DOWNLOAD PDF THE EVOLUTION OF AIR NAVIGATION SERVICES

Chapter 1 : SHORT HISTORY OF THE AIR TRAFFIC CONTROL

Current crises in the air traffic industry demonstrate that changes are required to present systems. The levels of delay and poor safety standards being experienced around the world dictate the need for improved Air Navigation Services (ANS).

Although the first powered flight took place in USA , it was WW1 who forced the European combatants to search deeper into the airplane evolution and design. The idea to carry passengers too , is definitely European: This created some primitive traffic density that resulted soon on a mid-air collision in due to poor visibility. The first rules were established then considering a mutual exchange of weather information between aerodromes and using separated inbound and outbound tracks over the Channel â€" there are plenty of them nowadays over there. Most probably the first plane ever that received some ATC-type service Just few years from then , in UK , local rules for light signals guiding planes near the aerodrome were established. These rules , however , it did not have yet a global acceptance and did not go deeply enough to predict the future evolution. It was in USA where airmail thrived due to the longer distances and a numerous population and there this business went booming. They were flying mostly the DeHavilland DH-4 two-sitter biplane having converted one sit to a cargo compartment. People that serviced and maintained the light beacon system of the US Airways Division No doubt they were flying under visual conditions but mail delivery demanded an almost all-weather duty. The beacon was rotating at a steady specified speed while a second ,steady non rotating light beacon, would light only when the rotating beacon passed through the north. By measuring with a normal watch the time difference between the two flashes, the first of the non-rotating beacon and the second when the rotating one faced the pilot, one could tell with some fair accuracy on what direction from the beacon the plane was positioned at that time: At this stage US was more advanced than Europe in the civil aviation domain. Archie League No doubt flights have increased to a significant point and more than often help for runway conditions and guidance were necessary. Despite the virtual lack of runways the way we know them today , flights needed to know the surface wind as well as information for any other close traffic or what to do in emergency conditions. Archie started his career in St Louis around When aircraft would arrive without radio , Archie would use a set of flag signals to warn the pilots. The Cleveland Ohio tower was known to be the most modern aerodrome equipment around There was another name that stayed in history: Radios were known but not all planes using an airfield were so equipped while radio devices were far from reliable: In , in Newark , the first Flight Monitoring Center was established and was housed just below the tower in the middle of the aerodrome terminal. He got worried for the constant increase of flights and he thought that sooner or later an air collision would happen unless rules were properly established. He then tried to figure out what these rules could be and how to implement them. He considered as vital to maintain radio contact between all flights and pass information on any one affected by the presence of the others. This was not however enough for the safety of all flights unless all other operating companies would also follow them. TWA , United and Eastern were convinced by Earl Ward to adopt his methods and in Chicago , , these rules proved very successful in practice. Earl Ward while monitoring traffic from pilot reports. He was using small paper tags that were positioned on a map. He was also using pilot reports for visual bearings from various light beacons and he would estimate times-over-point using speed and distance. During the 70s this became the task of a computerised radar system The solution in case of conflict was meant to be the result of pilot actions. Gilbert was assigned the task of publishing these rules and many of them still exist today on the basics learned by all student Traffic Controllers. To us , these two , are considered as the fathers of Air Traffic Control mainly because of the essential difference from the service provided by the Airway Division until then. This ground operator of the 20s has evolved to the Air Traffic Controller we know today. Some would put more credit to Gilbert than Ward because he detailed many of the rules that gave birth to Aerodrome , Approach and Area Control. He used the aerodrome circuit and its legs to sequence traffic for the aerodrome. The circuit was a natural track pilots would fly to first identify the airfield conditions and then use the landing direction. He introduced the spacing of departing traffic due to time according to speed and departure tracks and the time separation along a track after reporting on significant visual waypoints. As for the Area he established the vertical separation based on feet -a round figure that later introduced the Flight Level system - and the 10 nm airway width. To establish a global system however one needed the State to take over such a task for the entire country and all the flights. The Air Commerce Department , in , took over this job under the form of a public service that developed as the Civil Aviation Authority. In more and more technical applications were introduced as standard ATC equipment , like the communication boxes , the headsets, the teletype , the radio locators and the paper flight progress strip boards. It is worth noting that these tools have stayed in many countries and for many years as the standard ATC equipment ; for some areas of the world they are still used in exactly the same way! Communication terminals, radio frequencies, flight progress monitoring paper strips and On the left , a typical Approach unit in the 30s: To the right an Area Control Center in the same period: Despite the technology of the days the basics of Air Traffic Control were set then , just before ; one may argue that there have been no context changes on the job itself until the end of the century but merely an introduction of technological improvements to relieve the human factor but otherwise doing the same basic job. It should also be mentioned that in , in UK at least , the first ATCO Air Traffic Control Officer school started its operations and the first terms of airspace organization appeared. The control has been divided initially in Aerodrome or Tower and Area Control. The Aerodrome was responsible for landing and taking-off traffic from ground and within an area of about 3 to 5 miles around the airfield. The rest was the care of the Area Control , which would not go that high as today: And then there were radio beacons and radar Although most of people believe that radar, radio navigation and ATC were born together , radar was introduced in ATC after WW2 and continued a long and fastidious way into getting integrated as its most prominent tool. Radio and Communications were and are still by far the major tools of the trade. The war , however , provided for some particular radio devices: The war , therefore, brought along with it some benefits for the ATC that had to do with helping the pilot to navigate beyond visual conditions and controllers to detect planes positions on a screen. One might say that , although the ATC principles remained the same , these tools have changed drastically the character of the job: The radio goniometers that initially helped E. Ward to plot aircraft positions on a map could help in almost the same way pilots to locate fixed radio beacons on the ground using radio signals only. It was possible now to navigate without having to check for the light beacons: Replacing the light beacons with radio beacons and positioning them along the standard routes gave the possibility of an extended airway network that could reach any possible direction in the air ,within the coverage of beacons. This type of beacons , named Non Directional Beacons NDB , were initially based on the Medium Frequency radio technology that was well known those days. They were very simple transmitters, easy to install and maintain with important coverage - but proved less reliable under bad weather and lots of interference. The start of such a structure that would allow flights to any point started in and it also gave the tools for a deeper airspace division: A small NDB used nowadays as a locator fix for approaching aircraft. They are less accurate and reliable than modern beacons , though , due to the fragility of Medium Waves propagation on long ranges. Yet , few are still in use in less critical distances. The task of the operator is to instruct pilots so as to maintain their track within that area while landing The radar as was used during the Battle of Britain had a major disadvantage: Using the GCA was very flexible: As for the GCA equipment could be carried on a track and be positioned near any runway in use: Heathrow was equipped with GCA in The ILS is practically used from about 20 up to 30 miles before the runway and guides the aircraft until few feet above the runway threshold. It is only due to extremely heavy fog that some ILS landings can not be completed. After the 80s some planes are equipped with Radio-Altimeters , a radar-like device , that provides information about the distance left below the plane and until the runway surface, which eventually limits , albeit not to zero , the lowest altitude the ILS can guide a plane safely to. However , many limitations during landings are nowadays due to obstacles close to the landing path , eg: It is not always the ILS to be blamed for all problems during landings! The radar with a rotating antenna that could cover all directions around was not far away and near allowed the monitoring of flights approaching an aerodrome. The range marks , lines and other details of the background in the screen are a simple map transparency projected properly into the screen. At a time only one sector area of the screen is illuminated and some of the adjacent areas can still be seen due to the phosphorus effect. With such a radar only the position information is directly provided , the altitude has to be reported by the pilots and the identity to be kept thanks to the memory of the controller. Such a device used for guiding traffic near aerodromes was later called the Terminal Radar. At that time a region of about 60 to 80 nm could be covered and it was at this year that a number of many important aerodromes , like Heathrow, was so equipped. Around a new unit appeared officially in ATC: It was a division within the Area Control that took care of the arrivals and departures which , due to heavy traffic , needed a separate unit to handle them. The Area Controllers who were controlling far larger areas were not equipped with radar yet and had to wait for many more technical improvements to come, although their traffic was increasing as well. The diagram above displays an airways system UK. Standard commercial traffic is guided only within these tunnels-airways. Their corner points are defined by radio beacons or points defined with the use of radio beacons The Atlantic crossings by air were not yet as frequent but were definitely expanding. It is important that in those days , international rules have started appearing affecting all flights over very large regions and that was to continue ever since quite successfully: This was another component linked to the existing radars - renamed then as Primary Surveillance Radars PSR - which was triggering a specific airborne device to answer a signal call from the ground located SSR. The answer was a number that was properly displayed on the standard radar screen and was used as an identifier for a flight, followed by an automatic altitude report from the altimeter itself. A rotating aerial hosting a Primary PSR , below, and a SSR above , antennae This made aircraft detection an easy thing and the altitude verification automatic , without having to ask the pilots often on the radio. Today the SSR is a necessity for any busy ATC environment while in some areas ,cheaper to buy and maintain, SSRs were enough to display aircraft positions and have even replaced totally the older PSRs in certain areas. Near the end of the 60s computers came into play trying to help the job of this new international profession. There were a number of tasks the human being had to execute daily that were not clearly and purely about controlling aircraft. The 3-digit number appearing below the 4-digit SSR code were the altitude in hundreds of feet the Flight Level actually. This removed the need for the pilots to report all level changes Many secondary, yet absolutely necessary functions, were based on picking up a telephone line to pass information on outgoing and incoming traffic, reading teletype messages or writing paper strips, calculating speeds, distances and times; that was time wise a considerable part of the job, however, and was sacrificing a number of personnel to these duties away from the controlling positions. It was thus considered necessary to allocate most of these tasks to computers. It was around these days the first basic software appeared that allowed clear printing, calculation and distribution of paper strips to the appropriate sectors. Other software took care of linking the radio transmissions and ground messages between the various sectors of control. Soon the need to expand radar coverage to larger area control centers introduced the multi-radar coverage. Again, computers were necessary to combine the echoes received from many radar sites and optimize the various accuracies of the aircraft positions, eliminate intrinsic radar errors and display in a comfortable and clear way all related information on the controller screens.

