56th American Helicopter Society Annual Forum 2000

Virginia Beach, Virginia, USA
2 – 4 May 2000

Volume 1 of 3

ISBN: 978-1-61782-937-6

Printed from e-media with permission by:

Curran Associates, Inc.
57 Morehouse Lane
Red Hook, NY 12571

Some format issues inherent in the e-media version may also appear in this print version.

Copyright© (2000) by the American Helicopter Society
All rights reserved.

Printed by Curran Associates, Inc. (2011)

For permission requests, please contact the American Helicopter Society
at the address below.

American Helicopter Society
217 N. Washington Street
Alexandria, VA 22314-2538

Phone (703) 684-6777
Fax: (703) 739-9279

staff@vtol.org

Additional copies of this publication are available from:

Curran Associates, Inc.
57 Morehouse Lane
Red Hook, NY 12571 USA
Phone: 845-758-0400
Fax: 845-758-2634
Email: curran@proceedings.com
Web: www.proceedings.com

TABLE OF CONTENTS

VOLUME 1

ACOUSTICS

Initial Tiltrotor Aeroacoustic Code (TRAC) Predictions for the XV-15 Flight Vehicle and Comparison with Flight Measurements 1
Prichard, Devon S.

Prediction and Validation of Helicopter Descent Flyover Noise 18
Janakiramram, Ram D.; Khan, Hamza

Structure of the Blade Pressure Fluctuations Generated by Helicopter Rotor Blade-Wake Interaction 36
Bouchet, Eric; Rahier, Gilles

Validation of a Helicopter Noise Prediction System 51
Kondo, Natsuki; Nakamura, Hideaki; Aoyama, Takashi; Saito, Shigeru; Yamakawa, Eiichi

AERODYNAMICS

Correlation of Experimental Measurements with a Finite-State Ground Effect Model 64
Iboshi, N.; Xin, Hong; Prasad, J. V. R.; Peters, David A.; Nagashima, T.

The Effect of a Preceding Blade on the Orthogonal Vortex Interaction 74
Doolan, C. J.; Coton, F. N.; Galbraith, R. A.

Experimental/Numerical Evaluation Of Integral Trailing Edge Flaps For Helicopter Rotor Applications 81
Hassan, Ahmed A.; Noonan, Kevin W.; Straub, Friedrich K.

On the Aerodynamic Stability of Helicopter Rotor Wakes 100
Bhagwat, Mahendra J.; Leishman, J. Gordon

Stereoscopic PIV Measurements in the Wake of a Hovering Rotor 120
Martin, B. Preston; Leishman, J. Gordon; Pugliese, Gregory J.; Anderson, Steven L.

AERODYNAMICS II

Application of Three-Component PIV to a Hovering Rotor Wake 139
Lourenco, Luiz; Abrego, Anita I.; Wadcock, Alan J.; Heineck, James T.; Yamauchi, Gloria K.

Background Oriented Stereoscopic Schlieren Applied to a Helicopter in Flight 155
Raffel, M.; Meier, G. E. A; Richard, Hugues

Dynamic Stall Control via Airfoil Thickness Variation 162
Yee, Kwanjung; Lee, Dong-Ho; Joo, Wandon

Navier-Stokes prediction of helicopter rotor performance in hover including aero-elastic effects 170
Philippe, Beaumier; Enrico, Chelli; Pahlke, Ing. Klausdieter

Rotorcraft Interactional Aerodynamics Calculations with Fast Vortex/Fast Panel Methods 181
Boschitsch, Alexander H.; Quackenbush, Todd R.; Wachspress, Daniel A.

