A90-28991   Aerodynamic quality of a plane delta wing with blunted edges at large supersonic flow velocities (Aerodinamicheskoe kachestvo ploskogo treugol'nogo kryla s zatuplennymi kromkami pri bol'shikh sverkhzvukovykh skorostiakh obtekaniia). P. I. GOREN-BUKH, *TsAGI, Uchenye Zapiski* (ISSN 0321-3439), Vol. 20, No. 1, 1989, pp. 108–112.

Experimental data on the aerodynamic quality of plane delta wings with blunted edges are reported for free-stream Mach 9 and Reynolds numbers of 1.2 x 10 to the 6th - 4 x 10 to the 5th. The data are compared with results calculated by the method proposed by Nikolaev (1987). A unified analytical-experimental dependence is obtained for the relative aerodynamic quality near the maximum-aerodynamic-quality regime.

A90-28989   Some characteristics of changes in the nonstationary aerodynamic characteristics of a wing profile with an aileron in transonic flow (Nekotorye zakonomernosti izmeneniia nestatsionarnykh aerodinamicheskikh kharakteristik profilia kryla s eleronom v transzvukovom potoke). IU. P. NUSHTAEV, *TsAGI, Uchenye Zapiski* (ISSN 0321-3439), Vol. 20, No. 1, 1989, pp. 97–102.

Changes in the nonstationary aerodynamic characteristics of a wing profile with an aileron in flow of an ideal gas are investigated numerically under conditions of harmonic oscillations in relation to the relative profile thickness, oscillation frequency, and rotation axis position. Vortex-free isentropic flow of an ideal gas is analyzed assuming that perturbations introduced by an oscillating airfoil and the frequencies of the oscillatory motions are small. The problem is reduced to that of solving the well-known Lin-Reissner-Jsien equation for the small perturbation potential.

A90-14560   Dynamic analysis of lifting surfaces of small relative thickness in the case of finite displacements (O dinamicheskom raschete nesushchikh poverkhnostei maloi otnositel'noi tolshchiny pri konechnykh peremeshcheniiakh). V. G. GAINUTDINOV, *Aviatsionnaia Tekhnika* (ISSN 0579-2975), No. 3, 1989, pp. 19–23. 5 Refs.

An algorithm is presented for the dynamic analysis of flexible lifting surfaces modeled by thin and thin-walled rods as well as lifting surfaces described by more complex models. Attention is given to lifting surfaces of large and moderate aspect ratios and lifting surfaces whose cross sections move like rigid disks under deformation. Equations of motion are obtained for the case of finite displacements, and an example of calculations is presented.

A90-18305   Application of the finite element method to the problem of rotational flow around wings. A. L. KUDRIAVTSEV and N. B. PLISSOV, Finite element analysis in fluids; Proceedings of the Seventh International Conference on Finite Element Methods in Flow Problems, Huntsville, AL, Apr. 3–7, 1989 (A90-18233 06-34). Huntsville, AL, University of Alabama in Huntsville Press, 1989, pp. 851–856.

A numerical method based on the solution of a boundary value problem for a nonlinear differential equation is used to determine the characteristics of an airfoil in a nonuniform flow. In addition, the characteristics of a finite-span wing are obtained through a numerical treatment of lifting-line theory suggested by Karman and Tsien (1945). The finite element method is used to solve these two problems. Numerical examples are presented which show the significant effect of vorticity on the aerodynamic characteristics of wings.

A90-14556   Structural analysis of the horizontal tail surfaces of subsonic transport aircraft (Strukturnyi analiz ploshchadi gorizontal'nogo opereniia dozvukovogo transportnogo samoleta). V. P. GOGOLIN, *Aviatsionnaia Tekhnika* (ISSN 0579-2975), No. 3, 1989, pp. 6–10.

The structure of the horizontal tail surfaces of subsonic transport aircraft is analyzed with allowance for alignment tolerances, static stability margin, and zero-lift balancing. The analysis has made it possible to develop an algorithm for solving problems involving the determination of maximum weight requirements for the implementation of novel design solutions. The discussion is illustrated by an example for a hypothetical aircraft.

A90-28979   Using the method of symmetric singularities for calculating flow past subsonic flight vehicles (Primenenie metoda simmetrichnykh osobennostei dlia rascheta obtekaniia dozvukovykh letatel'nykh apparatov). N. N. GLUSHKOV, IU. L. INESHIN, and IU. N. SVIRIDENKO, *TsAGI, Uchenye Zapiski* (ISSN 0321-3439), Vol. 20, No. 1, 1989, pp. 23–28. 8 Refs.

