DOWNLOAD PDF SPACE TRANSPORTATION SYSTEMS

Chapter 1 : Boeing: CST Starliner

The Space Transportation System (STS), also known internally to NASA as the Integrated Program Plan (IPP), was a proposed system of reusable manned space vehicles envisioned in to support extended operations beyond the Apollo program.

The turbopumps mounted on the replicated LE-9 engine undergo a series of testing to ensure their function and performance. At the Kakuda Center, there is a burn pond for disposal of hydrogen gas boil-off. Boiling off unused liquid hydrogen to dissipate produces a towering blaze that can reach fifty meters. Images of LE-9 development is available in the video below with excerpts from the unit testing. The project members of the past series of Epsilon launches have drawn strength from the similar campaigns. The notes sent to JAXA will be printed as part of the decal sticker attached to the body of the launch vehicle. JAXA appreciates the positive participation by many. Improvements are being made to lower the cost of LE-5B-3, without compensating the dynamics to blast off H3, a larger rocket and to sustain its flight. Following the design improvements for affordability and performance which reached the desired level in August , JAXA successfully conducted the test of the liquid hydrogen turbopump in December through January The liquid hydrogen turbopump -- equivalent of the heart of a human body -- draws in the propellants into the engine thrust chamber. Since March , the first engine with the hydrogen turbopump, assembled for certification was completed, kicking off its preliminary firing testing. The test is proceeding on schedule. By September , test results will expectedly prove the soundness of the basic design improvements. Varied configuration â€” zero, two or four booster s , depending on the desired thrust â€” gives the launch vehicle a higher degree of flexibility, one of its strengths. Based on the design review, since April , JAXA has started testing motor strength using the full-scale motor case. SRB-3 is subject to a series of tests, including ground firing and separation. The minute-long animation begins with the image of H3, now under development, punching through clouds up towards the space. With the development in full swing, JAXA appreciates support by all - we certainly draw strength from it to make the total process successful. The test schedule will be available on the website as soon as determined. Solid particles containing iron dust particles act to promote the formation of molecules in interstellar space, and are key to understanding physical and chemical processes there. Iron contained in dust particles comes in various forms such as metallic iron and iron oxide, each with different properties. Previous studies have suggested that iron is present mainly in forms other than iron oxide, iron carbide, and iron sulfide. To verify the possibility that metallic iron is present, a research team led by Dr. Kimura Hokkaido University performed in situ observations of gaseous iron cooling in a microgravity environment, and investigated the ease of iron aggregation the efficiency at which metallic iron forms. The experimental results showed that, unlike in the results of ground experiments, it was difficult for iron atoms to aggregate. In other words, it is difficult for metallic iron to form in outer space. The team speculates that iron in dust particles is not a metal, but rather contained as a compound, or adhered to other particles as an impurity. The results of this research were published in the online journal Science Advances of the American Association for the Advancement of Science on 21 January

Chapter 2 : Japan and Space Transportation Systems

SPACE TRANSPORTATION SYSTEM. SPACE SHUTTLE PROGRAM. The Space Shuttle is developed by the National Aeronautics and Space Administration. NASA coordinates and manages the Space Transportation System (NASA's name for the overall Shuttle program), including intergovernmental agency requirements and international and joint projects.

