



GREEN FORCES

PROVEN COMPANIES. INNOVATIVE SOLUTIONS.



DCAA

ITAR

AS9100



MIL-PRF



PROVEN COMPANIES. INNOVATIVE SOLUTIONS.

GreenForces is a consortium of proven companies that provide total high-tech solutions for the defense and aerospace industries.

**PROVEN
COMPANIES**



WHO WE ARE

An agile consortium of HubZone-certified companies that provide engineering and design, analysis, prototyping, testing and production services, under one contract, to industry quality standards such as AS9100 and Nadcap.

WHAT WE DO

Complete product lifecycle support from conceptual research and development, mechanical and electrical engineering, final design, prototyping, testing, integration and low / high volume manufacturing. The GreenForces consortium supports a wide range of industries such as printed circuit boards, investment castings, carbon composite manufacturing, supported by engineers with proven design and test experience.



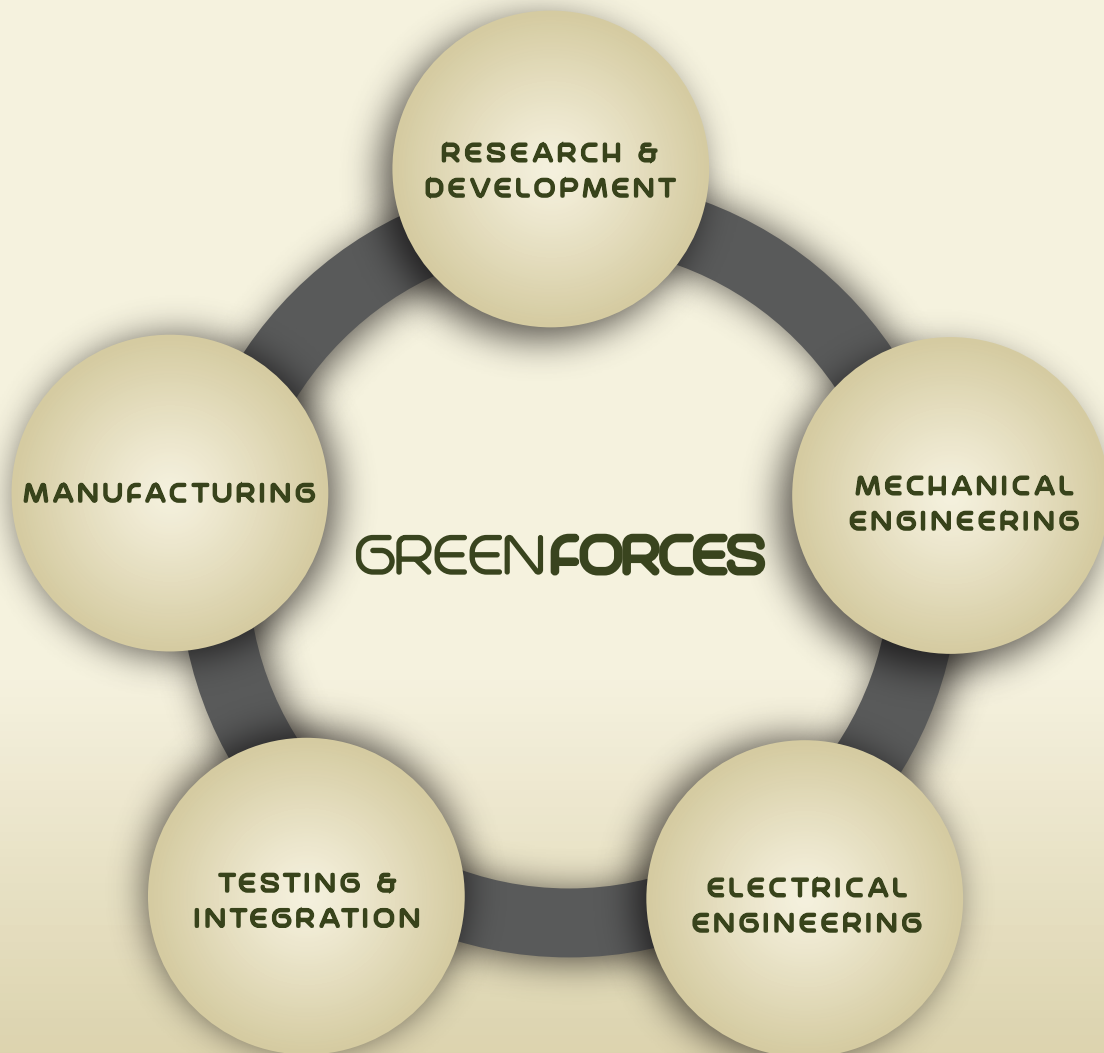
WHY GREENFORCES?

