<table>
<thead>
<tr>
<th>VOLUME 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>PREFACE</td>
</tr>
<tr>
<td>B LASCHKA ............................................ XXVI</td>
</tr>
<tr>
<td>IN MEMORIAM ............................................ XXXII</td>
</tr>
<tr>
<td>Frank L WATTENDORF 1906 - 1986</td>
</tr>
<tr>
<td>Hendricus J VAN DER MAAS 1900 - 1987</td>
</tr>
<tr>
<td>ICAS-VON-KARMAN LECTURE</td>
</tr>
<tr>
<td>ICAS-88-0.5 The International Vortex Flow Experiment for Computer Code Validation G DROUGGE ............................................ XXXV</td>
</tr>
<tr>
<td>ICAS-88-0.1 The Outlook for Wind-Tunnel Testing W R SEARS ............................................ not available</td>
</tr>
<tr>
<td>GENERAL LECTURES</td>
</tr>
<tr>
<td>ICAS-88-0.2 Flight Systems - Man/Machine Interface in the Computer Age S J MERHAV ............................................ not available</td>
</tr>
<tr>
<td>ICAS-88-0.3 Part I: Technologies for Future Transport Aircraft M J ROEDER ............................................ not available</td>
</tr>
<tr>
<td>Part II: Technology of the A320 Aircraft J P POTOCKI ............................................ not available</td>
</tr>
<tr>
<td>ICAS-88-0.4 Emerging Hypersonic Propulsion Technology E T CURRAN, H L BEACH ............................................ XLII</td>
</tr>
<tr>
<td>ICAS-88-0.6 NASA/Industry Advanced Turboprop Technology Program J A ZIEMIANSKI, J B WHITLOW Jr ............................................ LIV</td>
</tr>
</tbody>
</table>
ICAS-88-1.1.1  Simulated Environment Testing for Aircraft  
P W SMITH  ..............................................  1

ICAS-88-1.1.2  Windshear Detection and Avoidance: Airborne Systems Perspective  
R L BOWLES, R TARG  ...................................  7

ICAS-88-1.1.3  Takeoff Flight-Paths in the Presence of Wind and Wind Variation  
K -U HAHN  ............................................  21

ICAS-88-1.1.4  Results from a Programme of Low Altitude Atmospheric Turbulence Measurements by an Instrumented Aircraft  
G W FOSTER, J G JONES  .................................  32

ICAS-88-2.1.1  Recent European Advancements in Hypersonic Aerodynamics and Aerothermics related to 'HERMES' Program  
P PERRIER  ................................................. not available

ICAS-88-2.1.2  Effects of Reynolds Numbers on Static Characteristics of Aerodynamics of a Slender Cone  
Q Y ZHUANG  .............................................  43

ICAS-88-2.1.3  Heat Transfer Measurements on Biconics at Incidence in Supersonic High Enthalpy Air & Nitrogen Flows  
S L GAI, T CAIN, W S JOE, R J SANDEMAN, C G MILLER  ............................................  48

ICAS-88-2.1.4  Sensitivity of Supersonic Combustion to Combustor/Flameholder Design  
G S DISKIN, G BURTON NORTHAM  ....................  58

ICAS-88-3.1.1  Fatigue Crack Growth Under Cyclic Compression Role of First Load Cycle  
A F BLOM, D K HOLM, S SURESH  ........................  67

ICAS-88-3.1.2  Damage Tolerance and Engineering Properties of Aluminium-Lithium Alloys  
W G J 't HART, L SCHRA, R J H WANHILL  ...............  75

ICAS-88-3.1.3  Fracture Mechanics and Fatigue Characterization of Aluminium-Lithium Alloys  
G CAVALLINI, L LAZZERI, F BOSCHETTI, A SOLINA, M DE SANCTIS  ...................................  84
ICAS-88-3.1.4  A New Approach to Load Transfer in Bolted Joints
V WEISSBERG, K WANDER, R ITZHAKOV .......................  96

LAMINAR FLOW

ICAS-88-4.1.1  Natural Laminar Flow Research for Subsonic Transport Aircraft in the FRG
H KORNER ..............................................not available

ICAS-88-4.1.2  Toward Lower Drag with Laminar Flow Technology
W D HARVEY, P J BOBBITT .............................not available

ICAS-88-4.1.3  A Study of Viscous Flow Over Elliptic Cylinders
R BAHL ..................................................  102

ICAS-88-4.1.4  Design and Experimental Verification of an Advanced Fowler Flapped Natural Laminar Flow Airfoil
R BERTOCCHI ............................................  113

CFD APPLICATIONS TO PROPULSION

ICAS-88-5.1.1  Three Dimensional Inviscid Flow Calculations in Turbomachinery Components
T ARTS .....................................................  121

ICAS-88-5.1.2  Numerical Simulation of Turbulent Flow Through Tandem Cascade
D XU, G WU ..................................................  133

ICAS-88-5.1.3  3D Computations of Complex Internal Flow Systems
C HIRSCH, C LACOR .......................................not available

ICAS-88-5.1.4  Calculation of Flow Along a Cowl of a Shrouded Propfan Using a 3D-Euler Code
S LEICHER ..................................................  138
HELICOPTER FLIGHT DYNAMICS

ICAS-88-6.1.1 Experimental Investigation of Strong In-Flight Oscillation on Helicopters and its Prevention
X ZHI-MING ................................................................. 148

ICAS-88-6.1.2 Optimization of Helicopter Takeoff and Landing
T CERBE, G REICHERT ......................................................... 154

ICAS-88-6.1.3 Theoretical Modelling for Helicopter Flight Dynamics: Development and Validation
G D PADFIELD ................................................................. 165

ACTIVE CONTROL TECHNOLOGY

ICAS-88-1.2.1 Integrated Control Technology for Commuter Aircraft
Experimental Results and Future Potential
W ALLES, H BÖHRET, H WÜNNEBERG .................................... 178

ICAS-88-1.2.2 Active Flutter Suppression for a Wing Model
G L GHIRINGHELLI, M LANZ, P MANTEGAZZA ............................. 184

