

# **77th Annual Vertical Flight Society Forum and Technology Display (FORUM 77)**

The Future of Vertical Flight

Online  
10-14 May 2021

Volume 1 of 4

ISBN: 978-1-7138-3001-6

**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.  
These proceedings were created from a scanned original document, and are the best quality available.**

Copyright© (2021) by Vertical Flight Society  
All rights reserved.

Printed with permission by Curran Associates, Inc. (2021)

For permission requests, please contact Vertical Flight Society  
at the address below.

Vertical Flight Society  
2701 Prosperity Ave, Suite 210  
Fairfax, VA 22031  
USA

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

[www.vtol.org](http://www.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: 845-758-2633  
Email: [curran@proceedings.com](mailto:curran@proceedings.com)  
Web: [www.proceedings.com](http://www.proceedings.com)

# TABLE OF CONTENTS

## VOLUME 1

### ACOUSTICS I

THE DEVELOPMENT OF A COAXIAL ACOUSTICS TEST SYSTEM FOR ROTOR NOISE .....	1
<i>R. Zahirudin, D. Weitsman, E. Greenwood, J. Palacios</i>	
AEROACOUSTIC CHARACTERIZATION OF OPTIMUM HOVERING ROTORS USING ARTIFICIAL NEURAL NETWORKS.....	15
<i>C. Thurman, N. Zawodny</i>	
EVTOL ROTOR NOISE IN GROUND EFFECT .....	25
<i>B. Smith, R. Healy, F. Gandhi, A. Lyrantzis</i>	
EXPERIMENTAL AND COMPUTATIONAL INVESTIGATION OF STACKED ROTOR BROADBAND NOISE IN HOVER .....	39
<i>G. Jacobellis, R. Singh, C. Johnson, J. Sirohi</i>	
AEROACOUSTIC MEASUREMENTS FROM THE AERODYNAMIC AND ACOUSTIC ROTORPROP TEST (AART) IN THE NATIONAL FULL-SCALE AERODYNAMICS COMPLEX (NFAC) 40- BY 80-FOOT WIND TUNNEL.....	52
<i>J. Stephenson, N. Schatzman, B. Cheung, N. Zawodny, D. Sargent, B. Cim</i>	
AERODYNAMIC AND ACOUSTIC DESIGN OF THE JOBY AVIATION EVTOL PROPELLER.....	67
<i>J. Bain, G. Mikic, A. Stoll</i>	
EVTOL ROTOR NOISE STUDY USING COMPREHENSIVE MODELING COMBINED WITH ACOUSTIC ANALYSIS .....	77
<i>C. He, C. Ware, S. Yang, J. Kim, J. Baeder, Y. Jung</i>	

### ACOUSTICS II

PREDICTION OF RACER'S LATERAL ROTOT NOISE USING THE CONCERTO CHAIN .....	100
<i>G. Reboul, J. Bailly, L. Rottmann</i>	
AEROACOUSTIC ANALYSIS OF ASYMMETRIC LIFT-OFFSET HELICOPTER IN FORWARD FLIGHT.....	112
<i>P. Arias, Y. Jung, J. Baeder</i>	
AN ASSESSMENT OF MULTI-COPTER NOISE IN EDGEWISE FLIGHT .....	127
<i>B. Smith, F. Gandhi, A. Lyrantzis</i>	
INVESTIGATION OF EMPIRICAL ROTOR BROADBAND PREDICTION USING CFD BOUNDARY LAYER PARAMETERS EXTRACTION.....	140
<i>Y. Jung, J. Baeder, C. He</i>	
A NEW DISTRIBUTED ELECTRIC PROPULSION AIRCRAFT SIMULATION TOOL FOR COUPLED FLIGHT DYNAMICS, FREE WAKE, AND ACOUSTIC PREDICTIONS .....	152
<i>Z. Gan, B. Mukherjee, J.-P. Theron, M. Botre, K. Brentner, E. Greenwood, J. Horn</i>	

ACOUSTICS ANALYSIS OF A QUIET HELICOPTER FOR AIR TAXI OPERATIONS .....	171
<i>S. Li, S. Lee</i>	
ACOUSTIC PREDICTIONS FOR THE SIDE-BY-SIDE AIR TAXI ROTOR IN HOVER .....	185
<i>J. Sagaga, S. Lee</i>	

### **ADVANCED VERTICAL FLIGHT I**

STRUCTURAL DESIGN AND AEROMECHANICAL ANALYSIS OF A NEXT-GENERATION MARS HEXACOPTER ROTOR.....	198
<i>C. Chi, R. Lumba, A. Datta</i>	
AXIAL DESCENT OF VARIABLE-PITCH MULTIROTOR CONFIGURATIONS: AN EXPERIMENTAL AND COMPUTATIONAL STUDY FOR MARS DEPLOYMENT APPLICATIONS` .....	221
<i>M. Veismann, S. Wei, S. Conley, L. Young, J. Delaune, J. Burdick, M. Gharib, J. Izraelevitz</i>	
DRAGONFLY – AERODYNAMICS DURING TRANSITION TO POWERED FLIGHT.....	240
<i>J. Cornelius, T. Opazo, S. Schmits, J. Langelaan, B. Villar, D. Adams, L. Rodovskiy, L. Young</i>	
THE FUTURE OF ROTORCRAFT AND OTHER AERIAL VEHICLES FOR MARS EXPLORATION.....	254
<i>L. Young, P. Lee, E. Aiken, G. Briggs, G. Pisanich, S. Withrow-Maser, H. Cummings</i>	
CONCEPTUAL DESIGN OF THE DRAGONFLY LANDER.....	275
<i>J. Langelaan, S. Schmitz, D. Adams, R. Lorenz</i>	

