ACCUDYNE SYSTEMS, INC.
NEWARK, DE USA

Custom Automated Equipment for the manufacture of high performance parts using Carbon Fiber prepreg thermoset tape, tow or fabric

Accudyne Systems, Inc.
Company Abstract

Accudyne was founded in 1996 in response to an industry need for a company that could develop solutions to complex equipment problems. To provide these solutions, we integrate different areas of expertise including:

- Process Development
- Mechanical Engineering
- Electrical Engineering
- Software Engineering
- System Integration
- Machine Conceptualization
- Fabrication and
- Turn-key Deployment

Accudyne excels in the design and development of one-of-a-kind equipment and processes that result in dramatic production improvements over existing systems. Typically, our equipment provides our customers a disruptive competitive advantage.

Located in Newark, DE, Accudyne's 15,000 square foot manufacturing facility houses an engineering and design center, a mechanical shop and an electrical shop. Using Autodesk's Inventor or Solidworks solid modeling software for mechanical design and Autodesk's Promis*e for electrical design, Accudyne's in-house engineering and design center ensures confidentiality, maintains control of the schedule and cost, and most importantly, fosters interaction between designers and engineers. The mechanical and electrical shops allow Accudyne to maintain quality and schedule even when making modifications during final assembly.

Accudyne's staff continues to grow to satisfy our customers' needs. The team includes engineers, designers and technicians. Each of Accudyne's engineers has a primary expertise in one field, and a working knowledge of other fields. This interdisciplinary cross-knowledge allows for ease of communication, the ability to study a problem from many different perspectives and the insight to relate these perspectives.

Problems are thoroughly examined from the beginning to minimize technical obstacles during equipment deployment.

All machines are assembled and started-up in our facilities. This includes alignment, calibration and Quality Control to ensure correct equipment performance. Once the equipment is tested at our facility, our staff transports the machine, installs it, integrates it with the existing equipment, and runs the machine to ensure proper performance with the rest of the customer's process. After the machine is in place, we provide operator training for routine equipment usage. If desired, we can also provide in-depth training on diagnostics and maintenance and on programming the machine to perform other tasks. As a resource, we can provide a manual detailing safety procedures, troubleshooting, routine operating instructions and preventive maintenance. If needed, our engineers are available to provide technical support.

Paradigm Shift in Commercial Aircraft Manufacturing

High performance composites found their first use on aircraft in various NASA and military programs. Nearly everyone is familiar with the B-1 bomber and Stealth fighters. The use of these materials allowed these aircraft to perform at levels that were not possible with other aircraft manufactured using traditional materials.

Many of the composite parts were laid up or manufactured by hand. The quantities required and the budgets available provided a set of process economics that propelled the programs forward. The ensuing success of these aircrafts prompted a wider use of the material in other military aircraft. Now composites are used extensively in every military aircraft whether it is a fixed wing craft or a rotorcraft.

The commercial aircraft manufacturers were paying close attention since many of them had contracts in manufacturing parts or aircraft for military applications. It was inevitable that the use of composites would begin to find its way into commercial aircraft.

The commercial aircraft industry is at a paradigm shift much like the one that occurred when it exchanged fabric/wood construction for aluminum construction. The current shift is from aluminum to carbon fiber. The Boeing 787, the first all composite fuselage aircraft, is scheduled to fly in mid 2008. Airbus has announced that the A350 XWB , scheduled to fly in 2011, will have more than 70% composites content.

INDUSTRY CHALLENGES

Much of the technology that used carbon fiber in aircraft emanated from military programs in which the process economics in terms of man hours, cost per part, etc., are not acceptable in the manufacture of commercial aircraft. There are going to be hundreds if not thousands more aircraft with tens of thousands of parts such as flaps, stringers, frames, T & Z stiffeners, blades, etc. It will be impossible to sustain manufacturing levels that meet stringent quality standards if the manufacturers are going to rely on manual labor to manufacture all of the

parts. Currently, the metal parts used in commercial aircraft are made automatically on large CNC machines to ensure high quality and acceptable throughput.
The current state of technology in the manufacture of composite parts is mostly manual. It includes;

- Hand Lay up of fabric.
- Manual assembly of multiple composite pieces to make three dimensional parts.
- Manual prep to support VARTM, SCRIMP or RTM.