ICAS-88-1.2.3 ACT Wind Tunnel Experiments of a Transport-Type Wing
T UEDA, H MATSUSHITA, S SUZUKI, Y MIYAZAWA ....................... 194

ICAS-88-1.2.4 Multivariable Control System Design for an Unstable Canard Aircraft
D COWLING ................................................................. 205

TRANSPORT AIRCRAFT I

ICAS-88-2.2.1 Transonic Investigations on High Aspect Ratio Forward- and Aft-Swept Wings
T OHNUKI, N KAMIYA .......................................................... 216

ICAS-88-2.2.2 Design Philosophy of Long Range LFC Transports with Advanced Supercritical LFC Airfoils
W PFENNINGER, C S VERMURU .................................................. 223

ICAS-88-2.2.3 Aerodynamic Design and Integration of a Variable Camber Wing for a New Generation Long/Medium Range Aircraft
E GREFF ................................................................. 242
### OPTIMAL AIRCRAFT GUIDANCE

<table>
<thead>
<tr>
<th>ICAS-88-3.2.1</th>
<th>Open Loop Optimal Control of Multi-Engine Aircraft After One Engine Failure</th>
</tr>
</thead>
<tbody>
<tr>
<td>W JIANPEI, B KAUFMANN ..........................................................</td>
<td>255</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ICAS-88-3.2.2</th>
<th>Maximum Recovery Area in Approach for the Space Plane Hermes</th>
</tr>
</thead>
<tbody>
<tr>
<td>F JOUHAUD .................................................................................</td>
<td>269</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ICAS-88-3.2.3</th>
<th>On Minimum Time to Point, Maneuver, and Shoot: Singular Perturbation Feedback Law in Head-On-Pass Engagement</th>
</tr>
</thead>
<tbody>
<tr>
<td>H STALFORD, E HOFFMAN ..........................................................</td>
<td>275</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ICAS-88-3.2.4</th>
<th>Real-Time Guidance Laws for Three-Dimensional Interception</th>
</tr>
</thead>
<tbody>
<tr>
<td>M DO KHAC, H T HUYNH ..........................................................</td>
<td>287</td>
</tr>
</tbody>
</table>

### TURBULENCE MODELLING

<table>
<thead>
<tr>
<th>ICAS-88-4.2.1</th>
<th>Comparison of Differential Reynolds Stress and k-€ Turbulence Models for the Driven Cavity Problem</th>
</tr>
</thead>
<tbody>
<tr>
<td>R K COOPER, M WOLFSHEIN, M BEHNIA, G DE VAHL DAVIS, J REIZES ...............................................</td>
<td>297</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ICAS-88-4.2.2</th>
<th>Numerical Simulation of an Unsteady Turbulent Flow Past a Sudden Expansion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Y GAGNON, A GIOVANNINI ..........................................................</td>
<td>307</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ICAS-88-4.2.3</th>
<th>Efficient Numerical Simulation of Turbulent Flows</th>
</tr>
</thead>
<tbody>
<tr>
<td>E ARAD, M WOLFSHEIN ..........................................................</td>
<td>317</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ICAS-88-4.2.4</th>
<th>A Direct Aerofoil Performance Code Incorporating Laminar Separation Bubble Effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>F N COTON, R A McD GALBRAITH ...............................................</td>
<td>329</td>
</tr>
</tbody>
</table>

### COMPOSITES I

<table>
<thead>
<tr>
<th>ICAS-88-5.2.1</th>
<th>Delamination Buckling of Cylindrical Laminates</th>
</tr>
</thead>
<tbody>
<tr>
<td>G J SIMITSES, Z Q CHEN, S SALLAM ...........................................</td>
<td>339</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ICAS-88-5.2.2</th>
<th>Buckling of Edge-Damaged Cylindrical Composite Shells</th>
</tr>
</thead>
<tbody>
<tr>
<td>M SABAG, Y STAVSKY, J B GREENBERG .......................................</td>
<td>not available</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ICAS-88-5.2.3</th>
<th>Dynamic Bucking of Composite Plates and Columns Under Axial Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>T WELLER, J SINGER, H ABRAMOVICH, H RÖHRLE K JORDE ..................</td>
<td>not available</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ICAS-88-5.2.4</th>
<th>A Geometrically Nonlinear Theory of Shear Deformable Laminated Composite Plates and Its Use in the Postbuckling Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>L LIBRESCU, M STEIN ..........................................................</td>
<td>349</td>
</tr>
</tbody>
</table>
CERTIFICATION

ICAS-88-6.2.1 The FAA Designee System and its Contribution to Commercial Aviation  
F W ZAPPERT, R A PARKER ........................................ 360

ICAS-88-6.2.2 A Review of Requirements, Design Considerations and Resulting Experience for Extended Range Operation of Two-Engine Airplanes  
C F FICKEISEN .......................................................... 368

ICAS-88-6.2.3 International Regulations for the Safe Transport of Dangerous Goods  
J L COX ................................................................. 374

ICAS-88-6.2.4 Application of Physiological Measures to the Estimation of Pilot's Mental State  
R L HARRIS, A T POPE .............................................not available

MISSILE GUIDANCE AND CONTROL

ICAS-88-1.3.1 Optimal Guidance Law for a Bank-to-Turn Missile  
Y Di, Z Lan, X Gao, Y Wu, S Tang ..................not available

ICAS-88-1.3.2 Optimal Guidance for High Order and Acceleration Constrained Missile  
L RUSNAK, L MEIR .................................................... 383

ICAS-88-1.3.3 Real-Time Analysis of Microcomputer-Based Adaptive Flight Control Systems  
J CHEN, Y OU, Y WANG, J LIAN, C LU, S SU ................. 392

HYPERSONIC STRUCTURES AND MATERIALS

ICAS-88-2.3.1 Materials and Structures for Hypersonic Vehicles  
D R TENNEY, W B LISAGOR, S C DIXON ..................... 398

ICAS-88-2.3.2 Metallic Thermal Protection Concept for Aerodynamic Controlled Hypersonic Vehicles  
H GRALIENT, K KELLER ........................................... 416