A Study on Rotor Tip-Vortex Pairing Phenomena by using Time-Marching Free-Wake Method 202
Chung, Ki Hoon; Na, Seon Uk; Jeon, Wan Ho; Lee, Duck Joo

AIRCRAFT DESIGN

The Flight Test Results of the New Observation Helicopter (XOH-1) 214
Kataoka, Toshiyuki; Fujigaki, Tsutomu; Aiba, Masayuki; Tsukiji, Tadashi

Simultaneous Assessment of Requirements and Technologies in Rotorcraft Design 226
Mavris, Dimitri N.; Baker, Andrew P.; Schrage, Daniel P.

AIRCRAFT DESIGN II

The Cougar, a Multi-Purpose Helicopter With High Performance and Large Potential Of Evolution 236
Cabrit, Philippe

Effects of Higher Harmonic Control on Rotor Performance 240
Celi, Roberto; Cheng, Rendy P.; Theodore, Colin R.
Flight Testing Kaman Aerospace Corporation's Composite Main Rotor Blade 253
Wei, Fu-Shang (John); Gallagher, Frank
A New Concept in Supercritical Drive Systems for Advanced Rotorcraft 263
Brunken, J. E.
Some Design Issues for the Optimisation of the Compound Helicopter Configuration 277
Orchard, Matthew; Newman, Simon

AVIONICS AND SYSTEMS

Component Obsolescence Management for Rotorcraft Avionics Equipment 290
Wasson, James W.
Incorporation of Enhanced Infrared Countermeasures on the CV-22 Osprey 300
Frederking, Douglas D.
Landing Period Designator Visual Helicopter Recovery Aide; Theory and Real-Time Application 307
Applebee, Terrence; James, David; Manning, Anthony; Ferrier, Bernard
Lightning on Full Composite Helicopter using Fly by Wires 327
Poncon, Marc; Gineste, Pierrre Nicolas; Chatain, Bertrand; Enjalbert, Vincent
System Engineering Approach Leading to a Successful Functional Configuration Audit for the V-22 Osprey Integrated Avionics Suite 335
Berkowitz, Neil
The War Fighter's Decision Aid 341
Dehate, Evan; Bodenhorn, Chris; Patteson, Steve

CRASH SAFEY

Development of Numerical Tools for the Crash Pediction of Composite Helicopter Structures 349
Delsart, David; Kohlgruber, Dieter; Deletombe, Eric; Johnson, Alastair F.
Finite Element Simulation of a Full-Scale Crash Test of a Composite Helicopter 363
Jackson, Karen E.; Lyle, Karen H.; Fasanella, Edwin L.
Full-Scale Crash Test of the Sikorsky Advanced Composite Airframe Program Helicopter 381
Boitnott, Richard L.; Jackson, Karen E.; Kellas, Sotiris; Fasanella, Edwin L.
Impact Testing and Simulation of a Crashworthy Composite Fuselage 401
Jackson, Karen E.; Fasanella, Edwin L.
An Improved Concept for a Crashworthy Cyclic Control Stick 417
Carnell, Brian L.; Garman, James C.
Rotary Wing Aircraft Water Impact Test and Analyses Correlation 429
Wittlin, Gil; Smith, Michael R.; Schultz, Mike

CREW STATION & HUMAN FACTORS

Alternative Course of Action Training for Helicopter Pilots 443
Walters, Brett; Shively, R. Jay; Martin, Lynne; Dodd, Robert; Archer, Rick
Comparison of a Manned Helicopter Simulation to a Computer-Based Human Performance Model 449
Nadler, Itsik; Brickner, Michael; Burdick, Mark; Shively, R. Jay; Silbiger, Jacob
Conclusions From Active Centerstick Evaluations in the V-22 Simulator 454
Einthoven, Pieter
Duet- A Modern MMI Design and Software Generation Tool for the NH90 Avionics 466
Goelzenleuchter, Horst; Otte, Joerg
Flight Demonstration of an Associate System: A Rotorcraft Pilot™s Associate Example 476
Robertson, Greta
Human Factors in the Design of a Glass Cockpit for the SH-2G (A) 491
Bordett, Harvey; Hoagland, Michael; Chicoine, Russel; Henshke, Mark

DYNAMICS

Current Status of U.S. Army Comprehensive Helicopter Analysis System 499
Sopher, Robert; Lim, Joon W.; Lee, C. S.; Panda, Brahmanda; Cassarino, Sebastian J.