A panel method is presented for calculating flow past aircraft in the context of the potential theory of an incompressible fluid. The method makes it possible to calculate the complete aircraft configuration, including engine nacelles, suspended loads, and pylons. A characteristic feature of the present method is the principle of symmetric distribution of sources (sinks) and vortices on the opposite surfaces of the lifting elements. Comparisons are made with other analytical methods and experimental data. Isobar calculations over the surface of a transport aircraft are conducted as an example.

A89-54619   Separated flow past a concave conical wing of large transverse curvature at small angles of attack (Otryvnoe obtekanie vognutogo konicheskogo kryla s bol'shoi poperechnoi kriviznoi pod nebol'shimi uglami ataki). V. L. BORSHCH and V. V. KRAVETS, *Akademiia Nauk SSSR, Izvestiia, Mekhanika Zhidkosti i Gaza* (ISSN 0568-5281), July–Aug. 1989, pp. 130–136. 10 Refs.

Laminar flow past a wing model in the form of a circular half-cone with an angle of taper of 34 deg was modeled numerically in the context of a quasi-conical approximation for three-dimensional Navier-Stokes equations. Under such an assumption, the displacement of external nonviscous flow due to intense flow separation beyond the leading edges leads to flow patterns similar to those observed in the case of V-shaped wings with a bend in the transverse profile. A weak secondary separation is shown to occur under primary separation regions at nonzero angles of attack.

A89-52852   A second-order finite-difference scheme for calculating three-dimensional supersonic flows of an ideal gas (Konechno-raznostnaia skhema vtorogo poriadka dlia rascheta trekhmernykh sverkhzvukovykh techenii ideal'nogo gaza). M. K. AUKIN and R. K. TAGIROV, *Zhurnal Vychislitel'noi Matematiki i Matematicheskoi Fiziki* (ISSN 0044-4669), Vol. 29, July 1989, pp. 1057–1066. 13 Refs.

An explicit second-order finite-difference scheme for calculating three-dimensional stationary supersonic flows of an inviscid gas is proposed, and some methodological features of the scheme are discussed. Results of calculations for conical flows and a submerged jet are found to be in good agreement with the results obtained by using some well-known second-order schemes. Examples of calculations for complex three-dimensional supersonic flows are presented.

Japanese Aerospace Literature
This month: *Aircraft Design*

A91-49178   Quick automatic evaluation of propeller performance combined to an engine. SHIGENORI ANDO and MICHIYO KATO, *Japan Society for Aeronautical and Space Sciences Journal* (ISSN 0021-4663), Vol. 39, No. 449, 1991, pp. 294–302. 8 Refs.

A quick automatic method is presented for evaluating a propeller performance combined to an engine. The formulation is obtained through drastic simplification by retaining the essential parts only. A scheme—'thrust-consistent scheme'—is constructed for the part of propeller analysis. Accuracy examination has been made both for the static and the forward-moving conditions, and confirmed to be within 10 percent errors. One example of application to an engine-propeller combination is presented, which shows that the present method can be used to select the best set of several parameters such as diameter, solidity, and pitch.

A91-46819   Fundamental philosophy of PAR-WIG design at USA-DTNSRDC. SHIGENORI ANDO, *Japan Society for Aeronautical and Space Sciences Journal* (ISSN 0021-4663), Vol. 39, No. 448, 1991, pp. 218–226. 6 Refs.

Problems with the first-generation WIG (wing-in-ground) are discussed. The PAR (power augmented ram) technology is classified into three types: (1) wing PAR cushion; (2) fuselage PAR cushion; and (3) LEX/TEX PAR cushion. IGE (in-ground-effect) and OGE (off-ground-effect) improvements are addressed. Three types PAR-WIG designs are presented, and a PAR-WIG water impact design methodology is described.

A91-46820   Practical application of the wing-in-ground (WIG) effect vehicle. SYOZO KUBO, TETUYA KAWAMURA, TAKENORI MATSUBARA, and TOSHIO MATSUOKA, *Japan Society for Aeronautical and Space Sciences Journal* (ISSN 0021-4663), Vol. 39, No. 448, 1991, pp. 236–242. 31 Refs.