European astronauts prepare for their Spacelab mission, Interior of Spacelab LM2 A major component of the Space Shuttle Program was Spacelab, primarily contributed by a consortium of European countries, and operated in conjunction with the United States and international partners. The control algorithm, which used a classical Proportional Integral Derivative PID approach, was developed and maintained by Honeywell. Ascent, Descent, On-Orbit and Aborts. Considerable research went into the Shuttle computer system. The surface of the vehicle is colored by the pressure coefficient, and the gray contours represent the density of the surrounding air, as calculated using the OVERFLOW software package. After a single failure, the Shuttle could still continue the mission. After two failures, it could still land safely. The four general-purpose computers operated essentially in lockstep, checking each other. If one computer provided a different result than the other three i. This isolated it from vehicle control. If a second computer of the three remaining failed, the two functioning computers voted it out. A very unlikely failure mode would have been where two of the computers produced result A, and two produced result B a two-two split. In this unlikely case, one group of two was to be picked at random. The Backup Flight System BFS was separately developed software running on the fifth computer, used only if the entire four-computer primary system failed. The BFS was created because although the four primary computers were hardware redundant, they all ran the same software, so a generic software problem could crash all of them. Embedded system avionic software was developed under totally different conditions from public commercial software: However, in theory it could have still failed, and the BFS existed for that contingency. It is specifically designed for a real time embedded system environment. The CPU could process about , instructions per second. They had no hard disk drive, and loaded software from magnetic tape cartridges. In , the original computers were replaced with an upgraded model APS, which had about 2. The memory was changed from magnetic core to semiconductor with battery backup. Early Shuttle missions, starting in November , took along the Grid Compass , arguably one of the first laptop computers. Use on the Shuttle required both hardware and software modifications which were incorporated into later versions of the commercial product. The prototype orbiter Enterprise originally had a flag of the United States on the upper surface of the left wing and the letters "USA" in black on the right wing. The name "Enterprise" was painted in black on the payload bay doors just above the hinge and behind the crew module; on the aft end of the payload bay doors was the NASA "worm" logotype in gray. Underneath the rear of the payload bay doors on the side of the fuselage just above the wing is the text "United States" in black with a flag of the United States ahead of it. The first operational orbiter, Columbia, originally had the same markings as Enterprise, although the letters "USA" on the right wing were slightly larger and spaced farther apart. Columbia also had black markings which Enterprise lacked on its forward RCS module, around the cockpit windows, and on its vertical stabilizer, and had distinctive black "chines" on the forward part of its upper wing surfaces, which none of the other orbiters had. Challenger established a modified marking scheme for the shuttle fleet that was matched by Discovery, Atlantis and Endeavour. The letters "USA" in black above an American flag were displayed on the left wing, with the NASA "worm" logotype in gray centered above the name of the orbiter in black on the right wing. The name of the orbiter was inscribed not on the payload bay doors, but on the forward fuselage just below and behind the cockpit windows. This would make the name visible when the shuttle was photographed in orbit with the doors open. In , Enterprise had its wing markings changed to match Challenger, and the NASA "worm" logotype on the aft end of the payload bay doors was changed from gray to black. Some black markings were added to the nose, cockpit windows and vertical tail to more closely resemble the flight vehicles, but the name "Enterprise" remained on the payload bay doors as there was never any need to open them. Columbia had its name moved to the forward fuselage to match the other flight vehicles after STSC , during the â€”88 hiatus when the shuttle fleet was grounded following the loss of Challenger , but retained its original wing markings until its last overhaul after STS , and its unique black wing "chines" for the remainder of its operational life. The "worm" logotype, which the agency had phased out, was removed from the payload bay doors and the "meatball" insignia was added aft of the "United States" text on the lower aft fuselage. The three surviving flight vehicles, Discovery, Atlantis and Endeavour, still bear these markings as museum displays. Internally, the Shuttle remained largely similar to the original design, with the exception of the improved avionics computers. In addition to the computer upgrades, the original analog primary flight instruments were replaced with modern full-color, flat-panel display screens, called a glass cockpit , which is similar to those of contemporary airliners. This explains phrases such as "Main engines throttling up to percent. The percent figure was the original specified power level. During the lengthy development program, Rocketdyne determined the engine was capable of safe reliable operation at percent of the originally specified thrust. NASA could have rescaled the output number, saying in essence percent is now percent. To clarify this would have required revising much previous documentation and software, so the percent number was retained. The upgrades improved engine reliability, maintainability and performance. The normal maximum throttle was percent, with percent or percent used for mission aborts. For the first two missions, STS-1 and STS-2 , the external tank was painted white to protect the insulation that covers much of the tank, but improvements and testing showed that it was not required. The weight saved by not painting the tank resulted in an increase in payload capability to orbit. The resulting "light-weight external tank" was first flown on STS-6 [61] and used on the majority of Shuttle missions. STS saw the first flight of the "super light-weight external tank". This version of the tank was made of the aluminum-lithium alloy. The solid rocket boosters underwent improvements as well. Design engineers added a third O-ring seal to the joints between the segments after the Space Shuttle Challenger disaster. Several other SRB improvements were planned to improve performance and safety, but never came to be. These culminated in the considerably simpler, lower cost, probably safer and better-performing Advanced Solid Rocket Booster.

Chapter 3 : NASA - Advanced Space Transportation Program fact sheet

Space / Space Transportation Systems Why is a baby monitor picking up video of the space shuttle? For some reason, a baby monitor in Illinois has been picking up NASA's video broadcast of the space shuttle Atlantis mission.