- ▶ Single source of supply that delivers a wide range of services
- ▶ Agility of small business with capabilities of large business
- ▶ Proven industry leaders in respective core capabilities
- ▶ Quality to industry standards (AS9100 & Nadcap)
- ▶ Proven customer support and satisfaction
- ▶ DoD-certified HubZone

WHAT VALUE DOES GREENFORCES BRING TO CUSTOMERS?

- ▶ Reduction in lifecycle cost through value engineering
- ▶ Proven rigid circuit boards and test equipment
- ▶ Optimized investment casting components
- ▶ Advanced carbon composites components
- ▶ Advanced telemetric data acquisition
- ▶ State-of-the-art research facilities and staff

CONSORTIUM OF SERVICES



PROVEN COMPANIES



Providing complete design and field testing of lightweight structures for military and commercial aircraft and vehicles.

GS Engineering is focused on mechanical and electrical design and analysis services, advanced product development, instrumented field testing, and technology integration including lightweight structural system design and metal matrix composites. The core of GS Engineering is mechanical and electrical design in support of commercial and military transportation markets, both wheeled and tracked. Testing for development or certification of military vehicles and subsystems is a major component of GS Engineering's testing services.

ISO Compliant – AS9100 , DCAA Audited, DoD-Registered HUBZone Company



Circuit boards for a lifetime.

Of the 290 printed circuit board (PCB) manufacturers in North America, Calumet Electronics is one of only 16 companies accredited for rigid PCBs. The Nadcap accreditation recognizes Calumet's world-class manufacturing capabilities and affirms high-quality PCBs. Calumet's highly experienced team of in-house engineers provides a full suite of engineering services that leverages powerful technology and processes to deliver circuit boards that provide a lifetime of performance.

Nadcap, AS9001:20009, ISO9001:2008, MIL-PRF-31032, MIL-PRF-55110, ITAR, UL





Providing high quality, efficient solutions in composite materials.

Creative Composites manufactures advanced composite materials and structures designed to survive challenging environments. Composites maximize performance by reducing weight, increasing strength and chemical resistance, and decreasing manufacturing costs. Creative Composites guarantees product performance by utilizing finite element analysis to eliminate uncertainty through accurate simulation of complex systems.

AS9100, ISO 9001:2008, ITAR



High-performance wireless telemetry systems.

Infrared Telemetrics, Inc. is a global technology leader in providing wireless transfer of data from internal reciprocating and rotating components. Infrared, microwave and inductively coupled telemetry systems (inductive or battery powered) allow IR Telemetrics to measure operating parameters such as temperature, pressure and torque on pistons, connecting rods, crankshafts, bearings, turbines, clutches and gears. On-board electronic devices are custom-built in-house to fit package requirements and test parameters. IR Telemetrics' specialty is real-time, steady-state and transient data transfer from components operating in their production environment.



Delivering custom machining solutions through innovation, collaboration and productivity.

L'Anse Manufacturing, Inc. has been an expert in the investment casting industry for more than 30 years. Specializing in custom low-volume, high-mix machining and assembly applications, they take concepts from prototype to production. L'Anse Manufacturing has built a solid reputation in engineering support services and core manufacturing competencies including milling, turning, fixturing, straightening and light assembly.

