Welcome to JEC 2012!

Cannon’s latest developments in the field of Composites, Polyurethane and Thermosetting technologies are on show at JEC 2012 in Paris, presented by an international team of specialists.

The most complete range of Epoxy infiltration and injection technologies and tools:

- ESTRIM: Epoxy/PTA/Universal Reaction Injection Moulding technology, for the replacement of conventional, slow RTM processes with fast-setting high-pressure injection of Epoxy resin formulations. This technology is now available in two new versions, the Spray (SL) and Liquid Laydown (LL), for different, more advanced applications of large Composite parts in the Automotive industry.

- The E-System, a three-component high-pressure dosing unit for Epoxy, launched at the past edition of JEC, is now available in its second, enhanced version.

- The range of automatic Perforators for the preparation of Carbon and Glass fiber preforms used for resin impregnation and injection technologies.

- A complete range of handling and manipulation systems for dry or wet preforms and moulded parts.

A new compression moulding solution for Thermoplastic Composites, including prexes, exams and handling systems, for light-weight compression moulded reinforced plastic sheets.

Co-injection and Reinforced spray technologies for Polyurethanes, for an increasingly wider number of industrial applications.

Automated, industrialised technologies for the production of large composite parts destined to the automotives and wind generation market:

- The Epoxy DX dosing machines for infiltration in the wind blades, dosing machines for Polyurethane inserts, to replace the use of bulky wood or Polyurethane cut blanks;

- dosing machines and prexes for DCPD (Di Cyclo Penta Dione) resins to produce large, thin, high-modulus structural parts without glass reinforcement;

- Tailor-made handling and assembly equipment for large parts.

Compression moulding prexes up to 3,500 ton for SME, CMT, DWRT (Low Weight Reinforced Thermoplastics) and a new generation of Composites.

The latest models of Industrial Thermosformers, equipped with high-throughput hot plates, controlled non-contact of heating, patented adjustable plate systems for minimum set-up time and elimination of retraction plates.

The world’s widest network of Service Centers for the Composites and PUR processors.

Composite production? Talk to us!

Cann & Composites: integrated high-productivity solutions

We all know it: every decent cook can put together a meal, but you need an experienced chef to build a smart menu. It’s the details that make the difference. It’s the balance of calories, proteins, vitamins, flavours, tastes, consistency of the various components, their look and the final presentation.

All senses must be satisfied, all details must be cared of. The same - if you pardon the analogy - goes for the supply of technologies.

Every decent shop can put together one working machine. It will work, and probably for a very reasonable price. But whether your project involving at the same time high productivity, a quality product, contained costs, safety for your workers and respect for your environment, then you need a chef. Knowing the right ingredients that you use - your raw materials - and the different ways to process them helps in suggesting you the best exploiting, efficient and methods to transform a bag of plastics into an award-winning finished part.

Knowing what your competitors are doing (tomorrow?) on the other side of the World helps in suggesting you how to face a long-term industrial project.

Knowing how important is for you the presence of a local helping hand, able to speak fluently with your plant manager and his assistants, helps when you are in troubles.

Knowing that the chef has been there for more than four decades - and that his customers keep coming to his place, because the food is good and the bill is fair - helps you in making your decisions.

Welcome to the Cannon place: talking Composites, we know how to process them the way you need.

Almost fifty years in Polyurethane moulding - Cannon Affinis will celebrate them very soon - and in plastics compression moulding - our activities in this field started in1963 - mean something to those who pay the due respect to experience and history.

Thirty years of activity with dedicated Divisions providing specific solutions for the Automotive, Refrigeration, Construction industries mean something to those who care for dealing with a technical specialist rather than with a generic salesperson.

A deep knowledge of all the technologies involving low- and high pressure process of reactive materials - Urethanes, Epoxies, Silicones, DCMDP, Nylon RIM, etc. - with any kind of filler and reinforcement, compression moulding process of thermosetting and thermoplastic and reinforced resins, thermofoming process of plastics and fibre reinforcements, precise handling and manipulation of large moulded components and of their unstable preliminary sub-assemblies, all this makes something to processor searching for dedicated high-productivity solutions.

Throw in the fact that we do this with our own people, in the whole World, exchanging experiences and sharing tasks, thinking globally and acting locally.

You have found a reliable partner for the Composites and specialty plastics process.

We would like to talk with you about your next project concerning the thing we know best: your success and your satisfaction, without which we would not be here after half century of passionate work.

Welcome to Cannon. We Know How.

A new structure, to serve you better

Fresh News from Cannon: a new Technologies Team has been created, to rationalise operations and serve you better. Duing the next few months the new structure will consolidate human resources and technological experiences of existing Group Units providing since many years dedicated turn-key plants, especially for the industry of Composites.

Alberto Zarantonello, leader of this team, explains the reasons of this important organisational move.

"The industrial world is changing quickly. Our customers are living a geographical revolution. Internet and modern communications dictate new timing for war interactions. Modern designing and fast prototyping technologies have cut in time-to-market of the new projects dramatically. We must be ready for further evolutions in these directions. The current industrial structure of the Cannon Group has to be tuned to better fit the new scenarios. It’s our mission to bring our communication with the market, provide faster responses and make a better use of the incredible human potential that we have accumulated in different areas of our organisation. We can make much more efficiency by combining scattered resources of R&D, industrial engineering, manufacturing, sales and finance. With this new team we create a structure which combines important technological and human resources. Our customers will benefit from this move, because our acts will be optimized, more report will be available for a greater integration of information and more competent teams will be dedicated to the resolution of a complex problem. The World of Composites will be one of the first fields of activity to be touched by this evolution. The new Team, on the next steps, will work under the Cannon Corporate strategy," forms a strong technological group of people, that has already obtained brilliant achievements in the last 18 months, with eight ongoing projects. This makes me strongly determined to continue our focused activity."

The picture shows some of the Composite Specialties team of Cannon: (left to right) Hiashi Toyama, Albrecht Manderscheid, Lorenzo Shrama, Marco Zanotti, Paolo Salina, Marco Brenna, Alberto Bonamea, Martino Lanzendra, Antonio Coumou, Vittorio Pesenti.

Some of them will be full-time available in our booth at JEC: share your ideas and project with them!
Epoxy impregnation: Cannon provides four winning tools!