Automation is typically used for large parts and for that purpose tape and tow placement machines manufactured by Cincinnati Machine, Ingersoll, M Torres and GFM are used (see Figure1).

Figure 1

These machines are highly versatile and can be applied to many different applications. They are typically 4 – 5 million dollars and in the case of the tape and tow placement pieces of equipment require significant infrastructure support prior to deployment. They are not very efficient in the manufacture of small parts and as such are difficult to justify financially.

Part Specific Custom Automation Equipment

Accudyne Systems has observed a market need for part-specific, custom automation equipment to fill a gap that is left open by the large tape and tow placement equipment manufacturers. The quantities of various small to medium sized parts required on the emerging commercial aircraft programs provides the process economics for custom automation equipment. This section will detail several of the machines that Accudyne has successfully deployed in this area.

Flat Charge Laminator

Accudyne recently completed a machine to build a variety of long thermoset laminates for the aircraft industry. Shown in Figure 2, the machine forms 12” wide laminates up to 36 feet long. The laminates are used to make parts which are hot drape formed in a secondary process. The carriage holds 3 different rolls of thermoset prepreg fabric and two film rolls, and moves 50 feet under closed loop servo control. Material heads are individually controlled and include position and tension control of the web, transverse cutting, and heating to insure tack. Cutting of the unidirectional tape was accomplished by using a stylus cutter without cutting through the backing paper. A vacuum table is used to hold the laminate in place as it is being formed. Laydown speeds of 100 feet/minute with edge alignment of ±0.010 inches and add/cut accuracy of ±0.030 inches have been demonstrated. The laminator also features a turret loading system to automate material changeover.

Figure 2

High speed multi axis charge laminator

Figure 3 shows a 3 degree-of-freedom motion system developed by Accudyne for the high speed forming of a proprietary part using thermoplastic tape. Although smaller then the proposed system, it demonstrates the critical components that would be required in the larger system. The system in Figure 3 moves 5 feet in X, 5 feet in Y, and 370 degrees in Θ. With a 1650 pound payload, linear speeds of 5.0 feet/second and accelerations of over 13 feet/sec/sec have been demonstrated. Linear position resolution is 0.0005 inches with accuracy of ±0.008 inches and backlash of ±0.002 inches. Similar levels have been demonstrated with the rotation axis.

