PROSPECTS OF AN AEROSPACE INDUSTRY IN NIGERIA

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ABSTRACT

The Aerospace Industry is a key industry of high technology in both advanced and developing countries. Nigeria has good prospects for the establishment of the industry. This paper highlights these prospects by exploring the history of Aerospace Technology, material and manpower availability, and the benefits Nigeria would derive by establishing an Aerospace Industry.

1. INTRODUCTION

The Aerospace Industry is the industry that produces vehicles and/or machines that move off the ground (flight vehicles). Such vehicles include the full range of commercial airplanes, military airplanes, missiles, spacecraft, and orbiting and landing crafts [1]. Flight vehicles and hence the Aerospace Industry do not have a long history. However, the design and production of Aerospace vehicle is exacting and needs the expertise of many disciplines of science and Engineering.

1.1 BRIEF HISTORY OF AEROSPACE TECHNOLOGY

What seems to be taken for granted today about Aviation and space technology used to be a fantasy up to the beginning of this century. It was on December 17, 1903 that the Wright brothers made their legendary mankind's first sustained, controlled, and powered flight in a heavier-than-air machine at Kitty Hawk, North Caroline [2]. This first flight made about 305m distance in about 12 seconds. Two years later, when other aviation enthusiasts were still trying to get off the ground, the Wright brothers were making flights in excess of 30km in 30 min. in their home town Dayton Ohio. [2].

The Wright brother utilised their own wind tunnel and performed experiment with controlled kites and gliders. However, prior to the wright brothers powered flights which were the forerunners of today's sophisticated aircraft and spacecraft, numerous unpowered flights were being made. Beginning in 1891 Otto Lilienthal working near Berlin, Germany, was know to have made about 2000 gliding fights over a five-year period. Otto Lilienthal died on August 10, 1896, resulting from a gust in which he lost control and crashed from an attitude of 15m. During 1897, octave chanute designed and built several guilders which were flown by people near miller indiana, having been inspired by Lilienthal's work. Chanute attempted to overcome Lilienthal's control problems by attempting to achieve automatic stability. In this attempt, he added both vertical and horizontal stabilizing tail surfaces to his gliders. He also used the biplane configuration for added strength [2]. He however, relied on kinaesthetic control like his predecessor. This is what gave the Wright brothers the insight into the adequate control about all three axis which is a major prerequisite to successful flight. The Wright brothers applied an all-movable horizontal tail to provide pitch control (nose up or down). For yaw control (turning to left or right) they used an all-movable vertical tail, and the Wright brothers also devised adequate methods for roll control (lowering one side of the wing and raising the other) [2].

The Wright brothers had a three year lead before Charles and Gabriel Voisin demonstrated a similar capability in Paris, France. Charles Voisin made a controlled flight of approximately 100m in an airplane similar to the Wright flyer on March 30, 1907. A second airplane was built by the Voisin brothers for Henri Farman who made flights that exceeded 2000m later that year. At least five others succeeded in following the Wright brothers lead in flying, by the end of the year 1907, and thus the aviation industry continued to develop [2].

Aviation was known to have grown rapidly after the year 1908 with great improvements such as the use of flaps, retractable gears, cantilevered wing, all-metal construction, and the development of the turbojet engine. Before ten years after the Wright Brothers first flight, the useful load increased from 667N to more 13,300N and in the next ten years the useful load increased by a factor of ten. It is known today that the useful load is more than 1.78×10^6N [2]

In present day aviation technology, we talk about flying machines such as helicopters, prop planes, large transport jet planes, military airplanes such as fighters and bombers. In space technology, we talk about rockets and spacecrafts of various kinds. Thus Aerospace technology has become the greatest technology in the transportation of man and materials.