The recent introduction of new Cannon technologies for the manufacture of Epoxy based components has found an overwhelming response from the market. In addition to a significant number of low-pressure dispensing machines sold for the impregnation of the giant blades used for the eolic generators industry, Cannon have introduced three different impregnation systems based on high-pressure technology. A whole range of solutions is now available to respond to different needs and processes. Cannon supplies today the widest range of tools, including dispensers and mixing devices, preformers, presses, moulds, manipulators, ovens and controls.

Exactly two years ago, at Jec 2010 in Pitts, Cannon launched their new high-speed RTM technology for Carbon-reinforced composites based on Epoxy resins. The new process, called ESTRIM (Epoxy Structural Reaction Injection Moulding) was making possible the industrial use of new, fast curing Epoxy formulations developed to comply with the high productivity required by the automotive industry for their increasing number of structural composite parts. Based on a series of integrated processes - Carbon reinforcement handling systems, dedicated preformers, high-pressure dosing units for Epoxies, multi-component mixing heads with different distribution methods, polymerisation processes and relevant handling systems of preforms and moulded parts - the ESTRIM process immediately received a positive response from the industry.

The possibility to cut almost by one third the curing time of a large moulded part - going from a traditional 30 minutes cycle of conventional RTM down to 3 minutes with ESTRIM - appealed OEMs and Tier 1 companies.

All the major players in the field of automotive composite parts visited during the past 18 months the Cannon R&D laboratory in Italy, either to run moulding tests with their own raw materials and moulds or to discuss the supply of equipment for their composite research and production departments.

New Solutions Are Now Available

The intense exchange of experiences matured during these visits stimulated the development of new methods for distributing the liquid Epoxy resins in the Carbon preforms. In addition to the ESTRIM RTM fast injection technology, Cannon have developed two alternative methods for the impregnation of these more or less flat mats, both to be applied in open mould prior to the shaping of the parts.

- ESTRIM SL (Spray Laydown) – the Epoxy formulation is sprayed directly over the reinforcement, covering each square centimetre of mould with extreme precision, applying the desired amount of liquid resin where it is required by the part’s geometry. This technique allows for the use of various formulations, characterised by low fluidity, being directly deposited in situ the liquid does not need to flow through the fibres, avoiding any distribution problem. A certain degree of part’s three- dimensionality can be approached without problems, since the head can be tilted on a fourth axis over the vertical sides of a mould during the spraying operation.

- ESTRIM LI (Liquid Laydown) – the Epoxy formulation is laid over the Carbon preform to the rib of varying width, typically from 40 to 120 mm, impregnating perfectly the reinforcement without the minimum possibility of air inclusions in the moulded part. The production of large parts, weighing uniformly the huge, almost flat preforms that characterise parts such as roofs, engine hoods, fenders and doors. The reactivity of the systems being controllable on a part- to-part basis, this system allows for a comfortable laydown time even for the largest pieces. As in the SL alternative, the formulation does not need to flow through the mould, therefore guaranteeing the most homogeneous distribution of liquid resin in the Carbon reinforcement.

We should not forget the development of new alternatives for the traditional high-pressure injection in closed moulds, performed with the original ESTRIM technology. The experiences matured in the past in the field of short-stroke polymerisation processes have allowed for at least three more injection methods:

1. We can inject the resin with a variable output, commanding the operation by reading the internal pressure of the resin in the lines of the series of pressure sensors. The signal is sent to the unit, that defines the new output value to be applied and commands the dosing pumps accordingly.

2. We can apply the volumetric-compression method, by leaving the mould partially open during the injection (still guaranteeing the tightness of the exit) and applying the final compression stroke at the end of it.

3. We can inject the resin and apply a low clamping force on the mould, which will tend to open during the liquid filling phase: at the end of it we apply the full nominal clamping pressure and compress the mould and its content.

Worldwide recognition

Up to date, seven different contracts for these Epoxy dedicated technologies have been signed with major manufacturers of parts and Raw Material Suppliers, in Europe and Japan, in the past 18 months.

An important German manufacturer of composites parts, destined to the most prestigious car makers, purchased in 2011 the first E-SYSTEM dosing unit, in conjunction with a vertical press, which is based on the 4-tie-bar design to give all-around access to the resin. The clamping stroke design is selected to reduce the overall height, in order to install the equipment in the existing facilities at customers’ site, without additional civil work or space. The resin dosing system is guided over the tie-bars by means of long guides for improved parallelism during its movement. The lower table isforeseen with the possibility to slide outside of the press center, to ease the loading–unloading tasks, maintenance and cleaning, as well as the mould change operations.

The new E-System: an industrial success

The Cannon high-pressure metering unit E-SYSTEM is a powerful addition to the field of Epoxy resin processing. The benefits of high-pressure mixing technology have been appreciated for many years. High-precision metering pumps give precise output and high pressure to produce high quality mouldings. The process occurred both in the automotive sector, during the last years, ensures that the E- System metering unit improves the efficiency and bring the main processing parameters under closer control.

The equipment is available for processing very high quantity of hardener and a smaller quantity of release agent in high pressure. As a matter of fact, precise metering of the low output is by means of a hydraulic plunger, driven by a dedicated hydraulic unit. In particular, the release agent hydraulic cylinder is positioned as close as possible to the mixing head. The flow transducer installed between the dosing plunger and the mixing head allows the best metering by a closed loop system. Also base and hardener are metered in a closed loop system.

Many features of the metering unit deserve to be highlighted:

- Cepositive continuous level (for base and hardener materials) with four setting points: min/max alarm, start/stop filling. Accuracy level controls are also maintained constant quantity of material in the tanks.

- Rust-proof treatment of the pumps.

- Stainless steel components for the hardener material.

- Electrical cables and wires are fitted inside the machine frame, protecting them from dirt, allowing easy maintenance and giving a pleasant and tidy look to the machine.

- High-performance mixing heads, specifically developed for Epoxy resin hardening treatments of the mixing head parts is done not only on the surface but also in the core.

- Each component can be calibrated directly at the mixing head, so calibration conditions and working conditions are the same.

- A special program “weekend cycle” is highly customizable, for controlling the sequences of the metering unit in order to avoid the components stagnation when the system is not in working cycle for long periods.

- Precision is one of the main requirements for low output machines. Therefore the machine is provided with high-precision dosing pumps driven by closed loop motor (frequency control). Another interesting feature is the continuous recirculation of the resin in the mixing section. All these items together allow the system to continuously maintain the set temperature within a close tolerance range.