It is a mixture between spacecraft and aircraft, landing as a glider after a long lifting reentry. The OMS is used for orbit insertion, orbit circularization, orbit transfer, rendezvous, and deorbit. The OMS may be used to provide thrust above 70, feet altitude. Amounts available for interconnect depend on loading and number of OMS starts during the mission. Each pod contains one OMS engine and the hardware needed to pressurize, store, and distribute the propellants to perform OMS engine burns. For velocity changes greater than 6 fps, a single OMS engine burn is preferred, because engine lifetime concerns make it desirable to minimize engine starts. Two OMS engines are used for large velocity changes, or for critical burns. Propellant from one pod can be fed to the engine in the other pod through crossfeed lines that connect the left and right OMS pods. The OMS has important interfaces with the data processing system and the electrical power system. Electrical power is supplied to the OMS through main buses, control buses, and alternating current buses for the operation of switches, valves, instrumentation, gimbal actuators, and heaters. The pods are removable to facilitate orbiter turnaround, if required. Engines[edit] The OMS engines are designated left and right, descriptive of location. The engines are located in gimbal mounts that allow the engine to pivot left and right and up and down under the control of two electromechanical actuators. This gimbal system provides for vehicle steering during OMS burns by controlling the direction of the engine thrust in pitch and yaw thrust vector control in response to commands from the digital autopilot or from the manual controls. The OMS engines can be used singularly by directing the thrust vector through the orbiter center of gravity or together by directing the thrust vector of both engines parallel to the X axis. During a two-OMS-engine burn, the RCS will come into operation only if the attitude or attitude rate limits are exceeded. Each of the two OMS engines produces 6, pounds of thrust Each OMS engine is capable of 1, starts and 15 hours of cumulative firing. The minimum duration of an OMS engine firing is 2 seconds. The OMS engines use monomethyl hydrazine as the fuel and nitrogen tetroxide as the oxidizer. These propellants are hypergolic, which means that they ignite when they come in contact with each other; therefore, no ignition device is needed. Both propellants remain liquid at the temperatures normally experienced during a mission, however, electrical heaters are located throughout the OMS pods to prevent any freezing of propellants during long periods in orbit when the system is not in use. Each OMS engine has a gaseous nitrogen tank that provides pressurized nitrogen to operate the engine valves. The OMS engine does not have propellant pumps; propellant flow to the engines is maintained by pressurizing the propellant tanks with helium. In the OMS engine, fuel is burned with oxidizer to produce thrust. The major elements of the OMS engine are the bipropellant valve assembly, the injector plate, the thrust chamber, and the nozzle. The propellants ignite on contact, so theoretically the OMS engines could get ignited as often as desired, but the number of restarts gets limited by the supply of N2 used for operating the valves and purging the fuel lines of the engines, which is only enough for ten restarts. Differences between the orbiters[edit] Columbia[edit] Columbia OV was the first space-rated orbiter and was always the heaviest of the fleet. She was the only orbiter that never flew an ISS or Mir mission due to her mass. Atlantis[edit] Atlantis OV is pretty similar to Discovery, not much difference in mass or exterior appearance. Atlantis was used to launch Galileo to Jupiter and Magellan to Venus. Atlantis is also the space shuttle that comes with the default Orbiter distribution. Endeavour was the first orbiter delivered with an EDO capability and a 40 ft diameter drag chute used after touchdown to brake the orbiter on the runway.

Chapter 4 : Space Transportation System (STS) - OrbiterWiki

Get information on the Space Transportation Systems. The Japan Aerospace Exploration Agency (JAXA) performs various activities related to aerospace as an organization, from basic research in the aerospace field to development and utilization.

