Glider workshop Teacher guidelines

- Slide 1 & 2 Introduction to Fred Lanchester - Show pictures on slide 2 and ask what do these pictures have to do with someone born 150 years ago. 30 sec discussion in pairs
    1. Ask about plane winglet: seen on jet planes in the last 20 years to reduce drag and increase fuel efficiency (and therefore decrease plane ticket prices!)
       Reveal first picture – upswept wing patent from 1907 – Fred experimented with different wings and winglets in the 1890s coming up fundamental theories of flight. He filed a patent in 1907 for a flying machine with upswept wings for stability.
       (Extension: May need to explain what a patent is – an idea that has been written down and recorded formally so that no-one else can copy or steal that idea without permission. Patents can be valuable and Fred successfully filed over 200 patents in his lifetime)
    2. Ask about Landrover Discovery: what is special about that car? It's offroad/four-wheel-drive
       Reveal second picture – A patent for four-wheel drive from 1904. Fred was ahead of his time for many inventions that we see on vehicles today
    3. Ask about the Toyota Prius: A petrol electric hybrid car that Toyota first started building in 1997. A hybrid car combines a normal petrol engine and an electric motor and battery to power the car very efficiently. Fred's invention from 1927 is over 90 years old and works in exactly the same way as a Toyota Prius does today. When going downhill or coasting the excess kinetic energy from the petrol engine is converted to electrical energy and stored in the battery. When the car needs an extra boost, the electric motor uses the stored energy to help the car go uphill for example. *(Extension: Fred's hybrid car was never put into production but was a one-off prototype that can be found in the Thinktank museum in Birmingham, just under the Spitfire! It was tested for hundreds of miles and was the Mark 7 version of Fred's ideas. In his notebooks and sketchbook there are designs for a Mark 8 and Mark 9 but they were never built. The car had a top speed of about 50mph and petrol consumption of just under 40 miles per gallon (mpg)*)

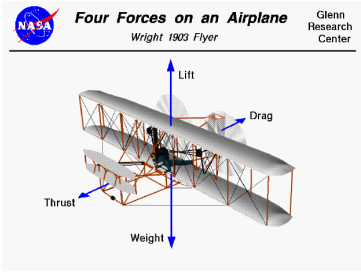
- Slide 3- Who was Fred Lanchester?
    - You might not have heard of him, but he was born in 1868 – just over 150 years ago and was an inventor and engineer who invented the first all-British four wheel petrol motor (top left picture) in 1895 (can play guess the year higher or lower to get the right year)
      (Extension: Can students identify what is missing from this car that you might find on a car today? The engine is there, under the rear seats and steering is done via a tiller similar to a canal or sailing boat. Steering wheels became more popular, but some drivers preferred tiller steering and it remained an option on Lanchester cars for several years.)
    - He set up the Lanchester Motor Company which produced cars in Birmingham until 1931 when it moved to Coventry. In the 1920s and 30s it was a competitor for Rolls Royce making luxurious limousines for royalty including King George VI. Queen Elizabeth II's first car was a Lanchester and she even went on honeymoon in Lanchester!

- He was also interested in aeronautics and experimented with gliders and flying machines in the 1890s. He saw the Wright Brothers fly and we have a letter from Wilbur Wright discussing their ideas in the archive

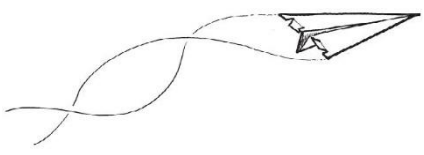
- Slide 4- Who was Fred Lanchester?
  - There is a strong local connection with Fred Lanchester. Lanchester cars were built in Birmingham and then Coventry until the mid 1950s and Fred also lived and worked in Coventry and Birmingham. Before Coventry University was called Coventry University, it was called Lanchester College of Technology and then Lanchester Polytechnic.
- Slide 5- Who was Fred Lanchester?
  - The Lanchester Interactive Archive opened in 2017 and contains a huge collection of his notebooks, sketchbooks, photographs, letters and blueprints which have all been scanned and are available online.
  - There is also a space in Coventry University's Lanchester Library where you can get inside a real Lanchester car and experience the augmented reality and interactive games (more at http://lanchesterinteractive.org/fun-games)
- Slide 6 – Back to 1894
  - Today's activity is going to look at Fred's experiments with gliders which he carried out in 1894 – so first we are going to go back in time and see what was going on in 1894. Show pictures on slide and ask students to identify what they are and what happened to them in 1894 – 30sec to 1 min discussion
    1. Tower Bridge opened
    2. Blackpool Tower opened
    3. First Merseyside derby between Liverpool and Everton (Everton won 3-0!)
    4. Rudyard Kipling published 'The Jungle Book'
       (Extension: Rudyard Kipling became friends with the Lanchester brothers and was very interested in their cars. When they had a new model they would lend it to Rudyard for his opinion and they would sometimes use his reports in their advertising)
    5. John Harvey Kellogg patented (can recap patents here) 'flaked cereal'
    6. 1894 was the 57th year of Queen Victoria's reign
- Slide 7 – Back to 1894
  In the summer of 1894, just a couple of miles from where Birmingham airport is today, Fred Lanchester and his brothers were experimenting…
  (from his book: in 1894 the author commenced the practical investigation of stability in flight, some preliminary theoretical work having shown that it should be possible to obtain automatic equilibrium with a suitably designed apparatus)
- Slide 8 – Where the experiments took place
  - The brothers lived in a house in Olton, near Solihull, which today is only a couple of miles away from Birmingham Airport.
  - They launched their gliders using a catapult from the first floor of the house over the garden and fields
- Slide 9 – Method
  - Although Fred was a good scientist, he didn't write down all his results!
    From the slide: " A considerable number of flights were made, probably some twenty or thirty in all; the records relate only to some half-dozen cases"