- The thermostatisation of the chemicals is a key point of the complete process. Cannon expertise in managing these chemicals leads to use selected tanks supplying temperature controlled oil by a thermostat, (base and hardener). To maintain the required temperature heated pipes are used: coaxial pipes with internal chamber for the heated oil and traced flexible hoses (base material).

These operations outside of the press working area are to the further benefit of the operator’s safety.

A few weeks later one of the most important European producers of car interior plastic parts ordered a E-System machine with LN 7/3 mixing head, plus a dedicated, special preheating oven that guarantees at the same time a fast and well distributed supply of heat over the preforms. This opportunity stems from a number of positive industrial experiences made in the 1990s by supplying dedicated oven for GMT (Glass Mat Thermoplastic sheets in Polypropylene).

The same heating concept – based on a mix of IR elements plus a forced circulation of air – was adapted to the new reinforcements and worked perfectly!

The Composites Development Centre of a major Japanese car maker purchased an E- System machine with LN 7/3 mixing head and other special equipment for its Mould Coating, for a new development project for exterior body parts.

Two E-System machines with LN 7/3 mixing heads were ordered during 2011 by another major Japanese producer of car parts, one of which - a very large one! - will be developed jointly with a major German car manufacturer.

Momenteum – formerly Exion, the world leading Raw Material Supplier for Epoxy formulations – after a set of positive trials in Cannon lab in Italy ordered a complete technology development line composed by one E-System dosing unit, one LN 7/3 head, two molds, a vacuum system and a clamping/polymerisation press for their German laboratory. See the full article on page 5.

Another major European manufacturer of composites, supplying parts to the two most prestigious German car manufacturers, has granted to Cannon an important contract for a complete ESTRIM LI (Liquid Laydown) system for the mixing of composite parts that can reach the size of 1200x800 mm. After the application of the liquid resin over its whole surface, the wet preform is handled into the press by a special frame and here it’s laid over the very hot mould; the polymerisation occurs here at 130 °C, under pressure. At the end of the cycle the robotic arm removes the cured part and introduces a new wet preform to be press. With the availability of proven industrial solutions for a vast range of needs, Cannon is today the ideal partner for composites – and also for simple - Epoxy processing projects for the composite industry.

Once more, the concept of “One-Stop-Shop” for all the chain of equipment and tools can be the winning move for both parties!
Cannon have designed and supplied dedicated preformers for composite parts for more than three decades. Glass, Carbon, Aramidic and natural fibres of every type and consistency have been successfully handled and precisely dispensed in large or small moulds in dozens of different applications. The availability of these dedicated tools – in addition to a complete range of mould carriers, presses, manipulators and other specially-designed equipment – is a significant plus in the search for a complete industrial solution aimed at the automated high-yield manufacture of injection composites based on Epoxy formulations and various types of fibre reinforcements.

The tight strength in the right places

The core of this high-strength material lies in the Carbon fibre. In contrast to quasi-isotropic materials like Aluminium or steel, which have equal strength in all directions, CFRP is anisotropic. This gives it very high strength, like a rod, in one direction, namely along the uniaxial compression axis. This is its key advantage. Using CFRP is more than simply a straight substitution, like using Aluminium in place of steel: it states a more 40-page report entitled «Mobility of the Future» made by BMW.

With its special properties, this high-tech material also opens the door to completely new approaches and design concepts.

Preforming and preform joining – a component takes shape

As the so-called ‘preforming’ stage, the cur but still flat fabric begins to acquire a shape. During this process a heat source is used to give a fabric stack a stable, three-dimensional contour. The final shape of the component is already clearly visible. Several of these preformed stacks can then be joined to form a larger component. For this: CFRP can be used, for example, to produce highly complex components with a large surface area, which would be extremely cumbersome to manufacture from Aluminium or steel. This has major benefits for vehicle body design and manufacture. For example, mounting parts or other features can be integrated directly into the component.

Also, complex structural components and entire body modules with varying wall thicknesses can be produced in a single moulding tool. At both process stages – preforming and preform joining – the big challenge lies in ensuring good production processability of the flexible fabric so that the preforms will maintain a stable shape and can be joined with maximum precision. This precise and delicate operation is performed using a sandwich composed by various layers of Carbon fabric, selected according to the mechanical resistance desired for the final, moulded part.

Special needs, special solutions!

Since preforms can be made with various reinforcements for different injection moulding methods, Cannon developed customised solutions for several OEMs and Tier 1 parts manufacturers. As an example of special project, the glass preformer made for Menzies in the USA for the production of a complete rear hub and tachometer for the GM’s Silverado pickup. The customer required the deposition of a huge amount of pre-cut glass fibre over a male plug. Cannon designed and built the whole system (below) using four synchronized robots that were more than 25 kg of pre-rolled glass moving in less than 15 seconds, applying a thick layer of fibre over a 9 m male plug. Transferred in a large press and submitted to pressure-forming immediately after, the glass, under the combined effect of heat and pressure, created a large, compact preform. This was later on introduced in a mould and impregnated with Polyethylene using the RIM technology, obtaining a monolite pickup body (and its tachometer) of impressive size and surface-finish quality.

The Cannon Group can supply, as a One-Stop-Shop supplier carrying the whole responsibility of the line, all the equipment required by this technology:

- High-pressure closed-loop controlled metering and injecting machine, and self-cleaning mixing heads
- Dedicated preformers for repetitive and fast production of inserts
- Dedicated moulding clamps and moulds, in various lay-out configurations
- Water-jet trimming equipment for the finished preforms
- Storage tanks and distribution circuit for chemical components
- All the ancillary equipment required by the process

More than 45 years of experience in preforms for composites, delivering all sorts of models up to 3,500 Tons of clamping force and up to 3,500 x 3,500 mm of plate尺寸 dimension, characterise the Cannon offer to a sector of the plastics industry that is featuring an impressive growth rate.

Designed and built to last, the Cannon presses for composites have been used for more than four decades for compression moulding of BMC, BMC, GMT trays. Characterised by a four-column construction, they allow for optimum distribution of pressure over the whole mould surface and for flexible approach from the four sides for all manual and automated loading and unloading operations.

