

mechanical design composites engineering structural health monitoring

The Metis Design Corporation (MDC) is a technical consulting firm that specializes in the development of new structural concepts for products. Our highly trained engineers combine hands-on design experience with creative thinking to develop novel solutions for a wide range of real-world applications. Using industry standard design and analysis tools, such as Pro/EngineerTM, SolidWorks[®] and MSC.NastranTM, MDC designs products that are optimized to meet our customers' needs, finding a balance between aesthetics, cost and performance. Our engineers also leverage their structures knowledge to develop custom codes for structural health monitoring (SHM) of composite structures.

The range of expertise at MDC gives our clients the convenience of having а product carried from conceptualization through design and analysis to testing and production, all under the same roof. All or this serves to streamline the design process, resulting in significant cost reduction and faster time-to-market. Existing products can also be analyzed to predict or explain failure, and be optimized for significant cost and weight savings or performance enhancement. MDC has developed strategic alliances with innovative manufacturers and testing houses to facilitate prototyping and evaluation of these products. MDC is also working to design, manufacture and commercialize a suite of robust damage detection devices to facilitate SHM.



Static finite element analysis of a reinforced part



Dynamic analysis of a tower with pre-loaded wires



Wave propagation model for damage detection



FEA model of Lamb wave propagation in composite



Mechanical Design

Metis Design is unique in that we deliver integrated in-house design and analysis capabilities. Our design process combines 3-D solid modeling tools with sophisticated FEA software to ensure that a new product will meet or exceed the harshest requirements and regulations. MDC can also analyze existing products to determine if and when the product will fail, as well as redesign them to fulfill requirements, reduce weight or decrease life-cycle costs. Additionally, MDC analyzes products that have already failed to determine the cause and to suggest preventative measures. Using a combination of mathematical methods and commercial software, MDC is able to provide solutions to problems in our many fields of expertise. From cryogenic piping to spacecraft structures and medical implants, our creative design and analysis team can answer any client's product development dilemma.

Composites Engineering

As manufacturers compete for stronger, lighter and more cost-effective structures, composite materials become critical for optimal design. The MDC staff has experience with several fiber types (graphite, Kevlar, glass, etc.), fabric forms (unidirectional prepreg, woven, random chopped, etc.), and manufacturing methods (autoclave, compression and injection molding, wet-layup, etc.), and is able to determine the best material solution for a given application. MDC has the know-how and experience to implement these materials in design projects using commercial software, custom codes and predictive models.

Structural Health Monitoring

Structural health monitoring (SHM) is an emerging field in which non-invasive damage detection techniques are integrated into a structure to continuously monitor components for cracks and delamination. Using this technology, scheduled manual inspections can be eliminated and condition-based maintenance can be implemented for more efficient design practices, more reliable structures, and more accurate component repair and replacement decisions. This results in a significant savings in the life-cycle costs of a structure, as well as significant gains in the safety of the system. SHM systems can be designed to remotely monitor structures, yielding the flexibility to perform real-time system checks in operation. The staff of MDC has a mature knowledge of a broad range of SHM techniques, and can custom design a system to suit the needs of any component in any environment. In addition, MDC is in the midst of several research collaborations, developing common components to be used for SHM infrastructure such as wirelessly rechargeable thin-film batteries and packaging for piezoelectric sensors.

Advanced Product Development Methods

Rapidly evolving technologies and changing global conditions require new approaches to product design and development, especially for complex systems such as aerospace products. MDC personnel create and facilitate the application of new techniques for rapid conceptual and preliminary design, and efficient "lean" detail engineering. Our capabilities include: seminars and a unique training simulation (game) to efficiently transmit powerful but sometimes difficult concepts of lean to engineers and enterprise managers, a manual on Value Stream Mapping for product development, a set of new tools and techniques for rapidly exploring a wide range of conceptual solutions to complex problems (tradespace exploration), and rapid preliminary design. MDC has created lean engineering and lean enterprise training programs for a number of major US aerospace companies. Additionally, MDC has used tradespace exploration tools for contracted studies of complex aerospace systems. Some of these products were produced in cooperation with the Lean Aerospace Initiative (LAI) at MIT.



