The Integration of Industry

By GROUP CAPTAIN H. R. FOOTTIT

"The scope of aeronautics is widening at such a pace that the aircraft industry is still pioneering."

—*S. Scott Hall*

HE WAS A MARTYR in a way. The British had sent him over to the U.S. experimental station at McCook Field to demonstrate the latest developments in their Guardian Angel parachute.

So in July, 1919, Lieutenant Caldwell climbed into the waiting aircraft with the pilot and they took off. Stowed on the aircraft, with a static line attached to Caldwell, was the parachute. As the pilot brought the plane over the field Caldwell clambered out and jumped. Something went wrong. Caldwell's falling body yanked the static line tight, the parachute pulled out, but it caught on the aircraft. As the watchers below held their breath, the line between the parachute and Caldwell snapped. The lieutenant plunged to his death.

Turning Point: Although a life had been sacrificed to the goddess of progress, Caldwell's death marked a turning point. The development of the free falling parachute—attached directly to the wearer instead of the aircraft—began with new enthusiasm. Parachute men such as Major E. L. Hoffman, Floyd Smith, and Leslie L. Irvin brought the free falling chute to fruition. As the years slipped by from that dire day in 1919, the parachute became such a standard, fixed size piece of equipment for military craft that the aircraft designer no longer bothered about it. All he had to do was to provide a simple stowage.

This detached attitude of the designer to the parachute, the radio, and other items of ground and airborne equipment was to prevail for the next 35 years. Then systems thinking arrived. Now the parachute is only a part of an escape system; the radio is part of an integrated electronic system; the auto-pilot is part of an automatic flight control system; and the ground starter cart is part of a servicing system.

As the fire of this systems thinking swept through the aircraft manufacturer's engineering department, it kindled a small flame at the top. Now managers are beginning to ask, "If we have to integrate our airplane design with all these special systems manufacturers, why don't we integrate the companies themselves?" In the past there have been such integrations, but these have taken place mainly for economic reasons. The vast Hawker-Siddeley group in the U.K., with its A.V. Roe off-shoot in Canada, and the United Aircraft Corporation in the U.S. are cases in point. But now we are seeing company integrations to get a project done, whether it be a guided missile, a jet transport, or a military interceptor. This is a new idea and a powerful one. And I think it foreshadows a new and better era in the purchase of tomorrow's civil and military air power.

Design Proposal: In the past the usual purchasing procedure for an aircraft that was still on the drawing board, was to have the designer submit his proposal to the customer. The aircraft man often allowed a limited choice in engines, and an unlimited choice in practically everything else that went into the new plane. Ground support equipment wasn't even thought

To be produced for British European Airways by an aeronautical combine comprising de Havilland, Hunting and Fairey interests, is the new DH-121 jet airliner. Rolls-Royce RB-141 by-pass engines will power new transport.

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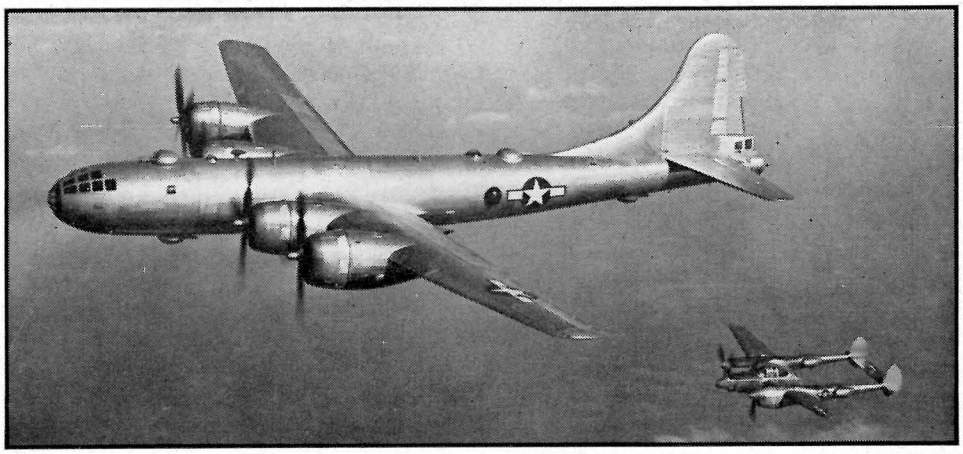