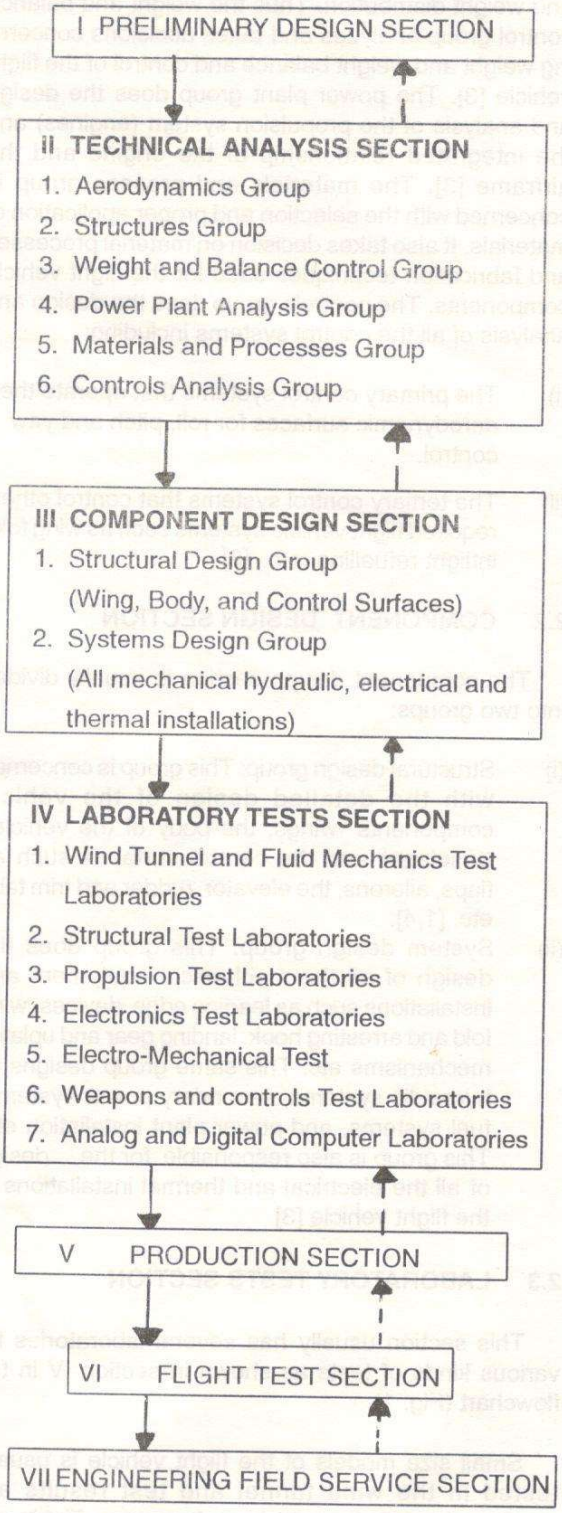
2. FLIGHT VEHICLE DESIGN AND PRODUCTION PROCEDURE

Present day commercial and military aircraft, missiles and space vehicles are highly scientific machines that necessitate the combined knowledge, experience and effort of hundreds of engineers and scientists working together for their production. The engineering division of an aerospace industry therefore consists of many groups of specialists whose specializations cover all the fields of engineering education such as Physics, and Chemical, Metallurgical, Electrical and the Aeronautical Engineering, etc. [1].

The engineering department of an aerospace company is usually broken into six sections each with its own sub-divisions (specialized groups). Fig. 1 is a flowchart showing the six sections and groups, and the flight vehicle design process. The preliminary design section concerns the identification of need and takes decision on specific design objectives.

2.1 TECHNICAL ANALYSIS SECTION

After the preliminary design, the technical analysis section takes over the design. In this section, the aerodynamics group takes care of the determination of the wing and fuselage shapes that best satisfy the design objectives.



The structures group then determines the structural configuration of the flight vehicle to suit the shapes determined by the aerodynamics group. Flight vehicle performance is very sensitive to weight

and weight distribution. Thus the weight and balance control group analyzes and takes decisions concerning weight and weight balance and control of the flight vehicle [3]. The power plant group does the design and analysis of the propulsion system (engines) and the integrated relationship of the engine and the airframe [3]. The materials and process group is concerned with the selection and proper application of materials. It also takes decision on material processes and fabrication techniques used for the flight vehicle components. The controls group does the design and analysis of all the control systems including:

(i) The primary control systems that operate the aerodynamic surfaces for roll, pitch and yaw control.