Possible future applications of the WIG-effect vehicle are considered. The IGE (in-ground-effect) and OGE (off-ground-effect) techniques are examined, and the aerodynamic problems of the WIG are discussed. Aspects of WIG technology development are examined, including wing efficiency, off-water and on-water problems, and the use of new materials. Environmental pollution concerns, including noise and exhaust emissions, are addressed.

A91-42817   Parametric study of airframe-integrated scramjet cooling requirement. TAKESHI KANDA, GORO MASUYA, YOSHIO WAKAMATSU, NOBUO CHINZEI, and AKIO KANMURI, *Journal of Propulsion and Power* (ISSN 0748-4658), Vol. 7, May–June 1991, pp. 431–436. 17 Refs.

The cooling requirement of a hydrogen-fueled airframe-integrated scramjet engine as well as an airframe is examined, and effects of various parameters including flight Mach number, flight dynamic pressure, engine wall temperature, and engine scale, on the engine characteristics are analyzed. The coolant required for the airframe is about 20 percent of the total coolant. Simple equations that correlate coolant flow rate with those parameters are derived.

A91-57004   Aerodynamic characteristics of two-dimensional membrane airfoils. TAKESHI SUGIMOTO and JUNZO SATO, *Japan Society for Aeronautical and Space Sciences, Transactions* (ISSN 0549-3811), Vol. 34, Aug. 1991, pp. 88–100. 9 Refs.

A theoretical and experimental investigation of a flow past two-dimensional inextensible membrane airfoils was made. The basic equations based on a linearized inviscid theory are transformed into a Fredholm integral equation of the second kind with an integral constraint. The equations have been solved by using the degenerate kernel method. Comparison between theoretical and experimental results indicates that: (1) the linearized inviscid theory can predict the essential properties of the flow around membranes longer than the chord by three percent or less; (2) as the length exceeds the chord by about five percent, viscous effect dominates; and (3) S-shaped membranes exist but exhibit sustained oscillations.

A91-55494   Galloping of rectangular cylinders in the presence of a splitter plate. Y. NAKAMURA, K. HIRATA, and T. URABE, *Journal of Fluids and Structures* (ISSN 0889-9746), Vol. 5, Sept. 1991, pp. 521–549. 11 Refs.

Results of the galloping of rectangular cylinders in the presence of a splitter plate that were obtained in free- and forced-oscillation experiments are presented. The free-oscillation experiment includes measurements of the growth rate of oscillation in the galloping of rectangular cylinders with $d/h = 0.2$ to 6.0, where d is the depth and h is the height. The forced-oscillation experiment includes measurements of the mean and fluctuating side-face pressures on rectangular cylinders with $d/h = 0.6$, 1.0, and 2.0, along with flow visualization using smoke. The free-oscillation experiment shows that rectangular cylinders with a splitter plate with d/h up to 5.0 are susceptible to galloping and that galloping vanishes at a value of d/h between 5.0 and 6.0. An interpretation of the galloping mechanism of rectangular cylinders with a splitter plate is proposed. A close similarity is found between low-speed galloping of rectangular cylinders with and without a splitter plate.

A91-44092   Supersonic air-intake study aiming at future airbreathing engine. K. SAKATA, S. HONAMI, and A. TANAKA, 27th AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference, Sacramento, CA, June 24–26, 1991. 7 pp. 5 Refs. (AIAA Paper 91-2012).

A development status evaluation is presented for Japanese efforts toward development of SST/HST airbreathing propulsion system air intakes featuring a minimum cruise Mach number of 3.0 and mixed compression operation within a two-dimensional ramp-type geometry framework. Experimental investigations have thus far encompassed a three-shock ramp system, multishock ramps with bleed systems, variable-geometry inlets, and inlets optimized for SST airframe integration. The avoidance of boundary-layer separation and the minimization of bleed airflow rates are identified as the most important steps toward achievement of performance goals.

A91-44091   Aerodynamic characteristics of Mach-3 air-intake tested in supersonic wind tunnel. R. YANAGI, S. SHINDO, A. MURAKAMI, K. SAKATA, S. HONAMI et al., 27th AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference, Sacramento, CA, June 24-26, 1991. 8 pp. (AIAA Paper 91-2011).

The present experimental investigations of ramp-type supersonic air intakes address the requirements of prospective SST, HST, and transatmospheric vehicles employing airbreathing propulsion systems. In addition to studying pressure recovery, these efforts have given attention to flow path flow patterns, using visualization techniques. The test results obtained illustrate the internal compression effect obtainable by means of cowl and throat terminal shock waves, and its importance to aerodynamic performance and stability. Also critical is an air-bleed system for avoidance of boundary-layer separation.