Design, Development, and Flight Testing Of The Active Vibration Control System for The Sikorsky S-92 511
Millott, Thomas A.; Goodman, Robert K.

VOLUME 2

Full-Scale Demonstration of Higher Harmonic Control for Noise and Vibration Reduction on the XV-15 Rotor 519
Kitaplioglu, Cahit; Betzina, Mark; Nguyen, Khanh
Hover Testing of the NASA/Army/MIT Active Twist Rotor Prototype Blade 532
Wilbur, Matthew L.; Shin, Sangjoon; Cesnik, Carlos E.; Wilkie, W. Keats; Yeager, William T.
Stability Analysis of Comprehensive Rotorcraft Models 546
Nikishkov, Yuri G.; Bauchau, Olivier A.

DYNAMICS II

Active-Passive Hybrid Optimization of Rotor Blades with Trailing Edge Flaps 554
Wang, Kon-Well; Zhang, Jianhua; Smith, Edward
AH64D Apache Longbow Dynamic Airframe Testing 571
Weisenburger, Richard; Collison, Thomas; Sundar, Ray; Meyyappa, Murugappan
Correlation of V-22 Dynamic Loads Model to V-22 Aircraft Drop Test 584
McCown-McClintick, Barbara; Orr, Stanley
An Electromagnetic Flap Actuator for Individual Blade Control 603
Gaudreau, Marcel P. J.; Hawkey, Timothy J.; Fink, David A.; Wellman, Brent; Ormiston, Robert A.
Practical Examples of New Technologies in Dynamics as Applied to Eurocopter Products 615
Cardin, Veronique
Wind Tunnel Testing of a Mach-Scaled Rotor Model with Trailing-Edge Flaps 627
Koratkar, Nikhil A.; Chopra, Inderjit

FLIGHT SIMULATION

Helicopter Simulation Modeling Techniques for Meeting FAA AC 120-63 Level D Qualification Requirements 651
Smith, Steven J.
Host, a General Helicopter Simulation Tool for Germany and France 660
Benoit, Bernard; Kampa, Konstantin; Dequin, Andre-Michael; Grunhagen, Wolfgang; Basset, Pierre-Marie; Gimonet, Bernard
Optimization of Rotorcraft Flight in Engine Failure 682
Chen, Robert T. N.; Jhemi, Ali A.; Carlson, Eric B.; Zhao, Yiyuan J.
Rapid Prototyping and Evaluation of Control Systems Designs for Manned and Unmanned Applications 696
Mettler, Bernard; Mansur, Hossein M.; Montegut, Michael; Frye, Michael
Simulation of Rotorcraft Response Including the Possibility of the Vortex-Ring State 715
Peters, David A.; Wasileski, Bryan
Structured Modeling Applied to Flexible Helicopter Rotor Blades 725
Katz, Amnon; Palmer, Kyle
Vortex Generated Rotor Wake Model for Real-Time Simulation 739
Graham, Kenneth S.; Katz, Amnon

FLIGHT SIMULATION II

Approaches for Improving the Rotor Load Identification Technology 752
Schrage, Daniel P.; Liu, Shoushen; Higman, Jerry P.
The Development of a Variable Fidelity, Multi-Disciplinary Comanche Flight Simulation 766
Higman, Jerry P.; Packard, Charlie; He, Chengjian; Saberi, Hossein-Ali; Tang, Kei
Dynamic Interface Analysis of the Embarked Operation of the CL-327 'Guardian' Unmanned Air Vehicle 778
Tessier, Claude; Langlois, Robert G.

