VOLUME 36 April - June 2019 ISSN 1391-0299

VIDURAVA

THE SCIENCE MAGAZINE OF THE NATIONAL SCIENCE FOUNDATION

Aeronautics

NATIONAL SCIENCE FOUNDATION

VIDURAVA

Volume 36

April - June 2019

Published by
National Science Foundation
47/5, Maitland Place
Colombo 07.

Source of Images: Internet/ Authors

Tel: 011-2696771-3
Fax: 011-2694754
E-mail: vidurava@nsf.gov.lk

'VIDURAVA' Science Magazine is available at http://www.nsf.gov.lk

Contents

ISSN 1391-0299

Editorial

A Lingua Franca Controversy that Stalled the Ceremonial Test Flight of the Supersonic Concorde

Concorde was a turbojet supersonic passenger jet that was jointly developed and manufactured by Aérospatiale and the British Aircraft Corporation (BAC) under an Anglo-French treaty. It had a maximum speed of over twice the speed of sound at Mach 2.04 (1354 miles per hour at cruise altitude), and could seat 92 to 128 passengers.

Significantly, the present writer, who was in Britain during the late 1960's following postgraduate studies, was aware of this marvelous development about which both Britain and France were proud to showcase frequently on the electronic media. Nevertheless, when it came to the stage of the ceremonial inaugural test flight in 1967, a major controversy erupted on nomenclature.

Concorde's name meaning harmony or union, reflected the cooperation on this project between United Kingdom and France.

The French authorities agreed that it would not be appropriate to call the Anglo-French aircraft "Super – Caravellé". It was concerned that the name for the aircraft should reflect the same meaning in both languages, and if possible the same spelling. Consequently, the British Aircraft Corporation suggested Concorde (with and without the final "e"). Other possibilities such as 'Alliance' and 'Europa' were also suggested.

On the other hand, when the British Cabinet of Ministers had earlier approved the project in principle, had declared that the aircraft should be called 'Concord' (English spelling without the 'e').

However, on the eve of the ceremonial test flight, controversy raged over the spelling. There was a concern that, if the French spelling (Concorde) was adopted, the common assumption would be that the aircraft was primarily French in origin. During this early post – colonial era, there was also a tendency among French speaking countries to reject the idea of the English Language being regarded as a global language.

The argument continued until the then British Minister of Technology Tony Benn, resolved it in 1968 in favour of the word Concorde spelt with the 'e', bringing to a close the controversy over the nomenclature, and thus peacefully facilitating the ceremonial test flight.

M. Asoka T. De Silva

Too Slow? Not Anymore!

W.Dakshina T Fernando

If someone ask me why I chose aviation I would in return pose the question, why do you want to walk when you can fly? Humans being at the top of the food chain have the natural tendency to push through obstacles to reach any target and conquer. Thus hunger in the evolving process, is in our blood. Once my mother told me "If you cannot jump over a wall, try to penetrate through it." May be that was the mind set which motivated our ancestors to conquer everything that seemed impossible, starting from the land, sea and finally the sky. Let me take you through where they were then, and where we can go through the skies, reaching the stars.

How slow were we then and how far are we now?

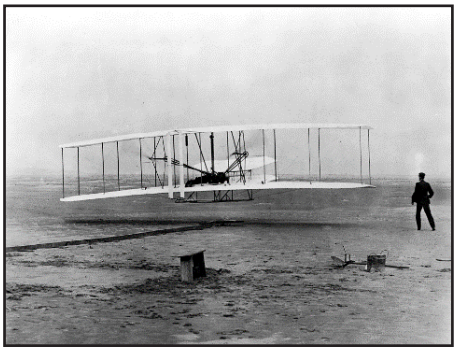
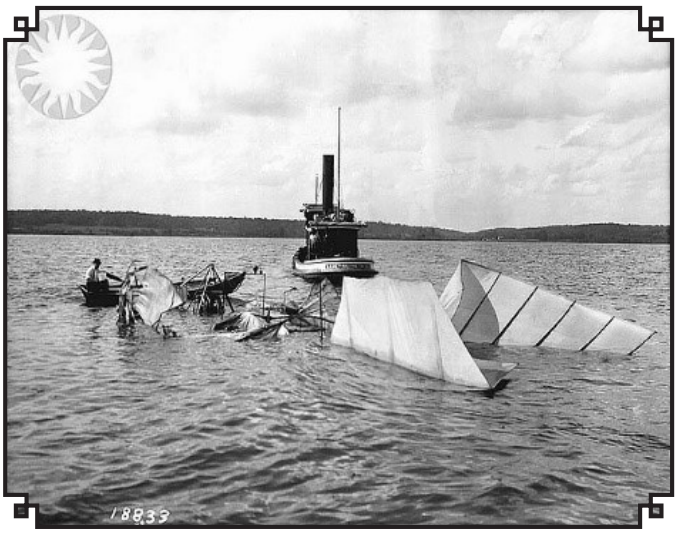


Fig 01 : First Flight

All of us try hard to grow up faster since we were infants. When we crawl we think of walking, when we walk we think of running. But there were two crazy brothers who wanted to think a bit more stupid than all of us, "the common people". They thought of flying when they started running. And yes, we were barely driving at that time! The legendary Wright brothers Orville and Wilber were these crazy brothers who wanted to jump over the wall but went through it. Today their crazy efforts have been responsible for one of the best inventions in the world, THE AIRCRAFT! This has the informal reputation of being the first man made machine that made all human beings to open their mouth, widen their eyes and say wow!, while looking up to see it fly. From the first day of 1903, when these brothers were able to keep their dreams above the ground for 59 seconds , we have come a long way to travel from our home nation to literally any place we like (even to the North Pole if you really want to).

Fig 01 : Wright Brothers



There is no end or limit to how

Fig 02 : SapceX 'Falcon 9' (Landing)

crazy people can be, and no one likes to be second to anyone else, and that is why today we have excelled the Wright brothers, and come this far to reach places that they could not, through sky.

There is a famous saying "Time is Money", and Speed is equal to Distance divided by time. Even a 5 year old child knows that the greater the speeds we reach, the more money we make. A 5 year old does not know that, but they also have the tendency to do things faster and then sit and cry. That is why we seek faster ways to get things done, not to cry, but to sit and relax.
People in aviation use big words like efficiency, safety, quality, and accuracy, but ultimately what is necessary is to get things done quickly. So our life goal is to make flying faster (safer too, otherwise no one will dare to fly!). Today global aviation has reached a point where it is possible to fly 15,348kms in 18.38hours. That is impressive!

Fig 03 : Concorde

Why do we need to go faster?

What is impressive is when we reach the level that we can not break the natural barrier. You can google and find out who Elone Musk is. You will then think that this man is so greedy that he has so much of money, and yet wants to reuse the same rocket again and again. But that is how it was possible to break natural barriers. Today it is possible to use the big boy in aviation "The Airbus A380" to carry 550 passengers including the crew in a single flight to any destination. People are still "apex" predators, and the competitiveness that comes with nature is still in the genes. It is possible to take many people for a long distance, but only a few need to go quicker than the others.

Fig 04 : Burning Engine of Concorde

Fig 05 : Concorde Crash Site

If light is made out of particles why is it not possible to travel like light quicker than anyone else? Thus it is possible to keep pushing the limits. The common fast planes for people are "Jets", where even the name sounds fast. But a jet is the flow of air out of the engines, where with different flows come different names, such as subsonic, supersonic and hypersonic. These are basically regions of air flow out of the engine and around the

Fig 06 : Lockheed SR-71 "Blackbird"

aircraft, which are differentiated with the speed. Though it has still not been possible to reach the speed of light, it has been possible to break through the speed of sound.

It has been possible to send people through the skies at the speed of sound. Are we satisfied? Not yet is the answer. Now the craze is to go beyond the speed of sound, at 5 to 10 times higher speeds. That is the stage that hypersonic aircrafts have reached. The names Kfir, Mig and F-35 are well known (at least in movies). These are the jets that have broken the sound barrier, and flown beyond the speed of sound. Why is it not possible to send more people at the speed of sound? As a matter of fact it can be done and it has been done. How, unfortunately this did not end well. The Supersonic civil aircraft "Concorde" was built in 1976 to make life a bit easier, but failed to serve the purpose for which it was meant.

The British-French Turbojet plane was able to deliver high-end supersonic transport for commercial purposes from 1976 to 2003 with the performance over Mach 2.04 (2,180km/h). Being one of the two supersonic money-makers the other was the Soviet-built Tupolev Tu – 144, which demonstrated the Russian competitiveness in this field since 1977. But with great achievements come great catastrophies as well.

But what may not be known is that everyone who flew in this marvel spent $12,500, valued at the 2018 Dollar rate (approximately Rs. 2.2 mill) for a round trip to New York-London and back, which is 30 times the normal fare to fly the same route. The 25th of July 2000 can be considered one of the darkest day in the aviation industry, when 109 people died in a single piece of debry where a 43.5 cm long and 3.4cm wide skid from the tire led to the piercing of the fuel tank which then started a fire in the engine, causing this huge beast to scream down to the ground like a firework. (You can read further about this crash by searching for Air France flight 4590).

This does not mean that people will give up with such disasters, when their is motivation to accomplish harder things and more noble things in life. The Concorde flew for 3 more years till it retired in 2003. In 2018 NASA revealed the resurrection of the Concorde, with the introduction of the second generation of supersonic passenger carriers, and is on the verge of giving more speed to peoples' lives. The X-59 QueSST, the brother of Concorde, is to scream in the airspace of US in 2023. Hopefully, for the best this time!

How fast can we get?

If one goes supersonic, it may be possible for everyone to go faster. That is where people walk to the edge of the flat earth and understand that it is round, and that helps them to walk further, towards the hypersonic region.

Today there are future designs that are seen only in science fiction and dreams. Everything starts with a dream, but it may not be the same person who achieves it in the end. However, there are dreams that may reach reality. Hypersonic dream is now in the second stage of scientific discovery. It is in the design stage, with a number of conceptual and theoretical designs in hand.

Many may have watched X- men, and imagined how cool it would be to have the X-plane. US Air Force had the real experience with it, reaching 3 times faster than the speed of sound. Untill the Lockheed SR-71 Blackbird was featured in the X-men movie, no one thought that this kind of aircraft can exist. But since 1960s, and retiring in 1998, the blackbird had cruised through the skies spying on everyone. The X-men's X-plane and the Blackbird are in figure 6. We have heard how fast the X-plane can fly, but Lockheed company and USAF have seen how fast it can fly with a top speed of 3,529km/h, and the world has understood that they can push the limits further. Being the fastest air-breathing manned aircraft since 1976 the urge for even higher speeds has not ceased. Now we are in the age of hypersonic aircrafts, and the race has begun.
As could be expected the

competition is between the worlds' top superpowers, USA and Russia. USA is now in the lead with Boeing X-51 Waverider, which is an unmanned experimental aircraft reaching 5 times the speed of sound (Mach 5) and that is around 6,174km/h. Where is Russia? Have they given up the race?
Russia is far ahead with lesser conventionality in certain aspects. The Avangard (Hypersonic glide vehicle) is the latest hypersonic aircraft of Russian origin. While Americans' have pushed the limits from Mach 12, Russians' have pushed the Mach 20 range with just payload. This is a design inspired by the Waverider design.
'Waverider' design is not magic but a surfboard, which rides the sea waves. In this, a wedge – shaped fuselage is specially designed to generate lift, as the air density is much less at high altitudes, whereas it would be really hard to gain any lift with conventional wing shapes. With this shape, that problem is no longer there, as it gains lift by surfing on the shockwaves generated.

Fig 07 : World Giants' Hypersonic Race

Shockwave is a specific phenomenon that happens when any object moves faster than the speed of sound. In simple terms, the air that is pushed by the object creates an area with increased pressure which is then preferred to as a 'pressure front'. When this pressure front move at supersonic speed, it creates a dense and pressured air cloud which is called a shock-wave.

Most of you might know or have seen the cone shaped cloud generating around the aircraft when it flies super-fast. As shown in the figure this cloud is formed due to condensation of water vapour in air. This happens when the air pressure around the aircraft drops, and so does the temperature, creating a cloud around it. That is how someone can show to a friend that, this jet is flying faster than the speed of sound.

Fig 08 : Sonicboom

The concept design of HyperSoar aircraft which focused on passenger transport, was developed to reach Mach 12 (14,700km/h), but there were so many barriers to overcome. How can a plane go that fast and not burn up to ashes? In fact it will burn up to ashes.

In the case of rockets, the necessity is to gain the speed to reach outer space so it could glide. If that is possible, the same process can be used for the plane as well. The HyperSoar is being developed to jump at hypersonic speed to outer space, and there after have a sustained glide and keep on jumping.

Though theoretically it is possible to achieve this goal, in practical conditions, it is likely that future generation may have the opportunity of witnessing what we can only observe today in fiction.

New Secrets (that I found while writing this article)
Riding a Supersonic Shockwave

We all known about internet surfing, sea wave surfing, crowed surfing etc. but here is the extreme end of surfing which no one might ever be able to physically do in one's lifetime, and that is, "Shock-wave Surfing".
A shockwave is well known, but to ride that wave is insane. It was commented at the outset that humans are a little bit crazy and that craziness brings out the best ideas. Today it may not be an idea, but tomorrow who knows, someone may surf a shock-wave as well. This may be explained in the following terms.
One may dislike Newton for doing such a great job in finding his theories and then making our student lives even harder. But is it not well recognized that everything he said has been applied even in high speed air-travel? It was no doubt irritating to even remember how annoying physics was because of him, but here is what even Newton did not know after he passed on his knowledge, that crazies will take it to an extreme.