### **ADVANCED VERTICAL FLIGHT II**

SCALING INVESTIGATION OF FEASIBILITY AND HOVER ENDURANCE FOR ELECTRIC QUASI-QUADROTOR CONFIGURATIONS.....	286
<i>B. Venepalli, D. Dancila</i>	
REDISTRIBUTED ALLOCATION FOR FLIGHT CONTROL FAILURE ON A COAXIAL HELICOPTER.....	296
<i>M. McKay, P. Vayalali, F. Gandhi, T. Berger, M. Lopez</i>	
FLIGHT DYNAMICS MODEL IDENTIFICATION OF A MESO-SCALE TWIN- CYCLOPTER IN HOVER .....	314
<i>C. Runco, M. Benedict</i>	
EXPERIMENTAL AND COMPUTATIONAL INVESTIGATION OF A UAV-SCALE CYCLOIDAL ROTOR .....	328
<i>J. Heimerl, A. Halder, M. Benedict</i>	
EXPERIMENTAL EVALUATION OF COAXIAL MICRO-UAS PROPELLERS.....	346
<i>M. Floros, H. Kang</i>	
SYSTEM IDENTIFICATION OF A THRUST-VECTORING, COAXIAL-ROTOR-BASED GUN-LAUNCHED MICRO AIR VEHICLE IN HOVER .....	356
<i>H. Denton, G. McCurdy, M. Benedict, H. Kang</i>	

### **ADVANCED VERTICAL FLIGHT III**

MACHINE LEARNING BASED APPROACH TO IMPROVE LOW-FIDELITY PREDICTIONS FOR A COMPOUND HELICOPTER .....	369
<i>G. Makkar, J.-P. Reddinger, F. Gandhi, F. Kopsaftopoulos</i>	
DUCT-WINGED INERTIAL BICOPTER: THEORY, DESIGN AND TESTING .....	387
<i>G. Gress</i>	
CONSIDERATIONS FOR ENABLING EXTREME UNMANNED AERIAL SYSTEMS THROUGH ADVANCED TECHNOLOGIES .....	395
<i>R. Singh, A. Bagai</i>	
DESIGNING A HIGH SPEED MORPHING ROTOR BLADE .....	407
<i>A. Kuczek, W. Zhao, Z. Chaudhry, F. Gandhi, D. Camp</i>	

### **AERODYNAMICS I**

WAKE UNSTEADINESS AND TIP VORTEX SYSTEM OF FULL-SCALE HELICOPTERS IN GROUND EFFECT .....	412
<i>C. Wolf, A. Weiss, C. Schwarz, J. Braukmann, S. Koch, M. Raffel</i>	
INVESTIGATION OF THE FLOW FIELDS OF COAXIAL STACKED AND COUNTER-ROTATING ROTORS USING PIV MEASUREMENTS AND URANS SIMULATIONS .....	432
<i>S. Platzer, M. Hajek, J. Rauleder, P. Mortimer, J. Sirohi</i>	
DEVELOPMENT OF SECONDARY VORTEX STRUCTURES IN ROTOR WAKES .....	455
<i>C. Schwarz, R. Brinkema, A. Bodling, M. Potsdam, C. Wolf, A. Gardner</i>	
AERODYNAMIC OPTIMIZATION OF THE SIZING AND BLADE DESIGNS OF HOVERING COROTATING COAXIAL ROTORS .....	475
<i>K. Chan</i>	
HOVER PERFORMANCE IN GROUND EFFECT PREDICTION USING A DUAL SOLVER COMPUTATIONAL METHODOLOGY .....	487
<i>A. Moushegian, M. Smith, G. Whitehouse, D. Wachspress</i>	
A COMPUTATIONAL INVESTIGATION OF SIDE-BY-SIDE ROTORS IN GROUND EFFECT .....	506
<i>R. Healy, J. McCauley, F. Gandhi, O. Sahni</i>	

### **AERODYNAMICS II**

TIME-RESOLVED STEREO PIV MEASUREMENTS OF A CYCLOROTOR IN HOVER .....	524
<i>A. Van Rooij</i>	
BOUNDARY LAYER TRANSITION MEASURED BY DIT ON THE PSP ROTOR IN FORWARD FLIGHT .....	545
<i>A. Gardner, A. Weiss, J. Heineck, A. Overmeyer, H. Spooner, R. Jain, C. Wolf, M. Raffel</i>	
PHYSICS OF BVI-INDUCED DYNAMIC STALL ON EQUIVALENT ONE-BLADED AND FOUR-BLADED ROTORS .....	556
<i>A. Grubb, M. Smith, R. Jain</i>	

INVESTIGATION OF THREE-DIMENSIONAL FLOW STRUCTURES ON A ROTATING WING USING A NOVEL ROTATING VELOCIMETRY TECHNIQUE .....	582
<i>A. Gururaj, M. Moaven, S. Morris, B. Thurow, V. Raghav</i>	

DOES SCATTER MATTER? IMPROVED UNDERSTANDING OF UH-60A WIND TUNNEL ROTOR MEASUREMENTS USING DATA-DRIVEN CLUSTERING AND CREATETM-AV HELIOS.....	593
<i>M. Ramasamy, R. Jain, T. Norman</i>	

CFD TURBULENCE TRANSITION MODELS VALIDATION FOR ROTORS IN UNSTEADY AXIAL AND FORWARD-FLIGHT CONDITIONS USING CREATETM-AV HELIOS.....	614
<i>R. Jain</i>	

RCAS, VVPM, AND PANEL COUPLING ENHANCEMENTS FOR INTERFERENCE AND DOWNLOAD PREDICTION.....	648
<i>J. Kim, M. Hasbun, H. Saberi, C. He, M. Bhagwat</i>	

### **AERODYNAMICS III**

HIGH-FIDELITY SIMULATION OF THE VOLOCOPTER-2X IN CRUISE FLIGHT .....	662
<i>S. Miesner, M. Kessler, E. Kramer, U. Schaferlein</i>	

SOLVING THE SHIP-ROTORCRAFT DYNAMIC INTERFACE PROBLEM USING LATTICE-BOLTZMANN AERODYNAMICS TWO-WAY COUPLED WITH BLADE ELEMENT BASED FLIGHT DYNAMICS.....	675
<i>J. Bludau, M. Hajek, J. Rauleder</i>	

HIGH-FIDELITY NUMERICAL INVESTIGATION OF DUCTED PROPELLER AERODYNAMICS/ACOUSTICS AND ADJOINT-BASED DESIGN OPTIMISATION .....	692
<i>T. Zhang, G. Barakos</i>	

