



Chapter II

Concept of Space and Air Space Applications

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“Interestingly, according to modern astronomers, space is finite. This is a very comforting thought-- particularly for people who can never remember where they have left things.”

- Woody Allen

Chapter II

Concept of Space and Air Space Applications

Space has fascinated people not only since a few decades but since ages. In many mythological stories, we have heard about space and the creatures coming from space. However, the general perception of most individuals about space is anything above the earth's surface, which is not reachable by human hands, but this is not the true meaning of space.

2.1 Classification of Space

For the purpose of this study, space has been classified into two broad categories – air space and outer space.

Airspace

Airspace means the portion of the atmosphere controlled by a particular country on top of its territory and territorial waters or, more generally, any specific three-dimensional portion of the atmosphere.

Outer space

Outer space, sometimes simply called space, refers to the relatively empty regions of the universe outside the atmospheres of celestial bodies. Outer space is used to distinguish it from airspace (and terrestrial locations). Contrary to popular understanding, outer space is not completely empty (i.e. a perfect vacuum) but contains a low density of particles, predominantly hydrogen plasma, as well as electromagnetic radiation, dark matter and dark energy.

This chapter exclusively deals with Air space, whereas the next chapter is devoted to outer space.

Airspace is divided into two basic types:

Controlled airspace exists where it is deemed necessary that air traffic control has some form of positive executive control over aircraft flying in that airspace.

Uncontrolled airspace is airspace in which air traffic control does not exert any executive authority, although it may act in an advisory manner.

Airspace may be further subdivided into a variety of areas and zones, including zones where there are either restrictions on flying activities or complete prohibition of flying activities.

By international law, the notion of a country's sovereign airspace corresponds with the maritime definition of territorial waters as being 12 nautical miles (22.2 km) out from a nation's coastline. Airspace not within any country's territorial limit is considered international, analogous to the "high seas" in maritime law. However, a country may, by international agreement, assume responsibility for controlling parts of international airspace, such as those over the oceans. For instance, the United States provides air traffic control services over a large part of the Pacific Ocean, even though the airspace is international.

There is no international agreement on the vertical extent of sovereign airspace (the boundary between outer space – which is not subject to national jurisdiction – and national airspace), with suggestions

ranging from about 30 km (the extent of the highest aircraft and balloons) to about 160 km (the lowest extent of short-term stable orbits). The Federation Aeronautique Internationale has established the Karman line, at an altitude of 100 km (62.1 miles), as the boundary between the Earth's atmosphere and the outer space, while the United States considers anyone who has flown above 80 km (50 miles) to be an astronaut; but descending space shuttles have flown closer than 80 km over other nations, such as Canada, without requesting permission first¹. Nonetheless both the Kármán line and the US definition are merely working benchmarks, without any real legal authority over matters of national sovereignty.

The world's navigable airspace is divided into three-dimensional segments, each of which is assigned to a specific class. Most nations adhere to the classification specified by the International Civil Aviation Organization (ICAO). Classes from A to E are referred to as controlled airspace. Classes F and G are uncontrolled airspace. Individual nations also designate Special Use Airspace (SUA), which places further rules on air navigation for reasons of national security or safety. SUAs range in restrictiveness, from areas where flight is always prohibited except to authorized aircraft, to areas that are not charted but are used by military for potentially hazardous operations (in this case, the onus is on the military personnel to avoid conflict).

2.2 Applications of Air Space

Human beings have always considered themselves superior to all other beings. It has been their constant endeavour to gain control over not only other living creatures but also over the elements of nature. This

¹ <http://en.wikipedia.org/wiki/airspace>

desire has led to several unimaginable inventions and discoveries over the course of time. One of the greatest inventions of all times was the wheel that revolutionized road transport, of which walking was the only means until then. Not being satisfied with faster and more efficient means of commuting than walking, the next step was water transport. But the thirst for supremacy can never be quenched and thus the next obvious step was to fly like birds in the sky. Inspired by mythological tales of flying chariots, humans started experimenting in this direction. Several attempts were made to use the airspace for balloon flights. In 1903, Oliver and Wilbur Wright succeeded in building and flying the first aero plane ever, turning our flights of fancy into a reality. Though the first flight by the Wright brothers was for a few seconds only, after the initial hiccups common to every new invention, flights were made possible for longer periods of several minutes and finally hours. Today an airplane can fly non-stop for several hours if it has enough fuel. The capacity of the planes also underwent drastic changes and from a single seat plane, we now have planes capable of carrying hundreds of people at a time, without toppling over due to the immense weight they carry. The weight of an airplane can be as much as 350 tonnes! And yet it glides along in the air like a light-weight bird. It can also perform manoeuvres like turning not only sideways but also upside down, and several other breath-taking actions as witnessed during the air-shows that are held regularly by the air force.

The engine-powered flight by the Wright Brothers opened up significant commercial and military perspectives. During the period immediately following World War I, aircraft were by and large state owned and used mainly for military purposes, but soon, they became ordinary means of transport, mostly owned and run by private companies. Today, there are several private airline companies catering

to passengers in various countries, vying with each other to provide better facilities in order to lure passengers to their airline, and all this has culminated in even wealthy individuals owning private jets with private airstrips for landing their planes.

2.3 Civil Aviation

Aviation is a global industry, owned and operated largely by private commercial companies, and forming a seamless network of engineering, design, manufacturing, sales, airline operations, customer services, maintenance, repairs, finance, leasing, insurance, marketing, advertising, media and other activities. There is also a comprehensive legal framework, comprising national laws and regulations connected by international treaties, which is under continual revision as the growing industry requires.

Civil aviation is one of two major categories of flying, representing all non-military aviation, both private and commercial. Most of the countries in the world are members of the International Civil Aviation Organization (ICAO) and work together to establish common standards and recommended practices for civil aviation through that agency.

Civil aviation includes two major categories:

- 1) Scheduled air transport, including all passenger and cargo flights operating on regularly-scheduled routes; and
- 2) General aviation (GA), including all other civil flights, private or commercial

Most countries also make a regulatory distinction based on whether aircraft are flown for hire:

- 1) Commercial aviation includes most or all flying done for hire, from sightseeing in a small plane to charter flights to a hunting lodge to scheduled service on airlines; and
- 2) Private aviation includes pilots flying for their own purposes (recreation, business meetings, etc.) without receiving any kind of remuneration.

All scheduled air transport is commercial, but general aviation can be either commercial or private. Normally, the pilot, aircraft, and operator must all be authorized to perform commercial operations through separate commercial licensing, registration, and operation certificates.

The Convention on International Civil Aviation (also known as the Chicago Convention) was originally established in 1944. It states that signatories should collectively work to harmonize and standardize the use of airspace for safety, efficiency and regularity of air transport. All the States that are signatories to the Chicago Convention, now 188, are obliged to implement the Standards and Recommended Practices (SARPs) of the Convention.²

Each signatory country has a Civil Aviation Authority (CAA) to oversee the following areas of civil aviation:

² <http://www.icao.int/icaonet/dcs/7300.html>

- Personnel Licensing — regulating the basic training and issuance of licenses and certificates.
- Flight Operations — carrying out safety oversight of commercial operators.
- Airworthiness — issuing certificates of registration and certificates of airworthiness to civil aircraft, and overseeing the safety of maintenance organizations.
- Aerodromes — designing and constructing aerodrome facilities.
- Air Traffic Services — managing the traffic inside a country's airspace.

The civil aviation authorities adhere to the standardized codes of the International Civil Aviation Organization (ICAO). Some of these authorities include the Federal Aviation Administration (FAA) in the United States, the Civil Aviation Authority (CAA) in Great Britain, the Luftfahrt-Bundesamt (LBA) in Germany, Transport Canada in Canada, and Director General of Civil Aviation (DGCA) in India.