Transportation and Space Author: Jean-Paul Rodrigue Transport geography is concerned with movements that take place over space and the physical features of this space impose major constraints on transportation systems, in terms of what mode can be used, the extent of the service, its costs, capacity and reliability. Physical Constraints Three basic spatial constraints of the terrestrial space can be identified. Topography Features such as mountains and valleys have strongly influenced the structure of networks, the cost and feasibility of transportation projects. The main land transport infrastructures are built usually where there are the least physical impediments, such as on plains, along valleys, through mountain passes, or when absolutely necessary through the digging of tunnels. Water transport is influenced by water depths and the location of obstacles such as reefs. Coastlines exert an influence on the location of port infrastructure. Aircraft require airfields of considerable size for take off and landing. Topography can impose a natural convergence of routes that will create a certain degree of centrality and may assist a location in becoming a trade center as a collector and distributor of goods. Topography can complicate, postpone or prevent transport activities and investment. An absolute barrier is geographical feature that entirely prevent a movement while relative barriers impose additional costs and delays. Under such circumstances, land transportation tends to be of higher density in areas of limited topography. Hydrology The properties, distribution and circulation of water play an important role in the transport industry as the hydrology is at the same time a support and a constraint for transport activities. Several river systems such as the Mississippi, the St. Lawrence, the Rhine, the Mekong or the Yangtze are important navigable routes into the heart of continents. Historically, they have been the focus of human activities that have taken advantage of their transport opportunities. Port sites are also highly influenced by the physical attributes of the site where natural features bays, sand bars, and fjords protect port installations. Since it is at these installations that traffic is transshipped, the location of ports is a dominant element in the structure of maritime networks. Where barriers exist, such as narrows, rapids, or land breaks, water transport can only overcome these obstacles with heavy investments in canals or dredging. Conversely, waterways serve as barriers to land transportation necessitating the construction of bridges, tunnels and detours. Freight and passenger movement can seriously be curtailed by hazardous conditions such as snow, heavy rainfall, ice or fog. Air transportation is particularly vulnerable to weather disruptions, such as during winter when a snow storm can create cascading effects of air services. There is a seasonality for global wind patterns. Jet streams are also a major physical component that international air carriers must take into consideration. For an aircraft, the speed of wind can affect travel time and costs. Tailwind conditions can reduce scheduled flight time up an hour for intercontinental flights. For instance, due to strong jet stream conditions during winter months, transatlantic flights between the American East Coast and Europe can gain between 30 to 45 minutes from the scheduled flight time eastbound. However, for westbound flights unusually strong jet stream conditions will lengthen flight time and may on occasion force a flight to do an unscheduled refueling stop in intermediary airports such as Gander Newfoundland or Bangor Maine. It is expected that climate change will increase the strength of the North Atlantic jet stream and could lengthen eastbound flights between North America and Europe. Climate is also having an impact transportation networks by influencing construction and maintenance costs. In temperate climates the freeze-thaw cycle can damage transport infrastructure such as road surfaces, particularly during spring when they are more continuous. Even volcanic eruptions can have an impact as it was the case in when an eruption in Iceland released large amounts of ashes in the atmosphere , which forced the closing of most airports in northwestern Europe as well as the cancellation of many transatlantic flights out of concern that the ash could damage jet engines. This feature explains the paths followed by major intercontinental maritime and air routes. Overcoming the Physical Environment Rapid technological developments have enabled transportation to overcome the physical environment. Prior to the industrial revolution most road paths were adapted to topography. Since then, efforts have been made for paving roads, bridging rivers and cutting paths over mountain passes. Engineering techniques in terms of arches and vaults used in Byzantine and Gothic church constructions in the twelfth century permitted bridge building across wider streams or deep river valleys. Road building thus has been at the core of technological efforts to overcome the environment since they are the support for local and even long distance travel. From the efforts to mechanize road transport modes to the development of integrated multilane highways, road building has transformed the environment. Innovations in maritime transport can be found around the world. The earliest developments came in the transformation of waterways for transportation purposes through the development of canal locks coping with adverse natural gradients. Further improvements in navigation came with the cutting of artificial waterways. Some of the earliest examples can be found in the Dutch canals, the Martesana canals of Lombardy, the canal de Briare in France or the Grand Canal of China. Further improvements in navigation technology and the nature of ships permitted to increase the speed, range and capacity of ocean transport. However, the increasing size of ships has resulted in excluding canals such as Panama and many ports from servicing the largest ships. Several port authorities have thus embarked in expansion programs. Passages through the Arctic Ocean are being investigated with a view to create new international connections. Artificial islands are also created to permit port installations in deep waters. From the early steam engines to the first high speed trains, increasing motive power has permitted physical obstacles to be overcome by rail. The role of technology has been determinant in the development of the air transport sector. From the experiments of the Montgolfier brothers to the advent of jet aircraft, aerial crossing of rugged terrain over considerable distance became possible. Technical innovation in the aeronautic industry has permitted planes to avoid adverse atmospheric conditions, improve speed, increase range and raise carrying capacity. With the rapid rise in air passenger and freight transport demand, emphasis has been given to the construction of airport terminals and runways. As airports occupy large areas, their environmental footprint is important. The construction of Chek Lap Kok airport in Hong Kong led to leveling mountainous land for the airport site. Kansai airport servicing Osaka has been built on an artificial island. While the site refers to the geographical characteristics of a specific location, its situation concerns its relationships in regard to other locations. For instance, a port site relates to attribute such as the suitability of its harbor while a port situation relates to its connectivity with its foreland other ports and hinterland the inland market it serves. Thus, all locations are relative to one another but situation is not a constant attribute as transportation developments change levels of accessibility, and thus the relations between locations. The development of a location reflects the cumulative relationships between transport infrastructure, economic activities and the built-environment. The spatial distribution of activities is related to factors of distance, namely its friction. Locational decisions are taken in an attempt to minimize costs, often related to transportation. All locations have a level of accessibility, but some are more accessible than others. Thus, because of transportation, some locations are perceived as more valuable than others. There is a tendency for activities to agglomerate to take advantage of the value of specific locations. The more valuable a location, the more likely agglomeration will take place. The organization of activities is essentially hierarchical, resulting from the relationships between agglomeration and accessibility at the local, regional and global levels. Many contemporary transportation networks are inherited from the past, notably transport infrastructures. Even if since the industrial revolution new technologies have revolutionized transportation in terms of speed, capacity and efficiency, the spatial structure of many networks has not much changed. This inertia in the spatial structure of some transportation networks can be explained by two major factors: Natural conditions can be modified and adapted to suit human uses, but they are a very difficult constraint to escape, notably for land transportation. It is thus not surprising to find that most networks follow the easiest least cost paths, which generally follow valleys and plains. Considerations that affected road construction a few hundred years ago are still in force today, although they are sometimes easier to circumscribe with civil engineering work. New infrastructures generally reinforce historical patterns of exchange, notably at the regional level. For instance, the current highway network of France has mainly followed the patterns set by the national roads network built early in the 20th century. This network was established over the Royal roads network, itself mainly following roads built by the Romans. At the urban level, the pattern of streets is often inherited from an older pattern, which itself may have been influenced by the pre-existing rural structure lot pattern and rural roads. While physical and historical considerations are at play, the introduction of new transport technology or the addition of new transport infrastructure may lead to a transformation of existing networks. Recent developments in transport systems such as container shipping, long range aircrafts and the extensive application of information technology to transport management have created a new transport environment and a new spatial structure. These transport technologies and innovations have intensified global interactions and modified the relative location of places. In this highly dynamic context, two processes are taking place at the same time: From a situation of diversification, linked geographical entities are able to specialize in the production of goods for which they have an advantage, and trading for what they do not produce. As a result, efficient transportation systems are generally linked with higher levels of regional specialization. Economic globalization clearly underlines this process as specialization occurs as long as the incurred savings in production costs are higher than the incurred additional transport costs. The continuous evolution of transportation technology may not necessarily have expected effects on the spatial structure, as two forces are at play; concentration and dispersion. Linked geographical entities may see the reinforcement of one at the expense of others, notably through economies of scale. This outcome often contradicts regional development policies aiming at providing uniform accessibility levels within a region. Transportation Networks and Geographical Specialization Transportation Networks and Geographical Concentration A common fallacy is to relate transportation solely as a force of dispersion, favoring the spatial diffusion of activities. This is not always the case. In numerous instances, transportation is a force of concentration and clustering, notably for business activities. Since transport infrastructures are generally expensive to build, they are established first to service the most important locations. For instance, even if it was a strong factor of dispersion, the automobile has also favored the clustering of several activities in a suburban setting. The faster the mode, the larger is the distance that can be overcome within the same amount of time. Transportation, notably improvements in transport systems, changes the relationship between time and space. It is however a spatially and socially uneven process since it will impact the accessibility of locations differently. For instance, infrastructure will not be laid up uniformly and segments of the population will experience a greater improvement in mobility because of their socioeconomic status. Differences in mobility are thus a defining characteristic of development. Days Required to Circumnavigate the Globe Mail Delivery Times between New York and San Francisco, in days At the international level, globalization has been supported by improvements in transport technology. This enabled the extended exploitation of the advantages of the global market, notably in terms of resources and labor.