The Massachusetts Institute of Technology (MIT) has run simulations and a practical test with two nylon balls through a supersonic flow of air with Mach

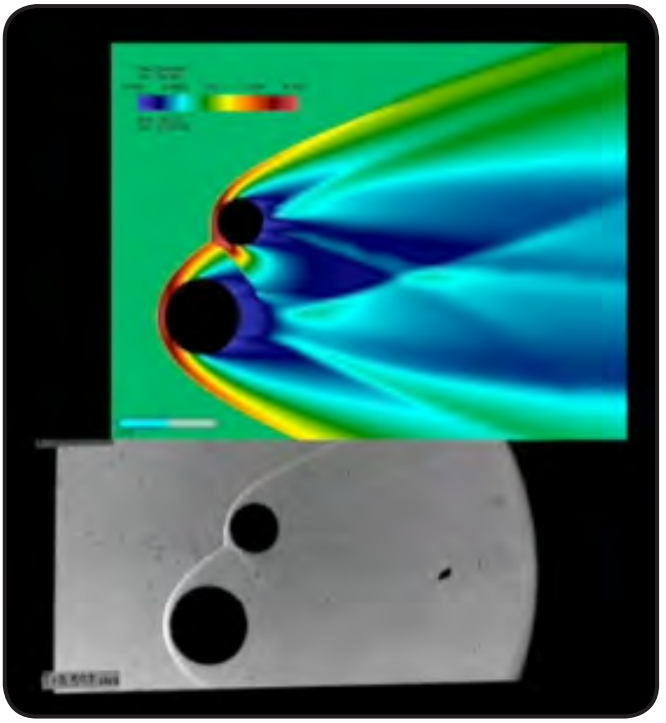


Fig 09 : Shockwave Surfing

4. The two balls while creating their own shock-waves, the aerodynamic forces acting on the smaller ball was able to work with Newton's 3rd law, and keep its trajectory with the force of the larger ball's shock-wave. This trajectory amazingly took the path of the bow wave of the larger ball and the small ball was surfing on that wave. The figure shows both the practical and simulational result of this Shock-wave surfing.

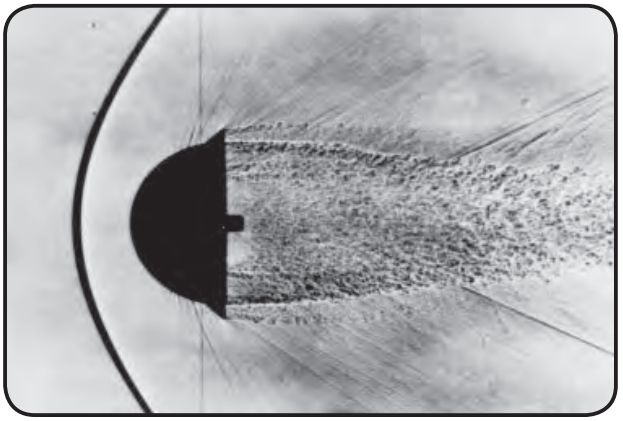


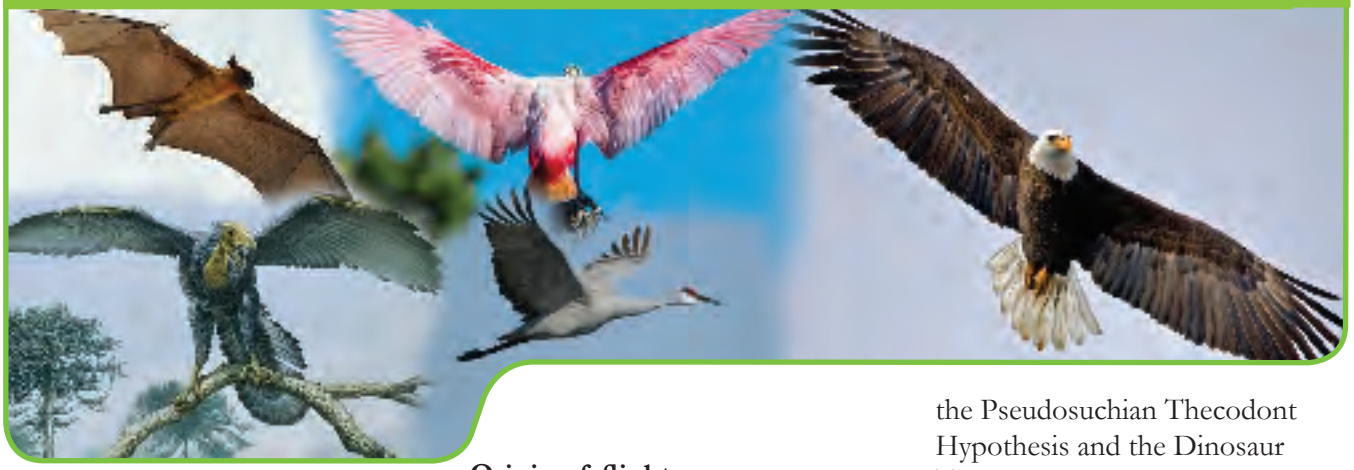
Fig 10 : Bow Shock

Shock-waves have its brothers and sisters too. Normal Shock-wave the big brother, Oblique Shock-wave, Bow Shock-wave, Moving Shock, Detonation Shock, Attached Shock and Recompression Shock.
Bow shock gets its name due to its shape. This shock –wave is detached from the object and shaped like a bow. This shape is shown in the image.
We as aviation enthusiasts have seen and are still seeing all the marvels in the world to rock the aviation science. Every day we try to make a breakthrough to achieve the impossible. Even in Sri Lanka we have great minds that have reached to the world's best, and pushed their limits to such extents that they have become legends. Dr Sarath Gunapala and Dr Keerthi Devendra are two of them who shook the world of science in aviation and rocketry.
Let this knowledge be of help to improve enthusiasm towards aviation in making the skies your home, and become legends for the generations to come. Let them be blessed to see the Planes jump and the Jets surf!

W.Dakshina T Fernando
Instructor Gr. II – General Sir John Kotelawala Defence University, Ratmalana

Aviation Fauna

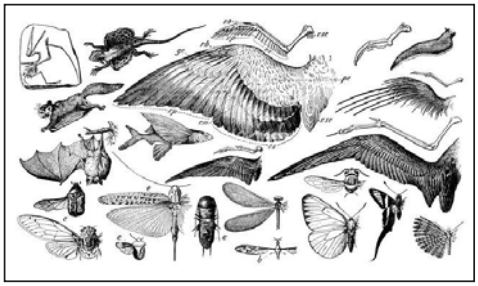
Dr D M Suratissa



Aviation fauna ranges from invertebrates to vertebrates comprising butterflies, insects, some fish, some reptiles, aves and mammals. It means that all these different groups of animals have different origins as flying objects, a phenomenon known as analogous. They use these capabilities to fly or glide. True flying animals have modified their fore limbs as wings which are strengthened by bones or membranes. All gliders do not have wings, but have their skin folded on the sides of the body and attached to the fore limbs and hind limbs, which expand when they need to glide from a high position to a low potition. Gliding is rudimentary flight displayed by certain types of fish (Exocoetus), amphibians (Rhachophorus), lizards (Draco), and in the case of some mammals, by some phalangers, flying lemurs and squirrels. Soaring and flapping are more efficient mechanisms, but need more profound morphological and physiological adaptations. Soaring flight is attained by certain birds, while flapping flight is accomplished both by birds and bats Here one can learn about the evolution of flight, and how animals were adapted to fly or glide.

Origin of flight

Flight is one of the most demanding adaptations found in nature because of the physical problems of moving in air. The common belief was that flight must have evolved from the trees down. Although most scientists agree that



birds have evolved or descended from reptiles, there is much coutroversy over from which group of reptiles' that birds evolved, and during which time period did they evolve. Two theories involved are the Pseudosuchian Thecodont Hypothesis and the Dinosaur Theory.

According to Pseudosuchian Thecodont Hypothesis, it has been suggested that birds evolved roughly 230 million years ago from small arboreal thecodonts.
On the other hand the Dinosaur Theory suggests that birds evolved about 150 million years ago from theropods, or bipedal carnivorous dinosaurs. The theropods are thought to have given rise to birds that existed in the Cretaceous period, 80 million years after *Archaeopteryx*.

Along with theories on evolution came theories for the evolution of flight. Scientists believe that feathers evolved from scales. There are several theories for the evolution of flight capabilities. These include Ground-up Theory, "Insect-net" Theory, and the Trees-

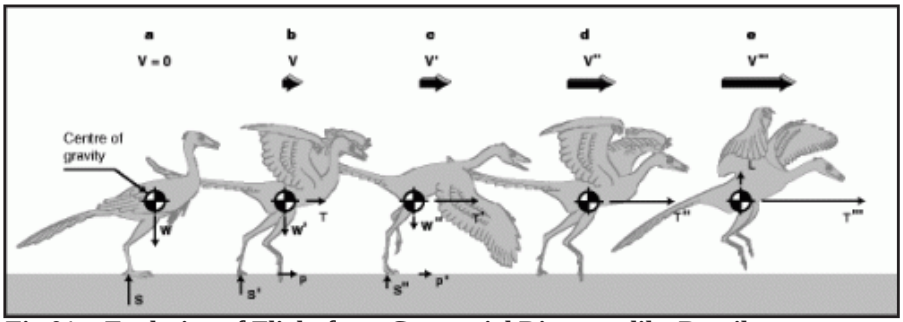


Fig 01 : Evolution of Flight from Coursorial Dinosaur like Reptile

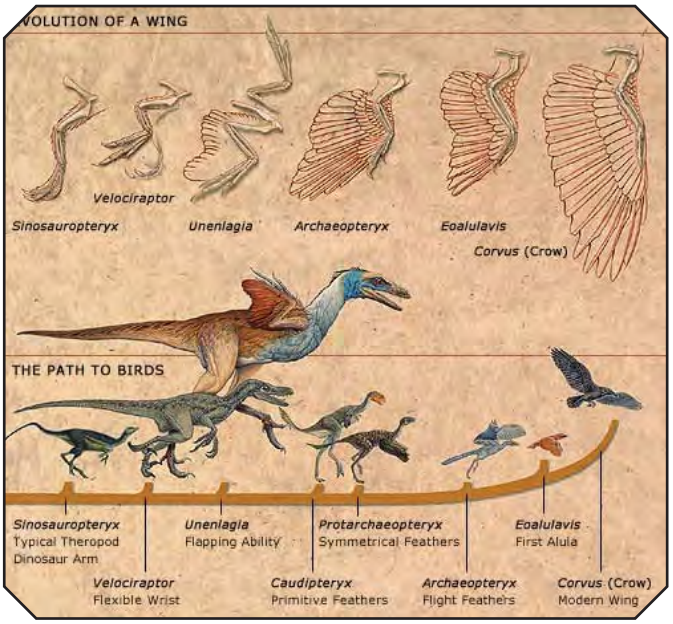


Fig 02: Evolution of a wing

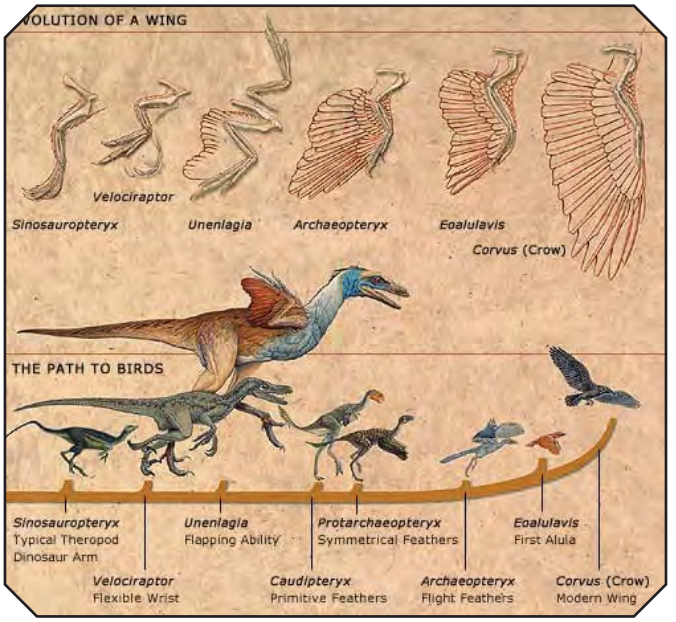


Fig 03: The evolutionary path towards birds

down Theory. Among these the Trees-Down Theory is the most widely accepted. According to this theory, the ancestors of birds were tree dwellers that jumped from branch to branch. Consequently, wings and feathers developed, allowing them to glide and fly.

This was the first animal that evolved with feathers and wings that showed moderate flight. *Archaeopteryx,* discovered in 1860, is the oldest known bird dating back to 150 million years. Its fossils were excavated out of Jurassic period limestone.

Archaeopteryx at first superficially resembled both a bird and a reptile. It was regarded as a primitive bird with feathers, but its fossilised skeleton looked more like that of a small dinosaur. It was amazing for a few reasons. It was about the size of a magpie. Unlike modern birds it had a full set of teeth, a long bony tail and three claws on its wings, which may have been used for grasping branches. It lacked the fully reversed toes which enable many modern birds to perch. In fact, except for the feathers, the bird-like feet, and the fact that it had a wishbone *(furcula)*, it did not really look like a bird. It was likely that though *Archaeopteryx* could fly, it probably did not have the full capacity to do so.

Fig 04: Fossil Archaeopteryx

Fig 05: Archaeopteryx- drawn by an artist

Pterosaurs

Pterosaurs (winged lizard)) hold a special place in the history of life on earth. They were the first creatures, other than insects, to successfully populate the skies. The evolution of Pterosaurs roughly paralleled that of their terrestrial cousins, the dinosaurs, as the small, "basal" species of the late Triassic period which gradually gave way to bigger, more advanced forms in the Jurassic and Cretaceous periods. The first Pterosaurs for which fossil evidence is available, flourished during the middle to late Triassic period, that is about 230 to 200 million years ago. These flying reptiles were characterized by their small size, long tails and obscure anatomical features. The key trait that distinguished Pterosaurs from land-bound feathered dinosaurs that evolved into birds, was the nature of their "wings", which consisted of wide flaps of skin


Fig 06: Pterosaurs – Flying Reptiles during Mesozoic Era

connected to an extended finger on each hand. Although these flat, broad structures provided enough lift, they may have been better suited to passive gliding than for powered, flapping flight.

Origin of birds

Birds constitute a very specialized group of vertebrates which had evolved from reptiles during Mesozoic era. Finally, three hypotheses appeared on the origin of birds.