India has a well-developed and large civil aviation network. There are 122 airports in the country, controlled by the Airports Authority of India (AAI), of which 11 are international airports. The air services of the country were liberalised in 1994 through a move towards an open-skies policy of the government. A number of operators now provide these services in India.

The total passenger traffic handled by Indian airports in 2001-02 was over 40 million, while the cargo traffic handled was around 854,000 tonnes. The country has witnessed immense traffic growth over the past three decades. The passenger traffic at the international airports located at the four major metro cities (Mumbai, Delhi, Chennai & Kolkata) has grown from 5.7 million in 1972 to almost 28 million in 2000. Most air traffic is handled at these four airports. Together they account for as much as two-thirds of the total passenger traffic and almost four-fifths of the total cargo traffic in the country.

2.4 Policy Framework of Indian Civil Aviation

The government has been quite active in evolving a policy framework for the development of the aviation sector in the country. Some of the most significant developments undertaken by the government include deregulation of the domestic airline markets, inviting private participation in the development of airport infrastructure and modernization of the air traffic system.

- The government allows up to 40% foreign equity in domestic air carriers. However, no direct or indirect equity participation by foreign airlines is allowed.
- Non-resident Indians and corporate bodies are allowed to hold up to 100% equity in domestic air transport services.
- For cargo operations, India has an open-skies policy. All foreign airlines are allowed to operate cargo services without any restrictions.

- The government has allowed 100 % Foreign Direct Investment (FDI) in airports. FDIs up to 74 % are approved through the automatic route and beyond that government approval is required.
- Private sector is allowed to operate scheduled airlines in the domestic sector.
- Private sector participation is also allowed in airport modernisation, ground services, and aircraft manufacture.

The government is pursuing a policy of enhancing the role of the private sector in improving the efficiency of the airport infrastructure in the country. The proposed privatisation of four of the largest international airports at Delhi, Mumbai, Chennai and Kolkata is a key element of this strategy. The government is also seeking private investment in building new airport facilities.

The government is planning to privatise the operation and management of the four international airports at Delhi, Mumbai, Chennai and Kolkata to private operators. These airports handle significant amounts of both passenger and cargo traffic. Projections show that traffic is likely to increase steeply at these airports.

2.5 The Global Outlook

As the major activity of civil aviation, passenger-handling has grown to reach a turnover of many hundreds of US \$ billions per year, arising from ticket sales to over one billion passengers per year. These revenues enable the financing of purchases by airlines of hundreds of

US \$ billions worth of aircraft every year. They also support related fields such as airport and passenger facility, design and operation, large-scale catering services, passenger entertainment systems, global computerised ticketing systems, and they generate a major contribution to hotel industry revenues.

As a further example of the scale of commercial aviation, the aircraft maintenance, repair and overhaul (MRO) sector alone has a turnover of nearly \$30 billion per year and is growing at an annual rate of some 3%. This activity is so sufficiently large that there is a world-wide system for licensing Airframe and Power plant (A&P) technicians, and specialised A&P schools for training new staff³. Thus MRO alone is larger than the commercial space industry today, or than the government-supported space industry.

But it is not smooth riding all the way. There can be several hitches to flying a plane like bad weather, bird hits, limited fuel capacity, limited passenger or cargo capacity, etc. But the worst nightmare of a pilot or passengers must surely be aviation terrorism.

2.6 Aviation Terrorism

Terrorism is the cruellest of crimes; it feeds off the personal suffering by luring governments into actions that abandon hard-earned freedoms of modern civilization. Gargantuan budgets committed to security mock the lives lost in poor countries to preventable disease and hunger. The dark complexity of suicide attacks has exposed inadequacies of security forces, moral philosophers, psychologists and

³ Collins, Patrick & Yoshiyuki Funatsu, "Collaboration with Aviation-the key to commercialization of space activities"

theologians alike. Failing to take advantage of the universal revulsion at the events of September 2001, the “war on terror” has instead magnified the global threat of terrorism.

Terrorism is a policy or ideology of violence intended to intimidate or cause terror for the purpose of “exerting pressure on decision making by state bodies”. The term ‘terror’ is largely used to indicate clandestine, low-intensity violence that targets civilians and generates public fear. Thus ‘terror’ is distinct from asymmetric warfare, and violates the concept of a common law of war in which civilian life is regarded. The term ‘-ism’ is used to indicate an ideology – typically one that claims its attacks are in the domain of a ‘just war’ concept, though most people condemn such attacks as crimes against humanity.

Terrorism is more commonly understood as an act which

- is intended to create fear (terror),
- is perpetrated for an ideological goal (as opposed to a materialistic goal or a lone attack), and
- deliberately targets (or disregards the safety of) non-combatants.

Some definitions also include acts of unlawful violence or unconventional warfare, but at present, there is no internationally agreed upon definition of terrorism.

A person who practices terrorism is a terrorist. Acts of terrorism are defined as criminal acts according to United Nations Security Council Resolution 1373 and the domestic jurisprudence of almost all nations.

The concept of terrorism is itself controversial because it is often used by states to de-legitimize political or foreign opponents, and potentially legitimize the state's own use of terror against them.

Terror has a Latin origin, meaning 'to frighten'. A 'Reign of Terror' was imposed by the government during the French Revolution. But in modern times 'terrorism' usually refers to the killing of innocent people by a private group in such a way as to create a media spectacle.

In November 2004, a United Nations Security Council report described terrorism as any act 'intended to cause death or serious bodily harm to civilians or non-combatants with the purpose of intimidating a population or compelling a government or an international organization to do or abstain from doing any act'. Terrorism is defined as the unlawful use or threat of violence against persons or property to fulfil their political or social objective and is usually intended to intimidate or coerce a government, individuals or groups, or to modify their behaviour or policies⁴. It includes espionage, sabotage, kidnapping, extortion, skyjacking (hijacking), robbery, bombing, holding a person prisoner or hostage or any threat to do any injury to a human being, animal or person, or property or any conspiracy to do any of the above in order to compel an act or omission by any person, or any government entity.

Sometimes anti-social elements indulge in criminal activities known as aviation terrorism. Aviation terrorism is an act of misdeed against

⁴ As defined by the 'American Task Force on Combating Terrorism' headed by former US President George Bush, in 1986

unarmed passengers and crew of a civil airliner, whether flying in the air or on the ground. It may be in the form of hijacking or sabotage. It also includes military action against civil aircraft. But such acts against the military or para-military are not considered as terrorism.

Terrorism has been practised by a broad array of political organizations for furthering their objectives. It has been practiced by both right-wing and left-wing political parties, nationalistic groups, religious groups, revolutionaries, and ruling governments.

The history of terrorist organizations suggests that they do not practice terrorism only for its political effectiveness; individual terrorists are also motivated by a desire for social solidarity with other members. The only general characteristic of terrorism generally agreed upon is that terrorism involves violence and the threat of violence. The attack is carried out in such a way as to maximize the severity and length of the psychological impact. Each act of terrorism is a "performance" devised to have an impact on many large audiences. Terrorists also attack national symbols, to show power and to attempt to shake the foundation of the country or society they are opposed to. This may negatively affect a government, while increasing the prestige of the given terrorist organization and/or ideology behind a terrorist act.

Something that many acts of terrorism have in common is a political purpose. Terrorism is a political tactic, like letter-writing or protesting, which is used by activists when they believe that no other means will give effect to the kind of change they desire. It is commonly held that the distinctive nature of terrorism lies in its intentional and specific selection of civilians as direct targets.

Those labelled as 'terrorists' rarely identify themselves as such, and typically use other euphemistic terms or terms specific to their situation, such as separatist, freedom fighter, liberator, revolutionary, vigilante, militant, paramilitary, guerrilla, rebel or any similar-meaning word in other languages and cultures. Some groups, when involved in a "liberation" struggle, have been called "terrorists" by the Western governments or media. Later, these same persons, as leaders of the liberated nations, are called "statesmen" by similar organizations. Two examples of this phenomenon are the Nobel Peace Prize laureates Menachem Begin and Nelson Mandela.