S-97 RAIDER® WAKE-EMPENNAGE INTERACTION FLIGHT DATA AND CORRELATION.....	706
<i>P. Lorber, J. Zhao, P. Bowles, H. Xin</i>	

RECONSIDERING THE THEORY AND APPLICATION OF HELICOPTER MANEUVERABILITY' .....	722
<i>J. Tritschler, O. Juhasz, J. O'Connor, J. McCue, J. Holder</i>	

MODELING OF THE BLADE CROSSOVER INTERACTION USING MACHINE LEARNING.....	735
<i>K. Sharma, V. Surendran, Y. Yu, D. Huang, K. Brentner, P. Anusonti-Inthra</i>	

### **AIRCRAFT DESIGN I**

LIFT OFF OF H160 WITH BLUE EDGETM BLADE.....	749
<i>J.-F. Hirsch, C. Lanouette</i>	

## **VOLUME 2**

OPTIMISATION OF THE AH-64A BLADE PLANFORM BASED ON HIGH-FIDELITY CFD METHODS.....	755
<i>T. Fitzgibbon, M. Woodgate, G. Barakos</i>	

A COMPARISON OF HIGH-FIDELITY SIMULATION APPROACHES FOR EVTOL ROTOR FLOWS IN DESCENT CONDITIONS .....	767
<i>A. Chopra, J. McCauley, R. Healy, F. Gandhi, O. Sahn</i>	
HELICOPTER ROTOR BLADE MULTIPLE-SECTION OPTIMIZATION WITH PERFORMANCE CONSIDERATIONS .....	780
<i>L. Allen, J. Lim, R. Haehnel, I. Dettwiller</i>	
FAULT TOLERANT INDIVIDUAL BLADE ACTUATION SYSTEM.....	792
<i>J. Kopp</i>	
THE SEARCH FOR AN IDEAL BEARINGLESS MAIN ROTOR (BMR) DESIGN .....	803
<i>D. Schrage</i>	

## **AIRCRAFT DESIGN II**

PRELIMINARY DESIGN OF SEVERAL NEW KINDS OF MARTIAN AIRCRAFTS.....	815
<i>B. Lou, A. Xie, X. Yan, D. Zhang, P. Zhao, S. Zhu</i>	
MILITARY MISSION SUITABILITY ASSESSMENT OF EVTOL AIRCRAFT CONFIGURATIONS.....	820
<i>M. Scott</i>	
MULTIDISCIPLINARY TRIM ANALYSIS USING IMPROVED OPTIMIZATION, IMAGE ANALYSIS, AND MACHINE LEARNING ALGORITHMS.....	835
<i>T. Herrmann, R. Celi, J. Baeder</i>	
PRACTICAL CONCEPTUAL DESIGN OF QUIETER URBAN VTOL AIRCRAFT.....	859
<i>C. Silva, W. Johnson</i>	
MULTI-FIDELITY SURROGATE MODEL FOR INTERACTIONAL AERODYNAMICS OF A MULTICOPTER.....	880
<i>O. Pinti, A. Oberai, R. Healy, R. Niemiec, F. Gandhi</i>	

## **AVIONICS AND SYSTEMS**

INCREMENTAL DYNAMIC INVERSION FLIGHT CONTROL FOR THE ACT/FHS EC 135 HELICOPTER.....	891
<i>J. Bachler, P. Petit</i>	
DEEP LEARNING BASED OBSTACLE AWARENESS FROM AIRBORNE OPTICAL SENSORS .....	902
<i>M. Ammalladene-Venkata, O. Halbe, C. Seidel, C. Groitl, C. Stahl</i>	
MODEL PREDICTIVE APPROACH FOR SHORT-TERM COLLISION AVOIDANCE.....	913
<i>A. Dikarew</i>	
RUST FOR SAFE AND SECURE AVIONICS AND MISSION SYSTEM SOFTWARE.....	923
<i>M. Taylor, J. Ehlinger, J. Imig, M. De Otto</i>	
AIR VEHICLE/MISSION SYSTEM ARCHITECTURE (AV/MSA) INTERFACE DEFINITION (ID).....	939
<i>S. Simi, W. Jacobs</i>	

## **CRASH SAFETY**

CONTRIBUTION TO IMPROVEMENT OF HELICOPTER DITCHING CAPABILITY ACHIEVED WITHIN THE SARAH EUROPEAN RESEARCH PROJECT .....	950
<i>S. Halbout, B. Bouscasse, Y. Jus, A. Jullien, H. Prakash</i>	
SIMULATION OF LIFT PLUS CRUISE VEHICLE MODELS TO DEFINE A FULL-SCALE CRASH TEST CAMPAIGN .....	963
<i>J. Littell, J. Putnam, M. Cooper</i>	
INTEGRATED OCCUPANT SAFETY FOR URBAN AIR MOBILITY APPLICATIONS .....	982
<i>G. Olivares, M. Unger, L. Gomez, P. Van Hooijdonk, V. Robinson, D. Barsotti</i>	
SPINAL INJURY RISK ASSOCIATED WITH PERFORMANCE REQUIREMENTS FOR MILITARY ROTARY-WING SEATS .....	995
<i>E. Lafferty, N. Flath, V. Chancey, B. McEntire</i>	
DEVELOPMENT OF AN IMPROVED GUNNER SEAT RESTRAINT .....	999
<i>R. Podob, C. Van Druff</i>	