The availability of a shing upper plate and a sliding lower plate (the shuttle system, that can also be supplied in a double version, sliding towards both sides of the press for an increased productivity rate of the working island) allows for ergonomic service operations and for the manipulation of the largest moulded parts. Presses with plates up to 3,500 x 3,500 mm dimensions have been manufactured, featuring specific pressures from 10 to 100 bars: the former is mostly used for materials requiring only a containment in the mould during an impregnation phase, while the latter is specific of true compression processes. When the highest dimension precision is demanded, a short-stroke press can be supplied, featuring a very compact design combined with excellent control of active or passive parallelism during the final clamping stroke and fast operating cycle, due to the limited amount of hydraulic oil used in the circuits.

Cannon supplied last year to Lamborghini (Audi – VW Group) a complex preforming line (above) used for two different applications: the manufacture of their larger Carbon preforms and the moulding of smaller Pre-prec parts. All these lightweight, high-modulus elements are mounted on the new ‘all-Carbon’ Aventador supercar, (below) launched on the market at the Geneva Car Show 2011.

Cannon customers in this field include all the major manufacturers of composite parts among them Fritomeier, Menosoli, Polynorm, Inoplast, Plastic Omnium, IIM, Reglar and several others. The booming sector of composites for the transportation industry – which requires high-productivity, energy-efficient, proven solutions using new types of formulations and reinforcements – can benefit today from the vast experience managed by Cannon.

A unique set of tools is available, to be used with and around these complex machines: handling systems, dedicated preformers with patented slip-control methods, pre-heating ovens, several methods for the impregnation of the reinforcement-mats with various families of reactive chemicals, all the safety systems around the working areas and a specific electronic control designed for these operations.
An innovative method for the manufacture of large decorative ceramic tiles has been developed in Italy by System, Fornaci Modenesi. Large, monolithic porcelain granites tiles that can measure up to 3,500 x 2,000 x 3.5 mm can now be manufactured with outstanding mechanical and aspect properties. These huge stone slabs are used as internal and external decorations for skyscrapers, factories, showrooms, hospitals and other residential or commercial buildings. The innovative process reduces by 66% the thickness of the tile, still maintaining all the good characteristics – impact resistance, flammability, versatility and different shapes – in a product which weighs two thirds less than a competing – even if not yet existing in this size – ceramic tile. The robustness of these shatter-proof decorative elements is provided by a mat of glass fiber, glued onto their back using a very thin layer of two-component Polyurethane adhesive.

A dedicated metering, mixing and spraying solution has been designed by Cannon for this sophisticated application. An intense, joined effort has characterized the development phase of this innovative technology, with System and Cannon R&D specialists playing as a team to achieve the desired result.

THE CUSTOMER

System SpA (www.system-group.it) is located in Forlì, near Modena, the heart of the Italian ceramic district, and operates in three major areas of activity: Ceramics, Logistics and Electronics. System is today recognized as a leading supplier of automated factories that provide the highest quality standards in the field of ceramics. The range of available solutions includes equipment and know-how for raw materials blending, pressing, decorating, firing, ceramic tile production, cutting, quality control and sorting, packaging and handling. They quickly extend the initial ceramics technology to logistics and controls, two fundamental components of success in a very competitive, cost-driven field. Internal development of electronic controls and LCCS (Laser Guided Vehicle) provides their technological offer with a further integration of dedicated equipment.

The System Group includes 28 local branches in 18 countries, devoted to the distribution and service of their equipment, with three local manufacturing sites in Spain, China and Brazil. The Group employs today a staff of 3,300, with a total turnover of 280 million Euros.

All the buildings of the Lamina Group are covered with their Lamina 3x1 m ceramic extra-large tiles

THE LAMINA® Process

LAMINA is a highly automated production process composed by seven main macro-functionalities: deposition of raw material, pressing in press which vary from 15,000 to 26,000 tons, wet or dry decoration, gas/electric hybrid kiln cooking, composite tiles line, dry laser cut for final product and the packaging. The entire process rotates around a special compacting system which turns raw materials, such as clays and feldspars, into slabs. LAMINA also revolutionizes logistics systems for traditional ceramics because it deletes the final product storing as cutting and packaging of the slabs happens upon shipment on the basis of the specific order.

The LAMINA® product

LAMINA indicates the assembly of deliverable products which lead to the use of 3.5 mm thick slabs, 1,000 x 1,000 mm or 1,200 x 3,600 mm and specific quality of only 7 kg/m². A 0.5 mm glass fiber layer, duly coupled with this laminate, confers notable resistance and flexibility features.

It is therefore possible to obtain different combinations from this fiber laminate (cased or textured laminates with fiber intervals) for applications where the physical features are essential. LAMINA can be applied in the building field for coverings, floors and revetments, for interior decoration (partition walls, false ceilings, doors and tables) and coverings, for design and for infrastructure (motorway galleries) including the photovoltaic field.

LAMINA®-coloured elements are used in Milan’s Underground stations (above) and in highway tunnels (top, left).

The whole production cycle occurs here with a fully-automated concept, completely designed and built by various System Group’s companies with raw materials selecting and mixing, distribution of powder batches, pressing, trimming of the obtained slabs, decoration with up to three different processes, cutting, firing at high temperature, composite production, intermediate storage of the large tiles, laser (or traditional) cutting into the ordered sizes, optical control of final quality, packing and labelling.

LAMINAM’s completely automated factory covers 12,000 m²

THE PROBLEM

The fragile nature of tiles is a fact well known for eumates. Even a porcelain granites tile features relatively poor impact resistance, and shatters in very sharp, dangerous fragments when hit by a violent impact. One can decide to make a thicker tile to improve impact resistance, but the weight, the raw materials, the energy required to cook it, the efforts made to transport and install it, the waste in case of defects and – final and fundamental – the cost increase with a linear growth, System is looking for a different solution.

INITIAL DEVELOPMENTS

When System decided to concentrate on the manufacture of the largest, strongest and thinnest ceramic slabs ever, they realized that the solution to these problems would have been a radical innovation for the entire world of ceramic. A continuous production process utilizing a non-conventional reinforcement. Several options were examined and – at the end of a wide selection of materials and processes – a true composite part was conceived, combining the aesthetic and wear resistant properties of a surface layer of porcelain grains with the mechanical strength and assembling capability of a flat layer of glass fiber. This approach – due to the peculiar characteristics of the chosen reinforcement, which is commonly supplied in large rolls of glass tissue, called mat – required a number of dedicated solutions. System started evaluating Polyurethane as the adhesive for the glass mat reinforcing the paper layer.