Hazard Analysis and Hardware-in-the-Loop Flight Simulation Test of FBW Research Helicopter 793
Shirasaya, Hideki; Ito, Takeo; Tomio, Takeshi; Ikeuchi, Kenzo; Kubo, Yoshiharu; Taira, Takaaki; Sudo, Ikuo
Simulation for Roton, A Recoverable Spacecraft with Tip Rocket Rotor 800
Siebold , Peter; Choi , Keeyoung; Sarigul-Klijn , Marti; Saberi, Hossein-Ali

HANDLING QUALITIES

Assessment of Handling Qualities for the Shipborne Recovery Task-ADS-33 (Maritime) 814
Carignan, Stephan J. R. P.; Gubbels, Arthur W.; Ellis, Kris
Comparison Between Experimental and Predicted Isolated Helicopter Rotor Transfer Functions for Unsteady Inputs on the Controls 825
Gimonet, Bernard; Eglin, Paul; Roth, German; Grunhagen, Wolfgang; Hellard, Sebastien; Tchen Fo, Frederic; Desopper, Andre
Evaluation of Aeronautical Design Standard-33 Using a UH-60A Black Hawk 842
Blanken, Chris L.; Cicolani, Luigi; Sullivan, Christopher C.; Arterburn, David R.
Benefits of Advanced Control Technology 875
Handcock, Andy; Howitt, Jeremy; Lane, Rob; Johns, Sara Louise; Charlton, Malcolm
System Identification and Control System Design for The Burro Autonomous Uav 885
Colbourne, Jason D.; Tischler, Mark B.; Cicolani, Luigi; Chad, Frost R.; Lamontagne, Troy; Tomashofski, Chris
MV-22 Handling Qualities Flight Test Summary 909
Klein, Gary; Roberts, Bradford; Seymour, Chris

HANDLING QUALITIES II

An Advanced Fly-By-Wire Flight Control System Designed for Airborne Research-Concept to Reality 910
Hindson, William S.; Dones, Fernando; McCorvey, Donald L.; Dryfoos, James B.
Development and Evaluation of Precision Approach Profile in IMC for Civil Rotorcraft 930
Kumamoto, Yuichi; Kimura, Kazuhiro; Fujimoto, Hajime; Amano, Takaki; Kobayashi, Keiji
Estimating Ship Deck Aerodynamic Influences on the V22 Using Modified Inverse Simulation Techniques 942
Host, Christian T.
Flight Dynamic Simulation with Refined Aerodynamics and Flexible Blade Modelling 959
Theodore, Colin R.; Celi, Roberto
Safety Concept of Technology Demonstrator ACT/FHS 975
Butter, Ulrich; Pausder, Heinz-Jurgen; Steinmaier, Frank
A Study to Improve Flying Qualities in IMC for Civil Helicopters 981
Amano, Koji; Kimura, Kazuhiro; Ozeki, Shuichiro; Tanase, Shoji; Sudo, Ikuo
UH-60 Black Hawk Disturbance Rejection Study for Hover/Low Speed Handling Qualities Criteria and Turbulence Modeling 989
Tischler, Mark B.; Blanken, Chris L.; Labows, Steven J.

HEALTH & USAGE MONITORING SYS. (HUMS) I

Experimental Analysis of Mast Lifting and Bending Forces on Vibration Patterns Before and After Pinion Reinstallation in an OH-58 Transmission Test Rig 1004
Huff, Edward M.; Tumer, Irem Y.; Barszcz, Eric; Lewicki, David G.; Decker, Harry; Zakrajsek, James J.
Experimental Analysis of Steady-State Maneuvering Effects on Transmission Vibration Patterns Recorded in an AH-1 Cobra Helicopter 1014
Huff, Edward M.; Barszcz, Eric; Tumer, Irem Y.; Dzwonczyk, Mark; McNames, James
Helicopter Engine Cycle Usage Validation with a Health and Usage Monitoring System 1026
Pettigrew, James L.
Honeywell Corrosive Environment Monitor (CEM) for Health and Usage Monitoring 1039
Crane, Robert; Lewis, Steve; Jiracek, Ron; Moffatt, John G.; Malver, Fred; Volk, John; Menon, Sunil; Busch, Darryl; Gibson, Paul

VOLUME 3

Rotor System Health Monitoring Using Coupled Rotor-Fuselage Vibration Analysis 1044
Yang, Mao; Chopra, Inderjit; Haas, David J.
Vibration Separation and Diagnostics of Planetary Geartrains 1057
Samuel, Paul D.; Pines, Darryll J.