The term was first used by the British to describe the Jewish movement to create the independent state of Israel. Ironically, the result of that terrorism is now a recognized country not only in the Middle East, but also in the world, by the very Western powers that condemned this struggle and termed it terrorism. President Truman refused to recognize Israel when it was created. The Russians were the first major power to recognize the product of that terrorism. Now, those who described the leaders of this independence movement as terrorists are the greatest supporters of their right to exist and will do anything to perpetuate its existence.

2.7 Hijacking

In relation to aviation, hijacking is the most common form of terrorism. It refers to the illegal capture of an aircraft. The International Civil Aviation Organisation (ICAO) uses a wider term 'unlawful interference' that includes unlawful seizure of aircraft, sabotage, in-flight attack on aircraft, attack of aircraft on ground, attack against ground radio facilities, unlawful act against safety of

civil aviation, etc. In the Hague Convention in December 1970, the ICAO declared that any person who forcibly takes control of the aircraft during flight is to be referred to as a criminal. In the Montreal Convention in September 1971, it declared that any person who attacks an aircraft or a ground facility or destroys an aircraft is a criminal.

Most of the instances of hijacking have been influenced by political reasons or with the intention of seeking asylum in another country. Several cases of hijacking have taken place for other reasons like obtaining ransom, and sometimes the perpetrators have been people of unsound mind. The first known instance of hijacking was in 1930 by Peruvian revolutionaries. They hijacked a Fokker F-7 aircraft for dropping leaflets in their favour. 1969 can well be called as the 'year of aviation terrorism' – there were 73 actual instances of hijacking of aircraft in that year alone! Ever since Peruvian terrorists hijacked the Pan-Am mail plane in 1930, there have been almost 1,000 incidents of aviation-related terrorism. Hundreds of aircraft have been hijacked while dozens have been destroyed by bombs in flight. Until 2001, the most lethal single act of terrorism had been the 1985 Air India Bombing (which killed 329 people — including 154 Canadian citizens).

In 1988 the ICAO held a convention at Montreal and adopted the Montreal Supplementary Protocol. It deals with acts of violence at airports and came into force from 6th August, 1989. India has ratified this convention.

Hijacking for monetary gain is another reason and one of the most significant instances in relation to India occurred in 1973. A Royal Nepal Airlines aircraft was hijacked and taken to Forbesganj, a small airstrip near the India-Nepal border, in the state of Bihar. In this

case, the hijackers were successful in escaping with three million rupees. The first instance of hijacking in India occurred in January 1971, in which a Fokker Friendship F-27 aircraft belonging to Indian airlines was hijacked en-route a flight from Srinagar to Jammu. It was taken to Lahore in Pakistan where the passengers and crew were released but the aircraft was set on fire.

Airliners remain irresistible to terrorists. They are fragile and full of people – allowing more death for the dollar than almost any form of attack. If the terrorist wants to take hostages, an airliner is fairly easy to control once the formidable logistical hurdle of getting weapons on board is accomplished.

The use of four hijacked aircraft as piloted cruise missiles in the September 11 attacks on the World Trade Centre raised the bar on successful terrorism and killed around 3,000 people in less than two hours. This attack differed from other acts of aviation terrorism in a very significant respect. While the usual acts of hijacking threaten civilians who are travelling in the hijacked plane, in this gruesome incident civilians on land were deliberately targeted. The hijacked planes were flown directly into a building known to contain thousands of innocent people working in their offices (50,000 worked in the towers and 2,00,000 passed through them as visitors on a normal working day).

Besides the risk involved to the safety of passengers and crew because of the hijackers, there is another substantial risk of which most people are not aware. A plane is capable of taking off with a heavy load, but it has to be lighter for landing, since a heavier weight may cause breakage of its landing gears or other damage to the under side of the plane. Ordinarily, as the plane flies, fuel is consumed and by the time

it reaches its destination and is ready for landing, not much fuel remains, thus causing a significant reduction in the weight of the plane. But if it is hijacked and the hijacker forces the plane to land at an intermediary destination, the extra amount of fuel needs to be expelled from the plane, and this may take several minutes or even 1 – 2 hours. If the hijacker does not allow this, the pilot is forced to land with the extra weight on board, thus endangering the safety of the passengers along with the aircraft.

The defences against anti-aircraft missiles are few. With no radar or laser guidance, there is nothing to warn a pilot that his plane is under attack. Aircraft don't fly with wingmen and can't practice evasive manoeuvres. Military aircraft spit out flares to distract missiles in danger zones – something airliners can't do over cities.

Over the years, aircraft have become better but imperfectly protected against hijacking and onboard bombs. But if aircraft can be difficult to attack, airports have large concentrations of people – many of whom can be found in a line-up in front of the ticket counter for a particular airliner. Massacre attacks with automatic weapons and hand grenades have occurred in airports in Israel and Rome.

The 2001 Tamil Tiger assault on the Colombo airfield destroyed half the aircraft of Sri Lanka's national airline, and caused hundreds of millions of dollars in damage to the country's economy. The IRA's use of large home-made mortars fired at Heathrow and Gatwick airports shut down these vital commercial hubs for several days together.

2.8 The Twin-Tower Attack

The World Trade Centre (sometimes referred to as WTC or Twin Towers) was a complex in Lower Manhattan whose seven buildings were destroyed in 2001 in the September 11 attacks. The site is currently being rebuilt with six new skyscrapers and a memorial to the casualties of the attacks.

On the morning of September 11, 2001, Al-Qaeda-affiliated hijackers flew two 767 jets into the complex, one into each tower, in a coordinated suicide attack. After burning for 59 minutes, the South Tower collapsed, followed a half-hour later by the North Tower, with the attacks on the World Trade Centre resulting in 2,750 deaths. The World Trade Centre collapsed later in the day and the other buildings, though they didn't collapse, had to be demolished because they were damaged beyond repair. The process of cleanup and recovery continued 24 hours a day over a period of eight months.

2.9 Nuclear Terrorist Threat

The proliferation of nuclear weapons or radiological dispersal devices to terrorist groups is perhaps one of the most frightening threats to security. Nuclear materials, technologies and know-how are more widely available today than ever before. Small quantities of both fissile materials and highly radioactive materials, sufficient to manufacture a radiological dispersal device, are actively traded on the black market. Although terrorist groups are not suspected of actually acquiring such materials in large quantities, it is difficult to know for sure.

A nuclear detonation by a terrorist group would most probably result in an unprecedented number of casualties. In contrast, a radiological dispersal attack would probably be less violent, but could significantly contaminate an urban centre, causing economic and social disruption. Both types of attacks would have significant psychological impacts on the entire population.

In order to manufacture a crude nuclear weapon, a terrorist organization needs to possess specialized expertise in areas such as high explosives, propellants, electronics, nuclear physics, chemistry and engineering. Knowledge of the physical and chemical properties of plutonium or highly enriched uranium (HEU) is essential. The terrorist group also must obtain detailed design drawings of weapons components and of the final assembled device. In the past, such information was difficult to come by in the open literature. Today important and useful information about the design and assembly of nuclear weapons or weapon components can be found on internet sites and World Wide Web pages. Unlike other resources, the internet provides a comfortable anonymity to those posting or seeking sensitive information. Given this anonymity, the internet can function as an instantaneous, global clearing house of information and can provide a useful first source for terrorist groups, which otherwise would have to search the public literature in more conspicuous ways.