Involved in one of first experiments in integrated design was the B-29, with Boeing, General Electric & USAAF working closely in development of the bomber's defensive system.

of. However, a contract would be signed. Then the aircraft company would march merrily on its way as though the only thing that mattered was to get the airframe drawings rolling into the shop. Installation engineers from the engine manufacturer would arrive and were looked on as a necessary nuisance. Airborne and ground equipment representatives were another necessary evil. In many cases it was only by continual prodding from the customer and long, drawn out meetings between customer, equipment supplier and aircraft designer, that somehow all the airborne equipment got stowed in the airplane and the ground support equipment delivered to the tarmac. In many cases, too, this ideal was only reached many months after the customer had taken delivery of the product.

From this procedure it is obvious that the customer had to dabble deep in the design and the phasing of the whole project, if he ever wanted to get his equipment in operation in a reasonable time. With this new concept of integration, however, I think that we are going to see these companies get together right from the proposal stage. Thus, in the days to come the customer will buy a "packaged deal" from the first proposal specification to the completed project. And if he does, it should cost him less and save him time.

Although this may sound like a new novel approach to purchasing we have already nibbled at such an idea in the past. Some fifteen years ago, for example, the U.S. Army Air Force decided that the B-29 bomber should have its defensive armament designed in conjunction with the airframe. The Air Force had arrived at this decision by a process of bitter experience. For the B-29's predecessor, the B-17 Flying Fortress, had run into trouble in fighting the air war in Europe during the early days of World War II. The B-17 had been called a Flying Fortress since it was equipped with five hand held guns. This defensive armament had been laid out by Boeing almost in the same way they provided the parachute stowages. When the Fortress went into battle it turned out to be an easy prey for the Nazi fighters. The B-17 had too little fire power, too many areas of single gun coverage, and too many blind spots.

Defensive Armament: After the B-29 contract was signed and the design under way, the USAAF sat down with Boeing and General Electric to look into the defensive armament. The companies decided to integrate their efforts. As R. A. Averitt of General Electric's Aviation Division said in 1945, "For the first time an attempt was made to design the defensive armament as a complete system providing a maximum of protection with a minimum of additional weight and drag imposed on the airplane." As a result of this integration the B-29 went into service with five remotely controlled turrets, and a tail cannon. Moreover, the guns were aimed and fired with the aid of mechanical computers that ground in corrections of speed, altitude and firing range. The whole system was laid out to give good protection to the bomber with wide, overlapping fields of fire.

Like everything else that must be battle proven, there were many changes to the B-29's defensive system after it went into service. Yet relatively speaking this integration of Boeing's and General Electric's design, development and production efforts was a marked success. The first stumbling steps towards the integration of the aeronautical industry had started. But it was only the beginning. To the missile designers must go the honors for pointing out the road to complete integration, that the airplane companies are just now starting to tread.

It all began at the end of World War II. The U.S. Army was captivated, like the rest of the world, by the great strides the Germans had taken in the development of their V-1 and V-2 missiles. The missile age had arrived and the Army intended to be in on it. They called in the Bell Telephone Co. Now it happened that Bell had coined the word "Bell System" towards the end of the 19th Century, and their engineers were well versed in system thinking. Moreover, Bell, during the war had been an associate manufacturer for the Army in producing a part of an anti-aircraft fire control system. As a result they received innumerable complaints about mismatched units of the system, since it contained many parts and boxes from other manufacturers. It was obvious to Bell that the fire control equipment had not been engineered along the integrated, system lines that they had pioneered for their telephone network.

System Thinking: With this background Bell was in a good position to get into the missile game when the Army called them in to do a study. Bell's engineers soon started to look at the missile in the way they were used to—as a complete system. After five months of study they suggested that other companies be integrated into the missile system design. The Army agreed. The result was the Nike, an anti-aircraft missile that has since been slated for the defence of many major U.S. cities from coast to coast. The integration of industry to fulfil this task centered mainly around Bell, their affiliate the Western Electric Co., and Douglas aircraft.

As it finally worked out the production of the Nike was split about

equally, with Western building the radars, command and control trailers, and various miscellaneous gear, while Douglas was responsible for the missile airframe, launcher and control equipment. Since Nike is one of the earliest missiles in the Western World to go into service, there is no doubt that this integration of the industry was a resounding success.