1. Therapod Dinosaur Hypothesis: The first hypothesis assumed that they came from the therapod dinosaurs.
2. The second hypothesis assumed that they came from crocodiles because they had an endolymphatic duct.
3. The third hypothesis claimed that it was neither the dinosaur line nor the crocodile line, reasoning that several dinosaurs were already very specialized.

Evidences in Favor of Reptilian Origin of Birds

Reptiles and birds appear quite different from external appearance, but both these classes of verte brates were basically similar. Birds are basically reptilian and the characters which distinguish a bird from a reptile were due to formers adaptation to aerial life.

Flight adaptations in birds

Unique avian characters

- Body contour-Stream lined body
- Presence of feathers
- Forelimb modified into wings
- Lack of teeth
- Many bones fused or reduced
- Bones pneumatized or air-filled
- Forelimbs specialized for flight
- Body Mass highly centralized
- Increased ability to withstand metabolic stress
- Unique respiratory system with air sacs
- Reproductive system comprise a single ovary which matured only during the reproductive season Streamlined body
- All birds have streamlined bodies. Since speed is a must for aerial life, it is necessary to minimize the resistance offered by air during flight. Hence the bodies of birds are fusiform or spindle-shaped, and lacks any extra projections which may offer resistance in the attainment of speed in air, like in the case of fish in water. During flight the air molecules must rapidly flow through the upper and lower surface of their body. If a bird has no streamlined body, air molecules will not be able to pass through its body smoothly, and hence will cause a considerable extent of friction. Therefore a bird needs a streamlined body, because that is the only perfect shape that can effectively reduce the aerodynamic drag, and consequently save more energy during flight.

All birds have feathers and share a common structure. A feather is a unique adaptation. A feather is lightweight, durable structure which is made mostly of keratins. Adaptations of feathers allow them to be used for specialized roles. Feathers provide insulation, waterproofing, and a lightweight to become airborne. There are many different kinds of feathers. They are contour feathers,down feathers, semiplumes , filoplumes ,and bristles.

Contour Feathers - Contour Feathers cover the body and wings. They are often asymmetrical and provide an aerodynamic shape to the wings. The smooth and streamlined surface is achieved because the feathers' barbs are joined together with barbules (branches on the barbs). The contour feathers used for flight are known as remiges (wing feathers and rectrices tail feathers).

Down Feathers - Down Feathers are simple in structure, and have no hooks or barbules. Their primary function is insulation.

A semiplume - Semiplume looks like a cross between a contour feather and a down feather providing insulation. Therefore it


Fig 07: Wing of bird with contour Feathers

Fig 08: Structure of a contour feather

Fig 09: Down Feathers

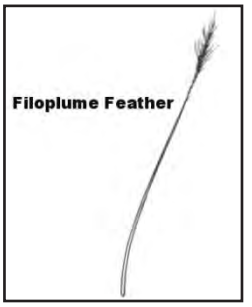
Fig 10: Semiplume Feather and Filoplume Feather

makes the bird more aerodynamic. Filoplumes - Filoplumes are long and hair-like feathers, which are sensory in function. Sensory corpuscles at the base of each filoplume allows a bird in flight to know the position of each of its feathers.

Forelimbs modified into wings

The forelimbs have transformed into unique and powerful propelling organs, the wings. During rest they remain folded against the sides of the body, but during flight they become expanded.
The surface area of the wings is increased by the development of elongated flight-feathers, the remiges. Infact the particular shape of the wing causes reduction in air pressure above, and increase below, with minimum turbulence behind. This helps in driving the bird forwards and upwards during flight.

The wing feathers are made up of primary,secondary and tertiary feathers. Primary feathers are the largest of the flight feathers and propel the bird through the air. They are the farthest away from the body, attached to the skin of the wing on the 'hand' of the bird. In most bird species, there are 10 primary feathers on each wing. If these flight feathers are damaged or lost, a bird cannot fly. Secondary feathers are those that run along the 'arm' of the wing, and sustain the bird in the air, giving it lift. The number of secondary feathers vary with different species. Feathers on a bird's wings provide a lightweight, but at the same time provides a solid surface to push against the air. When the wing flaps downwards, the feathers mesh together, and then part to allow air through as it sweeps upward again. While allowing it to fly, a bird's feathers keep it warm and dry.



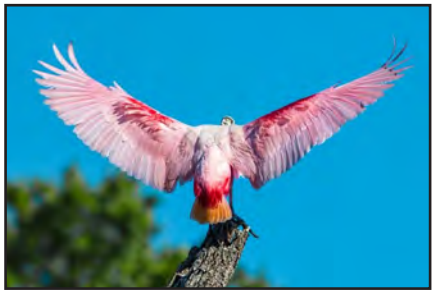


Fig 11: Wings of the Flying birds showing primaries, secondary and tertiary

Lack of Teeth

Birds lack teeth because flight requires a highly centralized body mass with light extremities. Therefore a bird's head must be very light. Teeth of the jaws for

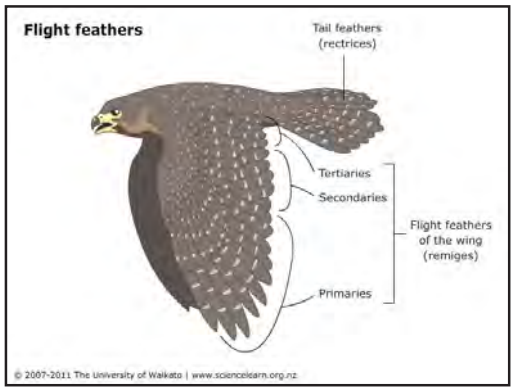


Fig 12: Flight Feathers

birds are no longer necessary. Instead of using teeth to tear food into pieces, birds use one of two strategies. They will either eat only food items of a size that they can swallow or they will have a beak which is adapted for tearing food.

Many Bones are fused or reduced

A bird's skeleton is designed for flight.For that purpose many bones are fused or reduced in size thereby reducing the mass of the skeleton, and redistributing mass towards the centre of the body. The main fused bone of the bird skeleton is known as synsacrum, which is made by fusing of the last thorasic vertebrae, lumbar vertebrae, sacral vertebrae and pelvic girdle.

Bones Pneumatized or Air-Filled

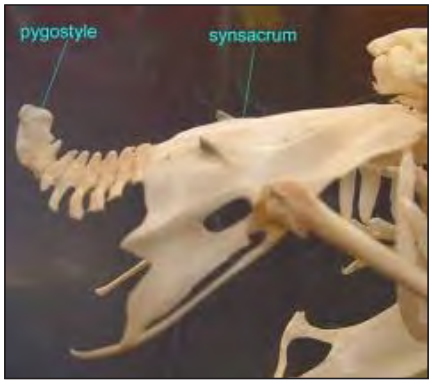


Fig 14 : Synsacrum of a Bird

Many bones in a bird's body are pneumatized.They contain large air pockets that are connected to the respiratory system. Therefore bird bones are very light. Small bone struts in the air pockets provide strength. Different species of birds show differing degrees of pneumatization. Small birds tend to show less pneumatization than large birds, and in birds adapted for diving, there is hardly any pneumatization at all.

Body Mass Highly Centralized

Apart from bones, the tissues and organs of birds have the same mass as mammalian size equivalents. But most of a bird's overall mass is found in its torso. The centre of mass in a bird is found between the wings. The limbs are far less muscled, compared with those of a typical mammal. Major flight muscles are located in the pectoral region rather than on the wings themselves. Birds also have very small heads and short, stubby tails. This also helps reducing the mass of the extremities.

Increased Ability to Withstand Metabolic Stress

Birds have the highest metabolic rate for their size of any vertebrate. A high metabolic rate allows them to fly efficiently. The fastest metabolic rates are found among the smallest birds like hummingbirds. Also, high metabolic rates allow some birds to fly at very high altitudes.Hence, they release fecal matter while they are flying which helps them to reduce their body weight.

Unique Respiratory System

The avian respiratory system is

Fig 13: Beak of the bird

unlike any other animal. It is composed of a sponge like lung, and a number of membranous air sacs. In the lung, the air channels, or bronchioles, run cross-current to the circulating blood. The transfer of oxygen from air to blood is extremely efficient, and because the lung does not expand when air passes through it, there is no change in the aerodynamics of a bird in flight. The air sacs fill and empty in a two-breath cycle, ensuring a constant flow of air through the lungs.

Reproductive system with a single ovary

In female birds, the presence of a single functional ovary on left side also leads to a reduction of body weight which is essential for flight. Thus, it is evident that birds are fully developed for terrestrial, arboreal and aerial environments.

Fig 15 : Pneumatized Bones of Birds

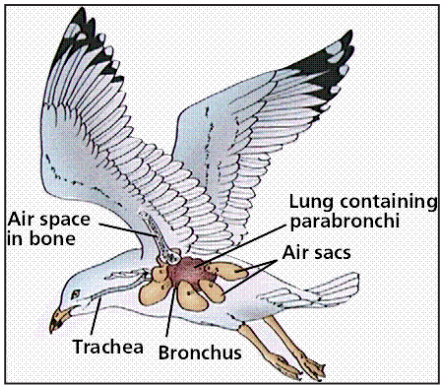


Fig 16 : Bird showing lungs and air sacs

modified to live on trees. Their mode of living is named as arboreal. Arboreal mammals are able to climb the trees and use their branches as the highways. There are three possible modes of aerial locomotion or flight namely, gliding, soaring and flapping. Gliding is the rudimentary flight, displayed among some mammals by some phalangers, flying lemurs and squirrels. Soaring and flapping are more efficient, and need more profound morphological and physiological adaptations. Soaring flight is attained by certain birds, while flapping flight is accomplished by both birds and bats.

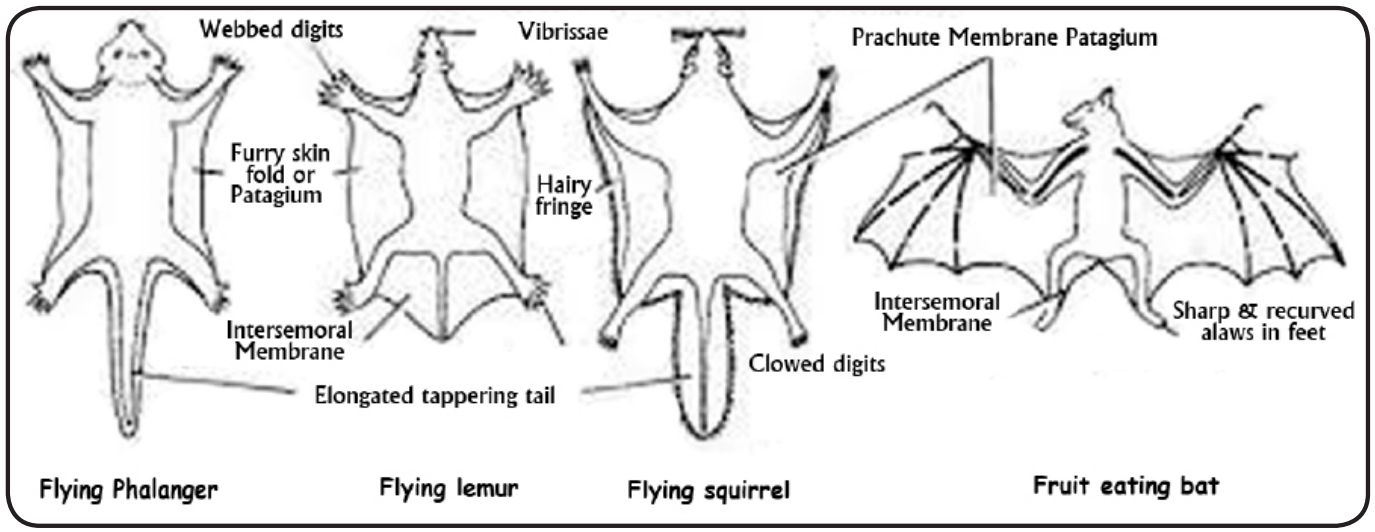


Fig 17 : Gliding and flying mammals

Fig 18 : Gliding Mammals

Gliding and flapping flight

Many mammals specially living in forest areas have become elongated, flattened and streamlined body. Their limbs are long and equal. Tail is long and gradually tapering. The double fold of furred skin, called patagium can be seen, or there is a parachute membrane that is stretched on either lateral side between neck, limbs, body and tail. It is sometimes also provided with a cartilaginous rod springing from the elbow or wrist. When the animal is at rest, the parachute is visible, as it remains folded close to the body by its own elasticity.

Gliding Mammals

Common examples are
(i) Order Marsupialia: Flying phalangers (Petaurus) and feather tails (Acrobates).
(ii) Order Dermoptera: Flying lemurs
(iii) Order Rodentia: Flying squirrels

Gliding Adaptations

Gliding mammals have an

Nature of Gliding Flight

Gliding is not a true continuous flight, It is merely a prolonged aerial leap, covering 10 to 20 metres at the most. This type of movement involves no propulsion other than the initial force of jumping. Gliding is characterized by leaping or jumping from a high point, and holding up by some sustaining organs, and finally gliding to a lower level. Thus, there is no locomotive force other than gravity.
The gliding mammals glide from one tree to another smoothly, and then swiftly downwards, supported by the outstretched parachute

Fig 19: Wings of Bats

and limbs. Aerial progress is in a straight line, rapidly losing height with little manoeuvrability. However, the flight can be guided to some degree by changing the position of the limbs, and by twisting the parachute membrane using the tail. Before alighting the animal raises the front body part to check speed and to soften its impact on the landing target.

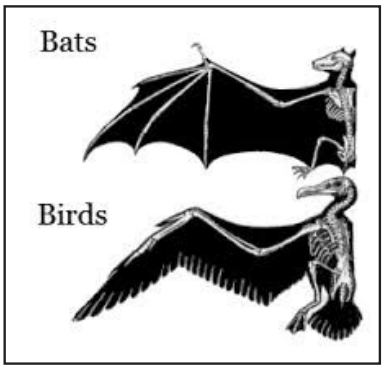
Flapping or Flying Mammals and Adaptations (Bats)

Bats belong to the order Chiroptera. Bats are the only mammals which have attained powered flapping flights. Though bats fly, their anatomy is more closely related to humans than to birds.