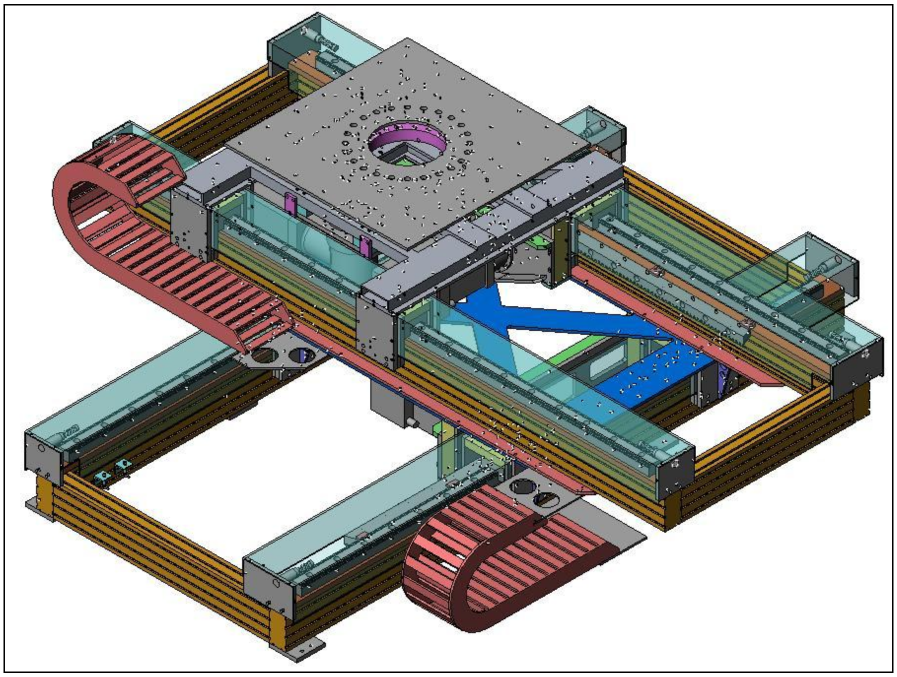

Figure 3

Tool Wrapper

Figure 4 below shows one of five tool wrapping machine segments that were assembled to create a machine capable of wrapping 46' tools for the aircraft industry. This machine was designed, built, and installed earlier this year. Finite Element Analysis was used to ensure proper frame design, as each of the five machine modules generates over 5000 pounds of clamping force during certain steps of the wrapping process. ASI demonstrated innovation in several aspects of this machine above the customer's specifications, including:

- Dramatically decreased tool changeover time by utilizing a creative tooling geometry, ultimately allowing the operator to perform a complete tooling change with the push of a button.
- Simplified machine installation by fabricating 5 identical sub-machines.

- Innovative machine construction to facilitate operator cleaning and maintenance.
- Automatic inflation and process optimization to minimize manual operator tasks and to thereby increase throughput.

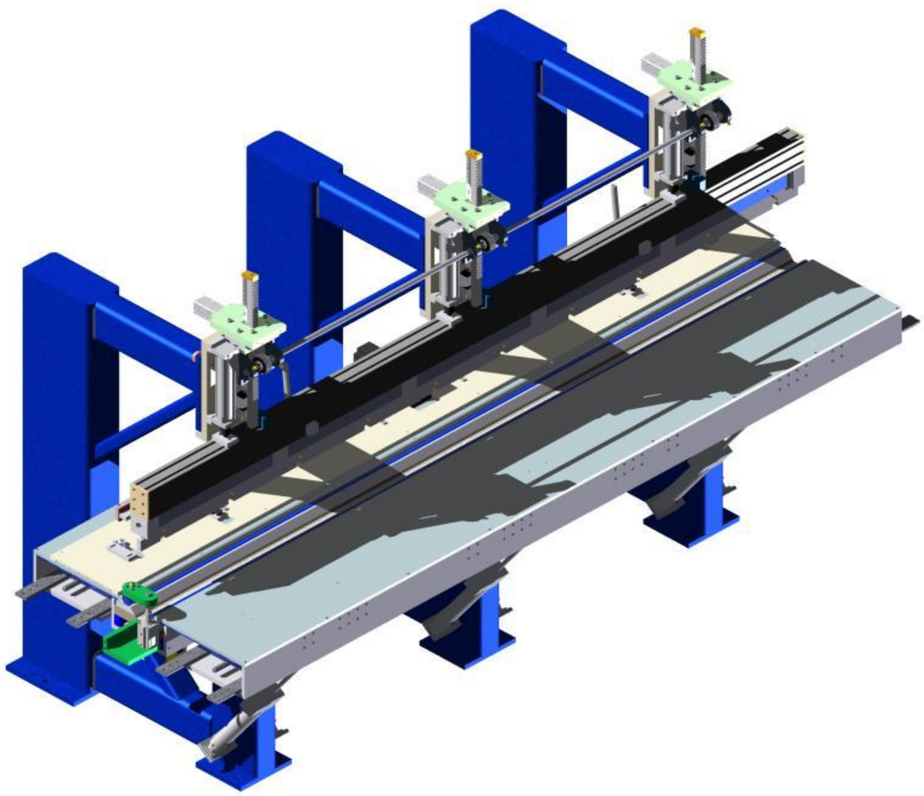

Figure 4 – Tool Wrapping Machine Segment

E-Beam curing and flat tape laying machine

Shown in Figure 5 below is a Flat Tape Laying Machine that was built and installed in the past year. The tape laying head was supported by a gantry that provided motion in the Y-direction, while the translating and rotating table surface provided motion in the X and Θ directions, respectively. The tape laying head was capable of laying, compacting, and cutting prepreg thermoset tapes. Precise cutting of the unidirectional tape was accomplished through a stylus cutter without cutting through the backing paper. This machine utilized ultrasonic and E-Beam curing technologies to cure the composite panels during layup. The machine also incorporated a closed circuit video camera focused on the work surface for process monitoring.