Seth S. Kessler, Ph.D. - President

Dr. Kessler, President and cofounder of Metis Design, received his S.B. and S.M. in Aerospace Engineering at MIT studying the effects of a cryogenic environment on composite materials and creating a design tool for composite structures subjected to extreme inertial loading. Dr. Kessler completed his Ph.D. in that same department at MIT researching techniques that use piezoelectric and MEMS devices to continuously monitor damage in composite structures. He specializes in composite materials, high-g systems design, active materials, cryogenics, damage detection and monitoring, and finite element modeling. Dr. Kessler interned for the Lockheed Martin Skunk Works as an advanced concepts and testing engineer on the X33/VentureStar and JSF programs. He was also a Draper Fellow working on the DARPA Funded WASP project. In 1998, he received the Admiral Luis De Florez Award from MIT for "Ingenuity and Creativity in Design", in 2001 was awarded the American Society for Composites Ph.D. Research Scholarship, and in 2002 the ASC Best Paper Award for Functional Composites. Dr. Kessler has more than two dozen technical publications, holds three patents and three pending patents, and is currently a member and contributing author for the AIAA, SAE, SPIE, and ASC.

Kristin Jugenheimer - Chief Engineer

Kristin Jugenheimer, Chief Engineer and cofounder of Metis Design, earned her S.B. in Mechanical Engineering from MIT with a minor in Biomedical Engineering. A National Science Foundation graduate fellow, Ms. Jugenheimer also received a S.M. in Mechanical Engineering from MIT for the design of a hand rehabilitation robot. Ms. Jugenheimer has worked for various design consultancies specializing in solid modeling and mechanical design. Previously, she worked for Boston Scientific Corporation designing a bench-level testing apparatus. There she also performed conceptual product design for the Microvasive Endoscopy Group that resulted in a pending patent. Ms. Jugenheimer has additional experience in the fields of rapid prototyping and machining. Her areas of expertise include solid modeling, kinematics, mechanisms, and mechanical system analysis and design.

Hugh McManus, Ph.D. - Senior Special Projects Engineer

Dr. Hugh McManus is involved in applying modern product development, business and technical practices to the aerospace industry. He has done pioneering work in application of lean techniques to product development with MIT's Lean Aerospace Initiative (LAI). Dr. McManus received a Ph.D. degree in Mechanical Engineering from Stanford University, and S. B. and S. M. degrees in Aeronautics and Astronautics from MIT. He has previously worked at Kaman Aerospace, at Lockheed Missiles and Space Company, and at teaching and research positions at MIT. Dr. McManus received the LAI book, Lean Enterprise Value, is working on a book on space system architecture and design, co-edited a book on high temperature applications of polymer composite materials, has been an associate editor of the AIAA Journal of Spacecraft and Rockets, and has published over 60 peer-reviewed journal and conference publications.

Additional Staff & Partnerships

Metis Design also employs a compliment of engineers with varied backgrounds to augment and diversify the company's skills. In addition to our employees, MDC has strong working relationships, strategic alliances and subcontracts with a variety of companies and top-tier academic institutions from around the country. In particular, several research collaborations exist between MDC and the Massachusetts Institute of Technology.





FEA of reinforced plastic cover

Metis Design Corporation project areas:

Consumer product development, specializing in reinforced plastics Advanced composites design, analysis and testing Cryogenic system design and testing Structural health monitoring and non-destructive evaluation systems Failure investigation, interpretation and prevention Complex computer aided design assemblies Static, dynamic, linear and non-linear finite element modeling Biomedical and rehabilitation device design Lean product development tools Space system architecture design and analysis Tradespace Exploration (Advanced Front-End Design Methods)

Metis Design Corporation software specialties include:

Computer Aided Design: SolidWorks®, Pro/Engineer[™] and CATIA[™] Finite Element Modeling: NASTRAN[™], ABAQUS®, I-DEAS[™], ANSYS®, PATRAN[™], ADINA[™], CosmosWorks[™] and Pro/Mechanica[™] Customized codes: MATLAB®, Mathematica®, and C++ Simulations such as composite failure analysis and wave propagation





Graphite/epoxy nose cones



Figures (left to right): SHM sensor, FEA of cryogenic pipeline, CAD model of civil utility product