THE CANNON SOLUTION

Cannon contacted Cannon Afros to evaluate the availability of a dedicated machine for this application. Cannon Afros was at the same time System’s supplier of dosing units for Silicone resin processing (used by System to produce their own cast Silicone printing rolls for the decoration of ceramics). System’s customer, having installed four of their automatic warehousing tower for their factory in Cantu Pavia, had asked to the response was prompt and positive. The specifications were well within those familiar to Afros for their range of machines, and the application was appealing.

A preliminary set of trials in Cannon R&D labs would have verified the feasibility of the request, to be further refined with the most appropriate technical adjustments. Due to the characteristics of the formulation, a spray application was defined as the optimal method to evenly distribute the adhesive on the back of the large tiles.

All the factors considered, Cannon set up their lab’s suitable Cannon B2 low pressure dosing unit connected to a dedicated spray mixing head mounted on a standard robot and organised a first set of trials with System’s ceramic slabs and chemicals. The first trials provided some very promising results. The layer of adhesive was evenly distributed, although a solution had to be designed to avoid a minimum build-up of material at the two extremes of the spraying pattern.

The idea of applying a method widely used in the painting shops – a controlled air-assisted atomization of the liquid formulation, immediately after the mixing chamber was evaluated. This method required the interruption of the flow of material at the end of each stroke. A very fast control and actuation was demanded, to follow the demanding performance of the head’s manipulator. The existing model of low-pressure, low-output mixing head was fitted with an atomizer specially designed and promptly made for the viscosity and output of the chemical formulation selected by System for their needs.

LAMINA tiles are reinforced with glued a glass mat: the application of the PU adhesive is made in this special spraying booth.

An extensive testing program submitted the new head to more than 60,000 spraying cycles both with and without chemicals, to prove the industrial usability of the new tool. The design proved to be adapted to the task. Since the response of the PU controlling the spraying process was not fast enough to guarantee repetitive results under extreme man conditions, a dedicate electronic circuit was designed and made in house, able to provide as quickly as requested the commands to the injectors mounted on the mixing head. This final solution optimized the spraying process, guaranteeing an even application of few grams of a hi-component rigid, compact Polyurethane adhesive on each square meter of ceramic slab.

COMPOSITE PRODUCTION

The spray head ensures a perfect mix and deposition of the liquid blend, while the closed loop control system of the Cannon B2 dosing machine keeps all the variables (temperature, viscosity, mixing ratio, recirculation), within the desired working range.

This Cannon B2 machine was specifically designed for the spray application of the PU adhesive.
MOMENTIVE invests in high productivity composites

MOMENTIVE Specialty Chemicals invests in an advanced application development center for lightweight composites in Germany. High-productivity resin injection can be applied to satisfy the fast-cycle requirements of the automotive composites industry, using Cannon's ESTRIM RTM equipment.

Based in Columbus, Ohio, MOMENTIVE Specialty Chemicals Inc. is the global leader in thermoset resins. MOMENTIVE was formed in 2010 through the combination of entities that own Momentive Performance Materials and Hexion Specialty Chemicals. The company has a long heritage of technology innovation, applications expertise and personalized service. They serve the global wood and industrial markets through a broad range of thermoset technologies, specialty products and technical support for customers in a diverse range of applications and industries.

MOMENTIVE's extensive product line of EPIKOTE® Epoxy resin and EPIKURE® Curing agent systems is well established in many composite, coating, electronics and adhesive applications. Their European Composite R&D Centre, located in Dusseldorf, Germany, develops new formulations for a range of innovative end uses.

The availability of fast-reacting formulations allows now for the replacement of slow RTM processes with fast-moulding methods, and MOMENTIVE is now actively strengthening new application know-how for the Automotive, Aerospace and Mass transportation industries with a focus on light-weight composite materials for mass production.

The Cannon solution for Momentive
Cannon designed and built a complete system for the German lab of Momentive, composed by one special E-System dosing unit (specifically conceived for the small lots of chemicals handled in a laboratory), a clamping/polymerisation press and several test moulds.

The high-pressure metering unit is designed to dispense Epoxy resin and hardener at injection pressures up to 180-200 bar. Compass and provided with the latest electronic controls, the E-System is able to work with a variety of Cannon mixing heads, suitable for direct injection in closed mould, free-pouring or even spray laydown over Carbon preforms to open moulds.

The supplied press features a four-columns structure, the most suitable design for easy approach and service to the mould area. The press allows for the use of very hot moulds, a characteristic of the fast ESTRIM RTM technology. But it is also adapted to other processing technologies, such as classic RTM, or Compression Molding techniques.

Several moulds which are in the building phase now have been designed for this press. They were specifically engineered to allow the production of test components using a large range of process and customer conditions.

More Cannon equipment for Baypreg
Cannon reports a number of successful sales in the past few months for processing Baypreg® Baypreg MaterialsScience Polyurethane system applied over a sandwich of glass mat and honeycomb.

This process allows for the production of very light yet structurally sound composites valued by the automotive industry for their fuel saving efficiency. Parts can be stiffened only where necessary thus optimizing the use of raw materials and saving weight. For this reason, automotive application Cannon patented a special "Spray-and-stay" method which uses liquid natural Carbon Dioxide (CO2) as a foaming agent which serves to prevent dripping of the formulation when it is applied to vertical walls.

A North American manufacturer, supplying large interior parts to Ford and other auto makers, is using a Cannon high-pressure dosing unit equipped with a Canpoxide kit to dispense liquid CO2, directly into the mixing chamber of a robot-mounted FPL head.

The resultant parts are used in luggage compartments as spare tire and storage bin covers. The reason the Cannon solution was selected by this manufacturer was the technical advantages of metering the expanding agent directly in the mix head rather than a component task as is usually done. The main advantages of method are the ability to control the exact amount of CO2 being used and the ability to apply it only when and where it is needed.

In 2011, another major manufacturer of auto parts in the Far East Asia purchased a complete production system to make a similar product for a large vehicle supplied to the Chinese market.

Just this year, a Japanese supplier of PUR chemicals and formulations equipped their R&D laboratory with a complete Cannon system for processing Baypreg® formulations in order to develop applications for their local automotive manufacturers and Tier 1 suppliers of energy saving auto parts.