ICAS-88-2.3.3 Application of Integrated Fluid-Thermal-Structural Analysis Methods  
A R WIETING, P DECHAUMPHAI, K S BEY, E A THORNTON,  
K MORGAN .......................................................... 424

ICAS-88-2.3.4 On the Determination of Heat Transfer in Structures of Re-Entry Vehicles  
C HABERLAND, A LAHRMANN, W NITSCHIE ...................not available
### AIRCRAFT CONTROL IN WINDSHEAR

<table>
<thead>
<tr>
<th>ICAS-88-3.3.1</th>
<th>On the Compensation of the Phugoid Mode Induced by Initial Conditions and Windshears</th>
<th>435</th>
</tr>
</thead>
<tbody>
<tr>
<td>L M B C CAMPOS</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ICAS-88-3.3.2</th>
<th>Optimization and Guidance of Landing Trajectories in a Windshear</th>
<th>445</th>
</tr>
</thead>
<tbody>
<tr>
<td>A MIELE, T WANG, W W MELVIN</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ICAS-88-3.3.3</th>
<th>Airbus Airborne Windshear System and Windshear Warning Design Process</th>
<th>463</th>
</tr>
</thead>
<tbody>
<tr>
<td>P CAMUS, J L BONAFE</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### PLANFORM OPTIMISATION

<table>
<thead>
<tr>
<th>ICAS-88-4.3.1</th>
<th>Turbulent Flow Measurement Behind the Wing/Body Junction of an Airbus A310 Model</th>
<th>468</th>
</tr>
</thead>
<tbody>
<tr>
<td>J OLSSON, J SZODRUCH</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ICAS-88-4.3.2</th>
<th>An Aerodynamic Comparison of Planar and Non-Planar Outboard Wing Planforms</th>
<th>481</th>
</tr>
</thead>
<tbody>
<tr>
<td>D A NAIK, C OSTOWARI</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ICAS-88-4.3.3</th>
<th>Flow Properties Associated with Wing/Body Junctions in Wind Tunnel and Flight</th>
<th>495</th>
</tr>
</thead>
<tbody>
<tr>
<td>A BERTELrud, J SZODRUCH, J OLSSON</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### COMPOSITES II

<table>
<thead>
<tr>
<th>ICAS-88-5.3.1</th>
<th>Large Deflections of Laminated Composite Plates and Shells</th>
<th>506</th>
</tr>
</thead>
<tbody>
<tr>
<td>R SCHMIDT</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ICAS-88-5.3.2</th>
<th>Dynamic Stability of Transversely Isotropic Viscoelastic Flat Plates</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>L LIBRESCU, N K CHANDIRAMANI</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ICAS-88-5.3.3</th>
<th>Optimization of Conical Anisotropic Shells</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>G V VASILIEV, G N ADAM</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### UNSTEADY AERODYNAMICS - NONVISCID MODELLING

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Authors</th>
<th>Pages</th>
</tr>
</thead>
<tbody>
<tr>
<td>ICAS-88-6.3.1</td>
<td>Unsteady Transonic Flows Past Airfoils and Wings Using a Fast Implicit Godunov Type Euler Solver</td>
<td>A BRENNERIS, A EBRELE</td>
<td>not available</td>
</tr>
<tr>
<td>ICAS-88-6.3.2</td>
<td>Thickness Effects in the Unsteady Aerodynamics of Interfering Lifting Surfaces</td>
<td>L P RUIZ-CALAVERA, W GEISSLER</td>
<td>514</td>
</tr>
<tr>
<td>ICAS-88-6.3.3</td>
<td>Unsteady Supersonic Flow Computations for Arbitrary Three-Dimensional Configurations</td>
<td>D D LIU, P C CHEN, P GARCIA-FOGEDA</td>
<td>524</td>
</tr>
</tbody>
</table>

### AIR TRAFFIC CONTROL

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Authors</th>
<th>Pages</th>
</tr>
</thead>
<tbody>
<tr>
<td>ICAS-88-1.4.1</td>
<td>ATSAM (Air Traffic Simulation Analysis Model) A Simulation-Tool to Analyze En-Route Air Traffic Scenarios</td>
<td>A HÜRMANN</td>
<td>545</td>
</tr>
<tr>
<td>ICAS-88-1.4.2</td>
<td>Flight Simulations on MLS-Guided Interception Procedures and Curved Approach Path Parameters</td>
<td>L J J ERKELENS</td>
<td>554</td>
</tr>
<tr>
<td>ICAS-88-1.4.3</td>
<td>Approach Flight Guidance of a Regional Air Traffic Aircraft Using GPS in Differential Mode</td>
<td>T JACOB</td>
<td>566</td>
</tr>
<tr>
<td>ICAS-88-1.4.4</td>
<td>In-Flight Inertial Guidance Alignment</td>
<td>D GOSHEN-MESKIN, I Y BAR-ITZHACK</td>
<td>575</td>
</tr>
</tbody>
</table>

### MODERN PROPELLER AERODYNAMICS

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Authors</th>
<th>Pages</th>
</tr>
</thead>
<tbody>
<tr>
<td>ICAS-88-2.4.1</td>
<td>From Single Rotating Propfan to Counter Rotating Ducted Propfan Propeller/Fan Characteristics</td>
<td>M LECHT</td>
<td>578</td>
</tr>
<tr>
<td>ICAS-88-2.4.2</td>
<td>Single and Contra-Rotation High Speed Propellers: Flow Calculation and Performance Prediction</td>
<td>P W C WONG, M MAINA, C R FORSEY, A J BOCCI</td>
<td>589</td>
</tr>
<tr>
<td>ICAS-88-2.4.3</td>
<td>From Single-Rotating Propfan to Counter-Rotating Ducted Propfan Propeller/Fan Characteristics</td>
<td>P SCHIMMING</td>
<td>not available</td>
</tr>
<tr>
<td>ICAS-88-2.4.4</td>
<td>Experimental and Numerical Study of Propeller Wakes in Axial Flight Regime</td>
<td>D FAVIER, A ETTOUIL, C MARESCA, C BARBI</td>
<td>602</td>
</tr>
</tbody>
</table>
DYNAMICS AND FATIGUE