HEALTH & USAGE MONITORING SYS. (HUMS) II

Joint Advanced Health and Usage Monitoring Systems (JAHUMS) Advanced Concept Technology Demonstration (ACTD) 1067
Haas, David J.; Baker, Treven; Spracklen, David; Schaefer, Carl G.
MH-47E Structural Usage Monitoring System (SUMS) Fleet Demonstration Results 1078
Robeson, Eric C.
Realizing an Expandable Open HUMS Architecture 1085
Hess, Robert; Chaffee, Mark; Page, Randal; Roseberry, Keith
Rotor Tuning Using Vibration Data Only 1092
Hayden, Richard; Ventres, Sam
Technology Insertion in Health and Usage Monitoring Systems: An Integrator's Perspective 1099
Edsall, Alexander
Toward Development of an Intelligent Rotor System 1109
Ghoshal, Anindya; Harrison, Jeremy; Sundaresan, Mannur J.; Schulz, Mark J.; Pai, P. Frank

INTG. MANUFACTURING PROCESS & CONTROL TECH.

Advanced Machining Techniques On Titanium Rotor Parts 1126
Tlusty, Jiri; Smith, Scott; Schueller, John; Leigh, Edmund
Efficient Machining of Titanium Rotorcraft Components 1145
Fitzsimmons, Mark; El-Wardany, Tahany; Fitzptrick, Peter
Material Technologies for a Composite Helicopter Main Rotor Blade 1159
Jouin, Pierre; Rice, Brian P.; Lee, William C.
Technology Selection Process for Thin Wall Machining and Very Efficient Machining of Titanium 1166
Varanay, Stephen
Wing Torque Box Bond Assembly Of The BA 609 1179
Carlson, David

MILITARY OPERATIONS

Comanche Helicopter in the Digital Battlefield 1190
Farr, Donald B.
Tiltrotor for Army Special Operations Forces (ARSOF) 1206
Werthman, Robert W.; Simon, Carl J.

PREVIEW OF TECHNICAL SESSIONS AT THE INTERNATIONAL POWERED LIFT CONFERENCE

Conceptual Aircraft Design -- Lost Art or Science? 1210
Wilson, Sam B.; Fila, Leo
Micro Air Vehicles --- THE New Military Capability 1215
Schnepf, Sharon

PRODUCT SUPPORT

Computer Aided Non Destructive Inspection and Disposition (CANDID): Overview and Benefits of Automating NDI of Rotorcraft 1219
Hazen, Steve P.

Product Support Alternative for the Apache Helicopter System 1229
Nenninger, Gary S.

PROPULSION

Advanced Rotorcraft Transmission II - Demonstrator Design 1250
Henry, Zachary S.; Ames, Eric C.
The Aviation Turbine Engine Diagnostics System (ATEDS), An Effective Tool for Army Maintenance 1260
Moffatt, John G.
Common Engine Program 1263
Butler, Gary L.
Design and Development of a Pylon Conversion Actuation System for a Civil Tilt Rotor Aircraft 1268
Hart, Kenneth E.; Fenny, Carlos A.
High Performance Barrier Filtration Systems 1287
Scimone, Michael J.; Frey, Steve; Flesher, Daniel

