ISAAC

Fabrication of a carbon-epoxy panel using AFP on ISAAC

ISAAC (Integrated Structural Assembly of Advanced Composites) is a highly accurate, automated robotic platform used to support research on the design, analysis, manufacturing and evaluation of advanced composite materials and structures. ISAAC can currently fabricate parts using automated fiber placement (AFP) and through-thickness stitching. ISAAC is located at the NASA Langley Research Center.

ISAAC

- State-of-the-art composite fabrication facility
- Scales directly to industry practice
- Easily enhanced to explore new technologies by adding alternate end effectors
- Ideally suited for basic research and is capable of supporting flight projects
- Enclosed in International Organization for Standardization (ISO) class 7 clean room with temperature and humidity controls
- Enclosure opens for easy import of hardware

NASAfacts

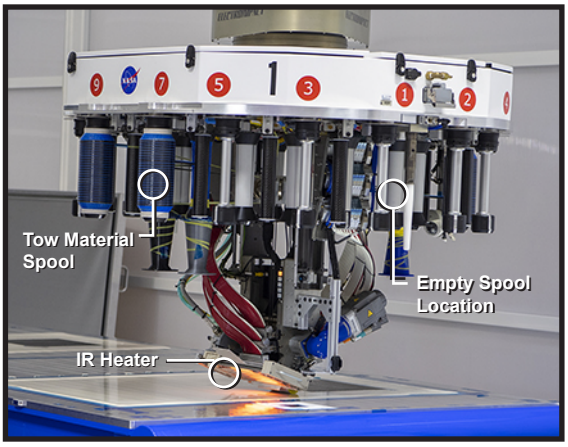
The system was designed and built by Electroimpact and comprises a commercially available KUKA KR1000 L750 robot with six degrees of freedom, a Siemens controller, and a 40-foot long linear track system with integrated carriage with 30 feet of travel. ISAAC includes a flat layup table, and a rotary table with mounting holes and positive indexing features for accurate part and tool positioning during the layup process. Including the track and rotary table, the entire system has eight degrees of freedom. ISAAC also has a selection of end effectors for performing various tasks, and capabilities can be expanded through development of additional end effectors.

ISAAC currently has end effectors for AFP, double-sided and single-sided stitching, laser projection, and cutting uncured parts with an ultrasonic knife. The end effectors incorporate a quick-change mechanism so that the robot can quickly swap out one end effector for another by automatically disconnecting and reconnecting all power, data, and pneumatic lines to the end effectors. End effector swapping is accomplished using two transfer stands.

The AFP end effector is a self-contained unit that can simultaneously place up to 16 tows of dry fiber or pre-impregnated slit-tape material. The end effector contains the spools of material, the tow backing take-up spools, pulleys to direct the tows, infrared heat lamps, compaction head, a cutter system capable of cutting individual tows as needed, and other hardware necessary to fiber-place the tow material.

AFP Information
Laydown rate: 100 to 2000 inches/minute
Material: Varies
Number of spools: 16 Tow widths: 1/4 inch
Tow thickness: 0.0025 to 0.010 inches

Maximum Work Envelope
Vertical: 14.5 feet
Radial: 13.5 feet
Rotational: ±150 degrees

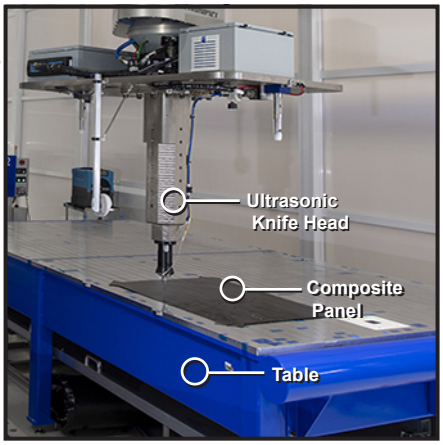


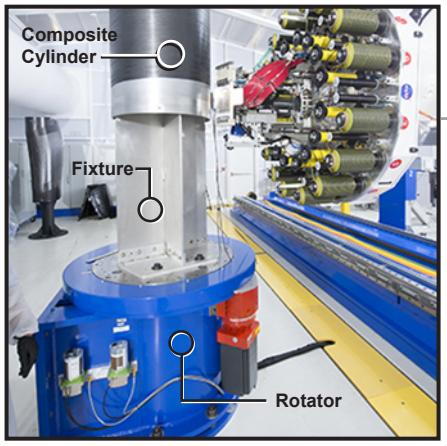
Software

- Operated using Electroimpact software button panel and hardware interface
- Operating programs created using the software packages by CG Tech
- Vericut Composite Programming (VCP) can read step files (STP), native Pro- Engineer part files, and native Solidworks part files
- Vericut Composite Simulation (VCS) uses the posted information to check for machine issues or interferences