## **CREW STATIONS I**

INVESTIGATION AND EVALUATION OF A MULTIMODAL PILOT ASSISTANCE SYSTEM FOR HELICOPTER OPERATIONS.....	1006
<i>T. Martini, P. Mevenkamp, N. Peinecke, M. Jones, J. Schmidt</i>	
ASSESSMENT OF AUGMENTED OPERATOR'S MENTAL WORKLOAD WITH VISUAL ASSISTIVE TECHNOLOGY IN SIMULATED ROTORCRAFT PILOTING TASKS.....	1023
<i>C. Lu, H. Oh, B. Hatfield, R. Gentili, R. Celi, J. Blanco, A. Vanleer, J. Mohler</i>	
MODELLING THE INFLUENCE OF AUTONOMOUS SYSTEMS ON PILOT WORKLOAD DURING HELICOPTER OPERATIONS .....	1033
<i>S. Jennings, D. Gowanlock, P. Comeau, J. Robazza</i>	
DESIGNING FLIGHT SCENARIOS TO ELICIT PHYSIOLOGICAL RESPONSE AMONG AVIATORS DURING HIGH WORKLOAD ENVIRONMENTS .....	1056
<i>L. Randles, J. Gerstner, C. O'Brien, K. Feltman</i>	
VISUAL-GRAVITATIONAL INTERACTIONS FOR ALTITUDE PERCEPTION DURING MANUAL AND SUPERVISORY CONTROL .....	1063
<i>M. Godfroy-Cooper, J. Sarrazin, E. Bachelder, J. Miller, J. Denquin, B. Bardy</i>	
THE DESIGN OF PILOT CUEING FOR THE DEGRADED VISUAL ENVIRONMENT MITIGATION (DVE-M) SYSTEM FOR ROTORCRAFT.....	1082
<i>Z. Scoboszlay, J. Miller, M. Godfroy-Cooper, B. Davis, K. Feltman, R. Hartnett, D. Durbin, J. Hicks, J. Plitsch, C. Ott, E. Leatherbury, J. Carr, D. Waldman, B. Fujizawa, M. Whalley, M. Takahashi, C. Goerzen, G. Schulein, W. Harrington, N. Mielcarek, R. Subr</i>	
DEGRADED VISUAL ENVIRONMENT MITIGATION (DVE-M) PROGRAM, BUMPER RADAR OBSTACLE CUEING FLIGHT TRIALS 2020.....	1110
<i>J. Miller, M. Godfroy-Cooper, Z. Szoboszlay</i>	



## **CREW STATIONS II**

PREDICTION OF MOTION SICKNESS ONSET FOR VERTICAL LIFT APPLICATIONS.....	1141
<i>P. Petit</i>	
ANTHROPOMETRIC ACCOMMODATION AND ERGONOMICS IN THE MH-60S NEXTGEN GUNNERS SEAT .....	1151
<i>L. Basham, J. Blankenship, A. Koch</i>	
3D CONFORMAL PILOT CUEING FOR ROTORCRAFT SHIPBOARD LANDINGS: A TIME HORIZON PARAMETRIC STUDY .....	1159
<i>R. Walters, V. Comandur, K. Feigh</i>	
SUSTAINING PERFORMANCE AND VIGILANCE DURING EXTENDED UAS OPERATIONS .....	1168
<i>A. Kelley, A. Hayes, R. Mackie</i>	
DO WE NEED BIOMEDICAL INTERVENTIONS TO MAINTAIN CREW PERFORMANCE UNDER SUSTAINED ATTENTION?.....	1177
<i>K. Feltman, C. Mathews, A. Kelley, L. Randles</i>	

## **DYNAMICS I**

ROTOR-BODY COUPLED VIBRATION ANALYSIS OF A HIGH-SPEED LIFT OFFSET COAXIAL ROTOR.....	1186
<i>S. Hong, J. Bae, S. Jung, S. Hong, J.-S. Park</i>	
COMPARISON OF WIND TUNNEL TILT ROTOR LOADS OF TWO HUB TYPES UNDER DIFFERENT PYLON ANGLES WITH MULTIBODY DYNAMICS ANALYSES.....	1205
<i>J. Baggett, J. Shen, A. Kreshock</i>	
FABRICATION, TESTING, AND 3-D COMPREHENSIVE ANALYSIS OF SWEEP TIP TILT ROTOR BLADES .....	1219
<i>J. Sutherland, A. Datta</i>	
INDIVIDUAL BLADE CONTROL FOR COMPONENT LOAD ALLEVIATION USING A MODEL PREDICTIVE CONTROL FORMULATION.....	1241
<i>C. Mballo, J. Prasad</i>	
AEROELASTIC LOADS AND STABILITY OF SWEEP-TIP HINGELESS TILT ROTORS TOWARD 400 KNOTS FLUTTER-FREE CRUISE.....	1249
<i>S. Gul, A. Datta</i>	
IN SEARCH OF EXTREME LIMITS OF A COMPOUND HELICOPTER IN HIGH SPEED FLIGHT.....	1272
<i>S. Maurya, I. Chopra, A. Datta</i>	
CFD-CSD SUPPORT FOR ROTOR DESIGN IMPROVEMENT TO REDUCE VIBRATIONS.....	1287
<i>J. Zhao, N. Tuozzo, M. Brigley, R. Modarres, M. Monico, S. Mäkinen</i>	

## **DYNAMICS II**

IMPROVED HIGHER HARMONIC CONTROL ANALYSIS FOR HART-II ROTOR .....	1300
<i>B. Im, G. Kong, S. Kang, S. Park, H. Cho, S. Shin</i>	

AEROSERVOELASTIC TEST CAMPAIGN OF THE AW609 CIVIL TILT-ROTOR.....	1311
<i>C. Lilliu, M. Favale, G. Tovo, A. Trezzini, N. Donini, A. Haidar</i>	
ANALYSIS METHODS FOR GROUND RESONANCE IN PARTIAL GROUND CONTACT.....	1322
<i>R. Lojewski, C. Kessler</i>	
PERFORMANCE ADVANTAGES AND RESONANCE ANALYSIS OF A VARIABLE SPEED ROTOR USING GEOMETRICALLY EXACT BEAM FORMULATION.....	1332
<i>R. Chandrasekaran, D. Hodges</i>	
VIBRATION REDUCTION IN ROTORCRAFT USING CLOSED-LOOP ACTIVE FLOW CONTROL.....	1356
<i>R. Patterson, P. Friedmann</i>	
AN EXAMINATION OF AERODYNAMIC AND STRUCTURAL LOADS FOR A ROTOR BLADE OPTIMIZED WITH MULTI-OBJECTIVE GENETIC ALGORITHM.....	1372
<i>J. Lim</i>	
MODELING AND ANALYSIS OF PROPROTORWHIRL FLUTTER.....	1386
<i>H. Yeo, H. Kang, A. Kreshock</i>	