This Bell, Western Electric and Douglas type of merger is not a permanent business structure. Instead it is a team assembled to complete a particular project. Our aircraft industry, including the engine and equipment manufacturers, have not, in general, grasped this idea when it comes to proposing a new civil or military airplane. The thinking in the airplane world runs more to the building of permanent business structures by corporate mergers. Canadair Ltd. in Montreal is a part of the General Dynamics Corporation. And A.V. Roe Canada Limited in Toronto is not only a member of the British Hawker Siddeley Group, but has been busily building its own Canadian corporate structure.

Mining to Jets: I was talking to E. G. Mahoney, manager of the Ottawa office of Avro Aircraft Limited. He told me that "the A.V. Roe Canada organization now includes 42 subsidiary companies." These vary all the way from mining coal to designing and producing intricate jet engines and equipment. The aeronautical division of the corporation is headed by Vice President Fred T. Smye. It includes Avro Aircraft, Orenda Engines, Canadian Applied Research, and Canadian Steel Improvement. Only the future will tell whether this type of permanent organization will band together with others to come forward with an integrated design proposal for some new military or civil air system. To date they have shown little tendency to do so. In fact companies that have an aircraft division and an engine division, such as the Bristol Aeroplane organization in the U.K., have been notorious for their lack of integration even when they've been embroiled in the same project. For some reason aircraft divisions tended to work far better with an independent engine manufacturer.

In the U.K. the government has adopted a definite policy of trying to get these aeronautical organizations together. As Minister of Aviation Harold Watkinson said recently, "Both the Minister of Supply and I feel that a policy of merged effort should be encouraged and we shall exert whatever influence we can in this direction in placing future orders." His words were directed at the corporate struggle that had been going on in England as both Bristol and de Havilland tried to land a contract for a new jet transport.

The story began when British European Airways issued a requirement for a 100 passenger, 1700 mile range jet airliner. To keep their fleet modern BEA had previously ordered some Comet 4's as an interim measure. Now they wanted a new jetliner for operations commencing about 1964. When the specification for the new transport was sent out, four British companies, Vickers, Avro, Bristol and de Havilland submitted design proposals. The Government was particularly keen that the project should be financed from company funds. None of the firms felt that they could risk their finances on this venture. So the project remained dormant.

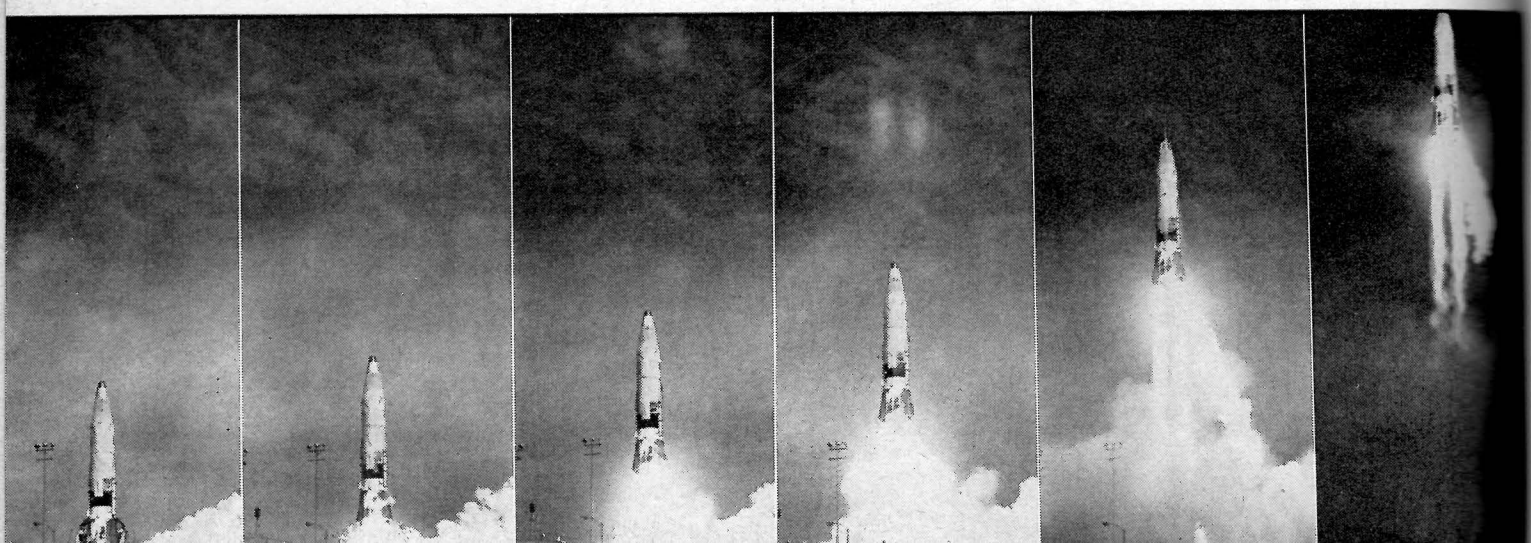
Tri-Motor: Bristol's had proposed a tri-motor jet, with the engines mounted close to the tail. This was the Bristol 200. The Hawker Siddeley Group looked over the proposal and decided that they would plunge into the contractual pool with Bristol. So it was subsequently announced that a separate company would be formed by the two organizations for the single purpose of designing and building the Bristol 200. Hawker Siddeley, backed by capital and reserves of some $157 million would own 65% of the new corporation, and Bristol, with capital of $45 million, would have 35%.