ISO 9001:2008, AS9100, DoD Registered HUBZone Company



Create the future.

Michigan Technological University is a world-class research institution, grounded in science, engineering, technology and sustainability. The College of Engineering comprises 3,500 students and 150 faculty members. Michigan Tech is a leader in the discovery and design of new devices and systems, and delivery of solutions to industries' most pressing problems. Michigan Tech promotes the utilization of new discoveries through the licensing and commercializing of technologies.

CAPABILITIES & EXPERTISE

ENGINEERING & DESIGN

GreenForces delivers innovative electrical and mechanical designs to support a wide range of customer needs. Advanced material integration is supported by CAE and industry or customer-specified structural design requirements. Design for manufacturing is supported by certified quality engineers, auditors and GreenForces manufacturers.

MECHANICAL

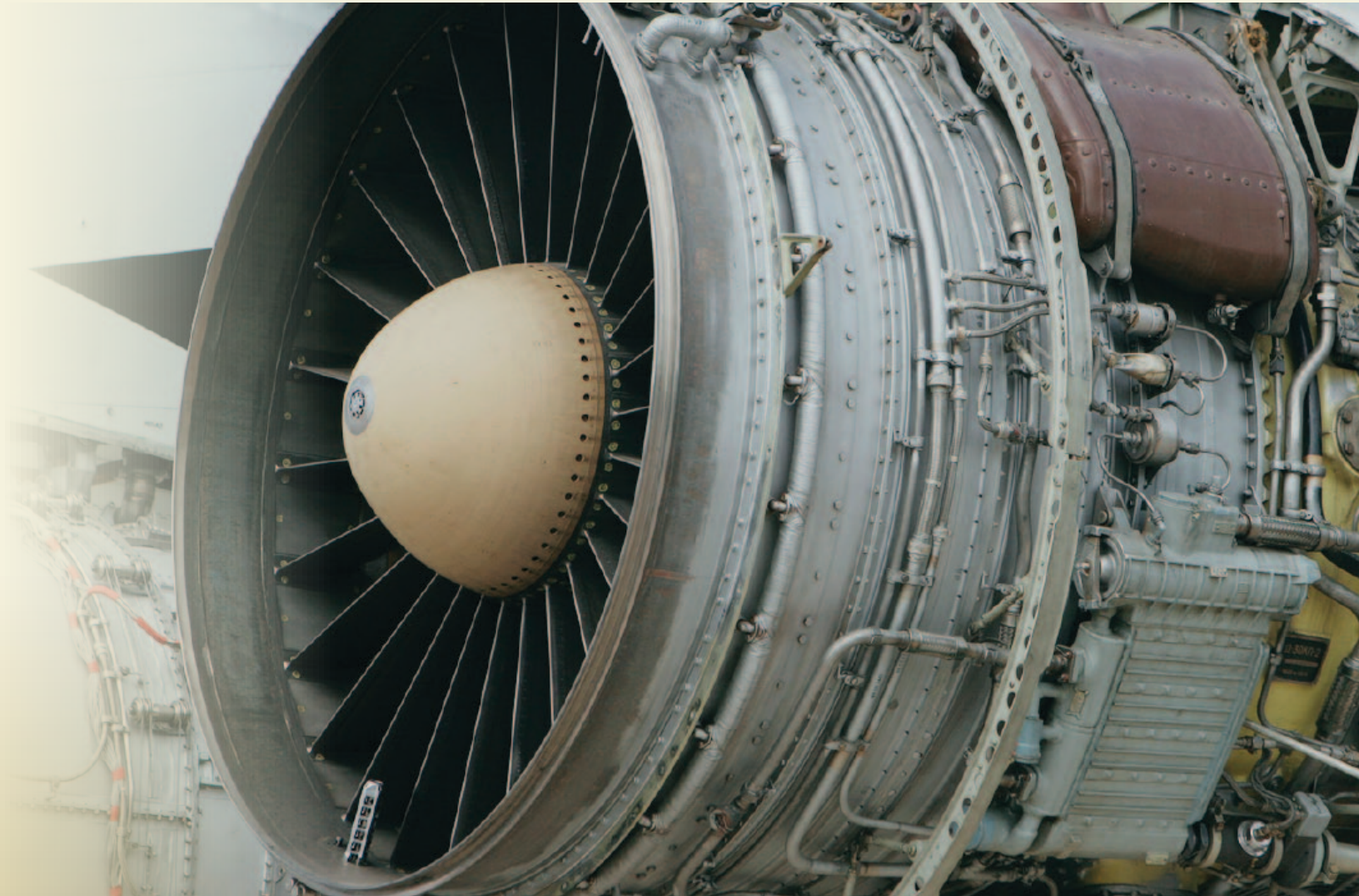
- ▶ Fully supported Computer Aided Design (CAD) and Computer Aided Engineering (CAE) departments staffed by advanced degreed Professional Engineers (PEs)
- ▶ Design software packages supported: Creo Elements (Pro/E)/Windchill PDM, CATIA/SmarTeam PDM, Siemens NX/TeamCenter PDM, SolidWorks, AutoCAD and customer-required packages
- ▶ Analysis software packages supported: ANSYS, Altair Hyperworks (Hypermesh/Optistruct), MathCAD, MATLAB and customer-required simulation software
- ▶ Full life cycle engineering support
- ▶ Advanced product development
- ▶ Lightweight product and structural design
- ▶ Component and system integration
- ▶ Energy and heat transfer design and analysis
- ▶ Design and development of 2-stroke, 4-stroke, and diesel power cylinder systems
- ▶ Interior system integration
- ▶ Technical data package support (ASME Y14.100, ASME Y14.34)
- ▶ Fatigue life prediction
- ▶ Fracture mechanics
- ▶ Advanced casting and forging
- ▶ Metal matrix composite
- ▶ Carbon composite
- ▶ Advanced aluminum alloy