### **DYNAMICS III**

AW609 CIVIL TILTROTOR DRIVE TRAIN TORSIONAL STABILITY ANALYSIS AND CERTIFICATION TEST CAMPAIGN.....	1401
<i>A. Haidar, L. Belluomini, A. Trezzini</i>	
HOW BIG IS A LOCK NUMBER?.....	1409
<i>C. Seidel, D. Peters</i>	
A LOOK BACK ON FLAP-LAG STABILITY AFTER 50 YEARS.....	1415
<i>D. Peters, A. Bergantz</i>	
UH-60A AIRLOADS WORKSHOP SETTING THE STAGE FOR THE ROTORCRAFT CFD/CSD REVOLUTION.....	1423
<i>H. Yeo, R. Ormiston</i>	

### **EVTOL I**

PANEL-METHOD-BASED PATH PLANNING FOR EVTOL IN URBAN ENVIRONMENT.....	1466
<i>Z. Unal, I. Yavrucuk</i>	
ELECTROMECHANICAL MODELING AND TESTING OF A NOVEL ELECTRICALLY DRIVEN STACKED ROTOR SYSTEM.....	1474
<i>M. Asper, J. Sirohi, M. Ricci, G. Ong II</i>	
DEVELOPMENT OF “ARIA”, A COMPACT, ULTRA-QUIET PERSONAL ELECTRIC HELICOPTER.....	1486
<i>D. Coleman, A. Halder, F. Saemi, C. Runco, H. Denton, B. Lee, V. Subramanian, E. Greenwood, V. Lakshminaryan, M. Benedict</i>	
INTEGRATED MULTI-PHYSICS SIMULATION FOR EVTOL IN-FLIGHT ENERGY REGENERATION USING PIEZOAEROELASTIC POWER HARVESTERS AND 6DOF CONTROL.....	1513
<i>L. Gomez, F. Brenner, Z. Huang</i>	

## VOLUME 3

ANALYSIS OF BUS VOLTAGE SAG DURING HIGH BATTERY POWER OPERATIONS ON  
HYBRID ELECTRIC URBAN AIR MOBILITY VEHICLES ..... 1542  
*K. Collins, P. Currier, R. Anderson, R. Fernandes, J. Shivakumar, S. Lahaji*

POST-MOTOR-FAILURE PERFORMANCE OF A ROBUST FEEDBACK CONTROLLER FOR  
A UAM-SCALE HEXACOPTER..... 1553  
*M. Bahr, M. McKay, R. Niemiec, F. Gandhi*

### **EVTOL II**

MODELLING OF A HYBRID-ELECTRIC SYSTEM AND DESIGN OF LOAD-FOLLOWING  
CONTROL LAW ON HYBRID-ELECTRIC URBAN AIR MOBILITY POWER PLANTS ..... 1564  
*S. Lahaji, R. Anderson, P. Currier, K. Collins*

MULTI-ROTOR EVTOL FLIGHT SIMULATION AND ASSESSMENT UNDER  
ATMOSPHERIC TURBULENCE..... 1573  
*M. Bahr, U. Hebbbar, E. Ferede, F. Gandhi*

A CFD BASED METHOD TO MODEL AERODYNAMIC INTERACTIONS IN COMPLEX  
EVTOL CONFIGURATIONS FOR REALTIME AND MEDIUM FIDELITY SIMULATIONS ..... 1583  
*G. Mikic, J. Bevirt, A. Stoll, J. Bain*

DESIGN AND SIMULATION OF A NOVEL EVTOL AIRCRAFT “AM20” TO UNDERSTAND  
CHALLENGES IN CERTIFICATION AND FLIGHT TESTING ..... 1591  
*N. Umopathy, N. Gopalakrishnan, T. Wiederkehr*

### **HANDLING QUALITIES I**

EVALUATION OF A SLUNG LOAD CONTROL SYSTEM FOR PILOTED OFFSHORE  
WINCHING OPERATIONS..... 1605  
*T. Jusko, M. Jones*

SYNTHESIS AND PILOTED EVALUATION OF ADVANCED ROTORCRAFT RESPONSE-  
TYPES USING ROBUST SLIDING MODE CONTROL..... 1622  
*O. Halbe, T. Mehling, M. Hajek, M. Vrdoljak*

EFFECTS OF DISK LOADING ON HANDLING QUALITIES OF LARGE-SCALE,  
VARIABLE-RPM QUADCOPTERS ..... 1644  
*A. Walter, R. Niemiec, F. Gandhi*

IMPACT OF HANDLING QUALITIES ON MOTOR SIZING FOR MULTIROTOR AIRCRAFT  
WITH URBAN AIR MOBILITY MISSIONS..... 1653  
*S. Withrow-Maser, C. Malpica, K. Nagami*

LOAD ALLEVIATION CONTROL USING DYNAMIC INVERSION WITH DIRECT LOAD  
FEEDBACK..... 1676  
*M. Scaramal, U. Saetti, J. Horn*

HIGH-SPEED ROTORCRAFT PITCH AXIS RESPONSE TYPE INVESTIGATION ..... 1688  
*T. Berger, M. Tischler, J. Horn*

## **HANDLING QUALITIES II**

ROBUST FLIGHT CONTROL FOR A VALIDATED XV-15 MODEL.....	1708
<i>H. Yang, R. Morales</i>	
EVALUATION OF THE PHASE-AGGRESSION CRITERION FOR PIO DETECTION IN REAL-TIME .....	1719
<i>S. Fasiello, M. Jump, P. Masarati</i>	
DEVELOPMENT OF UH-72A SIMULATOR MODEL IN SUPPORT OF ADS-33 TRAINING .....	1729
<i>W. Geyer, B. Gordon, C. Mattei, D. Robinson</i>	
A THEORETICAL FRAMEWORK UNIFYING HANDLING QUALITIES, WORKLOAD, STABILITY, AND CONTROL .....	1744
<i>E. Bachelder, B. Aponso</i>	
PROBABILISTIC TECHNIQUES FOR PILOT-VEHICLE INTERACTION AND HANDLING QUALITIES ANALYSIS .....	1764
<i>J. Cooper, M. Devore, A. Reed, D. Klyde, C. Schulze</i>	
PILOT WORKLOAD AND PERFORMANCE ASSESSMENT FOR A COAXIAL-COMPOUND HELICOPTER AND TILTROTOR DURING AGGRESSIVE APPROACH.....	1781
<i>E. Bachelder, T. Berger, M. Godfroy-Cooper, B. Aponso</i>	