(ii) The tertiary control systems that control other required flight vehicle systems such as wing fold, inflight refuelling, etc. [3]

2.2 COMPONENT DESIGN SECTION

The component design section is usually divided into two groups:

(i) Structural design group: This group is concerned with the detailed design of the vehicle components -wings, the body of the vehicles (fuselage) and the control surfaces such as flaps, ailerons, the elevator, rudder and trim tabs etc. [1,4].

(ii) System design group: This group does the design of all the mechanical equipment and installations such as leading edge devices, wing fold and arresting hook, landing gear and uplatch mechanisms etc. This same group designs all hydraulic systems, secondary power systems, fuel systems, and power plant installation etc. This group is also responsible for the design of all the electrical and thermal installations in the flight vehicle [3]

2.3 LABORATORY TESTS SECTION

This section usually has several laboratories for various kinds of tests as shown in section IV in the flowchart (Fig. 1)

Small size models of the flight vehicle is usually tested in the wind tunnel and test results are correlated to full size vehicle performance. Fluids and hydraulic system and components are tested in the fluid laboratory. The structural test laboratories are used for the testing of structural components, while the propulsion system (engines) are tested in the propulsion tests laboratories. The electronic tests laboratories take charge of the testing of electronic equipments such as avionics, tracking devices, radar etc. Electromechanical equipments also have laboratories for their testing. If the aerospace company involves the production of military hardware, then the company would also have weapon and controls, test laboratories for that purpose. Finally, the analog and digital computers used for various operations would also be tested in their own laboratories.

Until components and systems satisfy their required performances as seen from the results of the laboratory tests section, they are not used in the production of prototype flight vehicles. This is indicated by the return loop in the flowchart of Fig. 1

2.4 PRODUCTION SECTION

When the design of the flight vehicle is satisfactorily completed, then the production section gets involved in the development of the production process and the final production of the components and the complete flight vehicle. This section also work closely with the other sections during the design by producing test models and also gives advices to the other design groups on producibility.

2.5 FLIGHT TEST SECTION

The flight test section performs test flights on prototypes of the flight vehicles. From such prototype flight tests, some design and manufacturing defects in the flight vehicles can be identified and corrected before the product (Flight vehicle) becomes marketable.

2.6 ENGINEERING FIELD SERVICE SECTION

As the name implies this section carries out field service duties for the companies clients. It also serves as manufacturers representatives in client companies to train maintenance personnel. Field service personnel could also identify undetected design faults and suggest necessary corrections as shown in the flowchart of Fig. 1

3. MATERIALS AND PROCESSES

3.1 MATERIALS AND AVAILABILITY

The selection of materials for the flight vehicle is usually made to satisfy service requirements the most important of which is high strength to weight ratio so

as to provide minimum weight parts [3]. Other requirements include high resilience in order to resist shock loading, and the materials must be tough enough to withstand impact or dynamic loading. Materials for flight vehicle must also be able to withstand the environmental effects such as elevated temperature caused by aerodynamic heating and by combustion in the engine, the materials must be corrosion resistant and must also withstand the low (cryogenic) temperatures encountered in space and caused by liquid hydrogen fuel and liquid oxygen [4].

Thus materials commonly used in the Aerospace Industry include various alloy steels using alloying elements such as Molybdenum, Chromium, Vanadium, Cobalt and Manganese. Other commonly used materials are the various alloys of Aluminium, Magnesium alloys, Titanium alloys and Nickel alloys [5]. In present day flight (both commercial and military), composite materials are replacing good percentage of the metals.