Flight Adaptations of Bats

Bats possess many adaptations which are infinitely more profound. The modifications are not so conspicuous in their external features. But radical changes have taken place internally in their skeleton and musculature.
Wings - Wings or patagia of bats are thin like a paper and elastic membranes. Bat wings are highly articulated with independent joints and a thin flexible membrane covering them. Their wings are similar in structure to the human arm and hand.

Forearm is greatly elongated, carrying a hand with 5 fingers. In small insectivorous Micro-chiropterans, the first finger or pollex is short, free and sharply clawed. The other 4 fingers are clawless, enormously lengthened



and embedded in the web of wing to support it. In large fruit-eating bats or Mega-chiropterans, the 2nd finger also ends in a claw. The 3rd finger is the largest, corresponding to the leading edge of the wing membrane. The muscles and other body structures are specially designed in bats to support and operate the wings. The keeled sternum offers space for the attachment of great pectoral muscles which sustain the arms in flight.

Legs - In bats the hind legs are small, weak and with sharp curved claws on toes. Knee-joints are directed backwards which helps in maximum spread of wing membranes, but is of little help in other movements.
Tail - In bats, the tail is variable in size. It may be large, small or scarcely visible. When well developed, the tail supports the inter-femoral membrane which can act as a brake to flight.

Modern aviation

Aeroplanes

Aeroplanes owe much of their design to birds, and now it appears that man-made flying machines and birds have more in common than ever. People have looked up at birds for years, and they have inspired us to fly. Airplanes have wings like birds. They also have a light skeleton to decrease their weight, and they have a streamlined shape to decrease drag.The big difference is that airplanes do not flap their wings. Airplane wings are designed to create lift by changing the pressure, rather than by flapping them up and down.
Flight of the drones
Scientists look to the natural world

Fig 20 : Comparison of Bird Wing and Bat Wing

for inspiration, investigating the adaptations that allow winged animals to efficiently navigate through the air, even under difficult conditions. Aerial drones are ever more sophisticated, and are likely to continue to improve in performance as scientists uncover more of the secrets and success of slying in insects', bats' and birds.

Dr. D.M.Suratissa
Department of Zoology and Environmental Sciences
University of Colombo,
Colombo 03

Future Advances of Aviation

T. Chandana Peiris

We know birds and insects can fly. Gliders, hang-gliders, kites and boomerangs fly as well. For thousands of years people also have wanted to fly. Humans and animals are unable to fly because they do not have wings and a power source strong enough to keep the wings moving through the air to sustain the lift necessary for a flight.

On December 17, 1903, Wilbur and Orville Wright brothers piloted the first powered airplane at a height of 20 feet above a wind-swept beach in North Carolina. The flight lasted 12 seconds and covered 120 feet. According to the International Air Transport Association (IATA), in 2016 there had been a staggering 3.8 billion air travellers, and predicted that it will increase to 7.2 billion passengers by 2035, a near doubling of current levels. Most of this boost in traffic is expected to come from the Asia-Pacific region (which includes Asia, Australia, and New Zealand). U.S. airplane manufacturer Boeing, forecasts (projects) that worldwide demand for aircraft will top 39,000 planes in the next 20 years, of which over 15,000 will be headed to Asian markets.

Three factors are inducing more passengers in planes. "The first is the expansion of economies and the rise in incomes in Asia and Africa. Cheaper airfares, with more efficient planes and competition, are also making air travel more accessible.

However despite economic benefits, these passengers will also bring concerns about noise and air pollution, terrorism as well as the spread of diseases. This paper discusses the principles of flight, history of flight timeline, current challenges as well as the impact of aviation, and future development of aviation.

2. Principles of Flight :

Flights and birds are both affected by the same forces in flying. Four main forces which affect the flight abilities are weight, lift, thrust and drag.

Gravity is a force that pulls everything towards the Earth's surface, which is known as the weight force. Planes must be able to provide enough lift force to oppose the weight force. Lift is a force that acts upwards against weight, and is caused by the air moving over and under the wings.

Thrust is provided by muscles for birds and other flying animals. Thrust is provided by the engine

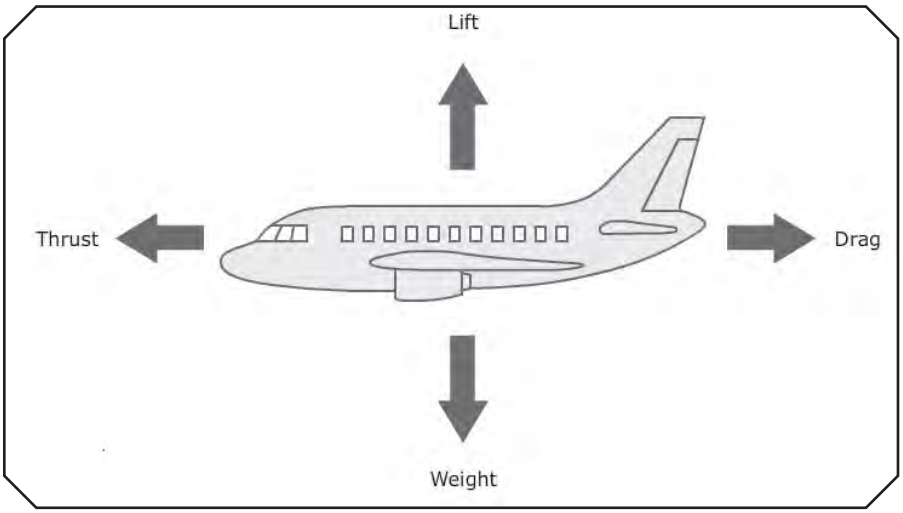


Fig : Forces affecting flight

Fig : Pre 1700s

Fig : 1800s

Fig : 1920s

for flying machines. The force working against the thrust is called drag. It is caused by air resistance, and acts in the opposite direction to the motion. The amount of drag depends on the shape of the object, the density of the air and the speed of the object. Thrust can overcome or counteract the force of drag. An object in flight is constantly engaged in the opposing forces of lift against weight (gravity), and the thrust against drag.

Fig : 1950s

Fig : 1980s

2010s

3. History of Flight Timeline

Around 400 BC Chinese discovered the kite that could fly in the air. Kites were used by the Chinese in religious ceremonies. They built many colourful kites for fun. More sophisticated kites were used to test weather conditions. Kites have been important to the invention of flight as they were the forerunner to balloons and gliders.
It is generally recognized that Wilbur and Orville Wright brothers were credited with the first real flight, which took place on 17 December 1903.

British inventor Frank Whittle invented the jet engine in 1930.First human lunar landing took place on July 20, 1969, when astronauts Neil Armstrong and "Buzz" Aldrin landed on the lunar surface. Today's aerospace revolution starting from the earliest dreams of flying in an atmosphere, to reach the planet through a rocket, is indicated in following figure.
Manufacturer Terrafugia introduced a roadable aircraft in 2011, when an aeroplane that can take off and land at any airport, can with the push of a button, fold up its wings and drive down the road.

4. What is Aviation Science?

Aviation science is the study of basic components required for a career in this industry. Aviation science includes all the support systems that keep airlines running in a safe, efficient and orderly fashion, including air traffic control, airport operations, airline management, maintenance and piloting an aircraft. The field of aviation has blossomed into a rich industry in which new breakthroughs happen almost daily.

5. Benefits of Aviation

Aviation is one of the most "global" industries which connects people, cultures and businesses across continents. Aviation provides the only rapid worldwide transportation network, which makes it essential for global business. It generates economic growth, creates jobs, and facilitates international trade and tourism. The air transport industry has also supported a total of 62.4 million

Fig : Roadable aircraft

jobs globally. It has provided 9.6 million direct jobs. Airlines, air navigation service providers and airports directly have employed over 3 million people. The civil aerospace sector (the manufacture of aircraft, systems and engines) employed 1.1 million people. A further 5.5 million work in airports at different positions. About 52.8 million indirect employment, such as tourism-related jobs have been generated through aviation.
The indirect impacts include employment and economic activity generated by suppliers to the aviation industry which include aviation fuel suppliers, construction companies that build airport facilities, suppliers of sub-components used in aircraft, manufacturers of goods sold in airport retail outlets, and a wide variety of other activities in the business services sector (such as call centres, information technology and accountancy).

Aviation continuously expands. It has weathered crises and demonstrated long-term resilience, becoming an indispensable means of transport. Historically it has been found that air transport had doubled in size every fifteen years, and has grown faster than most other industries. In 2016, airlines worldwide carried around 3.8 billion passengers, and 53 million tons of freight.

One of the industries that rely most heavily on aviation is tourism. By facilitating tourism, air transport helps to generate economic growth, consequently of poverty alleviation. Currently, approximately 1.2 billion tourists are crossing borders every year, over half of whom travelled to their destinations by air.

Aviation creates unique possibilities for empowering nations and peoples, regardless of their geographic location. It is a means of allowing people to access what they need: improved livelihoods, food, healthcare, education, safe communities and spaces, etc.

6. Current Challenges and Impact of Aviation

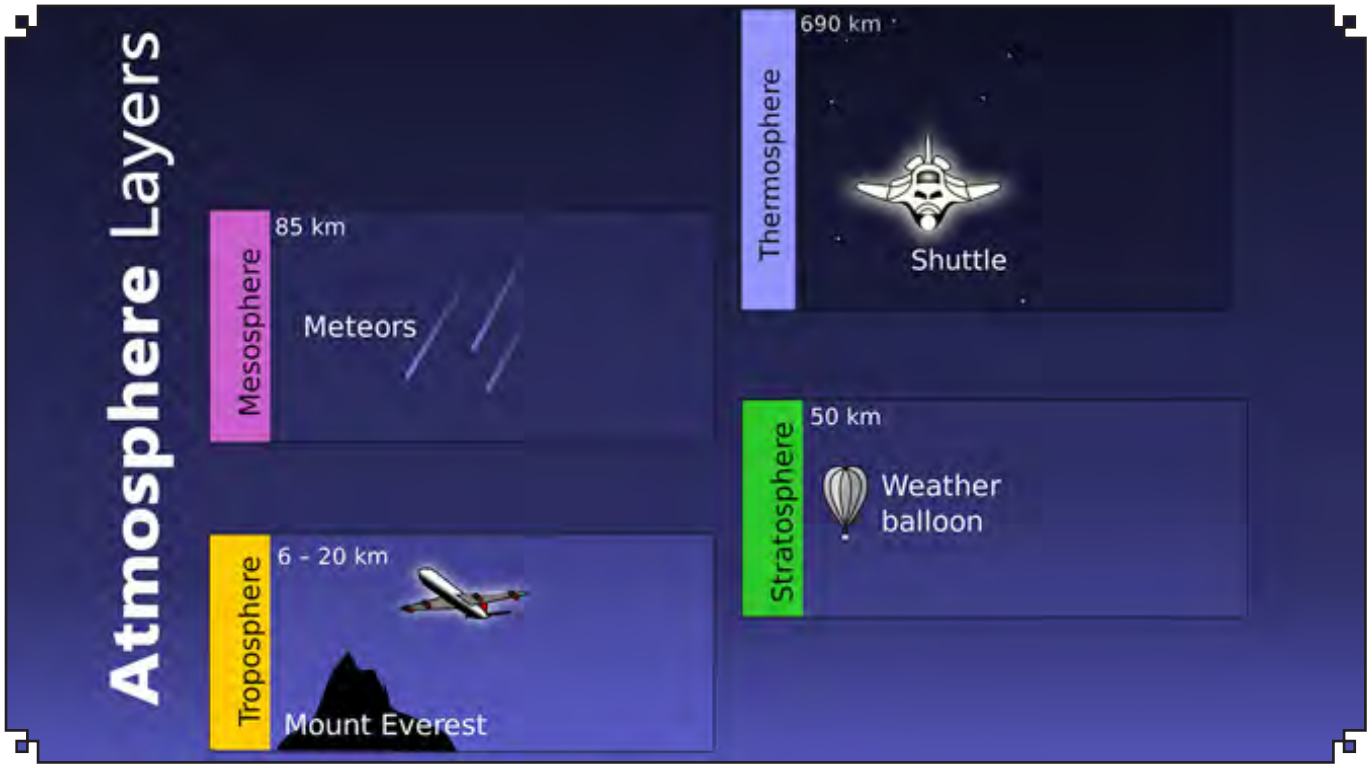
Aviation is one of the main drivers behind globalization, and the driving force towards development of the modern world.
The air travel industry has played a major role in global development. Worldwide, there are more than 2,000 airlines with over 23,000 aircrafts serving 3,700 airports. Air travel has grown continuously. The industry is expected to continue to grow at the same rate with the possibility of doubling total air travel in the next 15 years. Air travel has gone through extreme changes; from innovating technological advancements to security requirements.

Air travel is associated with several environmental, economic, and social benefits, as well as damages. Flying is a major contributor to air pollution, greenhouse gases, climate change, and noise pollution. The best solution to improve environmental, economic, and social components of the aviation industry is to transit towards fuel-efficient systems. More fuel-efficient airplanes will decrease greenhouse gas emissions, as well as decrease costs for both airlines and customers in the long run, and improve the social experience for passengers and airline workers. Though growth is enormous, there are yet some challenges in the aviation sector that airlines are facing. The current challenges or issues in the airline industries are:

(a) Security in the sky: Safety and security are the greatest challenges that this industry is facing. Airports, governments and airlines need to find out new and innovative ways, so that they can enhance their security, without compromising their service and overall comfort of the passengers.
According to IATA, in 2017 the estimated number of commercial flights was 36.8 million, excluding private, business and military aviation. In 2013 there were some 36.4 million flights and 16 fatal accidents.

(b) Aircraft Noise: Noise has historically been the principal environmental issue for aviation. It remains high on the agenda of public concern. Noise disturbance is a difficult issue to evaluate as it is open to subjective reactions. Its impact is not a lasting one on the actual environment, but it can have significant adverse effects on people living close to an airport, including: interference with communication, sleep disturbance, annoyance responses, learning acquisition, performance effects and cardiovascular and psycho-physiological effects.