A91-33227   Analysis of laminar separation bubble using a simple eddy-viscosity turbulence model. KENICHI RINOIE and NOBUHIKO KAMIYA, *Japan Society for Aeronautical and Space Sciences Journal* (ISSN 0021-4663), Vol. 39, No. 444, 1991, pp. 20–27. 11 Refs.

Laminar separation bubbles formed on airfoils were expressed numerically using a simple eddy-viscosity turbulence model. The eddy viscosity constant, epsilon(t), was set to a uniform value inside the turbulent part of the bubble. Overall characteristics of numerical results agreed closely with experimental results. The relation between epsilon(t) and velocity distributions was analyzed by the momentum balance inside the bubble. It was shown that the pressure recovery inside the bubble is proportional to epsilon(t). Finally, the semiempirical parameter which determines epsilon(t) was proposed.

A91-25746   A study of aerodynamic performance of cone-derived waverider configuration. KOICHI HOZUMI and SHIGEYA WATANABE, *Proceedings of the 1st International Hypersonic Waverider Symposium,* College Park, MD, Oct. 17–19, 1990, (A91-25728 09-02). College Park, MD, University of Maryland, 1990, 18 pp. 16 Refs.

Wind tunnel test results for a series of cone-derived waverider configurations at Mach 7.1 are examined with a view to possible hypersonic transport applications. A comparison with data obtained for conventional flat-bottom configurations confirms the high L/D and low lift characteristics of the present configurations. The advantages of the high L/D, low lift waverider configurations over high L/D, high lift hypersonic transport configurations are discussed.

A91-55451   Aircraft design experience. SHIZUO KIKUHARA, *Japan Society for Aeronautical and Space Sciences Journal* (ISSN 0021-4663), Vol. 39, Aug. 1991, pp. 379–387.

The design experience of the author who participated in 11 kinds of aircraft designs from the 1930's to the 1960's are presented. Four major designs of aircraft are emphasized including the H6K1 and H8K1, the N1K2-J, and the PS-1.

A91-40472   Analysis of circular elastic membrane wings. TAKESHI SUGIMOTO, *Japan Society for Aeronautical and Space Sciences Journal* (ISSN 0021-4663), Vol. 39, No. 447, 1991, pp. 180–187. 19 Refs.

Membrane wings, such as sails of yachts and hang-gliders, have quite complicated aerodynamic characteristics owing to interactions between compliant wings and the flow around them. All the existing methods of solution for three-dimensional membrane wing theories contain iterative procedures to deal with the strong nonlinearity of the problem. The uniform tension is assumed to weaken this nonlinearity, so that the iterative procedures can be eliminated. This method is applied to the problem of circular elastic membrane wings. Numerical results have been compared with experimental results. The consistency between the analysis and the experiment shows the validity of the method. The existence of two equilibria is also confirmed.

A91-37777   Aerodynamic characteristics of slender wing-gap-body combinations. YUZO YAMAMOTO, SHIGENORI ANDO, and KAZUO MIKI, *Japan Society for Aeronautical and Space Sciences, Transactions* (ISSN 0549-3811), Vol. 33, Feb. 1991, pp. 154–175. 13 Refs.

The aerodynamic characteristics of the slender wing-gap-body combinations are studied exactly within the frame of the slender body aerodynamic theory. Solutions are presented for slender configurations, in which the wings and the body have different incidences with respect to the free stream and arbitrary width chordwise gaps exist between the wings and the body. The expressions of the aerodynamic forces derived originally by Ward (1949) and the relations between the complex velocity and a downwash on the body are extended to the case of multiply-connected cross sections. The most practical cases encountered by missile aerodynamicists may be covered, and the basic lift results agree with those obtained by Dugan and Hikido (1954).

A91-24514   Applicability of Euler analysis to prop-fan aerodynamic design. MAKOTO KOBAYAKAWA, RYOJI TAKAKI, YOSHIFUMI KAWAKAMI, and FREDERICK B. METZGER, *Proceedings of the 17th ICAS, Congress* (Vol. 2), Stockholm, Sweden, Sept. 9–14, 1990, (A91-24301 09-01). Washington, DC, American Institute of Aeronautics and Astronautics, Inc., 1990, pp. 2073–2081. 8 Refs.

