Design 1 started from scratch and required over 8000 hours to complete. Design 2 started from design 1, but with tighter requirements, and required almost the same amount of time. The IGD system will offer significant reduction in both these efforts by offering a gimbal database of previous designs as well as a tight integration/automation of the overall process. The complimentary development of the IGD system with the AML language and knowledge-base, will serve to both confirm and guide this technology, and at the same time offer significant cost reductions to DOD programs. The successful development of the knowledge-based software to a mature system will reduce cycle times and impact life cycle costs.

Statistics for the Gimbal Design of an In-House Missile System

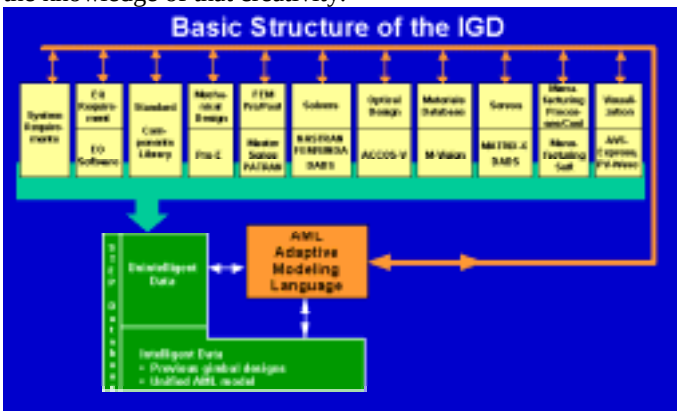
	Optics	Mechanical	FE Analysis	Servo	Total
Design 1	1,082[1] hrs	4,955 hrs	1,214 hrs	1,383 hrs	8,634 hrs
Design 2	1,286 hrs	2,356 hrs	3,384 hrs	0 hrs	7,026 hrs



[1]All data in this table has been multiplied by the same constant factor in order to protect proprietary information.

Technology Innovation

A generic solution to offering a design methodology to this complex problem is offered through the continued development of an Adaptive Modeling Language, AML, a knowledge based language/system offered by TechnoSoft, Inc. AML is an advanced modeling language for Knowledge Based Engineering that can capture the methodology and knowledge associated with design/simulation/manufacturing processes. AML facilitates adapting to changes by automating the design and manufacturing process and provides a unique interactive design environment. AML incorporates a unique underlying object-oriented part model for representing the part geometry, the part material, the part process plans, and the finite element model. The part model can allow for the interaction among the multiple disciplines involved in the design. An important characteristic of AML and the IGD system (shown below) will be the ability of the system to capture the knowledge to streamline the gimbal design process, allowing a software structure that permits creativity while simultaneously capturing the knowledge of that creativity.



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LINKAGES

The RaDEO-IGD program directly impacts all DOD programs at Lockheed Martin Electronics & Missiles. Both our pod systems (for example LANTIRN and TADS/PNVS) and our missile systems (for example Javelin and Longbow) required gimbal systems. The gimbal/seeker assembly in such systems accounts for over 70% of the cost of those systems, and the IGD system is a direct hit to reducing development time and cost for such systems. Because of this, the IGD system complements the goals of AM3. There is also direct collaboration between the RaDEO-IGD program and Coleman Research Corp.'s Collaborative Virtual Prototyping System (CVPS). The RaDEO-IGD program is also collaborating with the RaDEO-IPDE program to develop an Oracle STEP database for data transfer.

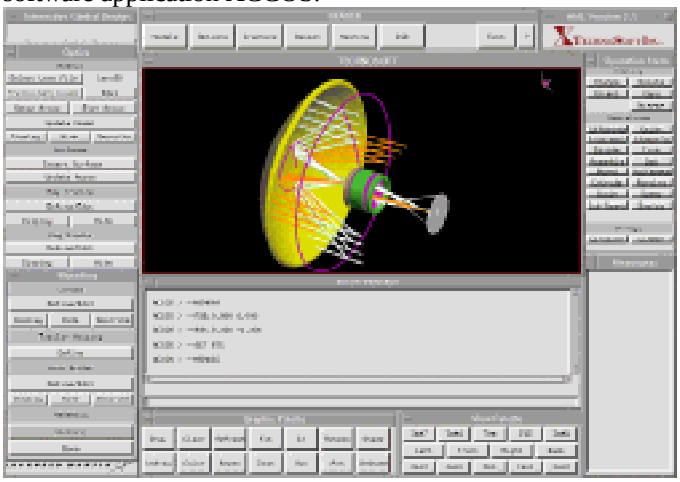
TECHNOLOGY TRANSITION

The contributors, components and deliverables of the RaDEO-IGD program are shown below.

The IGD system complements DARPA and joint service investments in seeker and sensor cost and cycle time reduction. Concept and validation stages of the DARPA Affordable Multi-Missile Manufacturing (AM3) can utilize this system to predict and assess engineering designs and manufacturing processes. Additionally, the JAST program (Affordable Modular EO/IR Sensors, JMCATS, etc.) will also directly benefit from this technology by being able to assess high risk, high cost system processes early in the acquisition cycle. The AM3 investment at the missile and seeker enterprise level and the DARPA investments at the component level, such as Interferometric Fiber-Optic Gyro (IFOG), Rapid Prototyping of Application Specific Signal Processors (RASSP), and Infrared Focal Plane Array (IRFPA) programs; all complement MANTECH programs for the Dewar Millimeter Wave (MMW) Transceiver, and the MMW Cost Reduction Program (CRP) in MMW Electronics, as well as Air Force and Navy efforts in Joint Advanced Strike Technology (JAST).

PROGRESS

The two figures below illustrate some of the recent accomplishments of the RaDEO-IGD program. The first figure illustrates the AML-developed IGD system's ability to perform optical analysis with its integration to the optical software application ACCOS.



The second figure illustrates the ability of the IGD to also integrate a mechanical gimbal design with the rigid/flexible body dynamics code, DADS, and simultaneously with the servo-system simulation software aplication Matrix-X. The IGD's architecture will allow for the integration of other applications arenas to perform efficient gimbal designs.

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