From among these materials, iron ore is readily available in this country (Nigerian) and the steel companies (Delta Steel Company and the Ajaokuta Steel Company) can satisfy all the steel needs of an Aerospace Industry if established in Nigeria. Molybdenum which is one of the key alloying elements of steel is also known to be available in the country. Aluminimum which forms the base of a good percentage of the flight vehicle materials is abundant in nearby Ghana and therefore can be easily imported for use in the Nigerian Aerospace Industry. Aluminimum will even become more easily available when the Aluminimum Smelter Company in Akwa Ibom State of Nigeria becomes operational. Glass and plastic industries are developing fast in the country and hence composite materials can eventually be produced for Aerospace Industry. When the new Petrochemical Industry is commissioned all the plastics needed by the Aerospace Industry will be internally sourced within the country. Thus it is only some of the alloying elements that may be have to be imported from distant countries.

3.2 MATERIAL PROCESSING

The materials that make up a flight vehicle are usually processed into various shapes and sizes such as sheets, plates, forging, castings, bars, rods, tubes and wires, and extrusions of various cross-sectional shapes. It is known that the importance of materials in technology is due largely to the ease with which they may be formed into these useful shapes [5].

In order to produce these shapes, machinery will be needed for extrusion, forging, rolling and bending. Other machines needed are those for shearing, punching, drilling, drawing of rods, wires and tubes, welding and riveting. Additional machine tools needed for materials processing includes turning machines (lathes), milling, shaping, boring, grinding, gearing, broaching and die casting machines [6].

The local availability of a number of these machines is a key to developing technology. However, Nigeria already has the "Nigeria Machine Tools" Industry in Osogbo which will in conjunction with the already expanding Steel Industry, satisfy more than 50% of the machinery requirements of the possible Aerospace Industry [7].

In addition to the processes mentioned above, materials for the flight vehicle also undergo various kinds of heat treatment process depending on the particular application. Thus, such heat treatment furnaces and accessories are also required by the Aerospace Industry [5].

4. MANPOWER AVAILABILITY AND TRAINING

As mentioned in sec. 2.0, the production of flight vehicles is a highly technical process that necessitate the knowledge, experience and efforts of several engineers and scientists. Thus the establishment of an Aerospace Industry requires a large supply of Engineers and Scientists of various specializations. It is common knowledge in Nigeria today, that various Engineering graduates and scientists are unemployed. Such Engineers and scientist include the various science and engineering disciplines required for the Aerospace Industry. In addition to the already unemployed graduates, the Nigerian universities produce a great number of graduates in the same fields every year. Table (i) shows the various Engineering and Science disciplines necessary for the Aerospace Industry and the Nigerian Universities that produce graduates in these disciplines [8].

As shown in Table (i), no Nigerian University teaches the very essential discipline of Aerospace Engineering. However, Nigerian governments both Federal and State, have trained a lot of Aerospace or Aeronautical Engineers overseas. A few of these engineers are employed by the Nigeria Airways and other airlines as flight and maintenance Engineers, while the greater number of these engineers work as mechanical or structural engineers, in other establishments. However, in other to maintain a steady supply of these engineers for the Aerospace Industry, if established, it is suggested that aerospace or Aeronautical Engineering be introduced in one or two Universities in this country.

5.1 MARKET PROSPECTS

The Aerospace Industry in Nigeria to be established has very high market prospects. A survey has shown that there are over fifteen (15) domestic airlines registered in the country which are operating various classes of aircrafts. Some of the oil companies operating in the country operate their own aircraft including helicopters. The Military owns and operates various types of aircraft including fighter planes, transport planes of various kinds and helicopters.

All the aircraft mentioned above have been imported from other countries with huge sums of money. The organisations mentioned above will continue to buy new aircraft as old ones have to be replaced. New aircrafts have to be purchased for the purpose of expansion. Thus the Aerospace Industry will not lack market for its product.

In addition to the domestic market, it is also expected that other countries particularly friendly African countries and other Developing countries may be interested in buying aircraft from the Nigerian Aerospace Industry. Consequently, when established, the Nigerian Aerospace Industry will have the responsibility only to produce reliable aircraft to service the already existing market.