Chapter 5 : Space Power Chapter 3: Space Transportation|National Space Society

Space Transportation Systems (STS) are the systems and architectures that deliver payloads and humans to outer space. Learn about space shuttles, rockets and other spacecraft.

Space Power Chapter 3: Space Transportation by G. Harry Stine Copyright by G. Harry Stine Reproduced with permission of the G. Harry Stine estate Table of Contents Chapter 3: A True Space Transportation System A big space transportation system will be necessary to lift the millions of tons of material into geosynch orbit required to build a powersat. Therefore, the difference between the Apollo flights and the SPS transportation system operation needs to be firmly established right at the start. The Apollo Program was a politically-motivated project, funded by the government with cost a secondary concern to the primary goal of getting to the Moon before the Soviet Union. We know the Soviets had a manned lunar program; we also know now and may have known at that time through intelligence sources that the Soviets had the capability of sending a single cosmonaut on a circumlunar mission in December , but that they apparently did not have the capability to land even a single cosmonaut on the Moon and return him to Earth alive. As a matter of fact, that is exactly what happened. National prestige was the primary driver behind Apollo. Hire another acre of engineers and print another billion dollars! There were others, but that example serves the purpose here. The space transportation system for the SPS program is not the same sort of animal. It is to the Apollo program as a transcontinental airline is to a single person flying a single-engined airplane across the country. The SPS space transportation system depends upon other factors than have been paramount in the governmental space program to date: Without these factors, the SPS program cannot be carried out at all. As a matter of fact, such a space transportation system is on the drawing boards of at least three aerospace companies as of An SPS space transportation system can be built starting today with technology that is either in existence or that can reasonably be expected to be in hand by But a space transportation system is more than vehicles. This is true of any transportation system. Some model railroad fans are interested in motive powerâ€”the locomotives. Others find their greatest interest in rolling stock. Still others enjoy track work while others delight in making realistic scenery. And yet another category of rail modeler enjoys the operation of the model system itself. So our discussion of a space transportation system will have to include these additional support elements as well. Specialized vehicles have been replaced by spacecraft with a greater versatility in the sort of cargoes they can carry. One sort of ship is required for the transatlantic portion of the tripâ€”i. But to navigate up the Mississippi and Ohio rivers from New Orleans to Pittsburgh requires smaller ships with different characteristics. The analogy holds true for sending cargoes to geosynch orbit. It will have to be done in two steps. Two different types of space vehicles are required for the different steps. More of its gross weight can then be devoted to its payload: For the second step in the trip, LEO to GEO, an entirely different ship is required, one that always operates in the vacuum of space and therefore does not need any aerodynamic shaping. Therefore, the deep space ship can be designed and built quite differently to maximize the efficiency of its operation in the unique environment of orbital space. For example, its rocket engines do not need the tremendous thrust required for a shuttle, so they can be more modestly sized. However, the payload that both a shuttle and a deep space ship carries can be divided into two classes: Each class of payload will require a different sort of care during transit. People must have pressurized, temperature-controlled environments around them and cannot be subjected to any accelerations exceeding three gravities, this being considered the maximum permissible acceleration for people who have not undergone extensive training in high-gee maneuvers. People will require feeding and sanitary facilities on any trip lasting more than a few hours. Cargoes of materials and supplies, on the other hand, may or may not require a compartment that is pressurized and temperature controlled; some cargoes may need only rudimentary temperature control with no pressurization requirements whatsoever. Some cargoes are acceleration insensitive, permitting boost accelerations that are higher and therefore more efficient in terms of how rocket propellant is used. In addition, a great deal more non-human cargo than human help is going to be required to build an SPS. Therefore, cargo freighters will probably be much larger and will transport heavier payloads. A cursory look at a passenger liner versus a tramp steamer or a wide-bodied jet airliner versus a heavy-lift cargo plane reveals the simple truth that engineers design and build passenger vehicles differently from cargo vehicles. Earth-to-orbit-and-return passenger shipsâ€”Passenger shuttles. Earth-to-orbit-and-return cargo shuttlesâ€”Freight shuttles. Orbit-to-orbit passenger shipsâ€—Deep space passenger ships. Orbit-to-orbit cargo shipsâ€—Deep space freighters. The characteristics shared by all four classes will be a lowest possible operating cost, b highest possible reliability, and c maximum possible use rate. The size of each type of ship depends upon the nature of the SPS construction job and its engineering details. Up to a point, the bigger the ship in terms of numbers of passengers or tons of cargo, the more efficient it becomes. But in the case of the shuttles, a limit on size is reached because of the time and facilities required to handle them, load them, launch them, and recover them on Earth. It would probably be most efficient to have one super-sized wide-bodied jet transport leaving each day from LAX to JFK, and vice-versa. The sizing of the space transportation