SS DAMAGE TOLERANCE AND AGING ROTORCRAFT STRUCTURES

A Special Session on Damage Tolerance and Aging Rotorcraft Structures 1310
Marquet, Thierry; Lincoln, Jack; Barndt, Gene; Everett, Richard; Summers, Harold; Harrison, Charles; Dickson, Bill; Rotenberger, Kevin; Eastin, Robert

SS JOINT TRANSPORT ROTORCRAFT

Enabling Technologies Critical for the Joint Transport Rotorcraft (JTR) 1317
Rosen, Kenneth M.; Dinuccio, Jacqueline M.
Overarching Rotorcraft Commonality Assessment 1327
Usry, Floyd; Preston, John; Ferrell, David

SS VERTICAL FLIGHT CONCEPTS FOR THE NEXT 50 YEARS

Future Directions in Rotorcraft Technology at Ames Research Center 1334
Ormiston, Robert A.; Aiken, Edwin W.; Young, Larry A.
Technologies for Future Vertical Flight Concepts 1355
Lemont, Harold E.
VTOL Hybrid Airship Review 1364
Grady, Walter T.; Lindenbaum, Bernard

STRUCTURE AND MATERIALS

Attaining Fatigue and Damage Tolerance Life Goals In Helicopter Bushed Assemblies 1377
Reid, Len.
Fatigue Strength and Damage Tolerance of Thin-Walled Riveted Structures with Cold-worked Holes 1383
Franada, B. G.; Restis, J.; Reddy, D. J.; Reid, Len.; Krasnowski, B. R.
Material Qualification Methodology for a Helicopter Composite Main Rotor Blade 1395
Ruffner, Daniel; Jouin, Pierre
Practical Application of Damage Tolerance and Flaw Tolerance to the Design and Management of Rotor Structure 1402
Tritsch, Douglas E.; Adams, David O.
Research on Practical Damage Tolerance Methods for Rotorcraft Structures 1412
Rousseau, Carl; Harrison, Charles; Cronkhite, James D.; Tritsch, Douglas E.; Weiss, William; Harrison, Charles; Rousseau, Carl

STRUCTURE AND MATERIALS II

Analysis of Quasi-Unbalanced Structures Exhibiting Intrinsically Smart Behavior 1425
Pastore, C.; Bogdanovich, A; Greenhalge, S.; Garfinkle, M.

A Closed-Form Solution For Laminated Composite Beams 1430
Rovenski, Vladimir; Rand, Omri
Monotonic and Fatigue Response of Co-cured Composite Lap Joints with Modified Interfaces 1441
Coates, C.; Armanios, E. A.
Structural Damage Detection Using a Scanning Laser Vibrometer 1455
Pai, P. Frank; Schulz, Mark J.; Jin, Si

TEST 7 EVALUATION

Apache Longbow Aerobatics 1465
Lee, Richard A.; Metzger, Mark; Lamborn, Lyndon C.
Bell Eagle Eye TrŒ911x Œ Tiltrotor Unmanned Aerial Vehicle:Recent Developments, Autoland Integration, and Flight Test Demonstrations 1473
Settle, Ben; Wise, Thomas
Flight Validation of V-22 Structural Design Approach 1487
Kisor, Ron
Methodology for In-Flight Tracking of Helicopter Rotor Blades Using Shape Memory Alloy Actuators 1499
Epps, Jeanette J.; Chopra, Inderjit
Neural Network Based Low Airspeed Sensor 1515
McCool, Kelly; Morales, Miguel A.; Haas, David J.
RAH-66 Comanche Tethered Hover 1526
Kothmann, Bruce D.
Scaled Model Jettison Tests of External Stores During Helicopter Autorotation 1540
Gates, Alfred; Wei, Fu-Shang John; Adrezin, Ronald; Yarlett, Amanda

ADDITIONAL PAPER

A Comparison of Active Sidestick and Conventional Inceptors for Helicopter Flight Envelope Tactile Cueing 1548
Whalley, Matthew S.; Hindson, William S.; Thiers, George G.
Author Index