(c) Customer satisfaction: Customers are the key to the growth of any business, and aviation industry is also trying to appease their customers. Nowadays, everyone owns a Smartphone with a stable internet connection which will help them to stay connected with the rest of the world. If the customers are not happy or satisfied with Airline services or offers, they



will certainly tend to give a negative feedback about the airline and will circulate it on various social media platforms. If this happens it will certainly tarnish the brand image and businesses. So, aviation people try to make more personalised interaction with their customers, and would try to improve their customer service score.
Technology: Advances in technology is another big challenge in the aviation industry. Like any other sector, the aviation industry has been impacted by the move for digitalization.

(d) New technology aircraft: As technology has penetrated to every sphere of life, new aircraft are being launched in the market. And the number of variants introduced by manufacturers has made the situation more complicated. Modern aircraft entering into airline fleets today bring with them fuel efficiency gains of 20-30% over their predecessors.

Today's aerospace and aircraft manufacturing industry seeks to produce more efficient aircraft. Modern aircraft produced today are about 80 per cent more fuel efficient per passenger kilometre than in the 1960s, and each new generation of aircraft continues this downward trend.

There are three significant regions of the atmosphere which concerns aircraft engine emissions and their impact on the environment: the free troposphere, the stratosphere, and the planetary boundary layer. The troposphere is where almost all weather related activities take place (clouds, precipitation, etc.), and extends from the ground level to about 15 km at the equator, and about 8 km at the poles. Because there is significant mixing in the troposphere due to weather systems, pollutants travel relatively freely once they are out of the layer of the atmosphere in contact with the ground (the planetary boundary layer, which is the part of the troposphere closest to the ground). Most ground emissions of air pollants stay in the boundary layer for several hours or days, and are restricted to local or regional impacts. The troposphere above the boundary layer is the free troposphere. The stratosphere has much less mixing than the troposphere. Therefore when pollutants enter the stratosphere, they generally remain there for long periods.

The significance of aircraft emissions is that these emmissions alone are directly injected into the free troposphere, and even to the stratosphere, as well as the planetary boundary layer. The main emissions of concern for climate issues are:
• Carbon dioxide (CO_2) - this has a long lifetime in the atmosphere and is the principal culprit of global warming.
• Nitrogen oxides (NOx) - almost




Fig : Credit: NASA **Credit: NASA/Boeing** **Credit: NASA/Lockheed Martin** **Credit: NASA/Cal Poly**

any combustion process in the atmosphere (which is 79% nitrogen) creates NOx. NOx is involved in atmospheric chemistry with ozone, and supports "acid rain" processes. Through the creation of ozone (O_3) in the troposphere NOx contributes to global warming. In the stratosphere, NOx is involved in chemistry which damages the ozone layer.

• Water vapour - Recent work has highlighted the potential climatic impact of clouds formed (partly) from the water vapour emissions (e.g. contrails) which is a normal by-product of fuel combustion. High thin cloud has an important role in climate issues, and changes to its amount and geographical distribution may be significant.
• Smoke and other particulates - Smoke and other particles and some sulphur compounds emitted by engines form effective nuclei for cloud droplets. At low altitudes, smoke contributes to local air pollution while higher in the atmosphere it may be involved in cloud formation, and thus in climate.

7. Future development of Aviation

Faster and more fuel-efficient aircrafts, planes that run on solar power, bigger windows, and fancier interior are the endless possibilities. As technology continues to improve, so will be the advancements in aviation. Aviation sector must make a genuine commitment to achieve Sustainable Development Goals (SGDs) with safe, affordable, accessible, efficient, and resilient aircrafts while minimizing carbon and other emissions that cause environmental impacts in future. Aviation is one of the most innovative industries in the world. The manufacturing sector is continually developing new technology, creating significant urban infrastructure development through the construction of airports and navigational infrastructure.

i. The future is Green

It's a well-known fact that many of the technologies used in aviation today are environmentally unsustainable. Flight emissions comprise one of the many culprits that contribute to this problem. Current market trend is towards more environmentally friendly flight technologies, with one of the most promising developments being the production of electric aircraft that do not emit harmful carbon dioxide and nitrogen dioxide gases.

According to the most recent figures from the Inter-governmental Panel on Climate Change (IPCC), aviation (domestic and international) accounts for approximately 2 % of global CO_2 emissions produced by human activity. International aviation is responsible for approximately 1 .3 % of global CO_2 emissions. Electric ultra-light aircraft passenger planes are a real possibility in the near future.

In the future, NASA expects flights that will burn 50 % less fuel than aircraft that entered service in 1998; release 75 % fewer harmful emissions; and minimize the radius of airport noise pollution by 83 %.

One of Boeing's advanced vehicle

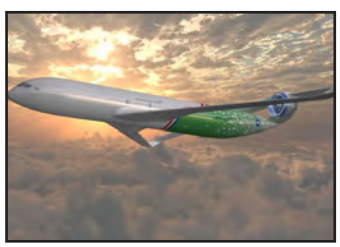
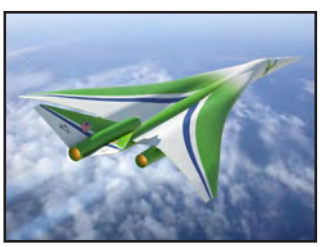





Fig : NASA/Northrop Grumman / NASA/Lockheed Martin / Plans to build planes with virtual windows

concept designs aims for better aerodynamic efficiency, creating as little drag as possible. Two vertical tails have been designed to shield engine noise. This design has been built using additional technologies to reduce noise and drag, along with long-span wings to improve fuel efficiency, and could potentially go into production by 2025.
This box wing design was made possible by the use of advanced lightweight composite (non-metallic) materials. A Rolls Royce Liberty Works Ultra Fan Engine uses advanced turbofan technology to maximize efficiency, achieving a bypass ratio (the flow of air around engine compared to through the engine) nearly five times greater than that of current engines.

This is the hybrid wing body-type subsonic vehicle AMELIA (Advanced Model for Extreme Lift and Improved Aeroacoustics), able to handle steeper and shorter take-offs and landings. AMELIA can potentially have a great impact on noise produced by airport traffic.

This is a cargo carrying aircraft which has been designed to be very efficient and ultra-quiet.
This is a possible future subsonic aircraft using a boxed or joined wing configuration to reduce drag and to increase the fuel efficiency.
The ability to fly at supersonic speeds over land in civil aircraft depends on the ability to reduce the level of sonic booms, says NASA, which has been exploring options

for quietening the boom, starting with design concepts and moving through wind tunnel tests to flight tests of new technologies. The sleek, pointed shape of this design concept would reduce the sonic shockwave signature and also reduce drag, resulting in increased efficiency. Imagine boarding a flight to discover that all the windows within the cabin have been removed and replaced by projected digital images on the walls. According to the Centre for Process Innovation (CPI), this will become a reality sooner, calculating the first plane to take to the skies within the next ten years.

Fig : Conception of a supersonic plane

Experts tend to assume that the potential for developing lower emission aircraft will be pursued first. As well as improvements to the efficiency of engines, the use of alternative fuels has a great deal of potential to reduce CO_2 and particulate emissions. According to NASA, non-fossil, organic fuels derived from algae or other plants, have already been added to the fuel mix of aircraft, and to test flights. The development of electric power units continue to progress. Currently, electrification of aircraft is challenging due to the high

weight and low energy density of batteries.

ii. The future is automated

The aviation industry has experienced steady growth in recent decades. Pascal Traverse, Cockpit R&T Program Leader at Airbus, estimates that "the global commercial aviation industry will need some 600,000 pilots in the next 20 years". This poses a problem, observing the fact that there are significantly fewer pilots currently in service.
Automated pilotless aircraft could provide a solution. However it is not so easy to teach a machine to take into account all that many variables. For this reason it has been suggested that a safety pilot needs to be there in case something unexpected happens.

Interim solutions may include "one-and-a-half" pilot aircraft, in which a human co-pilot assists an artificial intelligence (AI) pilot until technology reaches maturity. If the rate at which driverless vehicle technology has evolved is anything to go by, we are likely to see some significant developments in this area before long.

iii. The future is fast

Long travel times are a frustration. To reduce travelling time, new supersonic and hypersonic plane concepts are planned to be introduced. These aircraft are designed to break the sound barrier,

Fig : The e-volo Volocopter V2X may soon be revolutionising personal air travel

that is, more than twice the speed of sound.

NASA has planned to build its next experimental plane, which is designed to fly faster than the speed of sound without producing the loud sonic booms that have plagued air transportation. This plane is due to be delivered in 2021.

Because no one wants to hear that noise, the Federal Aviation Administration and similar international organizations have banned supersonic travel over land. Now, NASA believes that technology can break the sound barrier without being quite so loud about it. The secret is in the shape of the plane.

Concorde, the last remaining supersonic passenger jet, was withdrawn from service in 2003. But the romance of flying faster than the speed of sound lives on. Numerous companies are developing technology for more efficient and quieter supersonic travel. Noise reduction is the key function here, and preventing the supersonic boom from reaching the ground will be a significant achievement.

Aircraft such as Spike Aerospace's Spike S-512 craft could be in our skies by 2020s. The company says its plane will fly at the supersonic speed of Mach 1.6, and travel from London to New York in three hours.

iv. The Future is convenient

The latest aviation technologies mean passenger experiences are becoming ever-more convenient. Wireless connectivity allows passengers to enjoy a personalized experience, with in-flight entertainment. Soon flights will be faster, greener, more convenient and more comfortable.

v. Personal air transportation in 2050

Overcrowded roads, traffic jams that extend for several kilometres, and collaborative public transport

Fig : The vision of the future by Lilium GmbH: a vertical take-off jet to relieve the overcrowded streets

systems in major cities, demand innovative approaches and solutions. Established aviation businesses and start-ups from all over the world are therefore researching an aircraft that could transform local transportation from the roads to the air. Electrically powered "air taxis" could solve two problems at once: (a) by giving up the use of fossil fuels, particulate and CO_2 emissions could be substantially reduced, and (b) shifting local transportation from the ground to the air would remove the burden on streets.

While this might sound like a vision for the distant future, it is already technically feasible. The Karlsruhe-built Volocopter VC1 completed its maiden flight as far back as 2011, and is seen as a pioneer of electrified personal air transportation. Just a few years later now the Volocopter is on the verge of beginning its test operations as an autonomous air taxi in Dubai.

The electrically powered Lilium Jet, which has been developed in Munich, offers an impressive range of 300 km, and can take off and land vertically. By 2025, the taxi could begin operations as a five-seater, picking up passengers from the rooftop landing areas.

Boeing is the world's largest aerospace company, and the leading manufacturer of commercial jetliners, as well as defence, space and security systems. Boeing products and tailored services include commercial and military aircraft, satellites, weapons, electronic and defence systems, launch systems, as well as advanced information and communication systems. Boeing is organized into three business units: Commercial Airplanes, Defence, as well as Space and Security.

T. Chandana Peiris
Research Scientist
Arthur C Clarke Institute for Modern Technologies,
Katubedda, Moratuwa.
Email:chandanaaccimt@gmail.com,
T.P : 0774188847

Fast Developing Drone Technology

Prof. Rohan Munasinghe

Drones have already consolidated their position as an essential tool of the modern world. Drones, or unmanned aerial vehicles were first developed by the US military in early 1920s, but it was not meant for public untill as recent as late 1980s. Since then, drone development accelerated quite dramatically due to the developments in electronic and computer industries. It was during that time where light-weight, accurate and cheap electronic sensors and actuator drones were first developed. Today, military forces in developed countries use drones for spying, surveillance and even attacking enemy targets, while commercial drone manufacturers such as Chinese DJI continue developing light-weight, easy to use small drones for public and individual use. With so much of capability built-in and reliable and safe, flight performance drones are being deployed for various professional activities as well.

Drone System Design

Drones are autonomous flying vehicles, that need accurate and fast sensors to detect the attitude (orientation in space), altitude, position, heading and speed. These sensors are all electronic items that need to be very light-weight to be put on a drone. Drones have a flight controller, a miniature computer, which reads the sensors, and decide how the propellers are to be actuated. The propellers that drones have are usually BLDC electric motors which are controlled by the flight controller through electronic speed controllers. A complete drone system is shown in Fig. 1 below

Every drone is connected with a remote controller, which provides the external pilot to intervene in controlling the drone as and when necessary. These remote controllers are usually operated in free spectrum band (ISM). The flight controller of the drone sends down through a telemetry radio transmitter all the information about the drone to the ground team who watch it on the ground control station screen. This radio link that connects the drone and the ground control station also operates in the free band (ISM). Usually, 433MHz, 915MHz, 2.4GHz are the common radio links in drones.