Chapter 2 : Nike Air Max Evolution | Northern Clay Center

Evolution of Air Navigation Services Providers Liability Within the Performance & Risk Based Environment International Air Law Conference 85th Anniversary of the Warsaw Covention Warsaw, 24 October Maciej Rodak.

A private pilot planning a flight under VFR will usually use an aeronautical chart of the area which is published specifically for the use of pilots. This map will depict controlled airspace , radio navigation aids and airfields prominently, as well as hazards to flying such as mountains, tall radio masts, etc. It also includes sufficient ground detail â€” towns, roads, wooded areas â€” to aid visual navigation. The pilot will choose a route, taking care to avoid controlled airspace that is not permitted for the flight, restricted areas, danger areas and so on. The chosen route is plotted on the map, and the lines drawn are called the track. The aim of all subsequent navigation is to follow the chosen track as accurately as possible. Occasionally, the pilot may elect on one leg to follow a clearly visible feature on the ground such as a railway track, river, highway, or coast. The aircraft in the picture is flying towards B to compensate for the wind from SW and reach point C. When an aircraft is in flight, it is moving relative to the body of air through which it is flying; therefore maintaining an accurate ground track is not as easy as it might appear, unless there is no wind at allâ€”a very rare occurrence. The pilot must adjust heading to compensate for the wind , in order to follow the ground track. Initially the pilot will calculate headings to fly for each leg of the trip prior to departure, using the forecast wind directions and speeds supplied by the meteorological authorities for the purpose. These figures are generally accurate and updated several times per day, but the unpredictable nature of the weather means that the pilot must be prepared to make further adjustments in flight. A general aviation GA pilot will often make use of either a flight computer â€” a type of slide rule â€” or a purpose-designed electronic navigational computer to calculate initial headings. The primary instrument of navigation is the magnetic compass. The needle or card aligns itself to magnetic north , which does not coincide with true north , so the pilot must also allow for this, called the magnetic variation or declination. The variation that applies locally is also shown on the flight map. Once the pilot has calculated the actual headings required, the next step is to calculate the flight times for each leg. This is necessary to perform accurate dead reckoning. The pilot also needs to take into account the slower initial airspeed during climb to calculate the time to top of climb. It is also helpful to calculate the top of descent, or the point at which the pilot would plan to commence the descent for landing. The flight time will depend on both the desired cruising speed of the aircraft, and the wind â€” a tailwind will shorten flight times, a headwind will increase them. The flight computer has scales to help pilots compute these easily. The point of no return , sometimes referred to as the PNR, is the point on a flight at which a plane has just enough fuel, plus any mandatory reserve, to return to the airfield from which it departed. Beyond this point that option is closed, and the plane must proceed to some other destination. Alternatively, with respect to a large region without airfields, e. Similarly, the Equal time point, referred to as the ETP also Critical point CP , is the point in the flight where it would take the same time to continue flying straight, or track back to the departure aerodrome. The ETP is not dependent on fuel, but wind, giving a change in ground speed out from, and back to the departure aerodrome. In Nil wind conditions, the ETP is located halfway between the two aerodromes, but in reality it is shifted depending on the windspeed and direction. The aircraft that is flying across the Ocean for example, would be required to calculate ETPs for one engine inoperative, depressurization, and a normal ETP; all of which could actually be different points along the route. For example, in one engine inoperative and depressurization situations the aircraft would be forced to lower operational altitudes, which would affect its fuel consumption, cruise speed and ground speed. Each situation therefore would have a different ETP. Commercial aircraft are not allowed to operate along a route that is out of range of a suitable place to land if an emergency such as an engine failure occurs. The final stage is to note which areas the route will pass through or over, and to make a note of all of the things to be done â€” which ATC units to contact, the appropriate frequencies, visual reporting points, and so on. It is also important to note which pressure setting regions will be entered, so that the pilot can ask for the QNH air pressure of those regions. Finally, the pilot should have in mind some alternative plans in case the route cannot be flown for some reason â€” unexpected weather conditions being the most common. At times the pilot may be required to file a flight plan for an alternate destination and to carry adequate fuel for this. The more work a pilot can do on the ground prior to departure, the easier it will be in the air. IFR pilots may fly on other routes but they then have to do all of these calculations themselves with the LSALT calculation being the most difficult. The pilot then needs to look at the weather and minimum specifications for landing at the destination airport and the alternate requirements. The pilot must also comply with all the rules including their legal ability to use a particular instrument approach depending on how recently they last performed