Applicability of a numerical code to aerodynamic design of a prop-fan is guaranteed by precise agreement of numerical results with experimental data; i.e., not only integrated performance indices such as power coefficient and net efficiency but also pressure distribution on the blade surface should agree well between computed and experimental results. An Euler code using the TVD scheme is developed for this purpose. The numerical calculations are performed for the SR-7L prop-fan at freestream Mach number 0.5. The computed power coefficient, $Cp = 1.734$, shows comparatively good agreement with the experimental data, $Cp = 1.440 +$ or $- 0.080$ if the measurement error of the blade twisted angle is considered.

A91-24494   Experimental study on drag reduction of hypersonic transport configuration. Y. AIHARA, E. MORISHITA, T. OKUNUKI, S. NOMURA, and K. HOZUMI, *Proceedings of the 17th ICAS, Congress* (Vol. 2), Stockholm, Sweden, Sept. 9–14, 1990, (A91-24301 09-01). Washington, DC, American Institute of Aeronautics and Astronautics, Inc., 1990, pp. 1899–1907. 8 Refs.

The paper describes drag-reduction studies for HST configurations with a Mach number of 7, a Reynolds number of about one-million, and a volume coefficient of about 0.1. Characteristics tests with several variations of the configuration demonstrated that total slenderizing and blending of the wind-body assembly can lower the drag. The maximum available L/D ratio is 5.5. It is pointed out that better performance is expected if thermal control of the flow is implemented.

A91-24430   Quiet STOL research aircraft Asuka—Development and flight test. MIKIHIKO MORI, YOSHIO HAYASHI, NOBUYUKI TAKASAKI, and TAKASHI TSUJIMOTO, *Proceedings of the 17th ICAS, Congress* (Vol. 2), Stockholm, Sweden, Sept. 9–14, 1990, (A91-24301 09-01). Washington, DC, American Institute of Aeronautics and Astronautics, Inc., 1990, pp. 1266–1276. 13 Refs.

Development and flight test results of the Japanese research project on the fan jet quiet STOL research aircraft Asuka are presented. Asuka is designed to perform research on powered lift technology and STOL operation. Asuka provides many technological features including upper-surface blowing flaps, a boundary layer control system, a stability and control augmentation system, a flight control system with triplex hydromechanical series servo actuator, sonic abatement techniques, and a newly developed high bypass ratio fan jet engine with bleed air. The flight tests were conducted from October 1985 to March 1989 and flew about 170 hours and 97 flights. Particular attention was devoted to the aerodynamic performance of the high lift device and control techniques for STOL approach and landing. Some selected data are presented with an explanation of the flight tests.

A91-26694   PAR-WIG (power-augmented-ram wing-in-ground)—Some considerations for conceptual design of PAR-WIG effect vehicle. SHIGENORI ANDO, *Japan Society for Aeronautical and Space Sciences Journal* (ISSN 0021-4663), Vol. 38, No. 443, 1990, pp. 676–683. 12 Refs.

Investigations have indicated that PAR-WIG has almost twice the range capability of conventional aircraft due to higher L/D and lower empty weight fraction. This paper analyzes empty weight based on the available data, comparing this data with various other types. The synthetic effect of the wing aspect ratio on operational efficiency is examined.

A91-24492   Design and flight test on high AOA/spin characteristics of XT-4 intermediate jet trainer. N. TODA, N. UDAGAWA, T. ICHIHASHI, H. KOMAKI, N. MORITA et al., *Proceedings of the 17th ICAS, Congress* (Vol. 2), Stockholm, Sweden, Sept. 9–14, 1990, (A91-24301 09-01). Washington, DC, American Institute of Aeronautics and Astronautics, Inc., 1990, pp. 1883–1890.

Designs, development tests, and flight tests pertaining to the high AOA/spin characteristics of the XT-4 are described. Rotary-balance and spinning wind tunnel tests and spin testing using RPV models were performed to predict the poststall behavior. It was found that the XT-4 is extremely resistant to departure during the maneuver and that it has the capability of getting into intentional spin followed by a hands-off smooth recovery from any mode with engine distortion tolerance.

A91-24445   Large-scale numerical aerodynamic simulations for complete aircraft configurations. SUSUMU TAKANASHI, *Proceedings of the 17th ICAS, Congress* (Vol. 2), Stockholm, Sweden, Sept. 9–14, 1990, (A91-24301 09-01). Washington, DC, American Institute of Aeronautics and Astronautics, Inc., 1990, pp. 1415–1426. Research supported by NASDA and Japan Aircraft Development Cooperation. 10 Refs.