An impressive Board of Directors was lined up with representatives from Bristol's, Hawker Siddeley, and Short and Harland, associate producers of the Bristol Britannia. Sir Arnold Hall, former head of the Royal Aircraft Establishment, would be the managing director, and Dr. A. E. Russell, technical head of Bristol's would be the Chief Engineer. Apparently the company would only materialize when they were assured of an order. Since the de Havilland design was being rumoured as being the BEA choice, the skeleton Bristol-Hawker Siddeley group lost no time in looking into other markets. E. Burns, Ottawa representative for Bristol Canada told me last month that Dr. Russell and a team from the group were going around the U.S. carriers to see what interest they could arouse for the Bristol 200.

De Havillands solved their financial problem by teaming up (67½% interest) with the Hunting Group (22½%), and Fairey Aviation

(Continued on page 122)

The missile industry pioneered in product development by integration of effort, with such successful results as that shown below. Sequence photos record January 10th launching of an Atlas ICBM from Cape Canaveral, Florida.



moved from Montreal to new quarters in Hamilton with 10,000 sq. ft. of plant area. In their new location, the Simmonds firms plan gradually to expand repair and service facilities, eventually manufacturing a selection of suitable components, for which they are Canadian licensees, that are now manufactured elsewhere to Simmonds specifications. Included in line of proprietary aircraft accessories which Simmonds supplies and services in Canada is fuel gauging equipment used in TCA aircraft.

•**Daystrom Ltd.:** Formed recently at Toronto to handle sales, service assembly and manufacture of Daystrom Inc. electronic products in Canada. Manufacture of gyros and accelerometers for aircraft and guided missiles is planned at Canadian subsidiary's new plant.

•**Rotaire Ltd.:** An affiliate of Genaire Ltd., Rotaire specializes in helicopter repair, overhaul, maintenance and engineering, catering to needs of Canadian operators of military and civil rotary wing aircraft. Firm is supported by Genaire's shop facilities at St. Catharines and Malton. Working parties provide technical service in the field.

SPARROW

(Continued from page 88)

torpedo that has been developed by the Canadian Armament Research & Development Establishment. Practically nothing has been said officially about this weapon, but it is slated for service with both the RCN and the RCAF, presumably as armament for the CS2F-1 Tracker and the CP-107 Argus.

Although there is now some evidence of progress in the Canadian missile program, there is still little indication as to what the next step might be. As C. F. Hembery, president of Computing Devices of Canada, said at the 1957 AITA general meeting:

"Canada's place in missile development is not yet clear. The basic question is this: Can Canada afford to support a full scale development program on one or more types of guided missiles specifically adapted to Canadian defence, or must we rely on American and British developments? We have tried both ways, with the Velvet Glove and the Sparrow 2. If we attempt to manufacture foreign developments, we must accept the delays which this approach entails. If we try to do our own research and development, we must be prepared to bear the costs.

"The costs of development are considerable, and it is inevitable that much work already done elsewhere must be duplicated because of security restrictions. The argument in favor of manufacturing under license is mainly economy. We avoid duplication of effort, and we save engineering man hours. On the other hand, we may lose up to two or three years in getting a missile into operational use.