one. In recent years, strict beacon-to-beacon flight paths have started to be replaced by routes derived through Performance Based Navigation PBN techniques. When operators are developing flight plans for their aircraft, the PBN approach encourages them to assess the overall accuracy, integrity, availability, continuity and functionality of the aggregate navigation aids present within the applicable airspace. Under the PBN approach, technologies are able to evolve over time ground beacons become satellites become In flight[edit] Once in flight, the pilot must take pains to stick to plan, otherwise getting lost is all too easy. This is especially true if flying in the dark or over featureless terrain. This means that the pilot must stick to the calculated headings, heights and speeds as accurately as possible, unless flying under visual flight rules. The visual pilot must regularly compare the ground with the map, pilotage to ensure that the track is being followed although adjustments are generally calculated and planned. Usually, the pilot will fly for some time as planned to a point where features on the ground are easily recognised. If the wind is different from that expected, the pilot must adjust heading accordingly, but this is not done by guesswork, but by mental calculation â€" often using the 1 in 60 rule. For example, a two degree error at the halfway stage can be corrected by adjusting heading by four degrees the other way to arrive in position at the end of the leg. This is also a point to reassess the estimated time for the leg. A good pilot will become adept at applying a variety of techniques to stay on track. The compass reading will be used to correct for any drift precession of the DI periodically. The compass itself will only show a steady reading when the aircraft has been in straight and level flight long enough to allow it to settle. Since this is an unplanned leg, the pilot must be able to mentally calculate suitable headings to give the desired new track. Using the flight computer in flight is usually impractical, so mental techniques to give rough and ready results are used. A method for computing this mentally is the clock code. However the pilot must be extra vigilant when flying diversions to maintain awareness of position. Some diversions can be temporary â€" for example to skirt around a local storm cloud. In such cases, the pilot can turn 60 degrees away his desired heading for a given period of time. Once clear of the storm, he can then turn back in the opposite direction degrees, and fly this heading for the same length of time. Radio navigation Good pilots use all means available to help navigate. ADF uses non-directional beacons NDBs on the ground to drive a display which shows the direction of the beacon from the aircraft. The pilot may use this bearing to draw a line on the map to show the bearing from the beacon. By using a second beacon, two lines may be drawn to locate the aircraft at the intersection of the lines. This is called a cross-cut. NDBs also can give erroneous readings because they use very long wavelengths , which are easily bent and reflected by ground features and the atmosphere. NDBs continue to be used as a common form of navigation in some countries with relatively few navigational aids. VOR is a more sophisticated system, and is still the primary air navigation system established for aircraft flying under IFR in those countries with many navigational aids. In this system, a beacon emits a specially modulated signal which consists of two sine waves which are out of phase. The phase difference corresponds to the actual bearing relative to magnetic north in some cases true north that the receiver is from the station. The upshot is that the receiver can determine with certainty the exact bearing from the station. Again, a cross-cut is used to pinpoint the location. Many VOR stations also have additional equipment called DME distance measuring equipment which will allow a suitable receiver to determine the exact distance from the station. Together with the bearing, this allows an exact position to be determined from a single beacon alone. For convenience, some VOR stations also transmit local weather information which the pilot can listen in to, perhaps generated by an Automated Surface Observing System. Prior to the advent of GNSS , Celestial Navigation was also used by trained navigators on military bombers and transport aircraft in the event of all electronic navigational aids being turned off in time of war. Originally navigators used an astrodome and regular sextant but the more streamlined periscopic sextant was used from the s to the s. From the s airliners used inertial navigation systems , especially on inter-continental routes, until the shooting down of Korean Air Lines Flight in prompted the US government to make GPS available for civilian use. Finally, an aircraft may be supervised from the ground using surveillance information from e. ATC can then feed back information to the pilot to help establish position, or can actually tell the pilot the position of the aircraft, depending on the level of ATC service the pilot is receiving. The use of GNSS in aircraft is becoming increasingly common. GNSS provides very precise aircraft position, altitude, heading and ground speed information. Recently, more and more airports include GNSS instrument approaches. The crew member, occasionally two navigation crew members for some flights, was responsible for the trip navigation, including its dead reckoning and celestial navigation. This was especially essential when trips were flown over oceans or other large bodies of water, where radio navigation aids were not originally available. GPS coverage is now provided worldwide. Most civilian air navigators were retired or made redundant by the early s.

