THE MANAGEMENT OF MODERN TECHNOLOGIES USED IN THE AERONAUTICAL INDUSTRY

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Abstract: *The management of the current applications of fiber-reinforced composites in commercial and military aircraft is very important now and in the future. The composite materials used in the aircraft industry are generally reinforcing fibers or filaments embedded in a resin matrix. The most common fibers are carbon, aramid, and fiberglass, used alone or in hybrid combinations. Carbon fiber is replacing fiberglass as the most widely used reinforcement. Composites are strong, durable, and damage tolerant. They meet design and certification requirements and offer significant weight advantages. This paper seeks to highlight that the innovative manufacturing techniques can also provide significant cost reductions.*
Keywords*: management, technology, composites, carbon fiber, fiberglass.*
JEL Classification*: L11; L23; L93 O32; O33.*

1. Introduction

The human society' developmental process results from a systemic interaction between three basic elements: *development, research, innovation* (Cismaru, Brenci, 2014). The economic field requires the creation of products with specific. To reach this objective it is required that the research to bring solutions concerning the conception, structure and constructive elements of the new products, while the innovation to bring techniques and technologies for creating the new products (Cismaru, I., Petrescu, I., Dragomir, C., Cismaru, L., 2017).

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The role of the management technology is to understand the value of certain technology for the organization. Continuous development of technology is valuable as long as there is a value for the customer and therefore the management of technology an organization should be able to argue when to invest on technology development (Pânzaru, S., 2015).

2. Aircraft Production Management

The management of modern technology uses advanced qualities of superior quality (Pânzaru, S., 2002). The composite components are used extensively on current commercial production aircraft such as the Boeing 757 and 767 and the Airbus A310, which employ about 1350kg. For the 737-300, composites are used for control surfaces, fairings, and nacelle components. Individual composite parts are 20 to 30% lighter than their conventional counterparts.

Recently designed small general aviation airplanes make extensive use of advanced composites. The Lear Fan 2100 uses carbon, glass, and aramid fiber materials totaling approximately 820 kg per aircraft.

With the exception of small, detail parts, most composite components, for commercial airplanes are of honeycomb sandwich construction. These may be either full-depth designs, such as the 767 outboard aileron shown in Fig. 1, or structures built of separate panels, such as the 767 rudder in Fig. 2.

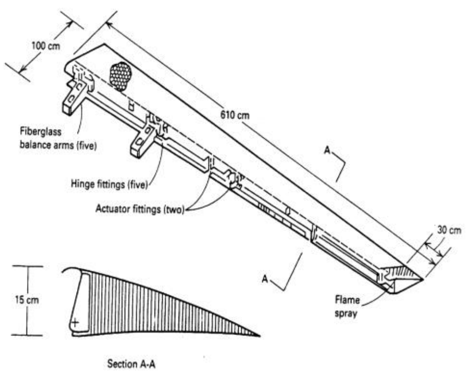

Fig.1. Aileron

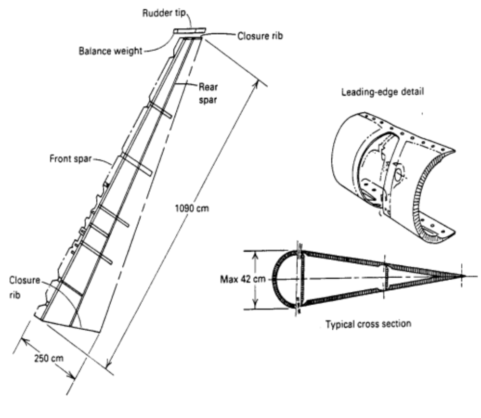

Fig. 2. Carbon fiber reinforced epoxy rudder

Figure 3 shows a Boeing 757 as a typical example of composites used for an engine nacelle. Because the structure is in close proximity to the power plant, 175 °C curing materials are generally employed.

Structures such as fairings, fixed wing, and empennage trailing edge panels are generally fabricated as a sandwich. Face sheets for these panels are made of carbon fiber or carbon fiber combined with aramid or fiberglass fabric (Fig.4). Such panels most often employ 120 °C curing systems, and are made either of tape or fabric materials, or with a layer of adhesive for bonding to the honeycomb core. Phenolic-coated fiberglass or honeycomb core is used. The panels are fabricated in a single-stage curing process that provides significant cost advantages in addition to weight savings.