ICAS-88-3.4.1 In-Flight Processing of Aircraft Fatigue Loads from Aerodynamic Parameters
D BARUCH, A BERKOVITS not available

ICAS-88-3.4.2 Fatigue Life Improvement of Thick Sections by Hole Cold Expansion
J Y MANN, P W BEAVER, J G SPARROW 617

ICAS-88-3.4.3 The Use of Static Analysis and the Stress Modes Approach as an Engineering Oriented Procedure for Calculating the Response of Aeronautical Structures to Random Excitation
G MAYMON 626

ICAS-88-3.4.4 Quadrilateral Coons Surface Shell Finite Element with Discrete Principal Curvature Lines
T Q YE, Y ZHAO 631

AERODYNAMIC DESIGN NUMERICAL METHODS

ICAS-88-4.4.1 Aerodynamic Optimization
K -W BOCK not available

ICAS-88-4.4.2 Subsonic Aerodynamic Prediction of Shuttle-Like Configurations Using Nonlinear Vortex-Lattice Method
D ALMOSNINO, J ROM 638

ICAS-88-4.4.3 Computational Aerodynamic Design Concepts for Futuristic Air Combat
S C GUPTA 644

ICAS-88-4.4.4 Navier-Stokes Computation of High-Speed Wing Flow
A RIZZI, C ERIKSSON not available

VORTEX FLOWS - VISCOUS EFFECTS

ICAS-88-5.4.1 Investigations on the Vorticity Sheets of a Close-Coupled Delta-Canard Configuration
H -C OELKER, D HUMMEL 649

ICAS-88-5.4.2 Study of Three-Dimensional Effects of Vortex Breakdown
M D SALAS, G KURUVILA 663

ICAS-88-5.4.3 Numerical and Experimental Determination of Secondary Separation at the Leeward Side of a Delta Wing in Compressible Flow
E M HOUTMAN, W J BANNINK 673
<table>
<thead>
<tr>
<th>Conference</th>
<th>Title</th>
<th>Authors</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>ICAS-88-5.4.4</td>
<td>Investigation of Flow Over Cavity-Blunt Body Combination at Supersonic Speed</td>
<td>O H Rho, D H Lee, J H Kim, S J Kim</td>
<td>681</td>
</tr>
<tr>
<td>HYPersonic Vehicle Design and Propulsion</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ICAS-88-1.5.1</td>
<td>Sänger II, A Hypersonic Flight and Space Transportation System</td>
<td>D E Koelle</td>
<td>687</td>
</tr>
<tr>
<td>ICAS-88-1.5.2</td>
<td>Air Breathing Combined Engines for Space Transportation Systems</td>
<td>A LARDELLIER, M POULIQUEN</td>
<td>694</td>
</tr>
<tr>
<td>ICAS-88-1.5.3</td>
<td>Driving Mechanisms in Unstable Ramjet Combustors</td>
<td>U G Hedge, D Reuter, B T Zinn</td>
<td>701</td>
</tr>
<tr>
<td>INLETS AND NOZZLES</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ICAS-88-2.5.1</td>
<td>New Guide for Accurate Navier-Stokes Solution of Two-Dimensional External Compression Inlet with Bleed</td>
<td>C K Forester, E Tjonneland</td>
<td>709</td>
</tr>
<tr>
<td>ICAS-88-2.5.2</td>
<td>Numerical Prediction of Flow Entrainment Around a V/STOL Aircraft in Ground Effect</td>
<td>C M Milford</td>
<td></td>
</tr>
<tr>
<td>ICAS-88-2.5.3</td>
<td>Investigation of the Pressure Distribution in 2D Rocket Nozzle with Mechanical System for TVC</td>
<td>T Dragović, B Jojić, Z Stefanović</td>
<td>719</td>
</tr>
<tr>
<td>EMERGING MATERIALS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ICAS-88-3.5.1</td>
<td>The Design of Aerospace Materials for the Future</td>
<td>C J Peel, R Moreton</td>
<td>724</td>
</tr>
<tr>
<td>ICAS-88-3.5.2</td>
<td>Emerging Materials Technologies for Future Aero Gas Turbines</td>
<td>A Hirst</td>
<td></td>
</tr>
<tr>
<td>ICAS-88-3.5.3</td>
<td>Some Novel Test Methods for, and Associated Problems of, Mechanical Strength Characterisation of Engineering Ceramics</td>
<td>G R Esoam, G Syers</td>
<td>744</td>
</tr>
</tbody>
</table>
VORTEX FLAPS

ICAS-88-4.5.1 Effectiveness of Combination of Apex and Leading-Edge Vortex Flap on a 74 Degree Delta-Wing or Without Trailing-Edge Flap
T D HSING, K X SHEN, Z F WANG, W H GUO, F G ZHUANG ................................. 749

ICAS-88-4.5.2 The Behaviour and Performance of Leading-Edge Vortex Flaps
D G ELLIS, J L STOLLERY .................................................. 758

ICAS-88-4.5.3 Control-Configured Vortex Flaps - A Feasibility Study
D M RAO ..............................................................not available

UNSTEADY AERODYNAMICS - VISCOUS MODELLING

ICAS-88-5.5.1 Viscous/Inviscid Interaction Procedure for High-Amplitude Oscillating Airfoils
W GEISSLER, I W CARR, T CEBECI ................................. 766

ICAS-88-5.5.2 Time-Consistent Computation of Transonic Buffet Over Airfoils
P GIRODROUX-LAVIGNE, J C Le BALLEUR ....................... 779

ICAS-88-5.5.3 Application of Unsteady Aerodynamic Methods for Transonic Aeroelastic Analysis
W WHITLOW .......................................................... 788

TRANSPORT AIRCRAFT II

ICAS-88-1.6.1 Transegession Investigations of Helicopter Dynamics
K SZUMAŃSKI ......................................................... 797

ICAS-88-1.6.2 The Aerodynamic Development of the Fokker 100
E OBERT ........................................................... 807