Chapter 3 : History of aviation - Wikipedia

Current crises in the air traffic industry demonstrate that changes are required to present systems. The levels of delay and poor safety standards being experienced around the world dictate the.

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Chapter 4 : History of Aviation - First Flights

2 A Coordinated Approach to Air Navigation System Evolution Dependable access to air transport services is a key enabler of improved social and economic prosperity worldwide.

See Your Ad Here History of Aviation On December 17, , Orville and Wilbur Wright capped four years of research and design efforts with a foot, second flight at Kitty Hawk, North Carolina - the first powered flight in a heavier-than-air machine. Prior to that, people had flown only in balloons and gliders. The first person to fly as a passenger was Leon Delagrange, who rode with French pilot Henri Farman from a meadow outside of Paris in Charles Furnas became the first American airplane passenger when he flew with Orville Wright at Kitty Hawk later that year. First Flights On December 17, , Orville and Wilbur Wright capped four years of research and design efforts with a foot, second flight at Kitty Hawk, North Carolina - the first powered flight in a heavier-than-air machine. The first scheduled air service began in Florida on January 1, Glenn Curtiss had designed a plane that could take off and land on water and thus could be built larger than any plane to date, because it did not need the heavy undercarriage required for landing on hard ground. Thomas Benoist, an auto parts maker, decided to build such a flying boat, or seaplane, for a service across Tampa Bay called the St. Petersburg - Tampa Air Boat Line. His first passenger was ex-St. Pheil, who made the mile trip in 23 minutes, a considerable improvement over the two-hour trip by boat. After operating two flights a day for four months, the company folded with the end of the winter tourist season. World War I These and other early flights were headline events, but commercial aviation was very slow to catch on with the general public, most of whom were afraid to ride in the new flying machines. Improvements in aircraft design also were slow. However, with the advent of World War I, the military value of aircraft was quickly recognized and production increased significantly to meet the soaring demand for planes from governments on both sides of the Atlantic. Most significant was the development of more powerful motors, enabling aircraft to reach speeds of up to miles per hour, more than twice the speed of pre-war aircraft. Increased power also made larger aircraft possible. At the same time, the war was bad for commercial aviation in several respects. It focused all design and production efforts on building military aircraft. In addition, there was such a large surplus of planes at the end of the war that the demand for new production was almost nonexistent for several years - and many aircraft builders went bankrupt. Some European countries, such as Great Britain and France, nurtured commercial aviation by starting air service over the English Channel. However, nothing similar occurred in the United States, where there were no such natural obstacles isolating major cities and where railroads could transport people almost as fast as an airplane, and in considerably more comfort. The salvation of the U. Airmail By , the U. With a large number of war-surplus aircraft in hand, the Post Office set its sights on a far more ambitious goal - transcontinental air service. It opened the first segment, between Chicago and Cleveland, on May 15, and completed the air route on September 8, , when the most difficult part of the route, the Rocky Mountains, was spanned. Airplanes still could not fly at night when the service first began, so the mail was handed off to trains at the end of each day. Nonetheless, by using airplanes the Post Office was able to shave 22 hours off coast-to-coast mail deliveries. Beacons In , the Army deployed rotating beacons in a line between Columbus and Dayton, Ohio, a distance of about 80 miles. The beacons, visible to pilots at second intervals, made it possible to fly the route at night. Mail then could be delivered across the continent in as little as 29 hours eastbound and 34 hours westbound - prevailing winds from west to east accounted for the difference which was at least two days less than it took by train. However, the government had no intention of continuing airmail service on its own. Traditionally, the Post Office had used private companies for the transportation of mail. So, once the feasibility of airmail was firmly established and airline facilities were in place, the government moved to transfer airmail service to the private sector, by way of competitive bids. The legislative authority for the move was the Contract Air Mail Act of , commonly referred to as the Kelly Act after its chief sponsor, Rep. Clyde Kelly of Pennsylvania. This was the first major step toward the creation of a private U. Robertson would become part of the Universal Aviation Corporation, which in turn would merge with Colonial, Southern Air Transport and others, to form American Airways, predecessor of American