The break-up of the Soviet Union has made nuclear weapons, materials and technologies more accessible to nations and terrorist groups, alike. In March 1996, Director of Central Intelligence John Deutch warned that the Soviet collapse has brought about "the chilling reality ... that nuclear materials and technologies are more accessible now than at any other time in history." According to U.S. intelligence, the deteriorating economic situation, low pay and poor morale among

Russian military personnel “could undermine the nuclear weapons stockpile’s security, making theft of warheads or subcomponents possible.

Beyond the immediate physical damage caused by a nuclear terrorist attack, the psychological, economic and sociological impacts of such an attack would be devastating. Unlike natural disasters, a nuclear attack may occur without warning, leaving little chance for preparation. An attack in an urban area would not only kill a large number of people, it also could render the area virtually uninhabitable for a long period of time. Survivors may have to be relocated; hospitals and shelters would quickly become filled with displaced persons, many of them injured or suffering from radiation exposure. The trauma of such an attack would leave lasting psychological and emotional scars on the survivors. The clean up task would no doubt rival even the largest efforts undertaken following comparable natural disasters, such as hurricanes, and would require long-term commitments from local, state and federal relief programs.

2.10 Combating Terrorism in India

There is an urgent need to have zero tolerance on terrorism and effective counter-terrorism legislation in place. People with no domicile records are getting passports issued and fake documents generated for a few dollars. The foremost thing is that the people of India have to understand and realize that we are actually at war with terrorism and we have to treat the matter in the same way that the USA has been dealing with a vigilant population which helps in quelling these incidents.

Unless we establish an excellent intelligence network and also have a strategic tie -up with other agencies like Mossad, CIA, FBI, etc., we cannot really make a dent in the terror networks that are extending gradually throughout India.

2.11 Measures to Prevent Aviation Terrorism

The system of security checks of passengers and their baggage was not prevalent earlier. All that was required was a valid ticket for a passenger to board the aircraft. Passengers were allowed to carry almost anything within the permitted limits of load, except inflammable articles like petrol or kerosene that could endanger the safety of the aircraft.

After 1968, during which year there were several incidents of hijacking, many countries began to have stricter security measures. But still, not much importance was given to it and people still managed to carry weapons or other restricted articles on board. For instance, an ex-naval official boarded a Trans World Airways B707 in October 1969 in USA, carrying with him a huge pile of grenades, firearms and other material inside the aircraft. He also took a rifle with him by concealing it into a fishing rod. Later he hijacked the aircraft and took it to Italy⁵. This reveals the standard of security arrangements that used to be made.

Another significant incident that exposes the lax security, or perhaps reveals the genius of evil minds, was the Kanishka crash. A person had booked a ticket for the flight and also checked in at the airport at Vancouver, but never boarded the flight. His baggage was loaded on

⁵ http://en.wikipedia.org/wiki/aviation_terrorism

the flight and it contained a plastic bomb. This exploded over the Atlantic Ocean, instantly killing all persons on board. Another person's baggage was loaded on a Canadian Pacific Airline flight from Toronto to Tokyo and was to be transferred to an Air India flight from Tokyo to Bombay. Because the Canadian pacific aircraft was delayed, the bomb contained in this bag exploded at the airport itself, instead of exploding in midair.

Today, however, the situation has changed drastically, in part due to the increase in various incidents of hijacking and bombing, but largely due to the September 11 attacks on the World Trade Centre. The restrictions on permitted articles have increased to such an extent that even items such as perfumes, sprays, talcum powder, scissors, nail cutters, etc. are not allowed as a part of the cabin luggage. Baby food is allowed but other liquid preparations like creams are restricted.

As nations began to recognize the importance of security due to the spurt in hijacking all over the world, they started adopting stricter security measures for making air travel safer. The first step in this direction was a thorough checking of passengers and their baggage. The staff and officials of airlines and airports were also subjected to such checks before entering the airport area. This strictness in checking resulted in the detection of a large number of arms and ammunition during the nineteen seventies and eighties. After this, the number of weapons carried by air travellers started decreasing.

It is now a regular practice at most of the airport to check the passenger and his baggage before boarding the aircraft. It is usually done by physical checking, X-ray machines, metal detectors and various other means. Special training is given to security personnel for handling airport security.

Unaccompanied baggage is not accepted by airline staff in India; the passenger has to travel along with it. If it becomes necessary to send such baggage, a suitable cooling period is allowed. In that case, the baggage is not loaded immediately on the aircraft, but is kept at a suitable place for a reasonable period, so that if an explosive is hidden in it, it gets time to detonate outside the aircraft in a safe place, instead of inside the aircraft.

Accompanied baggage is required to be identified by the individual passenger before it is loaded on to the aircraft. If it is not identified for any reason, it is not loaded. Though this practice may cause delays in take-off, it is necessary if security is to be maintained. Sikh passengers were earlier allowed to carry their 'kirpan' or dagger inside the cabin. But this privilege has been withdrawn now. Except a camera, any equipment containing a battery is restricted in the cabin.

Some countries adopt additional security measures besides those mentioned above.

- Israel carries security commandos on its flights, who usually sit among the passengers in civil clothes.
- On most aircraft, passengers are not allowed to enter the cockpit without any valid reason. They can enter only with the permission of the pilot in command.
- Israel was the first nation to introduce bullet proofing and automatic door closing technique for the cockpit doors of their aircraft. This practice has been adopted by other airlines too now.

- Some airports use the services of trained dogs for the detection of bombs, explosives, firearms, etc.
- Closed circuit TV cameras are extensively used for monitoring the entry, movement and exit of undesirable elements inside the airport. It is usually installed in sensitive areas such as arrival and departure lounges, check-in areas and security hold areas.
- In the 1970s it became a requirement to search all articles such as hand bags, brief cases and packages carried aboard a commercial aircraft. Since manual searching is not a satisfactory method, X-ray exam was introduced. Some airports like Frankfurt have special chambers called decompression chambers for checking baggage. They are made of steel and actual flight conditions are simulated, so that any bombs may get detonated.
- A similar physical examination of the passenger is also conducted. Each passenger is made to pass through metal detectors to detect weapons.
- Thermal Neutron Analyser (TNA) was developed in the USA in 1989 to detect the presence of Semtex plastic that is used in explosives. The baggage is bombarded with neutrons, which causes the scanned items to emit gamma rays. The concentration and other features of gamma rays reveal the presence of plastic explosives. But as it uses small amounts of radiation, it is not suitable for screening passengers or hand baggage.

- There are also some other methods like ‘enhanced x-ray system’, vapour detection, computer tomography among others.

2.12 Legal Action and Extradition

Some countries like the USA and Israel are very strict in taking legal action against hijackers. As per the 1974 Act of USA, the punishment for hijacking is 20 years of imprisonment. The 1971 Act of UK provides the penalty of life imprisonment. If the hijacking involves death, the punishment is converted to death penalty. In Pakistan, hijacking carries a penalty of life imprisonment or a death sentence.

In India, there was no specific penal action prescribed for hijacking before 1982. Trials were conducted on the basis of other clauses of the Indian Penal Code. Then in 1982, the Anti Hijacking Act was passed and action against hijackers became more stringent. But still there are no special courts established exclusively for the trial of hijacking cases. Perhaps the solution to the problem of hijacking lies in setting up special courts for this purpose and quick disposal of cases with stringent punishment.

2.13 Environmental Issues

The spectacular developments in aviation are certainly well-known and it cannot be denied that they contributed immensely to the development of transport, communications, and all the other benefits that have been discussed in this chapter earlier. However, these benefits are not without their side-effects, which cause damage and discomfort, especially due to the loud noise of aircraft and sonic boom. Industry and motorized transport is already contributing towards

adversely affecting the environment. Aggravating this is the incidence of noise caused by aircraft, which is especially harmful and detrimental. Some countries have legislative measures in place against excessive noise.