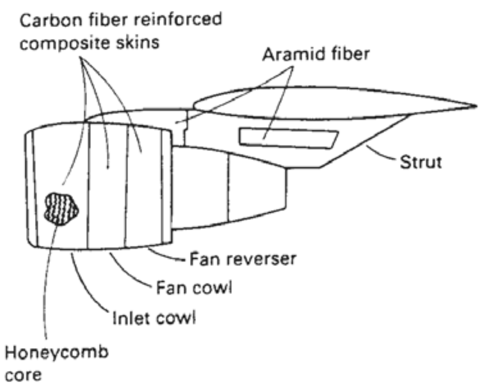

Fig. 3. Engine strut application

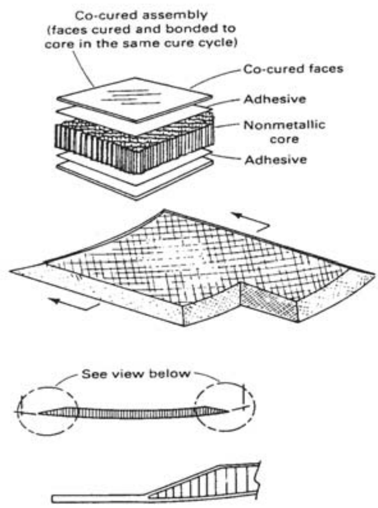

Fig. 4. Typical fairing panel construction

Composites are also widely used in the interiors of commercial aircraft. In addition to meeting mechanical property and processibility requirements, all materials used within the pressurized portion of the aircraft must meet both the flammability resistance requirements defined by regulatory agencies and, if applicable, smoke and toxic-gas emission guidelines of the airframe manufacturers. Additionally, visible portions of interior components must meet stringent aesthetic requirements to satisfy the airlines and their customers. Interior parts such as overhead luggage compartments, sidewalls, ceilings, floors, galleys, lavatories, partitions, cargo liners, and bulkheads are routinely made of composite components. In general, these are fiber-reinforced epoxy or phenolic resin honeycomb sandwich constructions. The phenolic resin system is used because of its excellent fire-resistant properties, including low flammability and low smoke and toxic gas emissions. The predominant design considerations for interior components are impact resistance, stiffness, and surface smoothness (Pânzaru, S., 2002).

Management of technologies assumes and the choice of fiber depends not only on structural requirements but on part contour and fabrication method. For relatively flat parts, unidirectional or woven fabrics can be used. For compound contours, stretchable, knitted fabrics are often necessary. The predominant fiber used in interior composites is fiberglass; however, carbon fiber use is increasing as structural applications increase. For example, a filament-wound door spring is employed on the 767. Using unidirectional carbon fibers in an epoxy matrix, the springs are only one-third as heavy as comparable steel springs and only half the weight of state-of-the-art titanium springs.

3. The management technology in the field of military aviation

The major U.S. aerospace industry users of carbon fiber prepreg materials include McDonnell Douglas, Boeing, General Dynamics, and Northrop. The largest application by far of composite material is for military programs, which constitute more than 40% of the aerospace total. For example, in 1985, 181 500 kg of composites were used by McDonnell Douglas in St. Louis for the F-15, F-18, and AV-8B fighter aircraft (Pânzaru, S., Dinescu, I., 2002).

About 26% of the structural weight of the U.S. Navy's AV-8B is carbon fiber reinforced composites. Components include the wing box, forward fuselage, horizontal stabilizer, elevators, rudder and other control surfaces, and over-wing fairings. The wing skins are one-piece tip-to-tip laminate, mechanically fastened to a multispar composite substructure: the design of the horizontal stabilizer is similar to that of the wing. Approximately 590 kg of carbon fiber epoxy is used on the AV-8B, providing a weight reduction of almost 225 kg.

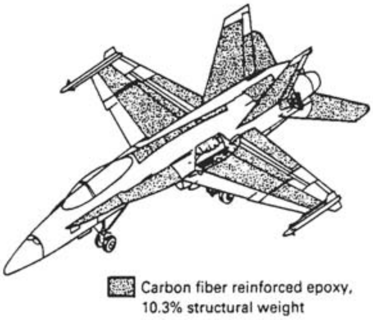

Fig. 5. F-18

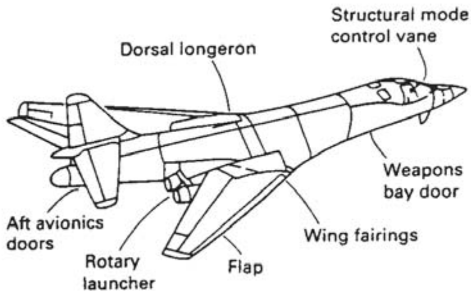

Fig. 6. B -1B composite applications

On the F-18 aircraft, carbon fiber reinforced composites make up approximately 10% of the structural weight and more than 50% of the surface area, as illustrated in Fig. 5. They are used in the wing, the horizontal and vertical tail boxes, the wing and tail control surfaces, the speed brake, the leading edge extension, and various doors. The F-18 composite wing skins are solid laminate; their thickness varies from root to tip, with a minimum thickness of about 2 mm. The tail primary structure is similar in construction.

