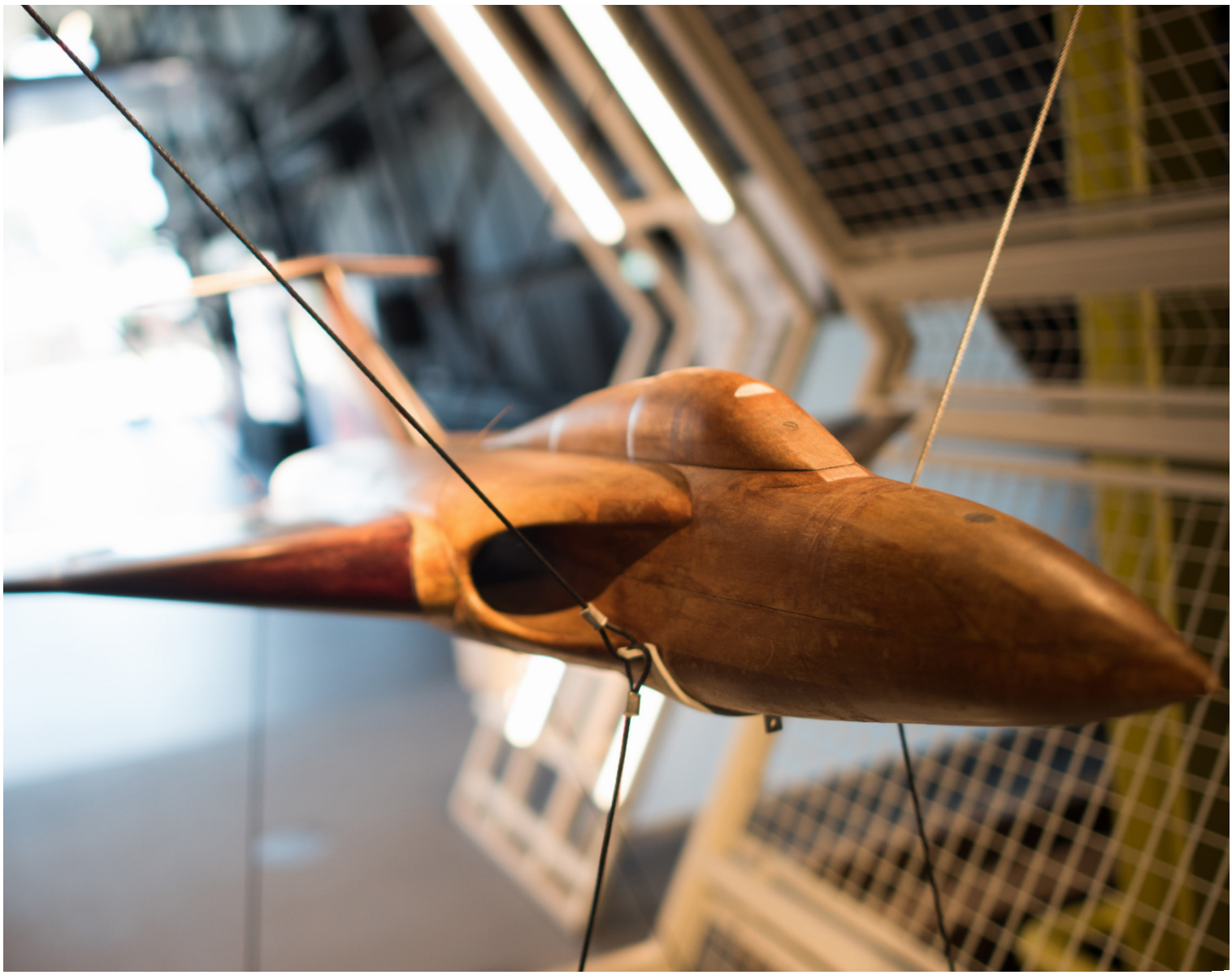


Materials, Mechanisms and Structures

Design and Technology
KS5 Resource

HERITAGE FUND

ROYAL AIR FORCE museum

H1 Past ...

Wooden propellers were used to generate the thrust needed to pull the plane forward, they were made from various hardwoods. Propeller production involves the process of stacking sheets of wood on top of each other and offsetting each layer from a central angle, they are then bonded together and carved into shape.

Why is this a better process than simply carving a single piece out of a large piece of wood?

Hint Consider how the grain of wood can be used to add strength to shapes

How might the introduction of metal propellers affect the cost of production?

Hint Consider ways in which metal can be shaped commercially compared with wood processing

H1 … to Present

The F-35 Lightning is our most modern aircraft. What you see on display is actually only a model as this plane is currently in use by the Royal Air Force. It is the result of a collaborative project involving many different countries and has extensive capabilities including stealth mode and advanced short take off and vertical landing (STOVL).

What kind of technology do you think the F-35 is able to hide from?

Why is advanced STOVL beneficial for modern fighter aircraft?