LAMINA is available in a wide range of surfaces, colours and textures.
Innovative processing systems for Composite parts in LWRT

LWRT (LightWeight Reinforced Thermoplastics) are a category of advanced GMT composites which combine traditional glass mats with one or more layers of textile reinforcements to create sheet-form composites. Several types of continuous filaments (carbon, aramid, thermoplastic polyester) are used for the textile reinforcement, while a Polypropylene (PP) fiber is used as plastic matrix. During the preparation process a “fleece” is obtained, that is hard to mesh the PP filaments which incorporate the textile filaments in a rather spongy composite that can weigh from 300 up to 2,000 g/m². When heated further, during the parts manufacturing phase, these sheets expand up to three times their original thickness: immediately compression moulded under limited pressures, they can generate large parts characterised by very high stiffness, strength, arc high stability, strength, and impact resistance. A wide range of densities can be obtained within the same moulded part, allowing for a combination of functional structures, noise absorption, thermal insulation. Being stamped at low pressure, these sheets can be coupled in mould with different acoustic foams, allowing for a one-step decoration process. Cannon provides a turn-key solution for the process of LWRT, composed of automated sheet handling, dedicated vertical or horizontal preheating ovens, compression press (with possible automated insertion of decorative foils), moulds, punching and trimming equipment, manipulation systems for the finished products.

Traditional GMT composites are traditionally used where high stiffness is required: for those applications where high stiffness and the possibility to create an aesthetic surface in a one-step process would be beneficial, LWRT provides:
- Higher stiffness/weight ratio
- Part moulding stamping at very low pressures (allowing for one-step decoration with films or fabrics)
- Possibility to mould very large parts in a single piece or several different parts in a common tool
- Increased sound absorption and thermal insulation,
- Capability to vary thickness over the part to provide different stiffness and strength according to local needs.

By changing the combination of components in the fleece, simply varying the ratio of the various fibers and the way the fleece is subsequently needle, it allows for the fine tuning of numerous mechanical properties to adapt them for a specific application. By increasing the content of glass vs. the PP fibers the stiffness the resulting part will result. Higher glass loadings are the most suitable for interior trim headliners and panels, where lightweight stiffness is a must feature. On the contrary, formulations with less glass are used for applications such as underbody shields which require higher impact and durability.

Another unique feature of LWRT vs. conventional GMT or stamped metal is the capacity to vary thickness across the finished part while maintaining the same area weight. The tool design is such that it allows for a different cut of compression over the sheet where a higher thickness is desired, allowing the part to be made thicker on the largest proportion of the moulded product, maintaining an improved local stiffness in thinner, more dense parts where, for instance, the fixation points are foreseen.

Several automotive pre-assembled parts are already using LWRT materials for applications like load floors, parcel shelves, sun shades, and trim panels, pillars and doors.

Thermo-compression for underbody panels

A major Italian manufacturer of automotive plastic parts has installed in its factory near Milano a complete plant from Cannon for the manufacture of protective shields in LWRT to be mounted under the engines of several AUDI models.

Thermoformed Composites: the Cannon experience

Several new machines have been recently designed and installed by Cannon for thermoformed composites. Developed upon the specific requirements of various customers that demanded a dedicated solution for their special processing needs, these machines are able to work with Cannon reinforced products, for the preparation of preforms destined to the impregnation with Epoxy resins, or with new thermoplastic composites for the production of external automotive body parts.

Carbon-reinforced preforms for a dream car

Lamborghini, the manufacturer of dream cars of the Audi-Volkswagen Group, recently commissioned to Cannon a special thermoforming machine for their Composite Materials R&D laboratory of Sant’Agata Bolognese, in Italy. Featuring a working surface of up to 1,500 x 1,200 mm, this new thermoformer is designed to work in environments where the presence of carbon fibers does not endanger the operators. A specifically protected electric circuit and the use of low-inertia, fast-acting infrared heating elements guarantees safe forming operations, optimum distribution of temperature across the whole piece, no overheated areas and a limited energy consumption.

The clamping frame holds the Carbon drape in position by exerting a pre-set adjustment of the clamping force, so that the movements of the drape will be controlled during the deep-draw forming operation, avoiding undesired wrinkles and an irregular positioning. As well known, the Carbon fibre drape allows a very limited forming, being this specification the ground and the limit of its success: first class mechanical properties, but not a thermoplastic behaviour. Therefore the machine allows limited pre-forming of the Carbon fibre drape for those parts that have a limited depth of draw.

Thermo-compression for decorative automotive interiors

Three large thermoforming units designed for the thermo-compression process have been recently supplied to an Italian manufacturer of interior components for special vehicles.

The sequence of operation starts with the unrolling of a layer of decorative material (either a textile or a thin plastic foil) which is cut and hung over the upper part of a mould.

A large sheet of LWRT (Low Weight Reinforced Thermoplastic) is automatically loaded from a pallet, brought under the heating bands of the thermoformer and heated up as usual with the thermoforming machines. When heat is applied over its surface the sheet expands up to 4-5 times its original thickness when ready, the heating bands are retracted and the sheet is laid on the lower part of the mould. The two platens of the press are moved one against the other: the mild compression that follows (at 1.5 bar) shapes the plastic layer and sintetises the decorative foil on the aesthetic side of the part. The process requires very simple tooling, that can even be made in wood.

The size of the pre-assembled parts reached, so far, 2,700 x 1,500 mm. This process allows for the production of lightweight, large, stiff decorative elements that can be used as headliners for vans and industrial vehicles, interiors for caravans and campers, dashboards, tunnels and other interior parts for commercial vehicles, earth moving machines, ambulances etc.

Special solutions are always available

Cannon provides dedicated thermoforming plants, where a combination of thermosetting and thermoplastic resins can be used to manufacture large, structural elements. Sheets of thermoformed ABS/POMA can be backed with a sprayed layer of reinforced Polyurethane with either the InterWet or the CureWet process. Both methods apply a blend of rigid foam and chopped glass fibres, with the former producing a strong, non-expanded material and the latter generates various thin layers of expanded, noise-absorbing, thermally-insulating Polyurethane with varying percentages of shorter glass fibres only where needed. These versatile processes can produce large elements for the transportation and naval industry, bathhouses, furnishing and leisure articles.

This thermoforming machine CREA 2714 - used for pressure forming and designed for maximum flexibility and reduced setup times - features these interesting characteristics:

- Max formable part: 2,750 x 1,400 x 650 mm
- Adjustable reduction plates
- Servo electric movements
- Halogen heating
- 50 tons pressure forming
- Automatic loading/unloading

The plant, delivered in 2011, includes a special vertical oven for the pre-heating phase, the press where the sheets are formed (above) and automatically trimmed to exact size, the moulds, the whole handling and manipulation system for raw sheets and finished products (below), that are submitted to a punching operation in a nearby station immediately after demoulding.