Layup Table

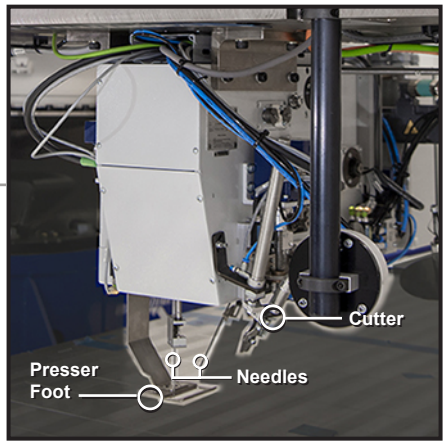
- 6 ft by 12 ft aluminum top table
- Center 5 ft by 10 ft has a grid pattern for accurate positioning
- Mylar or other film serves as a replaceable surface before each layup
- Mylar sheet held in place with tape, vacuum, or both





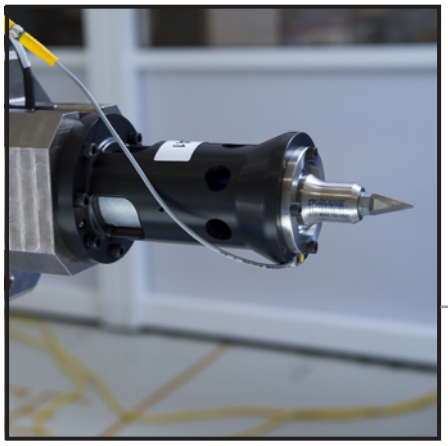
Rotatory Table

- Top plate diameters available: 3 ft and 6 ft
- Capacity: 20,000 lbs
- Speed: up to 5 rpm
- Acceleration time, 0-180 deg.: 6 secs.
- Indexing precision: ±10 arc-secs.
- Repeatability accuracy: ±10 arc-secs.
- Maximum table run-out: 0.005 in.
- Numerous attachment points for part or tooling



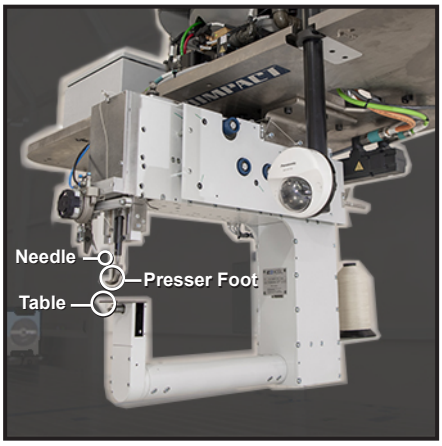
Single-Sided Stitching

- Fabricated by PFAFF Industriesysteme und Maschinen GmbH Branch OfficeKSL (Lorsch, Germany)
- Capable of stitching dry three-dimensional (3-D) preforms from one side of the part
- Creates a modified chain stitch
- Up to 19.7 inches/min stitch rate
- 3-D preforms infused to create stitched composite structures



Ultrasonic Knife

- Allows ISAAC to accurately cut complex patterns in an uncured laminate
- Provides clean edges with minimal mechanical deformation



Double-Sided Stitching

- Fabricated by PFAFF Industriesysteme und Maschinen GmbH Branch Office KSL (Lorsch, Germany)
- Capable of stitching dry preforms with access to both sides of the part
- One preforms typically stitched to another preform using single-sided stitching end effector
- Creates a chain stitch
- Up to 67 inches/min stitch rate

New Capabilities

- Modification to include a compact infrared heater system to allow AFP in more concave spaces
- Modification to AFP head for thermoplastic layup in development
- One breadboard development head availability to introduce new capabilities

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FS-2016-12-273-LaRC

NASA Facts