Hint Consider where aircraft might be based to access remote parts of world

H1 And the Future

Go through to the 'RAF: First to the Future' exhibition and find the wind tunnel models. Which ones do you think would have worked best and why?

Use the box below to illustrate three important features which make an aircraft more aerodynamic. Use annotation to explain your points.

H2 Monoplanes

The Bleriot XXVII was one of the earliest monoplanes, built by Louis Bleriot in 1910. Bleriot monoplanes were mainly used for training or short competitive flights and monoplanes didn't become widely used until the Second World War. This plane was made with a wooden fuselage and a 50hp Gnome engine.

Looking at the structure and design of the Bleriot XXVII, how well would it do in an air combat situation? Use the box below to sketch key features you think would help or hinder its success under attack.

H2 Biplanes

The Bristol F2b Fighter was designed by Captain Frank Barnwell as a reconnaissance fighter and delivered to the front line in 1917. The second crew member would have been the observer (and gunner). It had a wooden frame with a metal-framed rudder and two-spar fabric covered wooden wings.

Why do you think using these materials was beneficial for aircraft production during the First World War?

The Bristol Fighter was designed around the Rolls Royce Falcon III engine, and two major points on the design brief were good crew visibility and an unobstructed field of fire.

How well were these design features achieved?

H2 Triplanes

The Sopwith Triplane was first launched in 1916. This new experimental design was thought to combine the essential performance requirements of a fighter plane – increased rate of climb and great manoeuvrability.

Biplanes were extremely popular, and when a stable version was created, monoplanes took over. Why do you think the Triplane had such a short lived time at the top?

H3 Mechanisms

The Slingsby Grasshopper is on display in the entrance to Hangar 3. This glider was used for basic training and many cadets would have made their first solo flights in one of these.

What examples of mechanisms can you see on this glider? Sketch them in the box below and annotate to show how they might be used in powered aircraft.

H3 A first ...

The Gloster Meteor was the first British fighter jet. Fitted with twin Rolls Royce Welland turbojet engines, it was able to reach speeds of 962kph/598mph compared with 466mph of the first Gloster.

Name some advantages and disadvantages of having twin engines rather than a single engine (think about positioning of the engines).

Advantages	Disadvantages

H3 … and a record

The story of the Hawker Hunter is one of trial, error and ultimate perseverance. Chief designer Sydney Camm and manufacturer HawkerAircraft realised jet propulsion was the future and so created the P1040. Unfortunately, this was rejected by the RAF, they wanted something better.

Four more versions were created and then finally came the Hawker Hunter which broke the air speed record in 1953 by travelling at 727 mph. This plane became the RAF's main interceptor fighter and was also used for reconnaissance.

Considering the Hawker Hunter story, why is it beneficial to produce different prototypes before the final product?

H4 Spitfire vs Hurricane

Find the display of the 'Fighter Four' aircraft from the Battle of Britain.

The Spitfire and the Hurricane were the mainstay of the RAF's fighter aircraft in the Second World War. The design of these iconic aeroplanes was very different and people are still arguing about which was the best more than 80 years on.

Spitfire	Hurricane
• Monoplane • Designed by R.J. Mitchell • Concept was for a modern, fast fighter plane • Monocoque design • Made from aluminium • In 1942, wing production was significantly increased by use of compound die stamping • Elliptical wings • Revolutionary design • Adaptable and used as a fighter-bomber, offensive escort fighter and photographic reconnaissance aircraft.	• Monoplane • Designed by Sydney Camm • Concept was for a modern, fast fighter plane • Frame design • Made from metal, wood and linen • Due to more traditional construction methods, three Hurricanes could be made for every one Spitfire • Traditional wings • Developed from the Hawker Fury biplane.


Interior


Interior

H4 Spitfire vs Hurricane

The Spitfire was a revolutionary design, the Hurricane based on traditional design. What are the pros and cons of both approaches?

The Hurricane was much easier and quicker to repair – why?

What would be the benefits of using flush rivets on the wing edges of the Spitfire?

H4 Spitfire

There are two other Spitfires in these hangars (Mk XVI and F24). Sketch these planes below and annotate the changes made from the original design. What would have been the reasons for these changes?

H5 Mosquito – facts

Initially designed as an unarmed bomber

Nicknamed 'The Wooden Wonder'

Fuselage constructed in two pieces – internal equipment was fitted and then the pieces joined together