## **HUMS I**

MODEL-BASED FAILURE ANTICIPATION AND PREDICTIVE MAINTENANCE - A HELICOPTER LANDING GEAR APPLICATION.....	1792
<i>A. Rocher, R. Becquet, J.-C. Mare</i>	
DIRECT LOAD RECOGNITION AND DAMAGE ESTIMATION USING SUPERVISED LEARNING.....	1803
<i>C. Gallimard, K. Nikolajevic, J. Jouve, F. Beroul</i>	
PROBABILISTIC DAMAGE ESTIMATION FOR ROTORCRAFT CONDITION-BASED MAINTENANCE' .....	1815
<i>D. Musso, J. Rogers</i>	
PROGNOSTICS FRAMEWORK TO ENABLE A MAINTENANCE FREE OPERATING PERIOD .....	1827
<i>E. Dewind, R. Sopko</i>	
AN INVESTIGATION OF LEGACY VIBRATION CHECKS ON MODERN H-47 CHINOOK SYSTEMS VIA SEEDED FAULT TESTING .....	1836
<i>J. Hunt, T. Martin, T. Samper</i>	
PREDICTING A MAXIMUM STRESS USING MACHINE LEARNING AND PARAMETRIC FLIGHT DATA.....	1842
<i>M. Sweet, S. Forgerson, C. Demontfort</i>	
A MODEL FOR INFERRED GROSS WEIGHT USING HUMS DATA.....	1855
<i>E. Bechhoefer, T. Wells</i>	

## **HUMS II**

ON LEVERAGING NETWORK-WIDE INFORMATION FROM HOTSPOT SENSOR NETWORKS USING MULTI-OUTPUT PROCESS REGRESSION MODELS .....	1860
<i>A. Amer, F. Kopsaftopoulos</i>	
UNIFIED STATISTICAL FRAMEWORK FOR ROTOR FAULT DIAGNOSIS ON A HEXACOPTER VIA FUNCTIONALITY POOLED STOCHASTIC MODELS .....	1872
<i>A. Dutta, R. Niemiec, F. Kopsaftopoulos, F. Gandhi</i>	
EFFECT OF LOAD LIMITING CONTROL ON ROTORCRAFT MANEUVER PERFORMANCE AND COMPONENT DAMAGE GROWTH .....	1890
<i>A. Shah, C. Mballo, J. Prasad, J. Rimoli</i>	

## **HISTORY**

FLOYD CARLSON: THE LEGACY AND CONTRIBUTIONS OF ONE OF AMERICA'S GREATEST ROTARY WING TEST PILOTS.....	1898
<i>P. Fardink</i>	
HISTORY OF THE VERTOL AIRCRAFT CORPORATION, 1956 – 1960.....	1927
<i>K. Bartie</i>	
A BRIEF HISTORY OF VTOL IN-FLIGHT AIRCREW SYSTEMS .....	1945
<i>J. Virasak, E. Pinero Jr.</i>	
PRESERVE, EDUCATE & INSPIRE – FOUNDING THE AMERICAN HELICOPTER MUSEUM & EDUCATION CENTER.....	1967
<i>R. Beggs</i>	

## **MANUFACTURING AND TECHNOLOGY**

DEVELOPMENT OF MAGNESIUM LASER POWDER BED FUSION TO MANUFACTURE LIGHT-WEIGHT COMPONENTS FOR VERTICAL LIFT APPLICATIONS .....	1997
<i>M. De Smit, A. Paesano, M. Montero-Sistiaga, L. Hoen-Velterop</i>	
USE OF UNCERTAINTY QUANTIFICATION TO DETERMINE THE IMPACT OF MANUFACTURING ERROR ON THE HANDLING QUALITIES OF TILTROTOR AIRCRAFT .....	2007
<i>Y. Yuan, D. Thomson, D. Anderson</i>	
HOW SIKORSKY ADAPTED TO MEET THE U.S. ARMY FARA PROGRAM TIMELINE .....	2014
<i>R. Patry</i>	
VARIATIONAL TOLERANCE ANALYSIS (VTA) - DESIGN AND MANUFACTURING OPTIMIZATION USING STATISTICAL SIMULATION .....	2025
<i>A. Lavoie</i>	

## **MODELING AND SIMULATION I**

S-97 RAIDER® GENHEL MODEL DEVELOPMENT AND CORRELATION WITH FLIGHT TETST DATA.....	2036
<i>H. Xin, C. Zhang, A. Black, A. Thorsen, M. Luszcz, T. Smith, T. Herrmann, P. Jaeger</i>	

SIMULATION FIDELITY ASSESSMENT FOR ROTORCRAFT . METHODS AND METRICS - SKETCHES FROM THE WORK OF NATO AVT-296.....	2049
<i>M. Pavel, M. Tischler, M. White, O. Stroosma, M. Jones, D. Miller, V. Myrand-Lapierre, M. Nadeau-Beaulieu, A. Taghizad</i>	

EXTRACTION OF FLIGHT DYNAMICS DATA FROM LEVEL D QUALIFICATION FLIGHT TESTS APPLICATION TO TRAINING SIMULATORS MODEL FIDELITY ENHANCEMENT .....	2069
<i>A. Taghizad, M. Tischler, S. Richard, R. Clark</i>	

SIMULATION MODEL FIDELITY ENHANCEMENT USING CORRECTIVE FORCE AND MOMENT INCREMENTS - REVIEW OF ACTIVITY PERFORMED IN NATO-AVT PANEL 296.....	2085
<i>A. Taghizad, M. White, N. Cameron, G. Padfield, I. Yavrucuk, V. Myrand-Lapierre, M. Nadeau-Beaulieu, S. Richard, M. Tischler</i>	

UPDATING ROTORCRAFT SIMULATION ENVIRONMENTS BY USING "BLACK-BOX" INPUT FILTERS .....	2103
<i>S. Greiser, S. Seher-Weiss, P. Scepanovic, M. Nadeau-Beaulieu, V. Myrand-Lapierre, A. Gubbels</i>	