ELECTRICAL

- ▶ CAN-BUS/CAN-AERO Integration and Programming (A815)
- ▶ Avionics integration and validation
- ▶ Proprietary microprocessor programming
- ▶ Aircraft and vehicle power system design
- ▶ EMI/EMC Design (HIRF, lightning, grounding/bonding)
- ▶ Automated test equipment
- ▶ Printed circuit board development and design
- ▶ Hardware component selection
- ▶ Electrical circuit load auditing
- ▶ 3D harness routing and connector integration
- ▶ Detailed flat harness drawings (ASME Y14.100, ASME Y14.34, IEEE315)
- ▶ 2D electrical schematics
- ▶ Design software packages supported: CadSoft Eagle, PSPICE, Boardstation, DxDesigner, MATLAB Simulink, and MathCad

QUALITY & MANUFACTURING ENGINEERING

- ▶ Design for Manufacturing (DFM) supported by industry professionals
- ▶ Supplier development to AS9100 standards and quality certification
- ▶ Supply-base identification and vetting
- ▶ Certified Quality Engineers (CQE), Quality Auditors (CQA), Weld Inspectors (CWI)
- ▶ Develop and implement quality planning to support manufacturing
- ▶ Design manufacturing and inspection fixtures
- ▶ Manage supply base to AS9100 standards



TESTING

GreenForces provides full test support from identification and planning through execution, data analysis and reporting.

VEHICLE & FLIGHT

- ▶ Purpose-built militarized and customizable 500-acre+ ground test facility, with 7,100 sq ft supported by shop space
- ▶ 6,501 ft and 5,196 ft runways with 150 ft width (designator CMX)
- ▶ 20-ton stability table
- ▶ Data acquisition systems with 32-, 48- and 64-channel capabilities with up to 100 kHz sampling rate
- ▶ Various industry standard sensors packages including customizable sensors design
- ▶ Various dynamometers

METALLURGICAL & FAILURE ANALYSIS

- ▶ Mechanical testing, metallography, microstructural analysis, corrosion testing, elemental characterization
- ▶ Composite material testing