The B-1B bomber employs a number of composite structural components. Shown in Fig. 6, these include the dorsal longeron, weapons bay doors, aft equipment bay doors, and flaps. All of the materials, including adhesives, are 175°C curing systems. The structures include laminate, full-depth honeycomb reinforced panels, and composite face sheets bonded to aluminum core. The bay doors shown in Fig.7 employ carbon fiber reinforced tape face sheets, aluminum honeycomb core, and titanium fittings. Because the doors are in a position that is particularly vulnerable to foreign object damage, an aramid fiber reinforced phenolic outer layer provides penetration resistance. At a production rate of four aircraft per month, the B-1B uses 127000 kg per year of composite structure-3040 kg per aircraft - resulting in weight savings of approximately 1360 kg on each bomber.

Grumman Aerospace Cor-poration fabricates F-14A horizontal stabilizers from a boron fiber reinforced composite material. The stabilizers are moving surfaces that pivot about shafts that protrude from the fuselage;

each has an area of 6.5 m^2 with thickness chord ratio of 5% at the root and 3% at the tip.

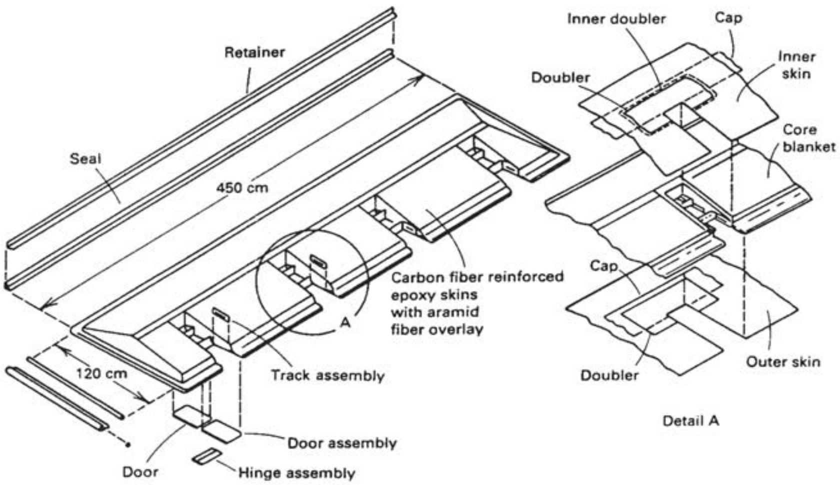

Fig.7. B-1B - weapons bay door

The stabilizer consists of the main structural box, leading and trailing edge sections, and tip. The last three components have conventional aluminum skins over a full-depth aluminum honeycomb core. The main box is a boron-fiber reinforced composite structure consisting of the root rib, two intercostals, outer bearing, outboard rib, front and rear beams, tip rib, honeycomb core, and two covers.

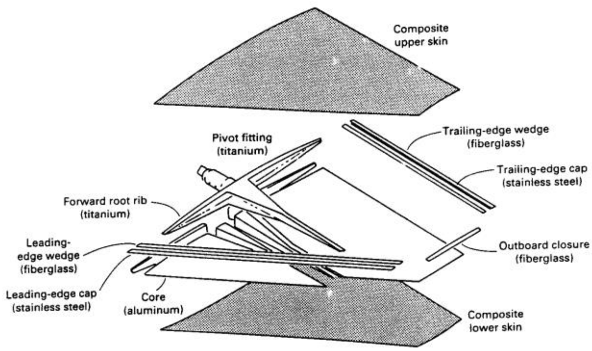

Fig. 8. F-16 composite horizontal stabilizer

General Dynamics of Fort Worth employs a carbon fiber reinforced epoxy horizontal stabilizer, vertical stabilizer, leading edge, and rudder in the empennage of the F-16 fighter, which it manufactures. The horizontal stabilizer in Fig. 8 has composite skins with aluminum honeycomb core.

Two other programs that employ considerable amounts of composite material were in progress as of 1986: the A-6 wing replacement program and the Navy's V-22. In the A-6 program, high-flight-time metal wings were being replaced by lighter composite wings with improved fatigue characteristics and much greater resistance to corrosion.