    - He got his brothers to help him draw the flight paths and time how long the flights took and record the conditions
    - They tried lots of different designs including elliptical wings (seen on the Spitfire 40 years later) fins at the front and back and even gliders powered by a rubber band propeller.
- Slide 10 – Results
    - Fred recorded a map of the gliders and some of them flew a long way –up to 300m, 3 times the length of a football pitch
    - Some of them flew over the road, so it must have been quite a sight to see these gliders being flown (usually on a Sunday because at the same times the brothers were working on the first all-British motor car and they were called the 'Unholy Trinity' because of all the noise they made!)
- Slide 11 – Results
    - This is a view of how the house and road looks today. Some of the flights didn't always go to plan, but Fred still recorded the results. Number 1 flew around almost in a circle
- Slide 12 – Results
    - Here are Fred's results. He wrote down when he did them (except the first one!) how much the glider weighed, the conditions *(Extension: why might the conditions such as wind might affect the results?)*
    - Flight 5 collided with a tree, showing that it didn't always work, but he still recorded the results

- Slide 13 – Results sheet – Challenge
    - Activity: To make a paper aeroplane/glider that can either travel as far or as high as possible.
    - Ask what things might affect the design of their glider. Materials, shape, weight?
    - Explain about the forces acting on the glider – Lift, drag, thrust and weight.



        1. All of these affect how well and far the glider will fly
        2. We will use a launcher so the thrust will be the same for all launches
        3. Making the plane more 'aerodynamic' (eg like Concorde)will reduce drag, enabling it go faster and further with the same thrust
        4. However there is less wing area to generate lift so planes like the Hercules transporter are able to lift more with a different wing design with less sweep
        5. Note that winglets (either up or down) help with stability and if the glider is stable it is more likely to have a long, straight flight



(Extension: By cutting 'flaps' into the trailing edge of the wing, ailerons can be made which affect the flight of the glider. With ailerons on both sides deflected upwards, the glider will tend to pitch upwards and gain altitude (until it loses momentum and stalls). With both deflected downwards it will pitch towards the ground and with one up and one down, the glider will tend to spiral (see left) These are the principles of aerobatic flight.)

- Reinforce rules
    1. NO throwing the gliders. We will test them using the launcher – Ask why we do this? Same thrust and angle each time makes it a fair test. Everyone would throw their gliders differently.
    2. Only 1 glider per student. If there is time you they create more than one glider, but then must choose which one to test in the launcher (think about different design requirements for distance vs height). It can be decorated with logos etc
    3. The design must be able to fit into the slot in the launcher. For normal paper and a dart design this is fine, but sometimes with thicker card a plane can become stuck and won't fly.

- Test flights.
    1. A space that is at least 10m long (a corridor or hall is usually sufficient, some gliders can fly in excess for 11m) with a ceiling of 3m.
    2. Slides 15 & 16 can printed out and the 'road' placed at around 8m as a target distance.
    3. If there is space, students can line up either side of the glider but must keep their eyes on the launcher at all times.
    4. If space is minimal and students must stand in front of the launcher at close range, safety glasses should be used.
    5. The launcher should be placed on a table and a tape laid on the floor to measure distance.
    6. In small groups each student should present their glider to the teacher who will launch it. Give a 3,2,1 countdown and tap the back of the glider into the launcher. The distance should be recorded by the student and time of flight using a stopwatch. *(Extension: The flightpath can also be drawn on the results sheet (Slide 14) and if time, repeat the experiment).* The student with the furthest glider can stand by their glider and the others collect theirs and go back to where they were standing. Note also any gliders that have particularly high attempts and remind students that Fred also had many failures and gliders that would turn back on themselves

- Review results – Once all the glider have flown, take the 3 that travelled the furthest and 3 the travelled the highest and see if there are any similarities in design, and any differences. Award certificates for the highest and longest flying gliders.

  If students only had time to launch their gliders once, ask for one way that the experiment could be improved. Repeating the experiment would meant that any anomalies can be taken into account and an average can be obtained for each glider. *(Extension: If distance and time are recorded, then speed can be calculated (distance/time in metres per second) Which were the fastest and slowest gliders?)*