## **MODELING AND SIMULATION II**

FAULT-TOLERANT CONTROL ALLOCATION ON A COMPOUND HELICOPTER IN CRUISE.....	2117
<i>P. Vayalali, M. McKay, F. Gandhi</i>	

ROTORCRAFT COUNTERMEASURE RELEASE SIMULATION.....	2133
<i>R. McKillip Jr., T. Quackenbush, M. Yu</i>	

FIDELITY ENHANCEMENT OF A MULTI-ROTOR DYNAMIC INFLOW MODEL VIA SYSTEM IDENTIFICATION .....	2149
<i>F. Guner, J. Prasad, C. He, D. Peters</i>	

DEVELOPMENT OF A RECONFIGURABLE CONTROL EQUIVALENT TURBULENCE INPUT MODEL FOR MULTIROTOR UAS .....	2177
<i>K. Truong, A. Gong, T. Berger, M. Tischler, C. Ivler</i>	

BELL V-280 HOVER FLIGHT DYNAMICS MODEL VALIDATION AND UPDATE WITH FLIGHT TEST DATA .....	2186
<i>M. Lopez, C. Duffy, M. Tischler, P. Ruckel</i>	

REAL TIME SYSTEM IDENTIFICATION METHODS FOR ESTIMATION OF SLING LENGTH ON THE LOAD STABILIZATION SYSTEM (LSS)REAL TIME SYSTEM IDENTIFICATION METHODS FOR ESTIMATION OF SLING LENGTH ON THE LOAD STABILIZATION SYSTEM (LSS).....	2203
<i>C. Ivler, D. Sikora</i>	

ANALYSIS OF HELICOPTER SLUNG-LOAD INSTABILITIES WITH AFCS FEEDBACK USING COUPLED LINEARISED MODELS.....	2221
<i>R. Lehmann, D. Howe</i>	

### **MODELING AND SIMULATION III**

THE EFFECT OF ATMOSPHERIC TURBULENCE ON HELICOPTER RECOVERY TO A TWIN-ISLAND AIRCRAFT CARRIER.....	2234
<i>N. Watson, I. Owen, M. White</i>	
A NEW APPROACH TO COMPREHENSIVE ROTORCRAFT AEROMECHANICS SIMULATION .....	2245
<i>J. Hofmann, F. Weiss, M. Mindt</i>	
NUMERICAL INVESTIGATION ON THE ROLE OF CONTROL INCEPTORS LAYOUT IN ROTORCRAFT-PILOT COUPLINGS.....	2263
<i>A. Zanoni, A. Cocco, P. Masarati</i>	
EXPERIMENTAL INVESTIGATION OF UNSTEADY INFLOW FOR A HELICOPTER MODEL IN SHIPBOARD OPERATIONS .....	2275
<i>N. Taymourtash, A. Zanotti, G. Gibertini, G. Quaranta</i>	
LINEAR MODEL IDENTIFICATION FOR ROTORCRAFT USING ADAPTIVE LEARNING .....	2285
<i>G. Gursoy, O. Aslandogan, I. Yavrucuk</i>	
LINEAR TIME-INVARIANT MODELS OF ROTORCRAFT FLIGHT DYNAMICS, VIBRATIONS, AND ACOUSTICS .....	2298
<i>U. Saetti, J. Horn, K. Brentner</i>	
LINEAR TIME-INVARIANT MODELS OF THE DYNAMICS OF FLAPPING-WING FLIGHT .....	2313
<i>U. Saetti, J. Rogers</i>	

### **VOLUME 4**

#### **OPERATIONS**

HEIGHT-VELOCITY CHARACTERISTICS COMPARISONS OF SINGLE-ROTOR AND COAXIAL HELICOPTERS .....	2328
<i>Y. Zhao, X. Yu, R. Chen</i>	
TEAMX OR MANNED AND UNMANNED COOPERATION .....	2340
<i>L. Thomassey, L. Arlen</i>	
ASSESSMENT OF THE OPERATIONAL COSTS AND THE PASSENGERS' WILLINGNESS-TO-PAY TO EVALUATE THE FINANCIAL VIABILITY OF AN AIR TAXI SERVICE .....	2352
<i>M. Fischer, D. Heckmann, A. Nase</i>	
IMPROVEMENTS TO A HELICOPTER GUN SYSTEM CONTROLLER USING ACTIVE DAMPING AND RAMP RATES FOR THE BENDING CORRECTIONS` .....	2362
<i>A. Sandoval, M. Handley</i>	
PARAMETER SENSITIVITY STUDIES FOR THE PERFORMANCE OF AN ELECTRIC BICP-VTOL UAV.....	2369
<i>A. Blanco, S. Esteban</i>	
AIR LAUNCHED EFFECTS PAYLOAD AND AIR VEHICLE INTEGRATION .....	2390
<i>J. Lengyel, P. Sosa</i>	

A RETROSPECTIVE & HISTORICAL ANALYSIS OF VERTICAL LIFT INFRASTRUCTURE ACCIDENTS FOR THE PURPOSE OF OPERATIONAL RISK IDENTIFICATION AND ACCIDENT PREVENTION .....	2398
<i>R. Alexander, R. Syms, C. Johnson, J. Roberts</i>	

## **PRODUCT SUPPORT**

ADVANCED MANUFACTURING IN SUSTAINMENT.....	2414
<i>H. Woodworth, A. Mark, C. Slezak</i>	
A MULTI-PHYSICS PREDICTIVE MODELING PLATFORM FOR QUALIFICATION OF MATERIAL MICROSTRUCTURE AND MECHANICAL PERFORMANCE OF AEROSPACE ADDITIVE MANUFACTURING PARTS.....	2421
<i>B. Jalalahmadi, J. Rios</i>	
THE 525 INTERACTIVE ELECTRONIC MAINTENANCE MANUAL LINKING ADVANCED AVIONICS AND WIRING TO FAULT ISOLATION .....	2428
<i>M. Gralish</i>	
BOILING DOWN AVIATION DATA: DEVELOPMENT OF THE AVIATION DATA DISTILLERY .....	2433
<i>M. Augustin, D. Dunaway, D. Le, S. Nixon</i>	
PRODUCT SUPPORT IN A MAINTENANCE FREE OPERATING PERIOD STRATEGY.....	2442
<i>A. Bellocchio, K. Pegues, S. Chetcuti</i>	
ADVANCEMENT OF U.S. ARMY MAINTENANCE PRACTICES FOR ROTORCRAFT USING MSG TECHNIQUES .....	2451
<i>A.-M. Bayoumi, R. Matthews, E. Barnett</i>	