The complete cycle time stays under 50 seconds, guaranteeing high productivity and complete automation of the process.

Another German supplier of plastic components for cars has just ordered a dedicated pre-heating oven for GMT parts for the manufacture of under-motor and under-chassis protections, and is investigating into the LWRT with great interest.
Alenia Aermacchi M346: made with a Cannon plant!

The recent commissioning of a complex assembly line manufactured by Cannon for Alenia Aermacchi in Italy gives us the opportunity to interview two top-ranking managers of a major aerospace and defense group. We meet Vito Antognazza and Francesco Attucci – former director of Industrial Engineering – who has been recently given the responsibility of the Cannon plant, near Novara, Italy.

Alenia Aermacchi is the recent fruit of a merger of the businesses, products, sites and traditions of Alenia Aeronautica and Aermacchi. The name traces its lineage to 1913, when the original Nieuport-Aermacchi was founded. The company leads the Aeronautics business of the state-controlled Finmeccanica, one of the world’s top 10 aerospace, defense and security players with a turnover of over 18.5 billion Euros and a global presence securing 75,800 skilled jobs in Europe, the United States and the world. Alenia Aermacchi is a 2.8 billion Euro global group known for its successful products, its balanced portfolio and ability to deliver on leading-edge programs.

They manufacture products and systems of superior quality and performance, including proprietary designs like the C-27J airlifter and M-346 advanced trainer, playing key roles in world-class programs like Eurofighter Typhoon, the F-35 Joint Strike Fighter and the Neutron European UC-AV demonstrator. Alenia Aermacchi also has a major role in commercial aircraft, designing and building advanced avionics for state of the art airliners, developing the new generation Superjet regions and building the market-leading ATR turboprops. With its wide network of prestigious subsidiaries and important joint ventures, the Alenia Aermacchi group supplies and supports advanced systems in worldwide use. This also allows them to cover the entire product life cycle from design to in-service support to modernization, achieving important synergies among the Finmeccanica aeronautics companies.

Cannon News: Mr Antognazza, Alenia Aermacchi recently signed the acceptance of a major assembly line built and assembled by Cannon in your Venegono plant. Can you tell us why this project is so important in the field of aeronautics?

Vito Antognazza: We produce in Venegono the twin-turbofan M-346. This is the most advanced jet trainer aircraft flying today. With its fully digital flight controls and avionics, which include the latest generation “fly-by-wire” system, together with a further handcontroller and high angle of attack maneuvering; the M-346 is fully representative of new generation fighters. It has been ordered, so far, by the Air Forces of Italy and Singapore. Our production schedule was pretty busy for this aircraft, and we needed to speed up its assembly. You can’t build these complex machines in a working island, so we do for a prototype!

CN: Can you explain to our readers, which are not experts in aeronautics, the difficulty of building this project?

FA: A large number of components must be brought together, with geometric precision in the order of few tens of a millimetre, in an upscaled version of the well known assembly line commonly used in the automotive industry. In this 100 meter long line we build the three sections of the aircraft – front, central and rear – and then we fit them together in a dedicated area.

The airplane is mostly built with structural parts, made with special Aluminium alloys and Titanium parts, combined with paneling and aerodynamic elements mostly made with Carbon-reinforced composites. Hundreds of machining, drilling, fitting and riveting tasks are performed during this phase.

To do this with high efficiency we conceived a line were the three sections – that are built on dedicated tools – travel through dedicated working stations that were a specific number of operations are performed by our specialists. The displacement is performed by an AGV (Automatically Guided Vehicle), commanded by the central computer, picks up the tools and brings them to the next station or, at the end of a sequence of operations, to the marry-up area. The main difficulties lie in guaranteeing an absolute positioning precision of the tools along the various working stations, and in the related timing. The logics driving the flow of single components and the use of the AGV must be optimised to avoid any downtime.

Cannon News: Mr. Attucci, you oversaw this line. Can you tell us how you ended up to assigning its construction to Cannon, and why?

Francesco Attucci: We had very clear ideas about the construction of the main components of our line, and required the intervention of a specialist for the movements and the process control. Examining various potential suppliers – in a field that certainly does not present a wide range of specialised companies – we noticed at Cannon an interesting concept for the handling of wide, heavy parts throughout a large assembly hall, making use of AGV. These parts – wide, curved panels for the thermal insulation of industrial roofs – were submitted to a number of different operations in different working areas. Exactly what we required, although in a much different level of precision. We demanded a repetitivity of positioning of few tens of millimetre, therefore the machining precision of our plant would have been one order of magnitude more sophisticated than that of that panel plant. The technical discussion took some months, but we eventually found a satisfactory response from Cannon and we signed the supply contract.

CN: The proprietary design of this line demanded a certain degree of in-depth development during engineering and designing. How did you share this important phase?

FA: We joined forces with Cannon Tecnos and made a team that worked side by side for several months. We knew what we wanted and we designed it, Cannon brought in the know-how related with all the movements and all the logic controls. The specialists cross-checked the other side’s work, agreed modifications when this was the ease and then gave green light to manufacture the huge plant’s components. Columns to lift the tools and their payload, wide centreing devices able to hold in place several tons of steel during the most delicate machining tasks, sliding platforms to safely hold the operators around specific working areas, the whole plant servicing every corner of the multi-level installation. The erection took several months, mostly spent in ensuring an absolute positioning precision between the various stations. Several things had to be corrected, but we somehow expected that the project was something new for both the involved parties, all things can’t go 100% right at the first time, when you are making a “first of” complex plant. The atmosphere was cooperative and frank, we re-discussed a few details and the work continued. Another moment of intense co-operation was experienced during the start-up phase. All our ideas had now to be proven, and we required a long time to optimize the interfacing between the airplane’s parts, the tools that are holding them, the AGVs and the manipulation system.

CN: How can you rate the final result?

FA: As you can see, the final result is quite impressive: the Cannon line covers 100x20 meters, reaching 10 metres of height. The parts flow from one working station to the next – we have two for the rear, five for the fuselage and two for the front – with the precision and the timing that we specified. This plant does exactly what we expected, and the electronic control designed and programmed by Cannon Automata helps us greatly in setting all the operative parameters and in saving all the production data, for an accurate and reliable certification of the produced quality.