Figure 5: E-Beam Flat Tape Laying Head and Gantry

Large Scale Laminator

Figure 6 depicts a large scale laminator that was recently installed and is now producing product. This unit feeds five 24" wide rolls of material side by side to form a ten foot band. A sixth supply of material is fed via a vacuum conveyor, cut, and tacked 90 degrees to the main band forming a 0/90 composite laminate. All rolls have active edge alignment and run under closed loop tension control. The process is continuous with 90 degree plies placed "on the fly".   Product temperature is controlled through the process region. Completed rolls of processed laminate can weigh up to 18,000 pounds.

In the area of thermoset composites, Accudyne recently completed a laminator that produces a continuous 12” wide tape having a 0/+45/0/-45/0 or 0/-45/0/+45/0 layup. This units uses active edge guiding, ultrasonic cutting and precision indexing to produce a partially consolidated laminate that serves as an intermediate product that is die-cut and stacked for later press forming.

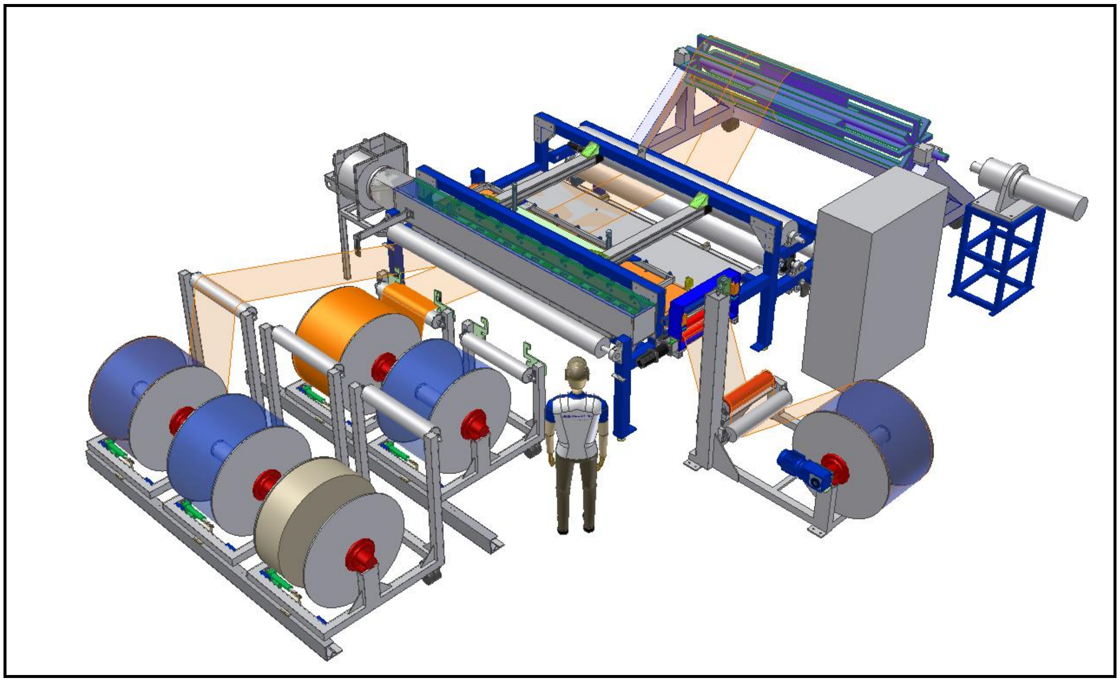

Figure 6 – Large Scale Laminator

SUMMARY

Accudyne Systems has provided multiple clients unique manufacturing automation machines for the composite market. Many of these machines provided disruptive technology that provided the user with a significant competitive advantage.

For more information contact Accudyne at or 302-369-5390 or visit our website at www.accudyne.com.