Navier-Stokes simulations of transonic flows are carried out for complete configurations of two kinds of test models which were designed to investigate the aerodynamic characteristics of the developing airplanes using the transonic wind tunnel. An O-O grid system for the computation is constructed by the automatic procedure based on the electrostatic theory. The Reynolds-averaged Navier-Stokes equations are solved on a supercomputer, FACOM VP-400, using an implicit finite volume, upwind TVD scheme. Computed pressure distributions as well as force coefficients are also compared with the experimental data.

A91-21368   Optimum spacing control of the marching grid generation. KAZUHIRO NAKAHASHI, 29th AIAA, Aerospace Sciences Meeting, Reno, NV, Jan. 7–10, 1991. 12 pp. 6 Refs. (AIAA Paper 91-0103).

A point-wise marching procedure to generate the grid is developed for external viscous flow computations about complex geometries. The grid spacings in the marching direction are controlled by using an optimization technique in which the advancing grid surface is minimized under an isoperimetric constraint. This is physically similar to the minimization of the free surface of a liquid by the surface tension. Thus the resulting grid is expected to be naturally smooth even in concave regions. For three-dimensional problems, the method is applied to a directionally-structured, prismatic mesh. The bases of the grid cells are triangles which cover the three-dimensional surface in an unstructured manner, while the direction away from the body is structured so as to achieve an efficient computation for viscous flows. The method is applied to generate a two-dimensional structured O-grid around a multielement airfoil, and a directionally-structured grid about a wing-fuselage configuration.

A91-14452   Newly constructed high speed wind tunnel at the Institute of Space and Astronautical Science (ISAS) and related activities. YOSHIFUMI INATANI, KEIICHI KARASHIMA, KOZO FUJII, NOBUHIRO TANATSUGU, and TAKASHI ABE, 2nd AIAA, International Aerospace Planes Conference, Orlando, FL, Oct. 29–31, 1990. 9 pp. 6 Refs. (AIAA Paper 90-5226).

The Institute of Space and Astronautical Science (ISAS) built a new high-speed wind tunnel facility in 1989 in Sagamihara campus. The objective of the facility construction is to conduct the aerodynamic research of high-speed air and space transportation systems, air-breathing propulsion systems and recovery systems, as well as basic studies in the field of high-speed aerodynamics. The facility consists of a set of high pressure air-supply system and a transonic and a supersonic tunnel. Although both wind tunnels are of conventional blow-down type, the manual procedures in tunnel operations and measurements are highly simplified by making use of fully automatic control systems to save manpower and driving energy necessary for the execution of the wind tunnel experiments. Brief summaries of the facility and its performance, and some of the results obtained in tunnel verification tests as well as a proposed experimental study are summarized.

A90-41753   Critical review of design philosophies for recent transport WIG effect vehicles (Wing-in Ground). SHIGENORI ANDO, *Japan Society for Aeronautical and Space Sciences, Transactions* (ISSN 0549-3811), Vol. 33, May 1990, pp. 28–40. 10 Refs.

The design philosophies behind various concepts of Wing-In-Ground effect vehicles are reviewed. Consideration is given to the Power Augmented Ram concept, the ability of Off Ground Effect flight, attitude stability, the form of the main wing, aspect ratio, alleviation of wave impact load, allowable altitude at In Ground Effect flight and wave height, block distance, and speed and wing loading.

A91-24407   A computational and experimental analysis of joined-wing aerodynamics. MASAKATA HASHIMOTO, MASAYUKI ISHIKAWA, NAOKI HIROSE, and TAKESHI OHNUKI, *Proceedings of the 17th ICAS, Congress* (Vol. 1), Stockholm, Sweden, Sept. 9–14, 1990, (A91-24301 09-01). Washington, DC, American Institute of Aeronautics and Astronautics, Inc., 1990, pp. 1017–1027. 14 Refs.