Our standards require a full control of every step, to be able to certify which component of our M-346. Antonius rules are notorious for their severity!

CN: Do you expect now, having completed this positive experience, to duplicate it for other plants of Alenia Aermacchi?

FA: With the experience acquired we would now simplify some details of this manufacturing concept, but we could definitely apply it to the assembly of other large aircraft parts.

Developing a project for the assembly of a new airplane, whose forecasted numbers and complexity of project are similar to those of the M-346, it would definitely make sense to apply this method to their production.

This complex line, wholly built by Cannon for Alenia Aermacchi’s Venegono factory in Italy, allows for the construction of the twin-turbfan M346, today’s most advanced lead-in fighter trainer aircraft. An Automatically Guided Vehicle transports the three parts of the airplane through the service stations where all the composites and aluminium-alloy components are fitted on the structure. All this happens with a precision of few tenths of millimetre!
The answer, my friend, KEEPS blowing in the wind!

In spite of the economic turmoil, that rotates around the world like trade winds, the eolic generators industry keeps growing steadily on a worldwide basis. His heavily in China last year by a market crisis – mostly due to the entry of low-quality, low-cost products that have spoiled the image of the whole Chinese wind blades industry – the market of eolic generators keeps growing elsewhere. “The expectations for wind power growth in 2010 were mixed, as the low level of orders seen during the financial crisis worked their way through the system. The results of this were felt much more strongly in 2010 than in the previous year, and the overall annual market shrink by 0.3% to 1.34 GW, from 14.8 GW in 2009. The new capacity added in 2010 represents investments worth EUR 4.8 billion (USD 7.1 billion). The US market installed almost 10% less than in 2005. In the European market, the new installed capacity in 2010 was 7.6% down on 2009, despite a 15% growth of the offshore market in countries like the UK, Denmark and Belgium, and rapid growth in Eastern Europe, but by Brazil and Mexico. In cumulative terms, the Latin America and Caribbean market grew by more than 53% during 2010. For the first time in 2010, more than half of all new wind power was added outside of the traditional markets of Europe and North America. This was mainly driven by the continuing boom in China, which accounted for half the new wind global installations, with 18.9 GW. China had in 2010 44.7 GW of wind power, and surpassed the US to claim the number one spot in terms of total installed capacity. But a growing number of small producers, unable to guarantee a good level of quality because of lack of technology and of skilled labour, generated several serious problems that somehow spoiled the image of the whole wind generators industry, cutting their production programs and sending the weakest ones to bankruptcy. Only the largest players remained in operation, and the young Chinese industry learned, once more, an old lesson: quality costs, but it pays back. Now planning, development and construction for the “Wind Base” programme, which aims to build 138 GW of wind capacity in eight Chinese provinces is well underway. In its revised Five-Year Plan, which was passed by the Chinese Parliament in March 2011, the government set a new target of building a total 90 GW of wind energy by 2015.

Catch the wind, with Cannon! This rising global activity further stimulated Cannon to dedicate human and financial resources to the development of solutions for the acolic generators industry. The series of dedicated dosing units for the infusion of Epoxy resin in the giant blades has been extended. New models are available to respond to new needs, as demanded by the growing number of international customers. In addition to the first major customer in this field – Siemens Wind Power, that has increased in 2011 their park of Cannon Epoxy DX low-pressure machines – several new manufacturers from Germany, Denmark, Brazil, United States have chosen the new Cannon machines for the infusion in their large acolic blades. Being very sensitive about their suppliers and new developments, they do not like us to disclose their names, then we won’t tell you whom they are… but they are all big!

The two graphics below show the total installed acolic capacity (left) and the new capacity installed in 2010, by country. Source: GWEC

New solutions, for higher industrialisation
On top of having extended the range of outputs up to 80 kg per minute, the new Epoxy DX machines feature now a three-component model, with an additional stream dedicated to a second hardener by regulating the blend of the two hardeners a complete range of reactivities can be obtained, to face any sort and size of blade. A pneumactic three-way valve controls now the neiculateation of the components immediately before the start of the infusion. Higher precision and better control of the ratio between the two components can be obtained with this fast valve, mounted very close to the head. For easier portability across their vast production halls not all the manufacturers like the idea of connecting their dosing units to the compressed air network, therefore Cannon have added a compressor on board, so the little amount of air required to operate the valve is produced locally. To provide a faster control of the infusion rate, a remote control has been developed, that allows the operator to reduce the output when necessary without having to run through the factory. A load cell has been added to the dosing system, to be fitted under the open container that receives the blended formulation from the metering machine and acts as a buffer for the infusion. The output of the dispenser is automatically adjusted in accordance with the weight of liquid present in the buffer when the interconnection stream flows down, due to the internal resistance of the glass reinforcement to the diffusion of the liquid, the dispensing machine reduces its feed rate, to avoid an overflow of the buffering container.

The Cannon Epoxy DX 35 has been upgraded with numerous new technical solutions to increase its reliability and ease of use.

More advantages, for higher rentabilty
Cannon has been selected as a supplier of Epoxy infusion machines by numerous qualified manufacturers because of several technical advantages, but the major benefit derives from its international presence and multi-national technical experience.

An international network of Technical Service centres is a fundamental plus, that guarantees the continuous presence of a qualified team of specialists and of spare parts in moments of need and difficulty.

The availability of several different technologies for metering and mixing the widest range of formulations – including adhesives and sealants, widely used in this industry – allows the Cannon customer to find quickly the right solution for his special needs without wasting time in trials and errors.

The Cannon Group attitude of providing turnkey plants for the most complex industrial applications goes by far beyond the supply of a simple dosing machine: an integrated production plant can be discussed and quoted, relying on the cooperation of different specialised companies.

To resume here the different technological solutions that Cannon provides to the acolic generators industry, let us mention:

- Metering and mixing machines for Polyurethane resins, that can be used for foam reinforcements instead of expensive balsa wood or blocks of XPS (Expanded Polystyrene).
- Metering and mixing equipment for DCPD resins (Di-Carboxylic Diene) used to manufacture compact plastic blades and other ancillary components.
- Thermforming machines for the largest available plastic cups, used for the exterior and the interior paneling elements of the nacelles.

The Epoxy DX 40 infusion machine is suitable for the manufacture of the largest acolic blades produced today.

- Complete manipulation and handling systems, already proven for the precise assembly of sophisticated aircrafts.