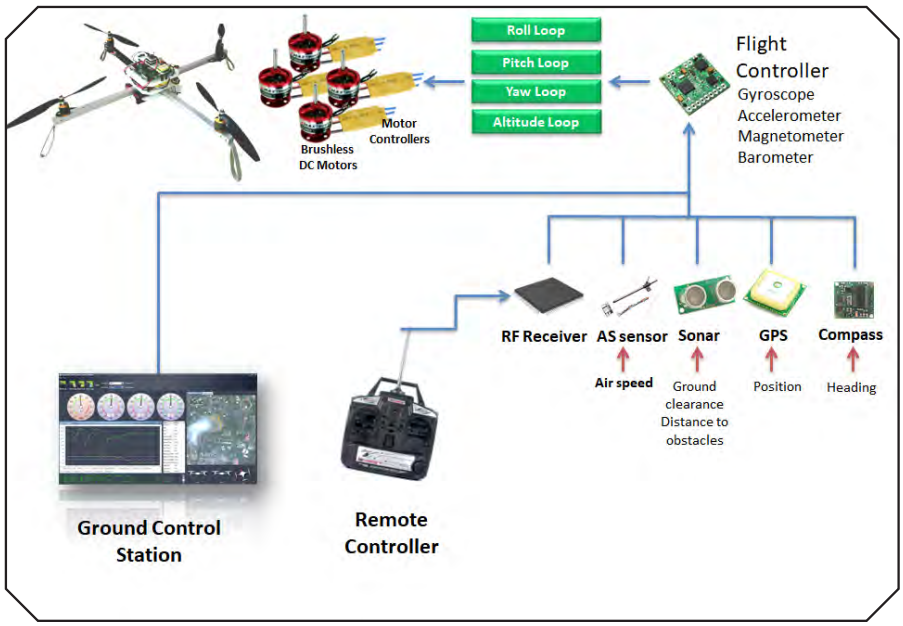


Fig 01 : Drone System

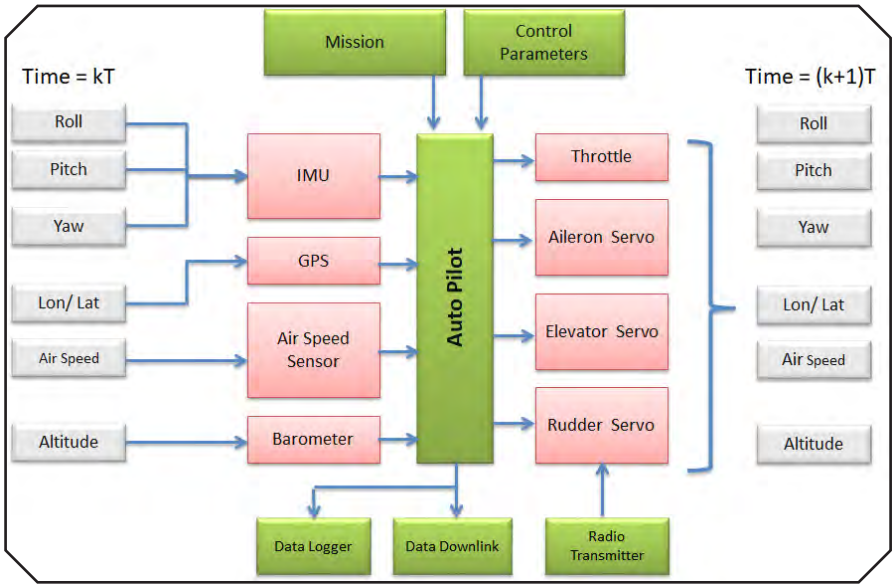


Fig 02: Drone control system

Drone Control

Flight controller is embedded with a number of gyroscopes, accelerometers, and a magnetometer for specific reasons. The gyroscopes and accelerometers are used to determine the attitude, and the orientation of the drone in space.

Altitude estimation is performed by the flight controller through multiple sensor fusion using a Kalman filter. The magnetometer inside the flight controller, and the compass connected to the flight controller externally are used to estimate the heading. When the drone is flying, GPS track is used to estimate the flight path. All these calculations are performed by the flight controller at 50-300 times a second, and in each calculation, it has to read the sensors and execute a complicated set of algorithms. Such capability in affordable consumer grade microcontrollers was not available until about the late 1990s.

To maneuver a drone to the left, the flight controller increases speed of the two right side propellers, and at the same time it reduces the speed of the two left propellers. This way, the drone tilts to the left and as a result it starts moving to

Fig : DJI Agras MG-1S drone spraying over crops

Fig : Autonomous package delivery drone of the University of Moratuwa delivering a package of 1kg

Fig : LiDaR Lite v3 sensor (905nm laser)

Fig 03 : Multi spectral drone camera (Green 550nm, Red 660nm, red-edge 735nm, Near Infra Red 790nm)

Fig 04: CeyHawk, 11kg engine powered long range drone developed at the University of Moratuwa

the left. On the other hand, if the drone has to be moved to right, the exact opposite controls will be implemented. This motion to the sideways which involved tilting the drone to the left or right is known as roll control as indicated in Fig. 1. In a similar way, flight controller controls the speeds of the propellers to move in other directions as forward/backward (pitch loop), up/down (altitude loop), or even to turn around its own vertical axis (yaw loop). In the case of winged type drones, ailerons and rudder are used together for roll control, while the elevator and throttle are used for altitude control. Fig 2 shows the control system for a fixed-wing drone.

Drone Capabilities

Drones need to have a good flying performance as well as payload carrying capability. Commercial drones in the weight range of 1-5kg have an exceptionally good set of flying skills already. Automatic take off/landing, hovering at an altitude, holding position, flying in a circular path around a specific point, are some of the major flying capabilities built-into small commercial drones. Detecting obstacles and avoiding collision with them, as well as vision based navigation and landing are the technologies currently being developed. Drones have also got a number of safety features such as automatic return to home in emergencies such as low battery voltage. They have get limitations in rolling and pitching to ensure safe flying, flight controller checks to see whether all of the sensors are working before taking off. As a result, drone deployment has now become quite safe and reliable.

Drone Applications

Drones can be equipped with a number of sensors required for the intended application. For example, a surveying drone carries a high resolution camera; a precision agriculture drone carries a multispectral camera (Fig.3); a package delivery drone carries a small package weighing 200g-1500g; a crop spraying drone carries a liquid fertilizer tank and nozzle system; a drone to map the ground profile in 3D carries a LiDaR (Light detection and Ranging) sensor.

Drone Types

There are three main types of drones: Multi-rotor, Fixed-wing and Hybrid. A Multirotor drone such as the one shown in Fig. 1 is easy to operate anywhere because its take-off and landing is gentle in a vertical motion. So, they do not need a huge open space. However, they consume more energy while flying because they do not have wings. The fixed-wing drones such as the one shown in Fig.2, are energy efficient because they can stay in air with a thrust smaller than their weight. However, they need open areas to take off and land, which is a detrimental feature.

The third type shown in Fig. 3 is the most recent drone type in which both multi-rotor capability and fixed-wing capability are available, so that it is able to take off and land vertically like a multirotor, and fly like a fixed-wing plane. This type is bit too complicated than the first two types. However, technology has been developed very recently for its reliable operation. Hence, in the near future, more of this type will be deployed for drone applications where longer flight times are involved.

Global Drone Market

With the rapid development of flying capabilities, safety features, user-friendliness and the

Fig 05: Hornet, quadrotor-wing hybrid drone of the University of Moratuwa (Funded by the National Research Council and the World Bank-AHEAD project)

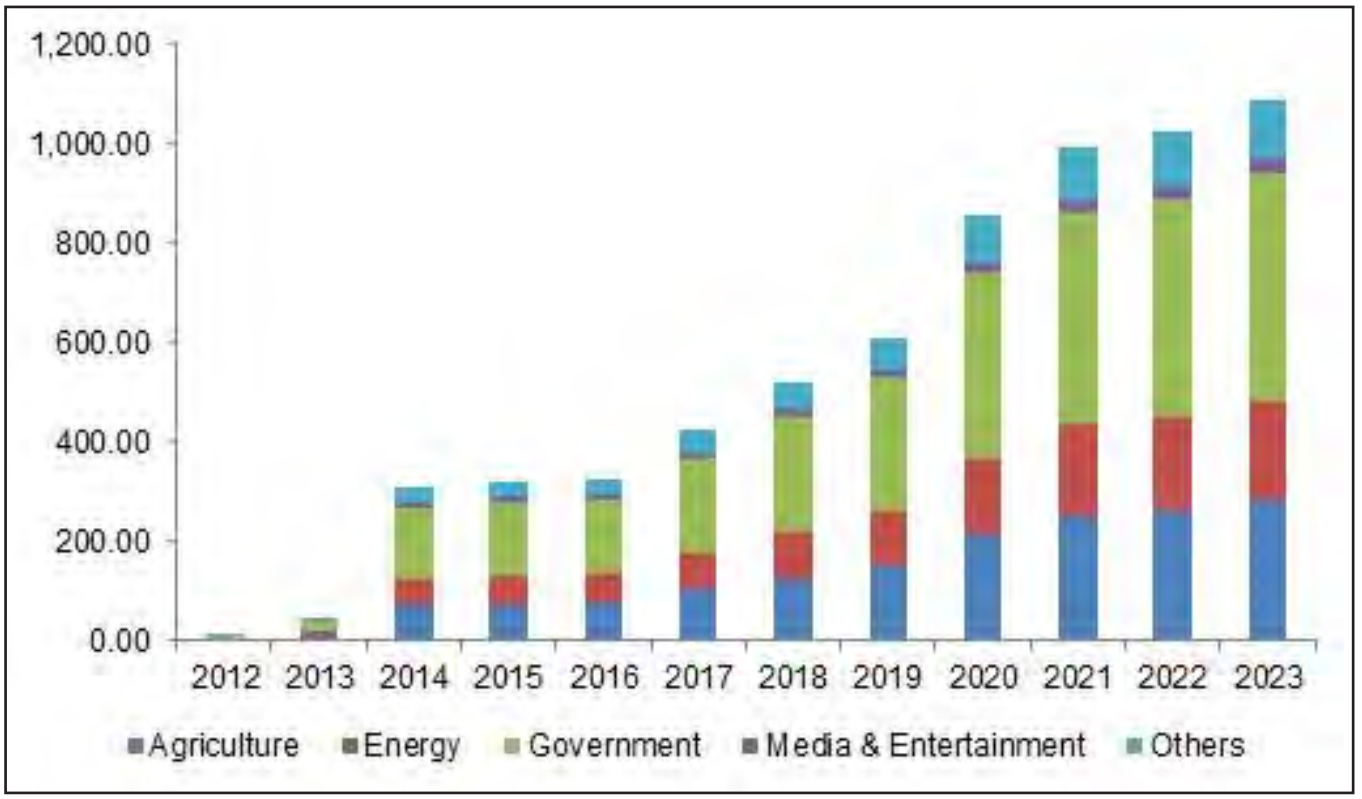


Fig 06 : North America commercial drone market size, by application, 2012-2023 (USD Million)

capability of handling a number of sensors and payloads, drones are increasingly deployed for a wide range of applications such as surveying, agriculture, surveillance, aerial photography, package delivery, construction site monitoring and gas/water/power-line inspection. Hence, the global drone market is expected to reach US$ 2 Billion by 2020. Fig. 6 shows the trend in drone deployment in the United States.

Drone Technology for Sri Lanka

Sri Lanka is a country which has a lot of potential for technology development. However, Sri Lanka is also a country where local innovations do not get commercialized and deployed. In the past, there have been many missed opportunities for Sri Lanka to become an innovative nation.

In this backdrop, it is extremely important that the local drone technology is developed and matured to be used for national development. In particular, Sri Lanka can use locally developed drones for improving our agriculture sector where drones equipped with multispectral sensors would fly over paddy fields monitoring plant health and other issues such as weed and pest invasions. With that information, it would be possible to manage the crop properly so that a higher yield can be achieved. Drones can be used for spraying the right amount of fertilizer which will reduce contamination of soil and ground water while reducing human exposure to chemicals. Locally developed drones can also be used to map and constantly monitor potentially unstable land masses, and alert authorities before hand landslides occurence. Locally developed hybrid drones can be used to take off from a naval ship and fly along the coastal line while monitoring any illegal activities in our seas. Package delivery drones such as the one shown in Fig 3 can be used to transport urgent blood samples between hospitals. The list goes on. Now it's time for Sri Lanka to turn those possibilities into reality.

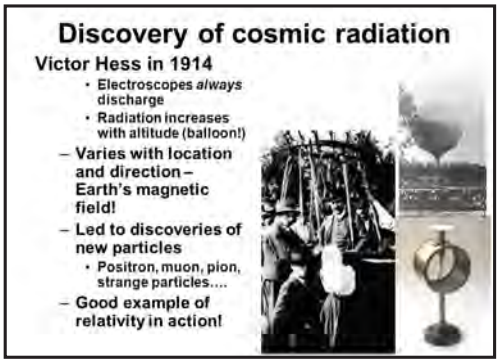
Prof. Rohan Munasinghe
Dept. of Electronic and Telecommunication Engineering
University of Moratuwa

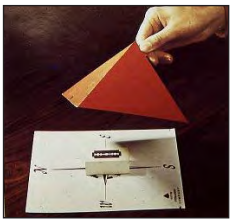
Ancient aircraft technology is not a mere hypothesis

Mr Janaka Priyantha Dayaratne

We have listened to many fairly tales in our childhood. We later realized that the elders who narrated these tales to us did not believe their stories to be true, but narrated these to pacify us. Those of us who listened to these with much enthusiasm then, now understand as adults that these stories as fictions. Among these, one story that took the forefront was the story of Rama-Ravana. We recall how we took Ravana's side, and he became the victor. We faintly remember the way we described the story taking Ravana's side, respecting the belief in Hindu gods according to which Rama is considered an incarnation of Vishnu. Whatever was the other information in the Ramayanyas' we held the view that the air ship *Pushpakayanaya* or the *Dandumonaraya* was definitely a mere myth or a fiction.

We considered the *Pushpakayanaya* only from the religious perspective, and did not have a special interest or inclination to investigate about the *yanaya* from any other aspect. In the *Lankavathara Suthra* of Mahayana Literature also reference is made to the *Pushpakayanaya* that Ravana used to travel by air. In around 1932, Martin Wickramasinghe in a narrative of a collection of stories for children refers to the *Dandumonaraya*, and has even included a picture of it. In the Ramayanaya written in Sanskrit about the Rama Ravana story, and in the *Janakiharanaya* written by Kumaradasa, one of our poets, it is possible to find some special information. Although given in an exaggerated manner we can accept them as fine sources of information for the analysis of the basic content. In this context we also have to remember the translation of *Janakiharanaya* by the chief prelate Pandit Dhammadhwa, where his translation is in the form of slokas; and also the translation of *Janakiharanaya* into Sinhala poetic stanzas (kavi) by Piyadasa Nissanka who was an expert translator of Sanskrit dramas, and the book of four stanza poems (kavi potha) – *"Ravaluwatha"*. The drama Sakvithi Ravana written by Arisen Ahubhudhu has had a great impact in bringing this tale to the modern day. Although some have pointed out certain deficiencies, "Ravana" the serial teledrama currently being telecast over a television channel, has made a great effort to surface passingly some significant information in this legend. It is also necessary to obtain information from the ancient texts regarding the martial arts and craft (*Angham-Ilangam* techniques) when investigating these legends. It may be possible to hold a view by investigating the literary sources, but it is not an easy task to convince





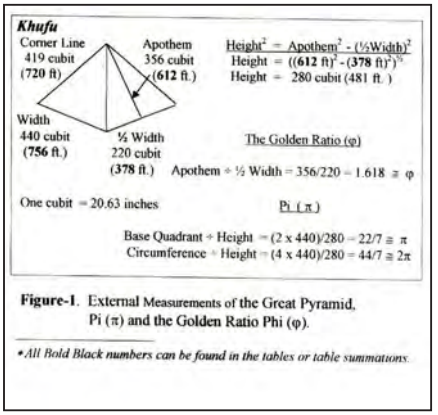
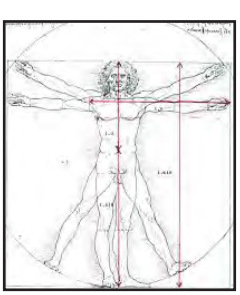


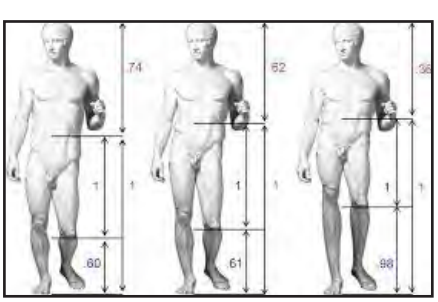
Figure-1. External Measurements of the Great Pyramid, Pi (π) and the Golden Ratio Phi (φ).