ICAS-88-1.6.3 Evolution of the LAVI Fighter Aircraft
S TSACH, A PELED ................................................... 827

ICAS-88-1.6.4 Design Evolution for a New Regional Airliner
J SPINTZYK, H KROJER ...........................................not available
GAS TURBINE TECHNOLOGY

ICAS-88-2.6.1 3D Flow Computations in a Centrifugal Compressor
With Splitter Blade Including Viscous Effect Simulation
V MILLOUR ...................................................... 842

ICAS-88-2.6.2 Detailed Measurements of the Flow in the Vaned
Diffuser of a Backswept Transonic Centrifugal Impeller
Ch FRADIN .................................................. 848

ICAS-88-2.6.3 Aerodynamic Response of Multi-State Blade
Rows
S FLEETER ..............................................not available

ICAS-88-2.6.4 Optical Diagnostic for Air Breathing Engines
Y LEVY, Y M TIMNAT ................................. 855

SYSTEMS EVALUATION

ICAS-88-3.6.1 Flight Evaluation of the ATTAS Digital Fly-By-Wire/
Light Flight Control System
D HANKE, H -H LANGE ................................. 866

ICAS-88-3.6.2 An Intelligent Fiberoptic Data Bus for Fly-By-Light
Applications
L C MANOHARAN, S MUTHUVEL ....................... 877

ICAS-88-3.6.3 Digital Electronics on Small Helicopter Engines
K J HICKS ............................................... 880

ICAS-88-3.6.4 Engine Control – A New High Accuracy Pressure Sensor
J PASCAL, H BARNY, H FIMA .............................. 886

CFD METHODS - I

ICAS-88-4.6.1 Accuracy Versus Convergence Rates for a Three
Dimensional Multistage Euler Code
E TURKEL .................................................. 892

ICAS-88-4.6.2 An Artificial Viscosity Model and Boundary Condition
Implementation of Finite Volume Methods for the Euler Equations
L WANG, F ZHUANG ........................................ 898
Numerical Simulation of Transonic Wing Flows using a Zonal Euler / Boundary-Layer / Navier-Stokes Approach
M A ZCHMATZ, F MONNOYER, K M WAKIE

Numerical Simulation of 2-D Turbulent Flow Fields With Strong Separation
W FRITZ
VOLUME II

TRANSPORT AIRCRAFT III

ICAS-88-1.7.1  The Designer's Impact on Commercial Aircraft Economics  
A L JACOBSON, D G MURPHY ........................................... 945

ICAS-88-1.7.2  Influence of EFCS-System Failures on Structural Design of Modern Transport Aircraft  
M BESCH ..........................................................not available

ICAS-88-1.7.3  Sensitivity Analysis and Multidisciplinary Optimization for Aircraft Design: Recent Advances and Results  
J SOBIESZCZANSKI-SOBIESKI ........................................ 953

ICAS-88-1.7.4  High Speed Commercial Transport Study Status Report  
M MACKINNON .......................................................not available

ULTRALIGHTS AND SAILPLANES

ICAS-88-2.7.1  The Calculation of Aerodynamic Forces on Flexible Wings of Agricultural Aircraft  
T GAUSZ .................................................. 965

ICAS-88-2.7.2  Aerodynamic and Structural Design of the Standard Class Sailplane ASW-24  
L M M BOERMANS, G WAIBEL ........................................ 969

ICAS-88-2.7.3  Man Powered Aircraft - State of the Art 1987  
G M LILLEY, P G FIELDING ........................................not available

ICAS-88-2.7.4  Flight Mechanical Analysis of Procedure Turns in Agricultural Aviation  
I LOVRO .......................................................not available
## BOUNDARY LAYER CONTROL

ICAS-88-3.7.1 **Flight and Windtunnel Investigations on Boundary Layer Transition at Reynolds Numbers up to 10^7**  
K R HORSTMANN, A QUAST, G REDEKER  
979

ICAS-88-3.7.2 **Experimental Study of the Behaviour of NACA 0009 Profile in a Transonic LEPU Configuration**  
J P BONNET, J DELVILLE, J LEMAY  
987

ICAS-88-3.7.3 **Turbulent Boundary Layer Manipulation in Zero Pressure Gradient**  
E COUSTOLS, J COUSTEIX  
999

ICAS-88-3.7.4 **Laminar Flow Control Leading Edge Systems in Simulated Airline Service**  
R D WAGNER, D V MADDALON, D F FISHER  
1014

## CFD METHODS II

ICAS-88-4.7.1 **A Parallel Algorithm of AF-2 Scheme for Plane Steady Transonic Potential Flow with Small Transverse Disturbance**  
S-Y LI, Q-W LIAO, D-J LUO  
1024

ICAS-88-4.7.2 **The Embedded Grid-Concept and TSP Methods Applied to the Calculation of Transonic Flow About Wing/Body/Nacelle/Pylon-Configurations**  
W DIEGIAN, S G HEDMAN  
1029

ICAS-88-4.7.3 **Multigrid Computation of Transonic Flow About Complex Aircraft Configurations, using Cartesian Grids and Local Refinement**  
B EPSTEIN, A L LUNTZ, A NACHSHON  
1038

ICAS-88-4.7.4 **Towards a General Three-Dimensional Grid Generation System**  
L G TYSKLL, S G HEDMAN  
1047

## AEROELASTICITY I

ICAS-88-5.7.1 **Research and Application in Aeroservoelasticity at the NASA Langley Research Center**  
J ABEL, T E NOLL  
1059

ICAS-88-5.7.2 **Aircraft Aeroelasticity and Structural Dynamics Research at the NASA Langley Research Center—Some Illustrative Results**  
R V DOGGETT JR, F W CAZIER JR  
1072
ICAS-88-5.7.3  Optimization of Nonlinear Aeroelastic Tailoring Criteria
F ABDI, H IDE, V J SHANKAR, J S SOBIESKI .............. 1083

ICAS-88-5.7.4  Aeroelasticity and Structural Optimization of Rotor Blades with Swept Tips
P P FRIEDMANN, R CELI ......................... 1092