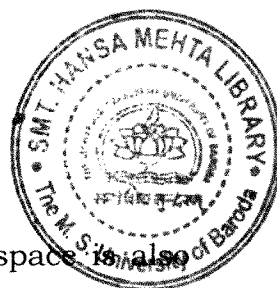
Excessive noise may be caused by any of the following processes –

- i) aircraft passing through the airspace
- ii) take-off and landing affecting areas adjacent to airports
- iii) test flights affecting those areas

In order to combat the effects of aircraft noise, especially in densely populated areas, legislative measures have been introduced in some countries. Besides, case law has played a useful role in providing relief for those suffering from excessive noise, though there are significant differences in legal practice between European countries and the United States.

With aircraft these days being regarded as ordinary means of transport, some amount of tolerance towards noise can be expected from the general public. Yet, it cannot be denied that the present situation is far from satisfactory, even though a few countries have already introduced legislation for damage caused by noise, while a few other countries are in the process of doing it. Some countries have introduced the concept of 'zoning', whereby construction in the vicinity of airports has been made contingent upon noise levels in the area. Other measures include restricting night flying, or making the use of certain runways conditional upon the wind direction. But in the absence of international rules, the best option at present would be to concentrate all efforts on technical know-how so that the noise of the aircraft itself is reduced.

2.14 Defence



Besides commercial passenger and cargo transport, air space is also used for defence applications. Anti-aircraft warfare, or air defence, is any method of engaging hostile military aircraft in defence of ground objectives, ground or naval forces or denial of passage through a specific airspace region, area or anti-aircraft combat zone. It is also used in denying entry into national air space to unauthorized aircraft.

From the initial introduction of aircraft into combat during the First World War the means to achieve air defence included infantry firearms, light anti-aircraft weapons, cannons and anti-aircraft artillery as well as barrage balloons and interceptor aircraft, with all aided by radar installations, growing in power and accuracy over the course of the 20th century, particularly with the introduction of the surface-to-air missile to self-propelled anti-aircraft weapons.

Radar systems use electromagnetic waves to identify the range, altitude, direction, or speed of aircraft and weather formations to provide tactical and operational warning and direction, primarily during defensive operations. In their functional roles they provide target search, threat, guidance, reconnaissance, navigation, instrumentation, and weather reporting support to combat operations.

Air defence by air forces is typically taken care of by fighter jets carrying air-to-air missiles. However most air forces choose to augment airbase defence with surface-to-air missile systems as they are such valuable targets and subject to attack by enemy aircraft. In addition, countries without dedicated air defence forces often relegate these duties to the air force. For example, the United States' strategic

air defence is the domain of the Air Force, even when it is performed by missiles launched from fixed installations.

2.15 Security and Surveillance

Radar

Radar (Radio Detection and Ranging) detects objects at a distance by bouncing radio waves off them. The delay caused by the echo measures the distance. The direction of the beam determines the direction of the reflection. The polarization and frequency of the return can sense the type of surface. Navigational radars scan a wide area two to four times per minute. They use very short waves that reflect from earth and stone. They are common on commercial ships and long-distance commercial aircraft.

Radar processing technology has been developed specifically for detection and tracking of small, low radar-cross section, non-linearly moving targets for locating and monitoring a wide range of targets including aircraft, ships, boats, vehicles and pedestrians. It provides full surveillance coverage ground level to altitudes up to 20,000 feet and allows the system to function as a multi-purpose sensor for simultaneous detection, alerting and tracking of aircraft, ships, boats, swimmers, vehicles and pedestrians and is an ideal, cost-effective solution for many force protection and homeland security applications.

It can be used for various applications, some of which are listed below-

- ✓ Airspace monitoring & surveillance
- ✓ Aircraft detection & tracking

- ✓ Marine and coastal surveillance
- ✓ Airspace see-and-avoid
- ✓ Intrusion detection
- ✓ Collision & obstruction avoidance
- ✓ Perimeter security
- ✓ Shoreline protection

It is used in several high security facilities and installations, some of them being –

- ✓ Commercial airports, civil aviation airports & military airfields
- ✓ Unmanned aerial vehicle (UAV) operations support
- ✓ Government installations
- ✓ Industrial plants, refineries & power plants
- ✓ Ports, waterways & coastlines
- ✓ Border control areas
- ✓ High security facilities

It is also used for border surveillance, fire detection, marine monitoring and public event security.

2.16 Mass Communications

Mass communication media like Radio and TV make use of air waves to receive and transmit information.

Radio

Radio is the transmission of signals by modulation of electromagnetic waves with frequencies below those of visible light. Electromagnetic

radiation travels by means of oscillating electromagnetic fields that pass through the air and the vacuum of space. Information is carried by systematically changing (modulating) some property of the radiated waves, such as amplitude, frequency, or phase. When radio waves pass an electrical conductor, the oscillating fields induce an alternating current in the conductor. This can be detected and transformed into sound or other signals that carry information.

Radio systems are used for applications from walkie-talkie children's toys to the control of space vehicles as well as for broadcasting, and many other applications.

Telephony

Mobile phones transmit to a local cell site (transmitter/receiver) that ultimately connects to the public switched telephone network (PSTN) through an optic fiber or microwave radio and other network elements.

Amateur radio service

Amateur radio, also known as "ham radio", is a hobby in which enthusiasts are licensed to communicate on a number of bands in the radio frequency spectrum non-commercially and for their own enjoyment. They may also provide emergency and public service assistance. This has been very beneficial in emergencies, saving lives in many instances. Radio amateurs use a variety of modes, including nostalgic ones like the Morse Code and experimental ones like Low-Frequency Experimental Radio. Several forms of radio were pioneered by radio amateurs and later became commercially important including

FM, single-sideband (SSB), AM, digital packet radio and satellite repeaters. Some amateur frequencies may be disrupted by power-line internet service.

Heating

Radio-frequency energy generated for heating of objects is generally not intended to radiate outside of the generating equipment, to prevent interference with other radio signals. Microwave ovens use intense radio waves to heat food. Diathermy equipment is used in surgery for sealing of blood vessels. Induction furnaces are used for melting metal for casting.

Radio control

Radio remote controls use radio waves to transmit control data to a remote object as in some early forms of guided missile, some early TV remotes and a range of model boats, cars and airplanes. Large industrial remote-controlled equipment such as cranes and switching locomotives now usually use digital radio techniques to ensure safety and reliability.

Television

Television (TV) is a widely used telecommunication medium for transmitting and receiving moving images, either monochromatic ("black and white") or colour, usually accompanied by sound. Although other forms such as closed-circuit television are in use, the most common usage of the medium is for broadcast television, which was modelled on the existing radio broadcasting systems developed in

the 1920s, and uses high-powered radio-frequency transmitters to broadcast the television signal to individual TV receivers. Television systems are also used for surveillance, industrial process control, and guiding of weapons, in places where direct observation is difficult or dangerous. Amateur television (HAM TV or ATV) is also used for experimentation, pleasure and public service events by amateur radio operators.

Television's broad reach makes it a powerful and attractive medium for advertisers. Many television networks and stations sell blocks of broadcast time to advertisers ("sponsors") in order to fund their programming.

2.17 Weather Forecasting

Weather forecasting is the application of science and technology to predict the state of the atmosphere for a future time and a given location. Human beings have attempted to predict the weather informally for millennia, and formally since at least the nineteenth century. Weather forecasts are made by collecting quantitative data about the current state of the atmosphere and using scientific understanding of atmospheric processes to project how the atmosphere will evolve.

Weather warnings are important forecasts because they are used to protect life and property. Forecasts based on temperature and precipitation are important to agriculture, and therefore to commodity traders within stock markets. Temperature forecasts are used by utility companies to estimate demand over coming days. On an everyday basis, people use weather forecasts to determine what to

wear on a given day. Since outdoor activities are severely curtailed by heavy rain, snow and the wind chill, forecasts can be used to plan activities around these events, and to plan ahead and survive them.