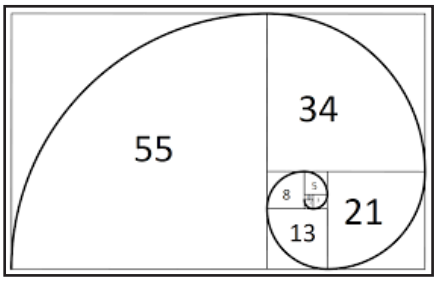
**All Bold Black numbers can be found in the tables or table summations.*

without recognizing modern day standards, which require analysis by specific western scientific methods. Nevertheless the technical information which has been generated regarding the *Dandumonaraya* or *Pushpakayanaya* of Ravana needs to be examined. According to western science, when an aircraft is launched into the sky, or takes off from the ground, it has to work against gravity. In addition the aircraft has to generate a force against its own weight, the weight of the passengers, and air resistance, all of which affects the speed of the aircraft. This is described further by the Bernoulls equation that we come across in advanced physics. It is compulsory to tally at with overtories phenomenon of western science. Accordingly it is necessary to consider the special characteristics of the materials that are used in the manufacture of the aircraft. The material has to be strong enough to bear air resistane and at the same time it should be light in mass. Victor Hess who initiated western scientific research about the atmospheric space during 1911 to 1912, experimentally confirmed that we receive cosmic energy from the universe. The western countries which continuously conducted research on this issue, have shown that the entire human environment requires this cosmic energy to a vast extent. At a primary level this cosmic energy has immense effect on the human body and its sustenance, which has amazing capabilities. Also cosmic energy greatly influences other physical material phenomena. Pyramids were built thousands of years ago long before the advent of western research and analysis. Research conducted later on pyramids, has unearthed a great deal of amazing information about these pyramids. These pyramids possess an unbelievable capacity to generate and donate cosmic energy. Investigation make us believe that they may have functioned as centers which distributed cosmic energy. It is possible for students to carryout various experiments at home regarding cosmic energy. For this purpose, it is possible to make a simple pyramid by cutting out four equilateral triangles using a thick piece of paper, and pasting the triangles to form a pyramid. They will be able to observe amazing results by placing various objects at 1/3 of the height at the centre of the pyramid. If one places a razor blade or a razor used for shaving, it should be possible to observe that it automatically gets sharpened. Also if a glass of milk in placed at this height inside the pyramid, the milk remains unspoilt for a few days, which otherwise would get spoilt within a day or less if placed outside the pyramid. Investigations conducted at the Scientific Vasthy Research Institute has clearly shown that if coconut milk is kept inside the pyramid, it automatically and definitely turns into coconut oil in 3 days. When carrying out these experiments a control has to be kept. That is, the relevant substance should be kept outside the pyramid as well, and compared with the substance kept inside the pyramid, as this is how experiments are carriedout in the laboratory. Then you will observe that the razor blade kept outside the pyramid will rust, while the cows milk soon get spoilt, and the coconut milk will become rancid.

Here even though a pyramid with four equilateral triangles was made, for optimum results the pyramid

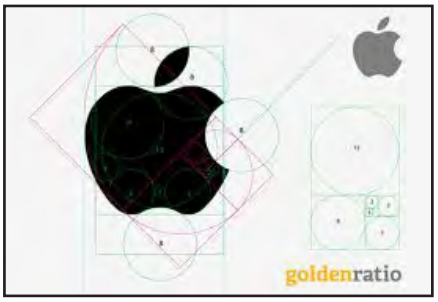






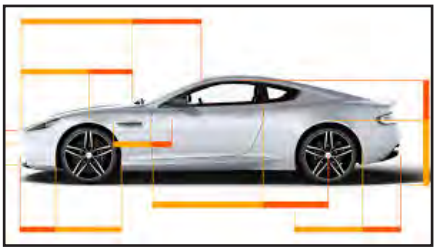
should be made in such a manner that the four inclined margins of the pyramid should be 1.47 times the centre height, and the margins of the base of the pyramid should be 1.57 times the centre height. The famous Egyptian pyramids have been built according to these proportions. It will be seen that when you consider each of the four traingles that were used, you will get a value approximately equal to 1.618 when the height of the triangle in divided by half the length of one side of the base. This proportion is referred to as the Golden Ratio in the western world. There is another fact that has to be specially considered. That is, if a hypothetical pyramid is constructed such that its base is at the equator of the earth, and its height is equal to the sum of the radius of the earth and that of the moon, then the resulting pyramid would be similar in shape to that of the Egyptian pyramid.

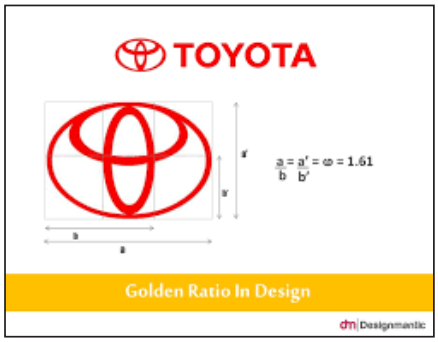
Leonado da Vinci was one of those who introduced this golden ratio to the modern world. He had shown that if a human with a natural body has his height divided by



the height between his navel and the base of the foot, or the height from the naval to the base of the foot is divided by the height from the naval to the head, the golden ratio is obtained. Approximately the same value is obtained when any of the higher terms in the summation series (of advanced mathematics) (0,1,1,2,3,5,8,13,21,34,55,89,….) is divided by the term just before it. This same ratio is commonly used in the modern manufacture of vehicles. Going beyond the limits, the same vehicle manufacturing institutions can adhere to this golden ratio even when making their approval emblems.

One can also observe that there is an electromagnetic field around the human body, by taking photographs using a Kirilian camera. The changes in this electromagnetic field around the body takes place due to the cosmic energy reaching us from the universe. A person who stays inside a pyramid for sometime with a vacant look (stare) will be able to observe that the area surrounding his body gets wider and clearer. Also the ionic

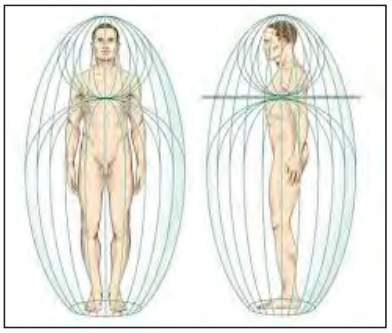


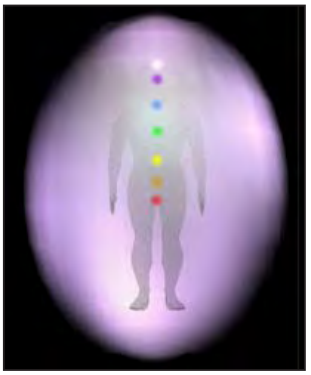


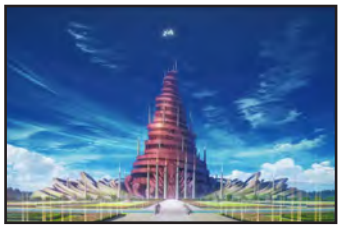
concentration becomes more negative.

A person who uses instruments to observe how this aural body changes, will notice that in an environment where the intensity of cosmic energy is more, the aura gets wider and clearer.

By using western scientific instrument and techniques, it has been possible to go beyond the limits in the analysis of the traditional energies, and thereby the ideas of ancient eastern sciences which were rejected or not accepted, are now in the process of becoming parts of modern western science. Accordingly, it can be very clearly accepted that physical bodies and their activities can be influenced by the

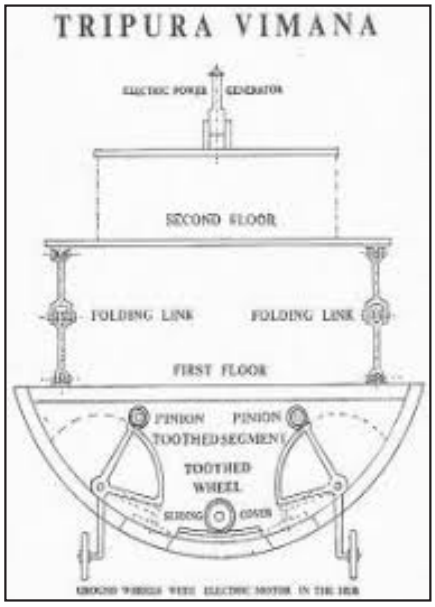






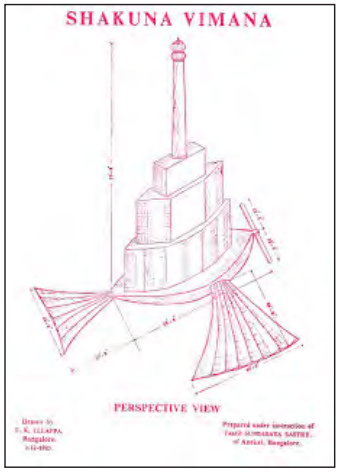
spiritual mind and cosmic energies.

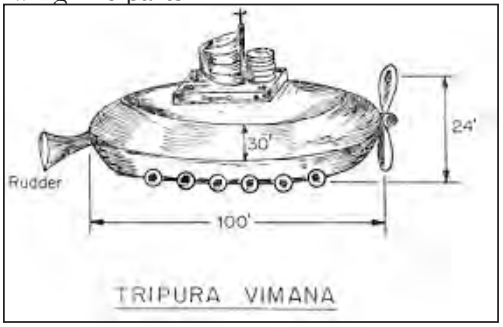
Under these circumstances, it is reasonable that even ancient and traditional spiritual methods, such as *yanthara, manthra* etc, which have been rejected or not recognized by western science are now being researched and investigated. Against this background, looking into the principles of ancient aircraft technology would be like looking at the ancient world through a novel window. The book *"Lanka Ithihasaye Hela Yugaya"* written by Dr Suriya Gunasekara is of much significance because this book provides a historical basis for the unbelievable literary attitude/concept which existed among the Sinhala authors and readership.



It is necessary to focus attention on the information provided in the above historical book, as well as in he book *"Vyamanika Sasthraya"*, and also in a few other similar books because the information there cannot be considered as mere fiction or myth, considering how far western science has reached today.

On investigating the concepts in *Vyamanika Sasthraya* (Aircraft science), it can be seen that there were four types of airvehicles (air crafts). They were: *Sakuna Vimanaya* which had wing-like parts which could be folded and opened; *Sundara Vimanaya,* which was storied and had about 20 wheels; *Rukma Vimanaya* which was golden in colour.





It is also stated that the pilot or the person who piloted any of these air crafts had to be knowledgeable in 32 matters. They are: *manthras, thanthra, kreetaka karshana*. Though it is not necessary to describe each and every one of these terms here, it is necessary to state that these terms encompassed many concepts of the glossary terms such as heat, temperature, speed, attraction, sound and energy, which are used in modern Western Science. *"Vymaanika Sastharaya"* has listed 31 parts that should be there in an "air craft" or a *Vimanaya*. Amongst these are various types of mirrors, engines and equipment. Also it is included as to know how these have to be used in a structurally complementary manner. So it is clear that these vehicles have gone beyond the hypothetical phase. A clay slate which confirms the reliability or trustworthiness of this technology has been discovered from an Egyptian pyramid. Most of the air crafts shown in the slab are very much similar in shape to the modern day air crafts. However, it is stated in the slab that this

civilization does not belong to them, but to some *"Sinha Minisun"* (Lion People) who came from the sky and have built them. So we are compelled to ask whether the only people who even had some concept about air vehicles were the Lion People-the Sinhalese. It is too early to confirm this. However if is very clear that it is not another group of people.

In these air craft technologies (*Vyamanika Silpa*), in addition to the nature and form of the vahicles, even the nature of the materials to be used are indicated. It is seen that all the substances used were such that they could easily absorb heat. Also 7 types of mirrors present in these air vehicles are indicated. The role of each type of mirror is also given. For example the *"Kunthini"* type of mirror was expected to prevent any harm to human blood, fatty sabstances, muscles, bone marrow bones, skin and the mind, which can be caused by the heat and electrical waves coming from the sun at higher elevations rather than at lower heights. Consequently it is also described as to how an air craft can be powered or energized. Seven types of "energy" that are used are described. Namely *Udhgama, Panja, Saurya shakthi spakarshani, Porashakthyspakarshani, Dolasshakthi, Kanthini, Mooa shakthi* and *Soon*. In the modern sense seven types of equipment similar to motors, are placed in definite locations of the air craft, in order to generate this energy. In the *"Vyamanika Sasthraya"*, these 7 motors are given as *Thundila, Panjara, Amsupa, Apakarshaka, Saandanika, Dharpanika* and *Shakthi Prasavaka*. The role of each of these motors is also given, but it is not necessary to give these details here.