METALLIC ALLOYS

ICAS-88-6.7.1  Behaviour of Aluminum-Lithium Alloys in Typical Aircraft Structural Applications
J C EKVALL, D J CHELLMAN ......................not available

ICAS-88-6.7.2  Alloy Design, Microstructure and Mechanical Properties of Superlight High Stiffness Aluminium-Lithium Materials
M PETERS, W BUNK ................................ 1109

ICAS-88-6.7.3  Ni18, A new High Strength, Damage Tolerant PM Superalloy for Turbine Discs Application
A WALDER, M MARTY, J L STURDEL, E BACHELET,
J H DAVIDSON, J F STOHR ...................... 1120

MEASUREMENT AND CRASHWORTHINESS

ICAS-88-1.8.1  A System for Measuring, Recording and Processing Flight Test Data
J T M VAN DOORN, P J H M MANDERS,
O VAN TEUNENBROEK ...................... 1127

ICAS-88-1.8.2  Non-Destructive Methods Applied to Aviation Equipment Testing in Service
J LEWITOWICZ .................................. 1145

ICAS-88-1.8.3  Application of a Flight Performance Advisory System to the F/A-18 Aircraft
M J FRIEDMAN ......................not available

ICAS-88-1.8.4  Damage Development in Composite Materials During Fatigue, Impact and Hygrothermal Loading
I H J M VERPOEST, M G T WEVERS ..............not available

XVI
ADVANCES AVIONICS

ICAS-88-2.8.1 The Design, Development and Integration of the Complex Avionics Systems
P SCHIRLE .......................................... 1155

ICAS-88-2.8.2 Optimal Integration of Inertial Sensor Functions for Flight Control and Navigation
U KROGMANN ........................................not available

ICAS-88-2.8.3 Central Fault Display Systems
F VAUVERSIN, J P POTOCKI DE MONTALK .................. 1164

ICAS-88-2.8.4 Fit and Forget Avionics
T G HAMILL ........................................not available

WIND TUNNEL TESTING

ICAS-88-3.8.1 Some New Test Results in the Adaptive Rubber Tube Test Section of the DFVLR Gottingen
A HEDDERGOTT, E WEDEMEYER ......................... 1172

ICAS-88-3.8.2 Application of a Flexible Wall Testing Technique to the NASA Langley 0.3-m Transonic Cryogenic Tunnel
S W D WOLF .......................................... 1181

ICAS-88-3.8.3 Blockage Corrections at High Angles of Attack in a Wind Tunnel
P A GILI, D M PASTRONE, F B QUAGLIOTTI, E BARBANTINI ................................. 1192

ICAS-88-3.8.4 Cryogenic Wind Tunnels for High Reynolds Number Testing
R A KILGORE, P L LAWING ............................... 1199

CFD APPLICATIONS TO AIRCRAFT DESIGN

ICAS-88-4.8.1 NASA - The First Year
F R BAILEY, P KUTLER ................................. 1210

ICAS-88-4.8.2 Recent Developments and Industrial Applications of Euler- and Navier-Stokes-Solvers
B WAGNER, W SCHMIDT ................................not available

ICAS-88-4.8.3 An Efficient Method for Computing Transonic and Supersonic Flows About Aircraft
G VOLPE, A JAMESON ................................... 1224

ICAS-88-4.8.4 Managing CFD in Industry
R H WICHEMeyer ........................................ 1237

XVII
ICAS-88-5.8.1 A320 Full Scale Structural Testing for Fatigue and Damage Tolerance Certification of Metallic and Composite Structure
B BRANDECKER, R HILGERT
1244

ICAS-88-5.8.2 Summary of the Kfir Fatigue Evaluation Program
E REINBERG, A BROT
1257

ICAS-88-5.8.3 Space Shuttle Orbiter Windshield Bird Impact Analysis
K S EDELSTEIN, R E McCARTY
1267

ICAS-88-5.8.4 Multi-Mode GVT/FEM Correlation
S SIEGEL, V K GUPTA
1275

ICAS-88-6.8.1 The Application and Improvement of "Wall Pressure Signature" Correction Method for the Tunnel Wall Interference
J GUIQING
1291

ICAS-88-6.8.2 Analysis of Fluctuating Pressure on a Nose-Cylinder Body Measured in a Transonic Wind Tunnel
M EBIHARA, Y AIHARA
not available

ICAS-88-6.8.3 Unsteady Motion of Vortex-Breakdown Positions on Delta Wings
H PORTNOY
1299

ICAS-88-1.9.1 Design of Higher Bandwidth Model Following for Flight Vehicle Stabilization and Control
F HENSCHEL, G BOUWER
1304

ICAS-88-1.9.2 Phase II Flight Simulator Mathematical Model and Data-Package, Based on Flight Test and Simulation Techniques
A M H NIEUWPOORT, J H BREEMAN, M BAARSPUL
J A MULDER
1311

ICAS-88-1.9.3 Sensitivity of Reduced Flight Dynamic Model Depending on Elasticity of Aircraft Structure
J JANKOVIĆ
1328

XVIII
PROPELLER NOISE

ICAS-88-2.9.1  Predicting the Noise of Counter-Rotating Propellers
                J M CAILLEAU  ........................................  not available

ICAS-88-2.9.2  Analysis of the Transmission of Sound into the Passenger Compartment of a Propeller Aircraft Using the Finite Element Method
                P GÖRANSSON, P DAVIDSSON  .........................  1334

ICAS-88-2.9.3  The Ultralight Aeroplane - A "Pain in the Air" or an Environmentally Acceptable Flight Vehicle?
                H HELLER, W DOBRZYNSKI, H DAHLEN  ...............  1342

AIRCRAFT STABILITY AND CONTROL

ICAS-88-3.9.1  The Study of Global Stability and Sensitive Analysis of High Performance Aircraft at High Angles-of-Attack
                H GAO, Z D HE Z Q ZHOU  ..............................  1356