5.2 AIRLINES SERVICES

As found from survey, the Nigerian Aviation Industry already has a very large fleet of aircraft of various kinds. However, aircraft maintenance facilities are not properly developed in the country. As a result only very small amount of maintenance work is done in Nigeria. Most maintenance work on aircraft including the usual "C" and "D" checks are done in other countries. Huge sums of foreign exchange are wasted each year for such maintenance services.

Consequently, if the Nigerian Aerospace Industry is established, the industry could develop appropriate maintenance facility as an ancillary and reduce the problems of the aviation industry. This may help to raise funds from accruing profit to finance some part of the main industry.

5.3 COST BENEFIT

It is known that the Aerospace Industry is one of the most, if not the most, capital intensive Industry. Thus its establishment results in a very high opportunity cost, as money that can be used for other immediately profitable ventures will be locked up for many years before any appreciable gains could be achieved.

Nevertheless, Nigeria at the present imports all classes of aircraft both commercial and military. This uses up a lot of Nigeria's foreign exchange. If the Aerospace Industry is fully established, it will improve Nigeria's foreign exchange in the long run by reducing aircraft importation and also by possibly exporting Nigerian made aircraft to other countries. The Nigeria Aerospace Industry will also produce unquantifiable military benefits to the nation. Finally, the Aerospace Industry is also labour intensive, and hence its establishment will help to reduce unemployment in the country.

Table (i): Nigerian Universities and Aerospace Related Disciplines They Offer

UNIVERSITY	COURSES OFFERING										
	Industry trial Engineering	Aerospace Engineering	Mechanical Engineering	Metallurgical Engineering	Chemical Engineering	Electrical Engineering	Civil Engineering	Mathematics	Physics	Chemistry	Computer Science
ABU			X	X	X	X	X	X	X	X	X
FUT AKURE				X				X	X	X	
BAYERO			X			X	X	X	X	X	
BENIN			X		X	X	X	X	X	X	X
CALABAR								X	X	X	
IBADAN	X		X			X	X	X	X	X	X
IFE			X	X	X	X	X	X	X	X	X
ILORIN			X			X	X	X	X	X	
JOS				X		X		X	X	X	
LAGOS			X		X	X	X	X	X	X	X
MAIDUGURI			X		X	X	X	X	X	X	
FUT MINNA			X		X	X	X	X	X	X	
UNN			X			X	X	X	X	X	X
FUT OWERRI	X		X	X	X	X	X	X	X	X	
PORT HARCOURT			X		X	X	X	X	X	X	
SOKOTO								X	X	X	
ASUTECH			X	X	X	X	X	X	X	X	X
BENDEL			X			X	X	X	X	X	
CRS								X	X	X	
IMOSU								X	X	X	
LASU			X		X	X		X	X	X	
OGUN								X	X	X	X
OSUA			X			X	X	X	X	X	
RSUST			X		X	X	X	X	X	X	
TOTAL	2	0	17	6	11	18	16	24	24	24	8

6. SUMMARY

The establishment of an Industry such as the Aerospace Industry depends on factors such as the availability of materials, availability of manpower, and available market for the product. Thus the following specific conclusions can be made.

(i) Nigeria has some of the materials necessary for the production of flight vehicles.

(ii) Nigeria has a lot of manpower suitable for the establishment of an Aerospace Industry.

(iii) Nigeria will derive more benefits than cost in the long run if an Aerospace Industry is established.

(iv) A Nigerian Aerospace Industry has a ready market in the country both commercial and military, and will also have an export market in other African nations and elsewhere.

7. SUGGESTIONS

Since the Aerospace Industry is a capital intensive Industry, it will be very difficult for private financiers to establish the Industry and more so as profits will mature after several years. Thus Government should start the Industry. However, shares should be sold to interested private financiers and Government should not hold controlling shares for long. This should be done in order to eradicate the attitude factor which plagues Government owned companies in this country.

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