"In favor of developing our own missiles, it is said that against the money cost must be balance the value of building up a reservoir or experienced personnel which we can use if we find ourselves unable to obtain equipment from our allies."

FOOTTIT

(Continued from page 94)

(10%). In this way it was possible to finance the deal privately. A new company has been formed called "Aircraft Manufacturing Co. Ltd.," or "Airco". Rolls-Royce, in their usual manner, are financing the engines. It was recently announced that the Government had given British European Airways the go-ahead to negotiate with de Havillands and their associates for the D.H. 121 jet transport. So in the end it looks as though de Havillands have won the race. And the British Government has achieved a measure of success in their prodding for an integration of industry.

Independent Action: What the British Government has done by

COMING EVENTS

April 8-11—SAE National Aeronautic Meeting Hotel Commodore, New York City.

April 14-17—Design Engineering Conference, International Amphitheatre, Chicago, Ill.

April 21-22—AITA Semi-Annual Meeting, Empress Hotel, Victoria, B.C.

April 22-25—AGARD Wind Tunnel & Model Testing Panel Meeting on Ballistics, Freiburg, Breisgau, Germany.

April 28-30—IAS/USAF Office of Scientific Research Astronautics Symposium, Denver, Colorado.

May 19-22—Annual National Conference, Soc. of Aeronautical Weight Engineers, Belmont Plaza, New York City.

May 26-27—CAI Annual General Meeting, King Edward Hotel, Toronto.

June 9-10—Canadian Conference for Computing and Data Processing, University of Toronto.

June 14—Air Force Day across Canada.

June 24-26—31st Meeting, Aviation Distributors & Mfrs. Assoc., Mt. Washington Hotel, Bretton Woods, **N.H.**

October 8-10—IRE 1958 Convention & Exposition, Automotive Bldg., Exhibition Park, Toronto.

veiled coaxing, some American companies are now doing on their own. North American Aviation and Phillips Petroleum have formed a joint company called Astrodyne Incorporated. This firm will specialize in the development and production of solid propellents which would be suitable for such missiles as the Redstone and the Thor. There is no indication yet that this new company will propose a new missile project. But some of the ingredients for such a course are certainly there. Similarly the well known Aerojet Corporation has formed a partnership agreement with the Stauffer Chemical Company to work on boron based propellents. And other mergers and alliances seem to be shaping up on the American scene.

All these integrations of industry have a high note labeled "monopoly" —a word with a sour tone in Western democracies where laws are specifically framed to control such ventures. Yet there are certain advantages. Large companies can efficiently distribute the jobs to their own specialized plants; overhead, packing, shipping, and handling tend to be cheaper; materials can often be purchased in large lots at lower prices; more funds are often available for research. Still the average man fears the power of big concerns. Gertrude Williams pointed out in her book *Economics of Every Day Life* that the unified demands for production in two world wars tended to bring companies together. Some of them then stayed together "so as to have a representative body capable of negotiating with the Government." In other words, big words can come from big business and the government will sit up and listen. But we worry lest the direction of endeavour they're proposing is in the interest of country or merely in the interest of the company.

Economists recognize that these large firms with only one source of business require a stable and straight forward production run to remain efficient. Since the aircraft industry is noted for its violent ups and downs it will need top rate management to sail a straight course. Moreover, as Gertrude Williams points out, "Every increase in the scale of production puts a bit more strain on the capacity of the men who are in control at the top. Not only does direction become more difficult, but any mistake in judgment is more expensive and more disastrous." The net results of these integrations, then, is a highly tuned company organization that can easily swing to costly discords if the management or the project develop even a slight degree of instability.

The Only Way: Regardless of these disadvantages, I think that the only way we can ever get these complex airplane or missile systems into being —with all their airframes, engines, electronics, specialized equipment, ground support units, systems trainers, crew trainers, ground electronic aids, and a myriad of other gear—is by an integration of industry. This integration does not necessarily have to be a permanent business structure. In fact here are a few indications that it may be better if it isn't. With the proper management, however, I don't think it matters. The basic point is that the contractors, from the first line on paper, must get together as a team. For if the team can't phase in these complex, overlapping developments, to produce the best system in minimum time with minimum cost, then no one can.

As S. Scott Hall of the Ministry of Supply said some time ago, "the aircraft industry is still pioneering." And if they don't get together and pioneer the integration of their industry then some other industrial organization will step in and do it for them. The time is fast running out.