The aerodynamic characteristics of a joined-wing were investigated by computational methods and by a low-speed wind tunnel test to show its advantages over the conventional configurations and the feasibility of adapting it for practical application. An initial analysis by the extended lifting-line theory and a second analysis by the three-dimensional potential-flow panel method were performed to clarify the effects of geometrical parameters on the joined-wing aerodynamics, such as solid/planar types, sweep angles, span ratio, and area ratio of the rear and front wings. A third analysis involves finite-difference computation of the three-dimensional Euler equations to obtain the lift and drag characteristics in the high subsonic to transonic regime. It is shown that the three-dimensionally diamond-shaped joined-wing configuration has a higher value of lift-to-drag ratio than the planely joined one.

A91-14449   Concept and technology development for HOPE spaceplane. TESTSUICHI ITO, TOSHIO AKIMOTO, HIROSHI MIYABA, YASUOMI KANO, NORIO SUZUKI et al., 2nd AIAA, International Aerospace Planes Conference, Orlando, FL, Oct. 29-31, 1990. 9 pp. (AIAA Paper 90-5223).

HOPE spaceplane has been studied for several years in NASDA. The purpose of the current study is to establish the feasible concept of HOPE and to prepare the technical bases. The primary mission of HOPE is the Space Station Freedom/JEM logistics transportation complementing with U.S. Space Shuttle fleet. Besides previous concept of ten ton class orbiter launched by H-II rocket, extended size orbiter concept has been studied along with enhancement of H-II rocket, which is called H-IID (derivative) rocket. An orbiter derived from this study weighs 20t at lift off and has three to five tons of payload capability, based on the H-IID configuration of H-II first stage with six solid boosters strapped on. Subsystems design and technology development in such field as aerodynamics, structure and materials, guidance-navigation and control, and Space Station interface are in progress. In order to acquire the reentry flight data, orbital reentry experiment is planned and under development utilizing orbital flight opportunity of H-II test flight in 1993. These concepts are under review and trade off in NASDA for establishing HOPE development scenario.

A90-48856   An expert system for instruction of preliminary aircraft design. YOSHISADA MUROTSU and CHOONG SIK PARK, Presented at the AIAA, AHS, and ASEE, Aircraft Design, Systems and Operations Conference, Dayton, OH, Sept. 17–19, 1990. 9 pp. 9 Refs. (AIAA Paper 90-3261).

This paper describes an expert system for instruction of preliminary aircraft design using a new tool based on an object-oriented approach. The system executes the programs described by users, which represent design knowledge, including the design objects and the design processes. The system also generates computational models and implements them according to the design knowledge. The system has the following features: (1) users can directly describe design knowledge without programming experts; (2) users can read the programs as manuals or documents of aircraft design.

A90-45859   Propulsive lift augmentation by side fences as applied to Japan's experimental STOL aircraft, ASKA. MASATAKA MAITA, KATSUMI TAKEDA, HAMAKI INOKUCHI, TAKASHI INOUE, and MASUMICHI KURIYAMA, Technical Papers presented at the 8th AIAA Applied Aerodynamics Conference (Part 1), Portland, OR, Aug. 20–22, 1990, (A90-45845 21-02). Washington, DC, American Institute of Aeronautics and Astronautics, 1990, pp. 161–167. 11 Refs. (AIAA Paper 90-3009).

A static ground-based study was conducted of the aerodynamic characteristics of the external upper-surface-blowing (USB) propulsive-lift configuration of the Japanese Quiet STOL Experimental Aircraft, designated 'ASKA'. A comparison was made of flows associated with two configurational alternatives: one employing side-fences, the other using vortex generators. The USB concept incorporating side-fences achieved an effective enhancement of the exhaust flow attachment, as well as an improvement in such other respects as aeroacoustics and/or structural thermal loading.

A91-46592   Development of the intermediate jet trainer (XT-4). HIROYASU TAKAO, KOHKI ISOZAKI, and NORIO TODA, *Japan Society for Aeronautical and Space Sciences Journal* (ISSN 0021-4663), Vol. 38, No. 434, 1990, pp. 111–123. 2 Refs.

Aircraft design and flight testing are reviewed for the XT-4 program. Particular emphasis is placed on reliability analysis and maintenance characteristics.

A90-28007   A practical flight path for microwave-powered airplanes. TAKESHI ITO, *Japan Society for Aeronautical and Space Sciences, Transactions* (ISSN 0549-3811), Vol. 32, Feb. 1990, pp. 228–231.

Although some types of closed flight paths have been proposed for microwave-powered aircraft, they have unfavorable features from a viewpoint of aircraft designers, especially under the strong wind conditions. Here, by defining the time variation of the air-speed vector, a well-behaved practical periodic flight path is deduced.