ICAS-88-3.9.2  Determination of Departure Susceptibility and Centre of Gravity Limitations for Control Augmented Aircraft
                M MEDINA, M SHAHAF  ..................................  1364

ICAS-88-3.9.3  Aerodynamic Design of a Manual Aileron Control for an Advanced Turbo-Prop Trainer
                O L P MASEFIELD  ....................................  1374

LOW SPEED FLOW

ICAS-88-4.9.1  Experimental Investigation of the Complex 3-D Flow Around a Body of Revolution at Incidence
                G IUSO, M ONORATO, M S OGGIANO, S DE PONTE, B YUZHIANG, Z XIAODI  .........................  1382

ICAS-88-4.9.2  The Flight Performance of an RPV Compared with Wind Tunnel and Theoretical (CFD) Results
                J L STOLLERY, D J DYER  ............................  1392

ICAS-88-4.9.3  Some Types of Scale Effect in Low-Speed, High-Lift Flows
                D S WOODWARD, B C HARDY, P R ASHILL  ...............  1402
VOXER FLOWS - N/S EULER EQUATIONS

**ICAS-88-5.9.1** Aerodynamic Applications of an Efficient Incompressible Navier-Stokes Solver
P -M HARTWICH, C -H HSU, J M LUCKRING, C H LIU ................... 1417

**ICAS-88-5.9.2** Basic Analysis of the Flow Fields of Slender Delta Wings Using the Euler Equations
S SCHERR, A DAS ............................................. 1428

**ICAS-88-5.9.3** Modeling of Vortex Dominated Flowfields in the Euler Formulation
K D LEE, S A BRANDT ........................................ 1437

DAMAGE MECHANICS

**ICAS-88-6.9.1** Stress Intensity Factor of Three Dimensional Crack at the Edge of a Hole
M OORE .......................................................... 1451

**ICAS-88-6.9.2** The Calculation of Energy Release Rate Components Using the Coupled Strain Energy
F WEINSTEIN .................................................... 1461

**ICAS-88-6.9.3** Axisymmetrical Response by a Penny-Shaped Interface Crack in Multi-Layered Composites
X MA, Z ZOU, W HUANG, C SHAO .............................. 1466

**ICAS-88-6.9.4** Impact of Carbon Fibre Composites
J MORTON ........................................................ not available

OPTIMAL DESIGN

**ICAS-88-1.10.1** Controlled Non-Conforming Finite Elements and Data Base as Approach to the Analysis of Aircraft Structure
Z BOJANIČ, M JOSIFOVIĆ ................................. 1472

**ICAS-88-1.10.2** Optimal Design of Large Laminated Structures
R I WATKINS .................................................. 1480

**ICAS-88-1.10.3** Efficient Procedures for the Optimization of Aircraft Structures with a Large Number of Design Variables
U -L BERKES, J WIEDEMANN ................................. 1487

**ICAS-88-1.10.4** Variation of Anisotropic Axes Due to Multiple Constraints in Structural Optimization
D W MATHIAS, G HORNUNG, H RÖHRLE ....................... 1498
### AIRCRAFT POWER PLANT CONTROL

**ICAS-88-2.10.1** Mathematical Model of a Turbo-Fan-Engine with Real-Time Capabilities  
R BROCKHAUS ........................................not available

**ICAS-88-2.10.2** Toward More Effective Redundancy in Digital Gas Turbine Engine Controls  
K ROBINSON ........................................not available

**ICAS-88-2.10.3** A Turbofan System Using a Nonlinear Precompensator and a Model - Following Riccati - Feedback  
H SOLTER ..............................................1505

**ICAS-88-2.10.4** Propulsion Interface Unit (PIU) Controller on PW1120/DEEC Re-Engined P4 Aircraft  
I FRISCH, D IVerson, E T Jonneland .................1511

### TRANSONIC FLOW

**ICAS-88-3.10.1** The Cause and Cure of Periodic Flows at Transonic Speeds  
J GIBB ................................................1522

**ICAS-88-3.10.2** Calculation and Measurement of Transonic Flows Over Aerofoils with Novel Rear Sections  
P R ASHILL ............................................1531

**ICAS-88-3.10.3** Experience in Application of Active Vibration Control Technology to a Wind Tunnel Model and to Flying Airbus  
K KOENIG ..............................................1542

**ICAS-88-3.10.4** Transonic Magnus Force on a Finned Configuration  
M RINGEL, A SEGINER ................................1553

### AEROELASTICITY II

**ICAS-88-4.10.1** Flutter Calculation of Flutter Models for JAS 39 Gripen  
V J E STARK .............................................1559

**ICAS-88-4.10.2** Three Dimensional Flow Simulation with Application to Aeroelastic Analysis  
J L F AZEVEDO ........................................1570

**ICAS-88-4.10.3** Design and Analysis of a High Speed Composite Material Wing Flutter Model  
A P N SUTHERLAND .....................................1580

**ICAS-88-4.10.4** Orthogonalisation: A Tool for Improved Test Data  
D M WILSON ............................................1591
COMPOSITES IV

ICAS-88-5.10.1 Advanced Composite Development for Large Transport Aircraft
R D WILSON .......................................................... 1600

ICAS-88-5.10.2 Composite Secondary and Primary Structures for Pilatus Aircraft. Experience from the Development and Considerations for Future Applications
V DORER, K WIESSLER ............................................. 1605

ICAS-88-5.10.3 New Developments in ARALL Laminates
L B VOGELSAANG, J W GUNNINK, D CHEN,
G H J J ROEBROEKS, A VLOT .................................. 1615

ICAS-88-5.10.4 Randome Technology
M NATTER, H-W SCHRODER, W SCHAER ......................... 1634

DESIGN OPTIMISATION AND CAD/CAM

ICAS-88-1.11.1 Integrated CAE-Application of a CAD/CAM System Through the Extensive Use of Interfaces
L THIEME .......................................................... 1641

ICAS-88-1.11.2 Aircraft Configuration Analysis/Syntesis Expert System: A New Approach to Preliminary Sizing of Combat Aircraft
R BARGETTO, B MAZETTI, G GARBOLINO ...................... 1645