Airlines. Juan Trippe, one of the original partners in Colonial, later pioneered international air travel with Pan Am - a carrier he founded in to transport mail between Key West, Florida, and Havana, Cuba. Pitcairn Aviation, yet another Curtiss subsidiary that got its start transporting mail, would become Eastern Air Transport, predecessor of Eastern Air Lines. Dwight Morrow, a senior partner in J. The board heard testimony from 99 people, and on November 30, , submitted its report to President Coolidge. The report was wide-ranging, but its key recommendation was that the government should set standards for civil aviation and that the standards should be set outside of the military. The legislation authorized the Secretary of Commerce to designate air routes, to develop air navigation systems, to license pilots and aircraft, and to investigate accidents. The act brought the government into commercial aviation as regulator of the private airlines spawned by the Kelly Act of the previous year. Instead of paying carriers a percentage of the postage paid, the government would pay them according to the weight of the mail. More importantly, he jumped into aircraft manufacturing, and in , produced the Ford Trimotor, commonly referred to as the Tin Goose. It was one of the first all-metal planes, made of a new material, duralumin, which was almost as light as aluminum but twice as strong. It also was the first plane designed primarily to carry passengers rather than mail. The Ford Trimotor had 12 passenger seats; a cabin high enough for a passenger to walk down the aisle without stooping; and room for a "stewardess," or flight attendant, the first of whom were nurses, hired by United in to serve meals and assist airsick passengers. Charles Lindbergh At 7: It was the first trans-Atlantic non-stop flight in an airplane, and its effect on both Lindbergh and aviation was enormous. Lindbergh became an instant American hero. Aviation became a more established industry, attracting millions of private investment dollars almost overnight, as well as the support of millions of Americans. The pilot who sparked all of this attention had dropped out of engineering school at the University of Wisconsin to learn how to fly. He became a barnstormer, doing aerial shows across the country, and eventually joined the Robertson Aircraft Corporation, to transport mail between St. In planning his trans-Atlantic voyage, Lindbergh daringly decided to fly by himself, without a navigator, so he could carry more fuel. His plane, the Spirit of St. Louis, was slightly less than 28 feet in length, with a wingspan of 46 feet. It carried gallons of gasoline, which comprised half its takeoff weight. There was too little room in the cramped cockpit for navigating by the stars, so Lindbergh flew by dead reckoning. He divided maps from his local library into thirty-three mile segments, noting the heading he would follow as he flew each segment. When he first sighted the coast of Ireland, he was almost exactly on the route he had plotted, and he landed several hours later, with 80 gallons of fuel to spare. The trip took an exhausting 33 hours, 29 minutes and 30 seconds, but he managed to keep awake by sticking his head out the window to inhale cold air, by holding his eyelids open, and by constantly reminding himself that if he fell asleep he would perish. In addition, he had a slight instability built into his airplane that helped keep him focused and awake. Lindbergh landed at Le Bourget Field, outside of Paris, at Paris time on May Word of his flight preceded him and a large crowd of Parisians rushed out to the airfield to see him and his little plane. There was no question about the magnitude of what he had accomplished. The Air Age had arrived. The Watres Act and the Spoils Conference In , Postmaster General Walter Brown pushed for legislation that would have another major impact on the development of commercial aviation. Known as the Watres Act after one of its chief sponsors, Rep. Watres of Pennsylvania , it authorized the Post Office to enter into longer-term contracts for airmail, with rates based on space or volume, rather than weight. In addition, the act authorized the Post Office to consolidate airmail routes, where it was in the national interest to do so. Brown believed the changes would promote larger, stronger airlines, as well as more coast-to-coast and nighttime service. Immediately after Congress approved the act, Brown held a series of meetings in Washington to discuss the new contracts. The meetings were later dubbed the Spoils Conference because Brown gave them little publicity and directly invited only a handful of people from the larger airlines. He designated three transcontinental mail routes and made it clear that he wanted only one company operating each service rather than a number of small airlines handing the mail off to one another. His actions brought political trouble that resulted in major changes to the system two years later. Scandal and the Air Mail Act of Following the Democratic landslide in the election of , some of the smaller airlines began complaining to news reporters and politicians that they had been unfairly denied airmail contracts by Brown. One reporter discovered that a major contract had been awarded to an airline whose bid was three times higher than a rival bid from a smaller airline. Congressional hearings followed, chaired by Sen. Hugo Black of Alabama, and by the scandal had reached such proportions as to prompt President Franklin Roosevelt to cancel all mail contracts and turn mail deliveries over to the Army. The decision was a mistake. The Army pilots were unfamiliar with the mail routes, and the weather at the time they took over the deliveries, February , was terrible. There were a number of accidents as the pilots flew practice runs and began carrying the mail, leading to newspaper headlines that forced President Roosevelt to retreat from his plan only a month after he had turned the mail over to the Army By means of the Air Mail Act of , the government once again returned airmail transportation to the private sector, but it did so under a new set of rules that would have a significant impact on the industry. Bidding was structured to be more competitive, and former contract holders were not allowed to bid at all, so many companies were reorganized. The entire industry was now reorganized and refocused. Aircraft Innovations For the airlines to attract passengers away from the railroads, they needed both larger and faster airplanes. They also needed safer airplanes. Accidents, such as the one in that killed Notre Dame Football Coach Knute Rockne along with six others, kept people from flying Aircraft manufacturers responded to the challenge. There were so many improvements to aircraft in the s that many believe it was the most innovative period in aviation history. Air-cooled engines replaced water-cooled engines, reducing weight and making larger and faster planes possible. Cockpit instruments also improved, with better altimeters, airspeed indicators, rate-of-climb indicators, compasses, and the introduction of artificial horizon, which showed pilots the attitude of the aircraft relative to the ground - important for flying in reduced visibility Radio Another development of enormous importance to aviation was radio. Aviation and radio developed almost in lock step. Marconi sent his first message across the Atlantic on the airwaves just two years before the Wright Brothers? By World War I, some pilots were taking radios up in the air with them so they could communicate with people on the ground. The airlines followed suit after the war, using radio to transmit weather information from the ground to their pilots, so they could avoid storms An even more significant development, however, was the realization that radio could be used as an aid to navigation when visibility was poor and visual navigation aids, such as beacons, were useless. Once technical problems were worked out, the Department of Commerce constructed 83 radio beacons across the country.