vehicles in the DOE Baseline Study came about as a result of a series of reiterative trade-offs between all of the factors that were taken into consideration. Then changes were made in the sizing to determine effects on costs and other SPS elements. The general ground rules followed were: The optimum spacecraft sizes that came out of the study were as follows: The freight shuttle should be capable of lifting at least metric tons , pounds to LEO. This was not surprising. Both the Saturn 5 and the best-guess estimate of the Soviet Heavy Launch Vehicle the Class G launch vehicle are quarter-million pound to orbit launchers, but the Saturn 5 was designed with technology. The freight shuttle designed with technology is nowhere near as large, and the unique requirements of the space transportation system not only reduces the cost of such a launch vehicle but its size as well. For example, the Boeing version of the freight shuttle would be 76 meters feet tall and about 74 feet in diameter with a base diameter of feet. The passenger shuttle can be achieved by using the existing NASA space shuttle orbiter, putting a passenger module in the cargo bay, and launching it as a two-staged vehicle with a reusable fly-back booster. The deep space passenger ships are also designed to carry 75 passengers in a variation of the passenger shuttle module. Since such a craft is a freighter, and since it will be propelling a very large solar array, propulsion is by means of an electric rocket motor using solar electricity generated by the array itself. The deep space freighter becomes a very small electric rocket motor module capable of being attached to an array and capable of being remotely-controlled from LEO or GSO if necessary during its flight. There may also be a manned electric rocket module in case people are required to perform guidance, navigation, control, maintenance, or other tasks during trans-orbital flight. Going back and forth between LEO and GEO is nowhere near as difficult in terms of technology, engineering, and energy as that first step: Airplanes have been successfully most of the time doing it one way for more than 75 years. Their horizontal takeoff and horizontal landing HTOHL uses the aerodynamic lift generated by motion of the craft through the atmosphere. All three operational modes are useful for the Earth-to-orbit step of our space transportation system, and advanced designs using the three modes have left the drawing boards already. The initial passenger shuttle will probably be based on an extension of current NASA space shuttle technology which, when operating at full-bore, will be capable of launching a space shuttle once a week utilizing VTOHL. But this operational mode requires separate facilities for takeoff and for landing. The ultimate for the shuttle task is single-stage-to-orbit SSTO , a single vehicle that ascends to space and returns without dropping off anything and by using only rocket propellants to do the job. Such a freight shuttle will be largeâ€—larger than the Saturn 5. Although an interim cargo shuttle can be cobbled-up using NASA space shuttle technology and hardware, the ultimate freighter shuttle for our space transportation system will be a ballistic VTOVL craft. With both winged VTOHL and ballistic VTOVL modes, two-stage configurations required less development of technology and could be done with a great deal of existing know-how; such two-stage designs turned out to be less sensitive to differences in operations which in turn led to the possiblity of lower operational costs. Winged vehicles VTOHL showed greater operational simplicity and reduced recovery and turn-around time when compared to ballistic vehicles VTOVL , even when the ballistic shuttles were landed in special recovery ponds adjacent to the launch sites. All types of shuttles, VTOHL and VTOVL, were more efficient if designed to use liquid oxygen and hydrocarbon fuel in a first stage and liquid oxygen and liquid hydrogen in the second stage. This is because of the greater bulk of liquid hydrogen which has low density and requires a very big tank to contain a given weight of this fuel. SSTO came out second-best only on the basis of the available technology, in spite of the fact that SSTO is the way to go for Earth-to-orbit transportation, just as it was the only way to go for transatlantic airline transportation. Most transatlantic airplanes were flying boats, and all of them had to stop to refuel, usually at the Azores. There was a requirement for a very fast transatlantic mail plane, and Major R. Mayo of Imperial Airways of Great Britain came up with a solution. The biggest problem faced by a heavily-loaded airplane is taking off and climbing to its best cruising altitude. This is particularly true of a seaplane. On 21 July , using the Empire Class flying boat Maia as a first stage, the little Mercury seaplane made it from Ireland to Montreal non-stop in 20 hours and 20 minutes. The economics of space transportation requires the development of the SSTO shuttle. But, by the year , it would be. The HTOHL shuttle would take off from an ordinary airport runway and climb into space using wings, composite air-breathing engines such as turbofans converting to ramjets at altitude, plus rocket motors for power above the atmosphere. On its return, it would land on the same runway from which it took off. The HTOHL shuttle will be the ultimate because of its lower cost, its ease of operation, and a flight profile whose accelerations are comfortable to passengers. How many of each type of spacecraft are going to be required to build two ten-gigawatt SPS units in geosynch orbit, every year? Five of the freight shuttles, the heavy lift launch vehicles capable of placing a million tons of cargo in LEO at each launch, will be required. This means that each of the five ships is going to make seventy-five flights to orbit and return every year, or once every five days. Thus, there will be at least one freight shuttle launch every day. And one freight shuttle landing every day. Two passenger shuttles will be required, each making a flight every three weeks.