ICAS-88-1.11.3 Computer-Aided Structural Optimisation of Aircraft Structures
P BARTHOLOMEW, H WELLEN ..................................... 1650

ICAS-88-1.11.4 Computational Design and Efficiency Optimization of Agricultural Airplanes
R STAUFENBIEI, T SCHERER, I STEIGER ....................... 1664

LIFE CYCLE AND RELIABILITY

ICAS-88-2.11.1 The Review of Progress on the Development of Life Cycle Costing Techniques as an Aid to Procurement and Modification Decisions
D W DANIEL ......................................................... 1677
**ICAS-88-2.11.3** A Reliability and Maintainability Prediction Method for Aircraft Conceptual Design  
V C SERGHIDES, J P FIELDING ........................................ 1683

**ICAS-88-2.11.4** Mechanical Failure Analysis as a Means of Improving Quality Assurance in the Aeronautical Industry  
M KENDLER, E MAKEVET ............................................. 1693

**VOXETE FLOWS - EXPERIMENTAL**

**ICAS-88-3.11.1** Canard / LEF Design for a Multi-Mission Fighter Aircraft  
M SHEPSHELOVICH, D ABoudI, E BAHRAv,  
B EBSTEIN, A LUNTZ ............................................. 1700

**ICAS-88-3.11.2** Vortical Flows Around Delta Wings in Unsteady Maneuvers and Gusts  
R STAUFENBIEL, B STECKEMETZ, S ZHU ................. 1714

**ICAS-88-3.11.3** Quantitative Flow Field Visualization in Wind Tunnels by Means of Particle Image Velocimetry  
J KOMPENHANS .................................................. 1725

**ICAS-88-3.11.3** Vortex Breakdown - Investigations by Using the Ultrasonic-Laser-Method and Laser-Sheet Technique  
R H ENGLER .................................................... 1731

**ICAS-88-3.11.4** Effects of Maneuver Dynamics on Drag Polars for an Aircraft with Automatic Wing Camber Control  
J W HICKS, B J MOULTON ........................................ 1738

**ENGINE/AIRFRAME INTEGRATION**

**ICAS-88-4.11.1** Low Speed Wind Tunnel Investigation of Propeller Slipstream Aerodynamic Effects on Different Nacelle/Wing Combinations  
I SAMUELSSON .................................................. 1749

**ICAS-88-4.11.2** Very High Bypass Ratio Engines for Commercial Transport Propulsion  
H SKAVDAHL, R A ZIMBRICK, J L COLEHOUR,  
G P SALLEE .................................................... 1766

**ICAS-88-4.11.3** Aerodynamic Instability Definitions and Their Use in Illustrating Nonrecoverable Stall Technology  
W G STEENKEN ................................................. 1773

**ICAS-88-4.11.4** Engine Surge Simulation in Wind-Tunnel Model Inlet Ducts  
K W LOTTER, P -A MACKRODT, R D SCHERBAUM ............ 1773
ICAS-88-5.11.1 Molding and Joining of Continuous Fiber-Reinforced Polyetheretherketone (PEEK)
G KEMPE, H KRAUSS .................................. 1789

ICAS-88-5.11.2 Stability of Simply Supported Sandwich Panels
Having Anisotropic Faces Under Uni-Axial Compressive Load
R J FRITZ, C DIAMANTAKOS, M A STONE ......................not available

ICAS-88-5.11.3 NDE of Composites Using Lamb Waves: Theory
and Experiment
V DAYAL, V K KINRA ......................................not available

ICAS-88-5.11.4 The Measurement and Comparison of Material and
Structural Damping in Metal-Matrix Composites
V K KINRA, G G WREN, A K RAY ............................not available
RESERVE PAPERS

ICAS-88-1.1R  Icing Degree Moderate to Severe: If and Where in Clouds
              H-E HOFFMAN .................................................. 1801

ICAS-88-1.5R1 Rarefield-Flow Pitching Moment Coefficient Measure-
              ments of the Shuttle Orbiter
              R C BLANCHARD, E W HINSON ............................. 1813

ICAS-88-1.10R Integrated Structural-Aerodynamic Design
              Optimization
              R T HATKEA, P J KAO, B GROSSMAN, D POLEN
              J SOBIESZCZANSKI-SOBIESKI ............................. 1820

ICAS-88-3.7R  Transonic Shock Boundary Layer Interaction with
              Passive Control
              S RAGHUNATHAN, S T MCILWAIN .......................... 1826

ICAS-88-3.8R  Wind Tunnel Blockage Corrections for Bluff
              Bodies with Lift
              G N V RAO, J DEENADHAYALAN .......................... 1835

ICAS-88-3.11R Flow Field Visualization Study on a 65° Delta Wing
              K A BUTEFISCH ............................................. 1845

ICAS-88-4.5R  Non Linear Aerodynamics of Delta Wings in
              Combined Pitch and Roll
              J ER-EL, D SATER, D WEIHS ............................. 1852

ICAS-88-4.6R1 Boundary Conditions for Viscous Incompressible
              Two-Dimensional Flows
              A DAGAN, R ARIELI ....................................... 1859

ICAS-88-4.9R1 Flow Separation on Yawed Cylinders: Pressures and
              Wake Surveys
              S DE PONTE, A ABBÀ P BORSA .......................... 1866

ICAS-88-4.9R2 Body Wing Tail Interference Studies of High
              Angles of Attach and Variable Reynolds Numbers
              K HARTMANN, V KANAGARAJAN, D NIKOLITSCHEK ......... 1871

ICAS-88-5.7R  Effect of Aerodynamic Heating on Deformation of
              Composite Cylindrical Panels in a Gas Flow
              V BIRMAN, C W BERT, I ELISHAKOFF  .................. 1886

THE INTERNATIONAL COUNCIL OF THE AERONAUTICAL SCIENCES ............ LXXVIII

ICAS PROGRAM PLANNING COMMITTEE .................................. LXIX

ICAS MEMBER ASSOCIATIONS .......................................... LXX

ICAS ASSOCIATE MEMBERS ............................................. LXXIV

XXV