Chapter 5 : Saab - The evolution in the skies: virtual air traffic control - Future Airport

The Procedures for Air Navigation Services â€" Training (PANS-TRG) are the result of the evolution of the work initiated by the Flight Crew Licensing and Training Panel (FCLTP) on the implementation of the training required for the.

On 19 October, the Montgolfiers launched the first manned flight, a tethered balloon with humans on board, at the Folie Titon in Paris. On 21 November, the Montgolfiers launched the first free flight with human passengers. On 1 December, Jacques Charles and the Nicolas-Louis Robert launched their manned hydrogen balloon from the Jardin des Tuileries in Paris, as a crowd of , witnessed. After Robert alighted Charles decided to ascend alone. Ballooning became a major "rage" in Europe in the late 18th century, providing the first detailed understanding of the relationship between altitude and the atmosphere. The young Ferdinand von Zeppelin first flew as a balloon passenger with the Union Army of the Potomac in In the early s ballooning was a popular sport in Britain. These privately owned balloons usually used coal gas as the lifting gas. This has half the lifting power of hydrogen so the balloons had to be larger, however coal gas was far more readily available and the local gas works sometimes provided a special lightweight formula for ballooning events. Airships were originally called "dirigible balloons" and are still sometimes called dirigibles today. Work on developing a steerable or dirigible balloon continued sporadically throughout the 19th century. Another advance was made in , when the first fully controllable free-flight was made in a French Army electric-powered airship, La France , by Charles Renard and Arthur Krebs. However, these aircraft were generally short-lived and extremely frail. Routine, controlled flights would not occur until the advent of the internal combustion engine see below. The first aircraft to make routine controlled flights were non-rigid airships sometimes called "blimps". The most successful early pioneering pilot of this type of aircraft was the Brazilian Alberto Santos-Dumont who effectively combined a balloon with an internal combustion engine. Santos-Dumont went on to design and build several aircraft. At the same time that non-rigid airships were starting to have some success, the first successful rigid airships were also being developed. These would be far more capable than fixed-wing aircraft in terms of pure cargo carrying capacity for decades. Rigid airship design and advancement was pioneered by the German count Ferdinand von Zeppelin. Construction of the first Zeppelin airship began in in a floating assembly hall on Lake Constance in the Bay of Manzell, Friedrichshafen. This was intended to ease the starting procedure, as the hall could easily be aligned with the wind. Its first flight, on July 2, , lasted for only 18 minutes, as LZ 1 was forced to land on the lake after the winding mechanism for the balancing weight had broken. It would be several years before the Count was able to raise enough funds for another try. Although airships were used in both World War I and II, and continue on a limited basis to this day, their development has been largely overshadowed by heavier-than-air craft. Heavier than air[edit] Main article: This flying machine consisted of a light frame covered with strong canvas and provided with two large oars or wings moving on a horizontal axis, arranged so that the upstroke met with no resistance while the downstroke provided lifting power. Swedenborg knew that the machine would not fly, but suggested it as a start and was confident that the problem would be solved. The science of mechanics might perhaps suggest a means, namely, a strong spiral spring. If these advantages and requisites are observed, perhaps in time to come some one might know how better to utilize our sketch and cause some addition to be made so as to accomplish that which we can only suggest. Yet there are sufficient proofs and examples from nature that such flights can take place without danger, although when the first trials are made you may have to pay for the experience, and not mind an arm or leg. The 19th century[edit] Throughout the 19th century, tower jumping was replaced by the equally fatal but equally popular balloon jumping as a way to demonstrate the continued uselessness of man-power and flapping wings. Meanwhile, the scientific study of heavier-than-air flight began in earnest. Sir George Cayley and the first modern aircraft[edit] Sir George Cayley was first called the "father of the aeroplane" in Among his many achievements, his most important contributions to aeronautics include: Clarifying our ideas and laying down the principles of heavier-than-air flight. Reaching a scientific understanding of the principles of bird flight. Conducting scientific aerodynamic experiments demonstrating drag and streamlining, movement of the centre of pressure, and the increase in lift from curving the wing surface. Defining the modern aeroplane configuration comprising a fixed wing, fuselage and tail assembly. Demonstrations of manned, gliding flight. Setting out the principles of power-to-weight ratio in sustaining flight. In he set down the concept of the modern aeroplane as a fixed-wing flying machine with separate systems for lift, propulsion, and control. He also identified and described the importance of the cambered aerofoil , dihedral , diagonal bracing and drag reduction, and contributed to the understanding and design of ornithopters and parachutes. In he had progressed far enough to construct a glider in the form of a triplane large and safe enough to carry a child. A local boy was chosen but his name is not known. Minor inventions included the rubber-powered motor ,[citation needed] which provided a reliable power source for research models. By he had even re-invented the wheel, devising the tension-spoked wheel in which all compression loads are carried by the rim, allowing a lightweight undercarriage. Although only a design, it was the first in history for a propeller-driven fixed-wing