WIRELESS TELEMETRY BASED TESTING IN HARSH ENVIRONMENTS

- ▶ Piston wireless measurement
- ▶ Connecting rod wireless measurement
- ▶ Wrist pin rotation
- ▶ Crankshaft wireless transmission
- ▶ Bearings wireless measurement
- ▶ Torque converter wireless measurement
- ▶ Phase-torque
- ▶ Rotating shaft telemetry
- ▶ 32-channel digital transmitter
- ▶ Electro-magnetic crack detection system
- ▶ Wireless telemetry systems (inductive or battery powered)
 - ▶ Infrared
 - ▶ Microwave
 - ▶ Inductively coupled
- ▶ Mobile testing
- ▶ Rotary kiln wireless systems



MANUFACTURING

GreenForces combines unparalleled experience with state-of-the-art manufacturing equipment. Each company is committed to investing in the latest technology, enabling extremely close tolerances. GreenForces manufactures products in climate-controlled, quality-inspected facilities, managed by highly trained staff who ensure the accuracy of each component.

CIRCUIT BOARDS

- ▶ Rigid, Blind Vias, 0.25-3oz foil & 1-2oz plating Copper Weight, 10:1 Hole Aspect Ratio, .015" pitch SMT Spacing, 63/37 HASL (horizontal) Lead
- ▶ Solder Finish, SN100C HASL (vertical) Lead-Free Solder Finish, per IPC-4552 Immersion Gold Finish, per IPC-4553 (thick) Immersion Silver Finish,
- ▶ Carbon Ink, Gold Fingers, Controlled Impedance, 21" x 24" Largest Panel Size, Alodine Chemical Conversion Coating



CUSTOM MACHINING SOLUTIONS

- ▶ Machining experience with a wide variety of materials: aluminum, titanium, polymer-based, steels, copper, bronze, stainless steels
- ▶ Low-volume/high-mix from prototype to production
- ▶ CNC machining and turning (3-,4- or 5-axis) fixturing, stamping/forming, straightening, gate removal, light assembly, blanchard grinding, polishing
- ▶ Investment casting services
- ▶ Complete fixturing and machining of complex cast geometries
- ▶ Extensive background processing casting products from gate removal and straightening to complete machining
- ▶ Primary and secondary processing – strategic vendor relationships
- ▶ NDT, coatings, military-specification paint, electro-polishing
- ▶ Laser etching, nickel plating, vacuum heat treating
- ▶ Inspection capabilities to customer requirements

RESEARCH & DEVELOPMENT

GreenForces provides companies, skilled staff, capabilities and facilities to solve high-tech challenges within the defense, aerospace and commercial industries. Additional resources include access to student talent and high-tech lab space at Michigan Technological University for the development and evaluation of the latest technologies.

Search a wide range of faculty and facility expertise to help your company develop and evaluate the latest technologies.

- ▶ Advanced materials (carbon and MMC composites, nanotechnology, graphene, metallurgy, etc.)
- ▶ Energy and power systems (combustion, powertrain, systems integration, vehicle electrification, etc.)
- ▶ Noise, vibration and harshness (NVH)
- ▶ Microfabrication and materials characterization
- ▶ Resin mixing and formulation; RF-hysteresis heating; In-Situ polymerization of Thermoplastics
- ▶ Supported by Michigan Technological University academic professionals and facilities





ACCESS TO STUDENT ENGINEERING TALENT

- ▶ 3,500 undergraduate and graduate engineering students
- ▶ Educational access to engineering design and analysis software
- ▶ Senior Design and Enterprise student projects
- ▶ Remote office and lab space program available

MichiganTech[®]

Support student development (both STEM and business / marketing) by providing Fortune 500 companies the ability to source low cost center work to GreenForces and have the work managed and overseen by a proven engineering service supplier. Additional benefits include providing graduates experience with real world and corporate knowledge of the designated Fortune 500 company upon graduation.



Lakeshore Center
101 Lakeshore Drive
Houghton, Michigan 49931

906.231.7769

WWW.GREENFORCESLLC.COM