2.18 Commercialization of Air Space

With its commercialization, air space has become a profitable place of business. Civil aviation which was earlier the domain of government is now flooded with private airlines. Many countries including India also have regional private airline operators. Though the commercialization of air space provides increased business opportunities, it also poses a serious threat to the security and safety of both, passengers and staff. When from a busy metro airport, during peak hours, at least one flight takes off every minute, having adequate security checks is nearly impossible. The fatigue of the security staff leads to laxity in security checks, paving the way for terrorists/miscreants to give shape to their ulterior motives and risk the lives of hundreds of innocent people. The increase in air traffic does provide better employment opportunities too, but in a rush to employ people to carry out business operations, often inefficient or less qualified people are also employed. The person who is not adequately trained or efficient may not be in a position to cope with the tremendous pressure of work, especially during untoward incidents.

2.19 Multitude of Low-Cost Airlines

The proliferation of low cost airlines has multiplied the already existing problems of security and safety of passengers. Just to bring the flying costs down as low as possible, some of the low cost airlines tend to ignore regular service and maintenance of the aircraft. There have

also been complaints that in the aircraft of many low cost airlines the passengers can hardly see the in-flight support staff, i.e. air hostesses and stewards, but they meet cockroaches and lizards. Many airlines have been found to ignore flying norms for the pilots. The pilots, ground staff and technical staff are often not adequately paid, so as to be able to lure the passengers with the lowest possible airfare, which ultimately leads to inefficient work force. To increase the number of hours that aircraft remain in the sky, the airlines devote less time to checkups and maintenance. Even if a problem in the aircraft is noticed, the airline tends to ignore it so as not to ground the aircraft for maintenance in a bid to commercialize aviation time. The recent incident of the crash of an Airbus of Air France in June 2009 is a glaring example of how the airline ignored the safety of the aircraft and its passengers for a purely business decision. After the crash, it was revealed that the speedometer of the aircraft was faulty and the same had been brought to the notice of the airline. But a commercial decision not to replace it immediately, only with a view to keep the aircraft flying, cost the lives of more than 200 passengers on board. This carelessness can lead to several undesirable consequences besides endangering the safety of passengers, one of them being the increased probability of air collisions.

2.20 Air Collisions

Given the increased cruising speed and the density of air traffic, the introduction of suitable measures to prevent air collisions is of the greatest importance. This has become all the more evident in recent years with the increasing number of near misses. In 1976, an air collision that took place near Zagreb, Yugoslavia, was a tragic accident that resulted in both the crew and all the passengers losing their lives.

Negligence of the air traffic controllers was proved to be the cause of the collision between a Yugoslavian airlines aircraft and a British Airways Trident aircraft.

Another aviation disaster was averted recently at the Mumbai airport when two aircraft got clearance to take off simultaneously from two runways but the pilots stopped the planes in the nick of time. While an Air India aircraft was awaiting takeoff on the main runway, a Jet plane waited at the cross-runway. After clearance from the Air Traffic Control (ATC), both aircraft started moving and came almost opposite each other before their pilots aborted the take off. Another near-collision was averted on 9th February 2009 between a helicopter in the President's air entourage and an Air India flight. One of the reasons for such collisions is that the two runways run across each other in an X formation, instead of running parallel to each other.

2.21 Aftermath of 9/11

The commercialization of air space upset many people, but air space terrorism stunned them. Before 9/11, terrorism in air space was limited to hijacking only, though Kanishka, an air craft of Air India was sabotaged by implanting a bomb in the plane by Sikh militants during the Khalistan Movement. But on 9/11, the world witnessed a new form of air terrorism. Four domestic flights were hijacked by Taliban militants and two of them were forced to crash into two towers of the World Trade Centre, which formed the sky line of New York. These twin towers which were considered the business pride of USA became ground zero in less than an hour. These two planes were hijacked by the militants and the pilots were overpowered by them. In a dare devil suicidal attack, the militants who were trained as pilots, took over the control of the plane from the pilots, and crashed straight

into the towers in such a manner that the entire tower collapsed. The terrorists in another plane even tried to ram into the Pentagon, the defence centre of the USA and the White House, in which the first citizen of the world's only super power resides, but were not successful due to the resistance put up by the passengers on board. The aviation industry learnt a lesson in security and safety, but at a very high cost. Soon after the incident the aviation industry decided to have locked, bullet-proof cockpit doors that cannot be opened from the outside, to prevent the manoeuvring of the aircraft by militants in future. However, the commercialization of air space has still put the passengers and crew in a vulnerable position. The plight of the pilot today is like a soldier on the border. When the pilot leaves his house, he is not sure whether he will return home.

2.22 Air Sports

Sports are an essential part of human life and civilized society. Sports have helped even the people of enemy countries to unite. Sports stars have acquired the status of celebrities in almost all countries. The IPL matches get wider coverage than even the general elections. But the sports grounds and arenas on the earth are now outdated and least interesting. The eyes of man are set on the sky, which has given rise to many air sports. The term 'Air sports' covers a range of aerial activities such as:

- Aerobatics
- Air racing
- Ballooning
- General aviation
- Gliding
- Hang gliding
- Human powered aircraft
- Model aircraft

- Parachuting
- Paragliding
- Ultralight aviation
- Wingsuit flying

The sports listed above (apart from wingsuit flying) are governed internationally by Fédération Aéronautique Internationale and at the national level by aero clubs.

Aerobatics

Aerobatics is the practice of flying manoeuvres involving aircraft attitudes that are not used in normal flight. Aerobatics are performed in airplanes and gliders for training, recreation, entertainment and sport. Most aerobatic manoeuvres involve rotation of the aircraft about its longitudinal (roll) axis or lateral (pitch) axis. Other manoeuvres, such as a spin, displace the aircraft about its vertical axis. Manoeuvres are often combined to form a complete aerobatic sequence for entertainment or competition.

Aerobatic flying requires a broader set of piloting skills and exposes the aircraft to greater structural stress than for normal flight. In some countries, it is mandatory that the pilot wears a parachute when performing aerobatics.

While many pilots fly aerobatics solely for recreation, hundreds worldwide choose to fly in aerobatic competitions, a judged sport. Flight formation aerobatics are flown by teams of up to sixteen aircraft, although most teams fly between four and ten aircraft. Teams often fly V-formations – they will not fly directly behind another aircraft because of danger from wake vortices or engine exhaust.

Aircraft will always fly slightly below the aircraft in front, if they have to follow in line.

Air racing

Air racing is a sport that involves small aircraft. The first event in air racing history was held on 23rd May, 1909 - the Prix de Lagatinerie, held at the Port-Aviation airport, south of Paris, France. Four pilots entered the race, two actually started and nobody completed the full race distance. Léon Delagrange, who covered more than half of the ten 1.2-kilometre laps, was declared the winner.⁶

The first major international air race was the 22nd to 29th August, 1909 Grand Week of the Champagne at Reims, France. This race drew many of the most important plane makers and pilots of the era, as well as celebrities and royalty. The premier event of this race was the Gordon Bennett Trophy.

In 1947, an All-Woman Transcontinental Air Race (AWTAR) dubbed the "Powder Puff Derby" was established, running until 1977.⁷

The National Championship Air Races were soon moved to the Reno Stead Airport and have been held there every September since 1966. The five-day event attracts around 200,000 people.

Balloon

A balloon is conceptually the simplest of all flying machines. The balloon is a fabric envelope filled with a gas that is lighter than the

⁶ http://en.wikipedia.org/wiki/air_racing

⁷ *ibid*

surrounding atmosphere. As the entire balloon is less dense than its surroundings, it rises, taking along with it a basket, attached underneath, that carries passengers or payload. Although a balloon has no propulsion system, a degree of directional control is possible through making the balloon rise or sink in altitude to find favorable wind directions.