Chapter 6 : Transportation and Space | The Geography of Transport Systems

Space Transportation Systems Launch vehicles are an important means of transportation that link Earth and outer space. Launch vehicles put into space communication and weather satellites, which have a direct impact on our quality of life, as well as astronomical-observation satellites and planetary-exploration satellites.

Advanced Space Transportation Program: Paving the Highway to Space Going to Mars, the stars and beyond requires a vision for the future and innovative technology development to take us there. The high cost of space transportation coupled with unreliability is a virtual padlock on the final frontier. But, imagine the possibilities when space transportation becomes safe and affordable for ordinary people. Our dreams of everyday life in space and its promise for a better life on Earth are hostage to the high cost of space transportation. Next-generation Launch Vehicles Dramatic improvements are required to make space transportation safer and more affordable. Future space launch vehicles must be safer, more reliable, simpler and highly reusable. This third generation of launch vehicles â€" beyond the Space Shuttle and "X" planes â€" depends on a wide variety of cutting-edge technologies, such as advanced propellants that pack more energy into smaller tanks and result in smaller launch vehicles. Another emerging technology â€" intelligent vehicle health management systems â€" could allow the launch vehicle to determine its own health without human inspection. Sensors embedded in the vehicle could send signals to determine if any damage occurs during flight. In late , the Marshall Center began testing these radical rocket engines. Powered by engines that "breathe" oxygen from the air, the spacecraft would be completely reusable, take off and land at airport runways, and be ready to fly again within days. An air-breathing engine â€" or rocket-based, combined cycle engine â€" gets its initial take-off power from specially designed rockets, called air-augmented rockets, that boost performance about 15 percent over conventional rockets. Magnetic Levitation Launch Assist Magnetic levitation â€" or maglev â€" technologies could help launch spacecraft into orbit using magnets to accelerate a vehicle along a track. Just as high-strength magnets lift and propel high-speed trains and roller coasters above a guideway, a maglev launch-assist system would electromagnetically drive a space vehicle along a track. The magnetically levitated spacecraft would be accelerated at speeds up to mph and then shift to rocket engines for launch to orbit. A foot track was built at Marshall in mid for testing and design analysis of maglev concepts for space propulsion. Scaled demonstrations of maglev technology will be conducted on a foot track also planned at Marshall. Beamed-energy Propulsion Lasers and microwaves are among the beamed-energy propulsion concepts the Advanced Space Transportation Program is pursuing. Beamed-energy propulsion uses a remote energy source â€" such as the Sun, a ground- or space-based laser or a microwave transmitter â€" to send power to the vehicle via a "beam" of electromagnetic radiation. Presently, beamed energy is the most promising technology to lower the cost of space transportation to tens of dollars per pound. Tethers NASA-Marshall plans to use electrodynamic tethers for the first demonstration of a propellant-free space propulsion system, which could lead to a revolution in space transportation. An electrodynamic tether works as a thruster as a magnetic field exerts a force on a current-carrying wire. When electrical current flows through a tether connected to a spacecraft, the force exerted on the tether by the magnetic field raises or lowers the orbit of the satellite, depending on the direction the current is flowing. Assembly of the experiment hardware begins at Marshall in early Fastrac is less expensive than similar engines because of an innovative design approach that uses commercial, off-the-shelf parts and fewer of them. Fastrac uses common manufacturing methods, so building the engine is relatively easy and not as labor-intensive as manufacturing typical rocket engines. The Marshall Center designed and developed the Fastrac engine. Fastrac component testing continues at Marshall. Pulse Detonation Rocket Engines The Advanced Space Transportation Program also is developing pulse detonation rocket engine technology that could lead to lightweight, low-cost rocket engines. Like an automobile engine, pulse detonation rocket engines operate by injecting fuel and oxidizer into long cylinders and igniting the mixture with a spark plug. The explosive pressure of the detonation pushes the exhaust out the open end of the cylinder, providing thrust to the vehicle. Antimatter, Fusion and Fission Exotic, high-energy propulsion will be required to travel to the outer planets and other star systems. Antimatter propulsion could leap from science fiction to scientific fact. Antimatter has propelled science fiction vehicles at "warp speed" for years, and could actually power spacecraft in the new millennium. Because of its superior energy density, antimatter annihilation is often suggested as the ultimate source of energy for propulsion. A proton is positive, whereas an antiproton is negative. When regular matter collides with antimatter, they annihilate each other and produce phenomenal energy. In an antimatter engine, the charged particles would be channeled out the back of a spacecraft to produce thrust. In mid, the Marshall Center built a High Performance Antimatter Trap, which will store antiprotons for a day lifetime. The Trap will be used in future antimatter experiments for space propulsion. The Marshall Center is also developing fusion and fission propulsion concepts to tap their potentially high-performance capabilities. These exotic technologies could be used for human missions to Mars and beyond. An enormous amount of energy is released by fission â€" the splitting of one atomic nucleus into two atoms. NASA is also investigating fusion as a space propulsion alternative. The opposite of fission, fusion combines two or more lighter atoms to form one heavier atom, producing a tremendous amount of energy in the form of heat. The energy efficiency of fusion compares to a car traveling 7, miles on one gallon of gas. NASA is considering the launch of such a precursor mission by In addition to fission, potential propulsion concepts for interstellar missions include sails. Thin, reflective sails could be propelled through space by sunlight, microwave beams or laser beams â€" just as the wind pushes sailboats on Earth. Sails in space would have a very large surface area â€" almost a half-mile wide â€" but could be thinner than cellophane. While sails are not being considered for human missions, they offer low-cost propulsion for robotic probes. NASA is examining futuristic technologies in search of a breakthrough in space transportation, similar to the silicon chip breakthrough that revolutionized the computer industry and made desktop computers part of everyday life. Intense technology development is aimed toward accelerating a breakthrough in space propulsion. Information on the Internet.