The A-6 wing was being designed and built by Boeing Military Airplane Company. The V-22 aircraft is an innovative design that combines the advantages of the vertical takeoff and landing of a helicopter with the smooth, high-speed cruise and extended range of a fixed-wing airplane. The V-22 engines and propellers are vertically oriented for takeoff and landing, then pivot forward for cruise, with conventional wing surfaces providing aerodynamic lift. The V-22 will be built jointly by Boeing Vertol and Bell Helicopter Textron.

The A-6 replacement program requires a wing structural box made of carbon fiber reinforced epoxy. Figure 9 shows the design configuration of laminate skin fastened to composite intermediate ribs and spars, with titanium front and rear spars, and inboard and outboard tank end ribs. The skin panels are manufactured in a single piece using a 175°C curing tape material.

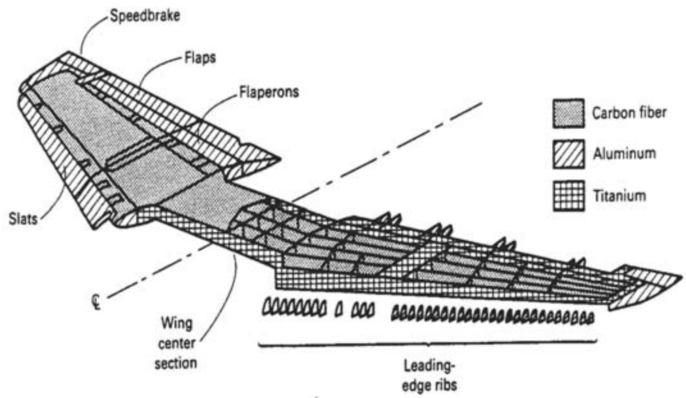

Fig. 9. A-6 composite wing

Trends clearly indicate that the use of composite structures will continue to grow in both commercial and military aircraft. New materials, with both improved properties and increased suitability to automated processing, will permit weight savings and cost competitiveness with traditional metal structures (Pânzaru, S, 2002).

A large number of solid-propellant missiles use composites for major structural elements, including the rocket motor case. This element of the structure greatly influences missile performance in terms of range and weight of payload. The solid-propellant-type motor burns its fuel inside the case, generating loderately high pressures, which are contained by the large case wall. High tensile strength, together with the low weight of composites, is the most important advantage. Conversely, the large tanks of a liquid propulsion system contain fuel at a very low pressure, because pumps pressurize the fuel to combustion pressures in the relatively small thrust chamber. The large tanks therefore benefit from higher modulus as opposed to higher strength. This fundamental difference between solid and liquid missiles explains the early exclusive use of composites for the solid-type fuel containment systems. The relatively recent development of much higher-modulus and moderate-cost fibers is beginning to show an advantage on new liquid-propulsion tanks.

The Altair motor case was used as the fourth stage on the Vangard missile and on many other missiles for the exploration of space, beginning in the late 1950s. It represents the initial step in the use of composites in both missile structures and space. Its construction was elementary compared to later composite motor cases, but nonetheless was considerably advanced over alternative metal case designs. The cylindrical body and the hemispherical domes were fabricated in a continuous filament winding operation using a ± 45° filament wrap angle. Metal skirt connections were bonded to the exterior.

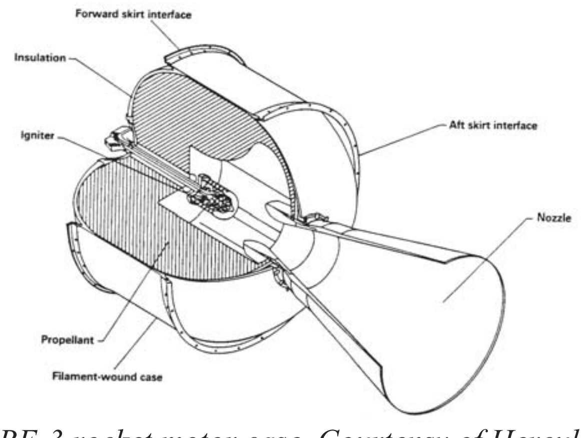

Fig.10. BE-3 rocket motor case. Courtensy of Hercules, Inc

Conclusions

However, factors that may inhibit a wider use of composites include cost, schedule, capital investment, and inspectability. Furthermore, inherent variations in raw materials and poorly defined cost data, as well as a lack of uniform, industry-wide specifications, test techniques, standards, and design allowables all contribute to create a degree of conservatism at this time.

Because of these factors, the approach management "check-and-balance" will result in the selection of composites for applications for which they are technically and economically most appropriate.

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