A balloon is a type of aircraft that remains aloft due to its buoyancy. It travels by moving with the wind. It is distinct from an airship, which is a buoyant aircraft that can be propelled through the air in a controlled manner.

The first recorded manned flight was made in a hot air balloon built by the Montgolfier brothers on November 21, 1783. The flight started in Paris and reached a height of 500 feet or so. The pilots, Jean-François Pilâtre de Rozier and François Laurent d'Arlandes, covered about 5 ½ miles in 25 minutes⁸.

There are three main types of balloon aircraft:

1) Hot air balloons -

These balloons obtain buoyancy by heating the air inside the balloon. They are the most common type of balloon aircraft. The term "Hot air balloon" is sometimes used incorrectly to denote any balloon that carries people.

2) Gas balloons -

These balloons are inflated with a gas of lower molecular weight than the ambient atmosphere. Most gas balloons operate with the

⁸ <http://en.wikipedia.org/wiki/ballooning>

internal pressure of the gas being the same as the pressure of the surrounding atmosphere. There is a type of gas balloon, called a super pressure balloon that can operate with the lifting gas at pressure that exceeds the pressure of the surrounding air, with the objective of limiting or eliminating the loss of gas from day-time heating. Gas balloons may be filled with various gases such as :

Hydrogen – mainly used for some sports balloons as well as nearly all unmanned scientific and weather balloons.

Helium – the gas used today for all airships and most manned balloons.

Ammonia – used infrequently due to its caustic qualities and limited lift

Coal Gas – used in the early days of ballooning; it is highly flammable

3) Rozière balloons -

These balloons use both heated and unheated lifting gases. The most common modern use of this type of balloon is for long-distance record flights such as circumnavigations.

Besides being used for sports activities, balloons have also been used in the military. The first military use of a balloon was at the Battle of Fleurus in 1794, when *L'Entreprenant* was used by French Revolutionary troops to watch the movements of the enemy. The first major-scale use of balloons in the military occurred during the American Civil War with the Union Army Balloon Corps established

and organized by Prof. Thaddeus S. C. Lowe in the summer of 1861. The first application thought useful for balloons was map-making from aerial vantage points. They have also been used for directing artillery fire, and for reconnaissance and observation purposes.

General aviation

General aviation (GA) is one of two categories of civil aviation. It refers to all flights other than military and scheduled airline flights, both private and commercial. General aviation flights range from gliders and powered parachutes to large, non-scheduled cargo jet flights. As a result, the majority of the world's air traffic falls into this category, and most of the world's airports serve general aviation exclusively.

In the United States, there are almost 20,000 airports and heliports, of which around 5,300 are available for public use by pilots of general aviation aircraft. In comparison, scheduled flights operate from around 600 airports in the U.S. According to the U.S. Aircraft Owners and Pilots Association, general aviation provides more than one percent of the United States' GDP, accounting for 1.3 million jobs in professional services and manufacturing⁹.

General aviation covers a huge range of activities, both commercial and non-commercial, including private flying, flight training, air ambulance, police aircraft, aerial fire-fighting, air charter, bush flying, gliding, and many others. Experimental aircraft, light-sport aircraft and very light jets have emerged in recent years as new trends in general aviation.

⁹ http://en.wikipedia.org/wiki/General_aviation

Gliding

Gliding is a recreational activity and competitive sport in which pilots fly un-powered aircraft known as gliders (sailplanes) using rising air to gain altitude or speed. The word 'soaring' is also used for the sport. When soaring conditions are good enough, experienced pilots can fly hundreds of kilometres before returning to their home airfields, and occasionally flights over 1,000 kilometres are made. However, if the weather deteriorates, they may need to land elsewhere, but motor-glider pilots can avoid this by starting an engine.

Powered aircraft and winches are the two most common means of launching gliders. These and other methods (apart from self-launching motor-gliders) require assistance from other participants. Gliding clubs have thus been established to share airfields and equipment, train new pilots and maintain high safety standards.

Local and national competitions are organized in many countries and there are also biennial World Gliding Championships. In the 1936 Summer Olympics in Berlin gliding was a demonstration sport, and it was scheduled to be a full Olympic sport in the 1940 Games. A glider, the Olympia, was developed in Germany for the event, but World War II intervened. Gliding did not return to the Olympics after the War, for two reasons: first, the shortage of gliders following the war; and second, the failure to agree on a single model of competition glider. Instead of the Olympic competition there are the World Gliding Championships. The first event was held at the Wasserkuppe in 1937. Since WWII it has been held every two years. Germany, the sport's birthplace, is still a centre of the gliding world. It accounts for 30% of

the world's glider pilots, and the three major glider manufacturers are still based there¹⁰.

Glider pilots can stay airborne for hours by flying through air that is ascending as fast or faster than the glider itself is descending, thus gaining potential energy.

The most commonly used sources of rising air are –

Thermals (updrafts of warm air);

Ridge Lift (found where the wind blows against the face of a hill and is forced to rise);

Wave Lift (standing waves in the atmosphere, analogous to the ripples on the surface of a stream).

Hang gliding

Hang gliding is an air sport in which a pilot flies a light and un-motorized foot-launchable aircraft called a hang glider. Most modern hang gliders are made of an aluminium or composite frame with a fabric wing. Pilots usually control the aircraft by shifting body weight, but other devices, including modern aircraft flight control systems, may be used. The pilot wears a harness and is hung beneath a lifting wing by flexible straps.

In the sport's early days, pilots were restricted to gliding down small hills on low-performance hang gliders. However, modern technology

¹⁰ <http://en.wikipedia.org/wiki/Gliding>

gives pilots the ability to soar for hours, gain thousands of feet of altitude in thermal updrafts, perform aerobatics, and fly cross-country for hundreds of miles. The Fédération Aéronautique Internationale and national airspace governing organizations control some aspects of hang gliding.

Human-powered aircraft

A human-powered aircraft (HPA) is an aircraft powered by direct human energy and the force of gravity; the thrust provided by the human may be the only source; however, a hang glider that is partially powered by pilot power is a human-powered aircraft where the flight path can be enhanced more than if the hang glider had not been assisted by human power. Likewise, HPA inevitably experience assist from thermals or rising air currents. Pure HPA do not use hybrid flows of energy (solar energy, wound rubber band, fuel cell, etc.) for thrust. In nil wind, a flatland-long-gliding aircraft is a form of HPA where the thrust in the nil wind is provided by the running of the pilot; when the pilot loses touch with the ground, his or her thrusting ceases to add energy to the flight system and a glide begins; the pilot may or may not add energy after the pilot stops touching the ground. Humans who tow up a manned kite form one type of human-powered aircraft.

As of 2008, human-powered aircraft have been successfully flown over considerable distances. However, they are primarily constructed as an engineering challenge rather than for any kind of recreational or utilitarian purpose.

Model aircraft

Model aircraft are flying or non-flying models of existing or imaginary aircraft, often scaled down versions of full size planes, using materials such as balsa wood, foam and fibreglass. Designs range from simple gliders, to accurate scale models, some of which can be very large.

Models may be built either as static non-flying models, or as flying models. Construction techniques for the two are usually very different.

Static model aircraft (i.e those not intended to fly) are scale models built using plastic, wood, metal or paper. Some static models are scaled for use in wind tunnels, where the data acquired is used to aid the design of full scale aircraft.

Collectors can buy models that have already been built and painted, models that require construction, painting and gluing, or models that have been painted but need to be snapped together. Snap models require minimal construction and are becoming increasingly popular.

Flying models are usually what is meant by the term aero-modelling. Most flying model aircraft can be placed in one of the following three groups:

- 1) Free flight (F/F) model aircraft fly without any attachment to the ground. This type of model pre-dates the efforts of the Wright Brothers and other pioneers.