Chapter 7 : Space Shuttle - Wikipedia

NHB IB REPRINT MAY Office of. Space Transportation Systems Flammability, Odor, And Offgassing Requirements And Test Procedures For Materials In Environments.

Experiments Launch vehicles are an important means of transportation that link Earth and outer space. Launch vehicles put into space communication and weather satellites, which have a direct impact on our quality of life, as well as astronomical-observation satellites and planetary-exploration satellites. Launch vehicles play an essential role in the assembly and supplying of the International Space Station. Currently, Japan has various kinds of launch vehicles to answer diversified launch needs. ISAS was caught up in the trouble. The negotiations prevented ISAS from launching any rockets in The loss of the No. Japan has decided to focus on the new HIIA rocket leaving a gap of years in its launcher capability. Japan had not lost a spacecraft due to a domestic launch vehicle or upper stage failure since At that time the development and maiden flights of two new low-capacity boosters: JAXA announced in May that would charge 3 million yen, or about 29, dollars, for launching the smallest centimeter-bycentimeter square satellite. The agency has been launching such satellites for free, provided that a selection committee acknowledges that the launch contributes to human resource development or other causes. As the demand for launching very small satellites grew, JAXA decided to offer the service for a fee. Japanese cargo space ships, including Konotori, will carry the satellites to the International Space Station. They will be released into space, starting in October JAXA said it would continue to offer free service for launches with specific aims, including development of human resources. The JAXA Space Transportation System Research and Development Center is researching reusable space transportation systems to make access to space more reliable and economical, like airplanes are now. Much research and development is necessary to realize such a goal. In cooperation with other divisions at JAXA, the Center is drawing up a long-term research and development plan, and is carrying out conceptual studies such as comparing reusable spacecraft concepts as well as conducting research into reusable propulsion systems, lightweight structures, and highly reliable flight guidance and control. Preparations for flight demonstrations are also in progress.

Chapter 8 : Space Transportation System - Wikipedia

Description. Design Methodologies for Space Transportation Systems discusses conceptual changes in the design philosophy away from multistage expendable vehicles to winged, reusable launch vehicles and presents an overview of the systems engineering and vehicle design process as well as trades and analyses.

Chapter 9 : JAXA | Space Transportation Systems

Description. This practical book gives young professionals all the information they need to know to get started in the space business. It takes you step-by-step through processes for systems engineering and acquisition, design and development, cost analysis, and program planning and analysis.