"Vyamanika Sasthraya" in addition has indicated in great detail and step wise, how the air craft has to be constructed right from the beginning, giving the sizes and the shapes. Also how each step of construction contributes to the final structure is stated. For example in the *"Sakuna Vimanaya"*, the function of the 28 parts are indicated. From the information given, it is likely that one of these parts is a steam engine.

Even the specific metal that has to be used in the construction is indicated. Accordingly, to construct the "column" (the 'mast' in the modern sense), a special alloy called *"Bhathakhasys"* has been recommended. Even the method of making this alloy is indicated. It is amazing how this agrees with modern scientific technology.

In the *"Vymanika sasthraya"*, it is mentioned that this mercury has been used as the fuel in the naval air crafts. The United States air force has used this idea and turned out the mercury vortex engine, and built a small air craft fitted with this engine and successfully flown it in 1998. This indicates that the ancient technological concepts were not merely hypothetical. As a mark of respect for the great services rendered, it is necessary to acknowledge that the information we have very briefly given in this article are described in great getail in the documents written by Dr Suriya Gunasekara

Janaka Priyantha Dayaratne
Visiting Lecturer
Chief Research Officer of the Scientific Architecture Research Institute

AVIONICS '19

Fig 1 : The e-volo Volocopter V2X may soon be revolutionising personal air travel

Fig 2

Fig 3

Fig 4

Fig 5 : An FPV Drone Operated by UAV pilot Naveen Ranasinghe

Avionics is the annual Remote Controlled (RC) Airshow organized by the Aeronautical Society of D.S. Senanayake College, Colombo with the intention of introducing the field of RC electronics to young Senanayakiens and creating them a platform to showcase their talents in this field.

This year, the 4th edition of Avionics was held successfully on the 21st of March with the graceful participation of our Principal Mr. Chanaka Bamunuarachchi and officials from the Civil Aviation Authority at the school ground. Various flying clubs and individual flyers such as RC Falcons, Naveen Ranasinghe and Oshada Saparamadu collaborated with us to make this event successful.

Fig 6

Fig 7 : A student with the plane he made during the workshop

Fig 8 : RC Falcons receiving a token of appreciation

Fig 9 : A photograph of the teacher In Charge and the organizing committee

Avionics 19' consisted of 2 sessions. First one was the flying session which was conducted from 10.15 a.m to 11.00 a.m. During the flying session our students were given the opportunity to fly RC planes and drones that were built by them. This session was also accompanied by our guest flyers. Photos of some Remote Controlled models built by our students and photos from this session are attached herewith. Afternoon session was devoted to a workshop conducted by Remote Controlled Falcons to students who were interested in this field. They were taught how to build an RC model aircraft and many other aspects were discussed during this session.

Ms Nimali Jayawardana
Teacher
D.S.Senanayaka College
Colombo 07

NSF strives to open the path for young science leaders

Research and innovations play a major role in socio-economic development of a country. The development of the innovative and investigative ability of the younger generation will lead to the generation of new knowledge that is essential for sustainable economic development of the country. Formal science education alone is not enough to cater to the growing demands of the dynamic world. Recognizing and uplifting their soft skills in science will help to enlighten their young minds towards innovation and logical thinking, and consequently make them good researchers as well as citizens with a good understanding of science. Hence it is vital to initiate programs addressing school children to identify, develop, and give practical aspects of training on science based education, to broaden their knowledge and skills to strengthen their understanding, and improve the ability to face any future challenges.

The National Science Foundation (NSF) being the premier driving force in promoting Science, Technology and Innovation for the country's economic and social prosperity, is dedicated to generate, disseminate, transfer and enhance the utilization of scientific knowledge towards the upliftment of the livelihoods of all Sri Lankans. To accomplish this vision, NSF conducts a wide array of programs targeting different categories of persons. Among these, the Science Research Projects Competitions (SRPC) is one of the annual events conducted by the Science Popularization Division of NSF. The prime objectives of SRPC is to identify and improve scientific thinking, investigative ability and creativity of school children, to enable them to become young budding researchers, and thereby help them to select the career path of a skilled professional researcher. Students of grades 09 – 13 of schools that have registered with NSF are eligible to apply for the above competition. Such potential candidates may enter the competition by submitting research proposals in their field of interest. The selected projects are subjected to continuous guidance and assistance under the supervision of experts in the relevant field as principal supervisors, and NSF monitors their progress at regular intervals.

The best ten projects of SRPC selected in competition among school science societies get the opportunity to participate in the "Sri Lanka Science and Engineering Fair" (SLSEF), along with the top ten finalists of the "Junior Inventor of the Year" competition, conducted by the

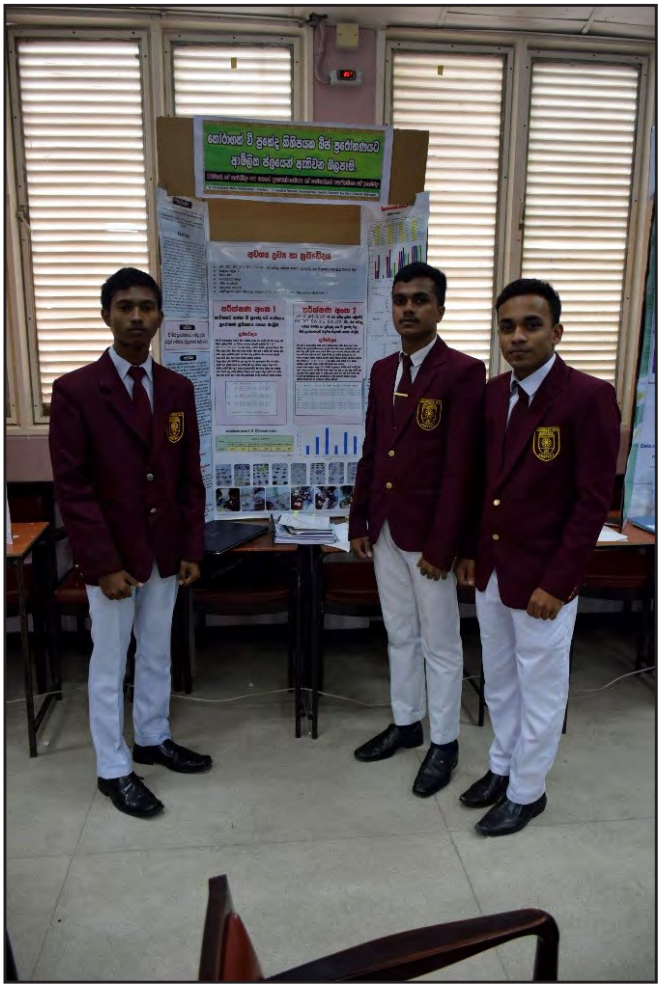


Fig 02 : Research team of Gnanodaya Maha Vidyalaya, Kalutara

Fig 01 : Sri Lanka Science and Engineering Fair 2019 – Panel of judges and participants

Institution of Engineers Sri Lanka (IESL). The details of the selected best ten projects are given in Table 01. The SLSEF is organized jointly with the cooperation of IESL, Intel and the Ministry of Education. The top three winners of SLSEF are eligible for participation and representing Sri Lanka at the Intel International Science and Engineering Fair (Intel ISEF).

The Intel ISEF is the world's biggest annual pre-college science competition, which is organized by the Society for Science and the Public, USA. Each year, around 1,800 high school students from more than 75 countries, regions, and territories get the opportunity to present their research findings and compete in Intel ISEF.

The SLSEF 2019 was successfully held on 11th of February this year at the Wimalasurendra Auditorium of Institute of Engineers Sri Lanka (IESL), Colombo. One SRPC Project which competed under the topic "Effect of acidity on seed germination of selected varieties of paddy", was selected as one of the best three projects of SLSEF 2019, and won the opportunity to take part in Intel ISEF 2019.

This research project was conducted by the students of Gnanodaya Maha Vidyalaya, Kalutara, under the guidance of Ms. Sanjeewani Udawatte and the team of students comprising R.S.R. Senavirathna, H.LC.D. Hashela and S.S.R. De Silva. This project was guided and supervised by Prof. Sudheera Ranwala, an expert in plant sciences and climate change, who is currently attached to the Department of Plant Sciences, Faculty of Science, University of Colombo. This project team, which is expected to participate

Table 01 : Science Research Projects Competition-2018
Selected competitors for the Sri Lanka Science and Engineering Fair

No	Name of the Student	School	Title of the research Project
01	A.U. Nidha Faatin N. Ann Dharahaa P. Ahanya	St. Cecilia's Girls College, Batticaloa	Monitoring the repetitive safety usage of various cooking oils used in Sri Lanka
02	T.Thinojan K.Abinaya K.Padanjaly	BT/ Paddirippu M.M.V., Nationa School, Kaluwanchikudy	Green synthesis of Iron oxide particles for the removal of cadmium ions in water
03	J. Indusara Dharmarathne	Nalanda College	Anti-diabetic related health food properties of selected traditional rice varieties of Sri Lanka
04	M.C.M. Vidumini Silva	Mahamaya Balika Vidyalaya	Destroying mealy bugs
05	M.D. Susiriwardana	Nalanda College	Investigation of the antibacterial properties in the root extract and leaf extract of the plant asparagus falcatus
06	W.A.B.G. Goonathilake D.M.H.S. Dissanayake S. Elabada Arachchige	Musaeus College, Colombo 07	A Microbial consortium to accelerate the decomposition of biodegradable polythene
07	Keshani Booso Helani Balasuriya Vinma Wettasinghe	Musaeus College, Colombo 07	The development of a risk assessment tool for the screening of non-communicable diseases among school children in Sri Lanka
08	Isumi Hettiarachchi Muthumalki Pragnaratne	Sirimavo Bandaranaike Vidyalaya, Colombo 07	Production of a lightweight and eco-friendly bricks using waste plastic
09	R.M.U.Ishan Rathnayke M.S. Dulshan Predeep	Thambuththegama Central College, Thambuththegama	Evaluation of repellent activity of botanicals for controlling red coconut weevil *(Rhynchophorous ferrugineus Olivier)*
10	S.S. Ravinath De Silva H.L.C. Denuwan Hashela R.S.Ransika Senevirathna	Gnanodaya Maha Vidyalaya, Kaluthara	Effect of acidity on seed germination of selected varieties of paddy

at the Intel ISEF to be held from 12th to 17th of May 2019, at Phoenix, Arizona, USA, will have the opportunity to compete with around 1800 students representing about 75 different countries of the world.

The NSF has now called for applications from schools for the SRPC 2019, continuing its mission to empower young research leaders of the country, and any school that had not applied yet to participate in the Science Research Project Competition is encourage to contact the Science Popularization Division of NSF as soon as possible for more information (www.nsf.gov.lk)
The winning three project of SLSEF will gain opportunity to participate in Intel ISEF. National Science Foundation is also in the process of looking for more opportunities for students to showcase their research projects in the international arena .

Ms Apeksha Herath
Scientific Officer
Science Popularization Division
National Science Foundation
apeksha@nsf.gov.lk

What have you learnt from the Vidurava 2019 April-June Issue? Scan your own memory!

Too Slow? Not Anymore

True or False?

1. People in aviation use big words like efficiency, safety, quality and accuracy, but ultimately what is necessary is to get things done quickly.

2. What is not impressive is when we reach the level that we can break the natural barrier.

3. A jet is the flow of air out of the engine, where with different flows come different names such as sub-sonic, supersonic, and hypersonic.

4. The Concorde flew for three more years till it retired in 2003.

5. Shockwave is a specific phenomenon that happens when any object moves less faster than the speed of sound.

Aviation Fauna

True or False?

1. 1. All gliders do not have wings, but have their skin folded on the sides of the body and attached to the fore limbs and hind limbs.

2. The first Pterosaurs for which fossil evidence is available flourished during the middle to late Triassic period.

3. There have been transitional types between the reptiles and birds, and consequently discussions on the origin of birds did not take the form of theories.

4. Birds lack teeth because flight requires a highly centralized body mass with light extremities.

5. The limbs of birds are well muscled compared with those of a typical mammal.

Future Advances of Aviation

True or False?

1. An object in flight is constantly engaged in the opposing forces of lift against weight, and thrust against drag.

2. Aviation science is the study of basic components required for a carrier in this industry.

3. One of the industries that rely least on aviation is tourism.

4. More fuel efficient airplanes will increase greenhouse gas emissions, as well as increase in costs for both airlines and customers in the long run.

5. Faster and more fuel-efficient aircrafts, planes that run on solar power, bigger windows, and fancier interiors, are the endless possibilities.

Fast Developing Drone Technology

True or False?

1. Drones are autonomous flying vehicles that need accurate and fast sensors to detect orientation in space, altitude, position and speed.

2. Flight controller is embedded with a number of gyroscopes, accelerometers and a magnetometer for specific reasons.

3. Drones have no limitations in rolling and pitching to ensure safe flying, and flight controller checks to see whether all the sensors are working before taking off.

4. The fixed wing drones are not energy efficient, because they cannot stay in air with a thrust smaller than their weight.

5. Drones can be used for spraying the right amount of fertilizer which will reduce contamination of soil and ground water.

Ancient Aircraft Technology is not a Mere Hypothesis

True or False?

1. In the *Lankavathana* Suthra of Mahayana literature, reference is made to the *Pushpakayanaya* that Ravana used to travel by air.

2. The material used in ancient aircraft had to be soft enough to bear air resistance, and at the same time it should be heavy in mass.

3. The Western countries which continuously conduct research on cosmic energy, have shown that the entire human environment requires this energy.

4. Investigations conducted at the Scientific Vasthy Research Institute, has clearly shown that if coconut milk is kept inside a Pyramid, it automatically and definitely turns to coconut oil in 3 days.

5. By using Western scientific instruments and techniques, it has not been possible to go beyond the limits in the analysis of traditional energies.

Answers

01) 1. True, 2. False, 3. True, 4. True, 5. False
02) 1. True, 2. True, 3. False, 4. True, 5. False
03) 1. True, 2. True, 3. False, 4. False, 5. True
04) 1. True, 2. True, 3. False, 4. False, 5. True
05) 1. True, 2. False, 3. True, 4. True, 5. False

National Science Foundation
47/5, Maitland Place
Colombo 07