- 2) Control line (C/L) model aircraft use cables (usually two) leading from the wing to the pilot. A variation of this system is the Round-the-pole flying (RTP) model.
- 3) Radio-controlled aircraft have a transmitter operated by the pilot on the ground, sending signals to a receiver in the craft.

Powered models contain an onboard power plant to propel the aircraft through the air. The model is usually powered by an electric motor or small piston engine, but other types of propulsion include rockets, small turbines, pulsejets, compressed gas engines and twisted rubber bands.

Parachuting

Parachuting, also known as skydiving, is the sport of jumping from enough height to deploy a fabric parachute and land safely. The first person to use a parachute was Andre-Jacques Garnerin who made successful parachute jumps from a hot-air balloon in 1797. The military first developed parachuting technology as a way to save aircrew from emergencies aboard balloons and aircraft in flight, and later as a way of delivering soldiers to the battlefield.

Early competitions date back to the 1930s, and it became an international sport in 1951. Sport Parachuting is performed as a recreational activity and a competitive sport, as well as for the deployment of military personnel, airborne forces and occasionally forest fire-fighters.

A typical jump involves individuals jumping out of an aircraft (usually an airplane, but sometimes a helicopter or even the gondola of a balloon), at approximately 4,000 meters (around 13,000 feet) altitude, and free-falling for a period of time before activating a parachute to slow the landing down to safe speeds. Once the parachute is opened, (usually the parachute will be fully inflated by 2,500 ft.), the jumper can control his or her direction and speed with toggles on the end of steering lines attached to the trailing edge of the parachute, and so he or she can aim for the landing site and come to a relatively gentle stop in a safe landing environment. All modern sport parachutes are self-inflating "ram-air" wings that provide control of speed and direction similar to the related paragliders. The decision of when to deploy the parachute is a matter of safety. A parachute should be deployed sufficiently high to give the parachutist time to handle a malfunction, should one occur. 600 metres (1,970 ft) is the practical minimum for advanced skydivers.].

Today, the majority of skydiving related injuries and deaths happen under a fully opened and functioning parachute, the most common cause being poorly-executed, radical manoeuvres near to the ground, such as hook turns, or landing flares performed either too high or too low. In the US and in most of the Western world skydivers are required to carry two parachutes. Many skydivers use an Automatic Activation Device (AAD) that opens the reserve parachute at a safe altitude in the event of failing to activate the main canopy themselves.

There are several different disciplines to embrace within parachuting. Each of these is enjoyed by both the recreational (weekend) and the competitive participants. There is even a small group of professionals who earn their living with parachuting. They win competitions having cash prizes or are employed or sponsored by skydiving related

manufacturers. Parachutists can participate both in competitive and in purely recreational skydiving events. World championships are held regularly in locations offering flat terrain and clear skies. An exception is Paraski, where winter weather and ski-hill terrain are required.

Types of parachuting include:

- ▶ Accuracy landing - Landing as close as possible to a target.
- ▶ BASE jumping - From buildings, antennas, bridges (spans) and cliffs (earth).
- ▶ Blade running - A kind of slalom with a parachute.
- ▶ Big-ways - Formation skydiving with many people all falling belly to earth.
- ▶ Canopy formation - Making formations with other parachutists while under canopies. (Also known as canopy relative work or CRW)
- ▶ Canopy piloting - Also known as 'swooping'.
- ▶ Formation skydiving - Making formations during freefall. [Also known as relative work or deployment-position (RW)]
- ▶ Freefall style
- ▶ Freeflying - Flying in multiple orientations (i.e. head down, flocking, and sit-flying). This is a more advanced approach to skydiving.
- ▶ Freestyle skydiving
- ▶ Military Parachuting
- ▶ Treejumping
- ▶ Para-ski
- ▶ Speed Skydiving - represents the fastest non-motorized sport on Earth, with speed up to 480 km/h (300 mph)
- ▶ Skysurfing - Skydiving with a board strapped to one's feet.

- ▶ Vertical Formation Skydiving - a subset of Formation skydiving that uses high-speed free-flying body positions instead of belly-flying.
- ▶ Wingsuit flying - Skydiving with a suit which provides extra lift, and powered skydiving where the wingsuit flyer adds propulsion.

Paragliding

Paragliding is a recreational and competitive flying sport. A paraglider is a free-flying, foot-launched aircraft. The pilot sits in a harness suspended below a fabric wing, whose shape is formed by its suspension lines and the pressure of air entering vents in the front of the wing.

The pilot is loosely and comfortably buckled into a harness which offers support in both the standing and sitting positions. Modern harnesses are designed to be as comfortable as a lounge chair in the sitting position. Many harnesses even have an adjustable 'lumbar support'. A reserve parachute is also typically connected to a paragliding harness.

The primary purpose of parachutes (including skydiving canopies) is for descending, as when jumping out of an aircraft or dropping cargo. In contrast, the primary purpose of paragliders is for ascending. Paragliders are categorized as "ascending parachutes" by canopy manufacturers worldwide, and are designed for "free flying" meaning flight without a tether.

Ultra light aviation

During the late 1970s and early 1980s, many people sought to be able to fly affordably. As a result, many aviation authorities set up definitions of lightweight, slow-flying aeroplanes that could be subject to minimum regulation. The resulting aeroplanes are commonly called ultralight or microlight, although the weight and speed limits differ from country to country. In most affluent countries, microlights or ultralights now account for about 20% of the civil aircraft fleet.

There is also an allowance of another 10% on Maximum Take-off Weight for seaplanes and amphibians, and some countries such as Germany and France also allow another 5% for installation of a ballistic parachute. In countries where there is no specific regulation, ultralights are considered regular aircraft and subject to certification requirements for both aircraft and pilot.

In India a microlight is an aircraft that has the following characteristics:

- ✓ Two seater aircraft having an all up weight of not more than 450 kg. without parachute and 472.5 kg. with parachute
- ✓ A stall speed of less than 80 km/h
- ✓ A maximum level speed of less than 220 km/h
- ✓ Not more than 2 seats
- ✓ A single engine, reciprocating, rotary or diesel
- ✓ A fixed or ground adjustable propeller
- ✓ Un-pressurized cabin
- ✓ Wing area more than 10 square metres
- ✓ A fixed landing gear, except for operation on water or as a glider

Indian ultralights require aircraft registration, periodic condition inspections and a current permit to fly which has to be renewed annually.

Ultralight/microlight aircraft were once regarded as “flying clotheslines”, since early aircraft were typically completely open, wire, tube and rag aircraft – these aircraft were seldom used for anything more than local area flying. However, ultralights are rapidly transforming into high performance aircraft, capable of very respectable speed and range. In recent years there has been a dramatic rise in the number of General Aviation pilots flying high performance ultralights due to the cost benefits. These aircraft are now often referred to as recreational aircraft.

Wingsuit flying

Wingsuit flying is the art of flying the human body through the air using a special jumpsuit, called a wingsuit that shapes the human body into an airfoil which can create lift. The wingsuit creates the airfoil shape with fabric sewn between the legs and under the arms. It is also known by the public as a birdman suit or squirrel suit. A wingsuit can be flown from any point that provides sufficient altitude to glide through the air, such as skydiving aircraft or BASE jumping exit points.

The wingsuit flier wears parachute equipment designed for skydiving or BASE jumping. The flier will deploy the parachute at a planned altitude and unzip the arm wings, if necessary, so they can reach up to the control toggles and fly to a normal parachute landing.

At a planned altitude above the ground in which a skydiver or BASE jumper would typically deploy his parachute, a wingsuit flier will deploy his parachute. The parachute will be flown to a controlled landing at the desired landing spot using typical skydiving or BASE jumping techniques.