Designed and built by de Havilland

Multi-role plane – pathfinder, bomber, reconnaissance

Faster than a Spitfire

Stressed skin of thin laminated plywood over a balsa core

H5 Mosquito - questions

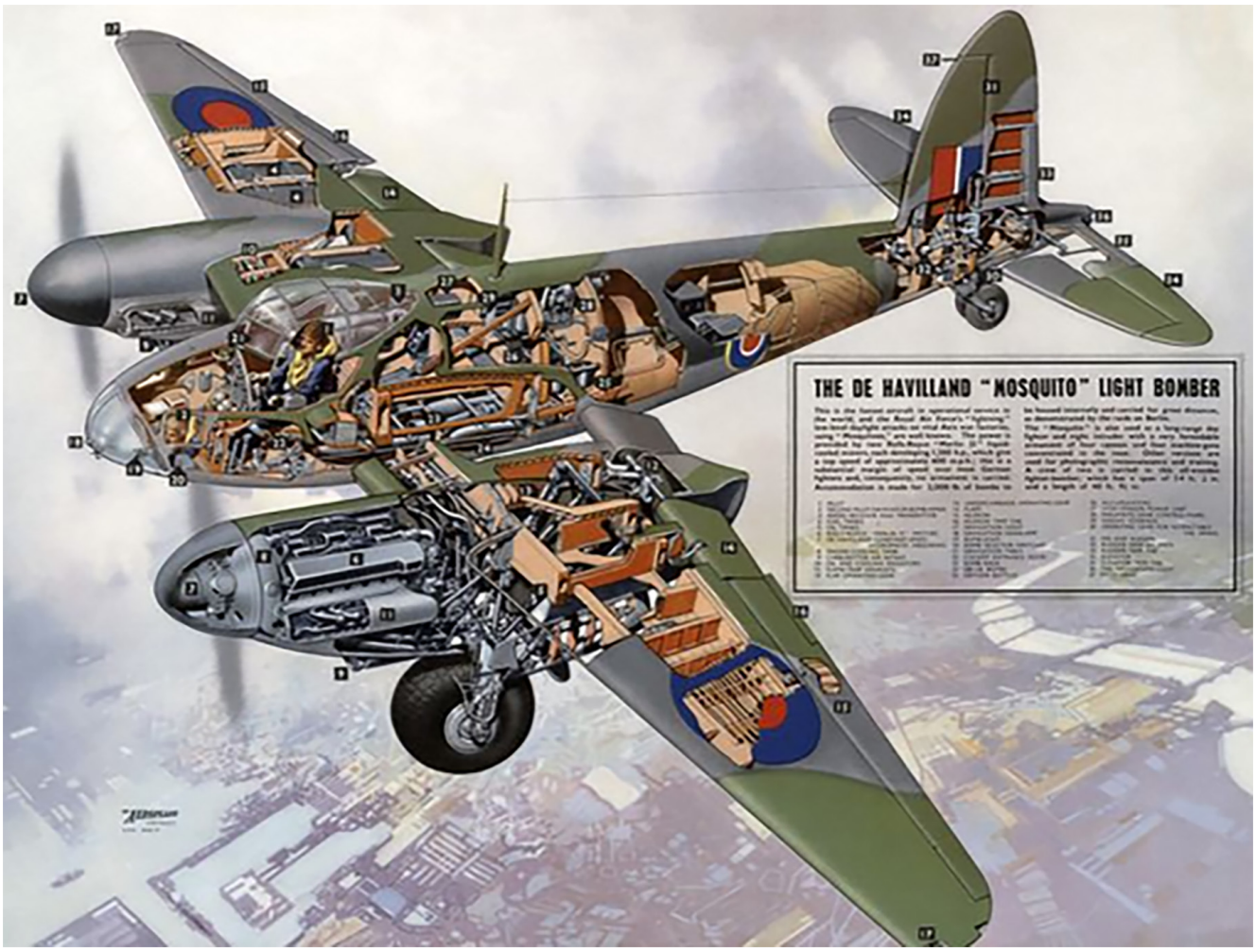
What benefits were there to building the Mosquito out of wood at the time of the Second World War?

Why did the designers decide to sacrifice defensive armaments in this plane and how did it help their design?

Why do you think it was such a versatile plane in terms of the number of roles it filled?

H5 Mosquito - design

Annotate the diagram below to show how the structure of this aeroplane has been designed to reduce stresses and strains (torsion, compression, tension etc).



H6 Typhoon

The Eurofighter Typhoon is a lightweight plane designed as a 'swing-role' aircraft.

With reference to the properties of each material, what are the advantages of using these in aircraft design?

Materials	Percentage	Advantages in aircraft design
Carbon fibre	70%	
Metals	15%	
Glass reinforced plastic	12%	
Other	3%	N/A

H6 Chinook

The Boeing Chinook is a tandem rotor, heavy-lift transport helicopter.

The Chinook uses many mechanisms in order to fly. List below which mechanisms could be used and how. (You can find examples if you look closely.)

Mechanism	Use

H6 Design

Hangar 6 contains relatively modern aircraft. Which of the design features would you adopt if you were creating your own plane? (For example, the swing wing on the Tornado, the carbon fibre on the Typhoon etc) Sketch and annotate your ideas in the box below.

Further ideas

The RAF Museum features many amazing examples of great design. If you have the time, take a look at these aircraft and see what you can discover.

Vulcan, H5

Lightning, H3

Vampire, H3

Sunderland Flying Boat, H1

Aeroplane engines have changed a lot since the early days of aviation. As you find the different types of engines around the hangars, think about and discuss how these changes have affected aircraft design.

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