aircraft. Employing two contra-rotating propellers on the first attempt, made indoors, the machine flew ten feet before becoming destabilised, damaging the craft. The second attempt was more successful, the machine leaving a guide wire to fly freely, achieving some thirty yards of straight and level powered flight. To test his ideas, from he had constructed several gliders, both manned and unmanned, and with up to five stacked wings. He realised that long, thin wings are better than bat-like ones because they have more leading edge for their area. Today this relationship is known as the aspect ratio of a wing. The latter part of the 19th century became a period of intense study, characterized by the " gentleman scientists " who represented most research efforts until the 20th century. Among them was the British scientist-philosopher and inventor Matthew Piers Watt Boulton , who studied lateral flight control and was the first to patent an aileron control system in Meanwhile, the British advances had galvanised French researchers. Developing his ideas with a model powered first by clockwork and later by steam, he eventually achieved a short hop with a full-size manned craft in It achieved lift-off under its own power after launching from a ramp, glided for a short time and returned safely to the ground, making it the first successful powered glide in history. He reportedly achieved a height of meters, over a distance of meters. The planophore also had longitudinal stability, being trimmed such that the tailplane was set at a smaller angle of incidence than the wings, an original and important contribution to the theory of aeronautics. A tailless monoplane with a single vertical fin and twin tractor propellers, it also featured hinged rear elevator and rudder surfaces, retractable undercarriage and a fully enclosed, instrumented cockpit. The Aeroplane of Victor Tatin, It was powered by compressed air. Flown tethered to a pole, this was the first model to take off under its own power. It was intended as a test rig to investigate aerodynamic lift: Completed in , on its third run it broke from the rail, became airborne for about yards at two to three feet of altitude [50] and was badly damaged upon falling back to the ground. It was subsequently repaired, but Maxim abandoned his experiments shortly afterwards. In the last decade or so of the 19th century, a number of key figures were refining and defining the modern aeroplane. Lacking a suitable engine, aircraft work focused on stability and control in gliding flight. In Biot constructed a bird-like glider with the help of Massia and flew in it briefly. The Englishman Horatio Phillips made key contributions to aerodynamics. He conducted extensive wind tunnel research on aerofoil sections, proving the principles of aerodynamic lift foreseen by Cayley and Wenham. His findings underpin all modern aerofoil design. Otto Lilienthal , May 29, He also produced a series of hang gliders , including bat-wing, monoplane and biplane forms, such as the Derwitzer Glider and Normal soaring apparatus. Starting in he became the first person to make controlled untethered glides routinely, and the first to be photographed flying a heavier-than-air machine, stimulating interest around the world. He rigorously documented his work, including photographs, and for this reason is one of the best known of the early pioneers. Lilienthal made over 2, glides until his death in from injuries sustained in a glider crash. Picking up where Lilienthal left off, Octave Chanute took up aircraft design after an early retirement, and funded the development of several gliders. In the summer of his team flew several of their designs eventually deciding that the best was a biplane design. Like Lilienthal, he documented and photographed his work. In Britain Percy Pilcher , who had worked for Maxim, built and successfully flew several gliders during the mid to late s. The invention of the box kite during this period by the Australian Lawrence Hargrave would lead to the development of the practical biplane. In Hargrave linked four of his kites together, added a sling seat, and flew 16 feet 4. In he published Experiments in Aerodynamics detailing his research, and then turned to building his designs. He hoped to achieve automatic aerodynamic stability, so he gave little consideration to in-flight control. It was launched from a spring-actuated catapult mounted on top of a houseboat on the Potomac River near Quantico, Virginia. On both occasions the Aerodrome No. On November 28, , another successful flight was made with the Aerodrome No. So little remained of the original aircraft that it was given a new designation. With the successes of the Aerodrome No. Spurred by the Spanishâ€"American War , the U. With the basic design apparently successfully tested, he then turned to the problem of a suitable engine. Now with both power and a design, Langley put the two together with great hopes. To his dismay, the resulting aircraft proved to be too fragile. Simply scaling up the original small models resulted in a design that was too weak to hold itself together. Two launches in late both ended with the Aerodrome immediately crashing into the water. The pilot, Manly, was rescued each time. Nine days after his second abortive launch on December 8, the Wright brothers successfully flew their Flyer.

Chapter 6 : Introducing CANSO | CANSO

TECHNOLOGY AND THE FUTURE EVOLUTION OF THE ATC SYSTEM Airport and Air Traffic Control System GOALS AND SERVICES OF THE ATC SYSTEM navigation aids.

Chapter 7 : Air University Press

The CANSO Global Air Navigation Services Performance Report is the collective effort of CANSO Member air navigation service providers (ANSP), which participate in this benchmarking effort on a voluntary basis, and covers data from the ANSPs' fiscal years and trend data from -

Chapter 8 : ACTE Research: The Evolution of Air Distribution

progressive evolution of the Procedures for Air Navigation Services â€" Air Traffic Control (PANS-ATC) prepared by the Air Traffic Control Committee of the International Conference on North Atlantic Route Service Organization (Dublin.