## **PROPULSION I**

MISSION PERFORMANCE AND COST CALCULATION FOR VARIABLE ROTOR SPEED DRIVETRAIN.....	2460
<i>H. Amri, A. Auer, C. Gross</i>	
THE EFFECT OF HUB MOMENT ON MAIN ROTOR SHAFT DRIVE GEARS .....	2475
<i>D. Binney, B. Hunte, Z. Wright, L. Liu</i>	
FAST MULTI-OBJECTIVE AEROACOUSTIC OPTIMIZATION OF PROPELLER BLADES .....	2484
<i>D. Lallier-Daniels, F. Bolduc-Teasdale, D. Rancourt, S. Moreau</i>	
MINIMUM WEIGHT DESIGN OF A TWO SPEED DUAL CLUTCH OFFSET COMPOUND GEAR TRANSMISSION FOR ROTORCRAFT APPLICATIONS.....	2497
<i>H. Desmidt, Z. Ai</i>	
NEW FLYING CRAFT WITH NO EXTERIOR MOVING PARTS .....	2504
<i>T. Daily</i>	

## **PROPULSION II**

DIGITAL DISPLACEMENT HYDROSTATIC TRANSMISSION FOR ROTORCRAFT AND DISTRIBUTED PROPULSION .....	2508
<i>N. Caldwell, D. Rancourt, P. McCurry, U. Stein</i>	



DISTRIBUTED ELECTRIC PROPULSION AND FLIGHT CONTROL CONCEPT TO MEET EASA SC-VTOL-01 10-9 CATASTROPHIC FAILURE CRITERIA .....	2528
<i>P. Darmstadt, S. Pathak, M. Mistry</i>	

OPTIMIZING TURBOGENERATORS FOR HYBRID-ELECTRIC APPLICATIONS.....	2551
<i>C. Heathco</i>	

MULTI-DOMAIN ELECTRIC DRIVETRAIN MODELING FOR UAM-SCALE EVTOL AIRCRAFT .....	2566
<i>M. Podlaski, R. Niemiec, L. Vanfretti, F. Gandhi</i>	

## **SAFETY**

IMPLEMENTATION OF A VOLUNTARY DESIGN AND MANUFACTURING SAFETY MANAGEMENT SYSTEM AT BELL TEXTRON .....	2580
<i>S. Harris, A. Garzaro</i>	

A PHYSICS-BASED INVESTIGATION OF LOSS OF TAIL ROTOR EFFECTIVENESS.....	2600
<i>P. Zanella, J. Prasad, C. Johnson, D. Mavris</i>	

ANOMALY DETECTION IN INITIAL CLIMB SEGMENTS FOR HELICOPTER OPERATIONS .....	2616
<i>H.-J. Chin, A. Payan, C. Johnson, D. Mavris</i>	

INTEGRATION OF SYSTEM RELIABILITY THEORY INTO QUANTITATIVE RISK ASSESSMENT .....	2628
<i>L. Pham, J. Hewitt</i>	

DEEP ENSEMBLE FOR ROTORCRAFT ATTITUDE PREDICTION.....	2635
<i>H. Khan, G. Rasool, N. Bouaynaya, T. Travis, L. Thompson, C. Johnson</i>	

HAZARD ANALYSIS FAILURE MODES, EFFECTS, AND CRITICALITY ANALYSIS FOR NASA REVOLUTIONARY VERTICAL LIFT TECHNOLOGY CONCEPT VEHICLES.....	2647
<i>A. Beiderman, P. Darmstadt, C. Dillard, C. Silva</i>	

INTELLIGENT HELIPAD DETECTION FROM SATELLITE IMAGERY .....	2669
<i>D. Specht, G. Rasool, N. Bouaynaya, C. Johnson</i>	

## **STRUCTURES AND MATERIALS I**

H160 COMPOSITE FUSELAGE – MULTIDISCIPLINARY APPROACH .....	2680
<i>R. Arelt, J.-C. Arent, S. Gorlich</i>	

SURFACE TOLERANT ADHESIVES FOR BONDED AIRFRAME STRUCTURES.....	2694
<i>M. Sharifi, I. Brown, G. Tandon, D. Jordan</i>	

VITRIMER COMPOSITES FOR ROTORCRAFT COMPONENTS .....	2708
<i>M. Kamble, C. Picu, N. Koratkar</i>	

A COMBINED X-RAY CT AND MECHANISTIC CHARACTERIZATION OF BEARING FAILURE MECHANISMS IN BOLTED COMPOSITE COMPONENTS .....	2713
<i>X. Cui, J. Xiao, J. Lua, S. Kariyawasam, E. Fulghum, C. Saathoff</i>	

NUMERICAL INVESTIGATION OF AUTONOMOUS CAMBER MORPHING OF A HELICOPTER ROTOR BLADE USING SHAPE MEMORY ALLOYS .....	2721
<i>E. Ferede, A. Karakalas, F. Gandhi, D. Lagoudas</i>	

## **STRUCTURES AND MATERIALS II**

QUICK ITERATION ALGORITHM FOR CYLINDRICAL GEAR CONTACT PATTERN DEVELOPMENT .....	2733
<i>B. Xu</i>	

RELIABILITY-DRIVEN ANALYSIS, DESIGN AND CHARACTERIZATION OF ROTORCRAFT STRUCTURES: DECISION-MAKING FRAMEWORK .....	2738
<i>M. Gurvich</i>	

LESSONS LEARNED FOR APPLICATION TO ROTORCRAFT STRUCTURAL INTEGRITY PROGRAMS .....	2743
<i>C. Demontfort, S. Forgeron, B. Harper</i>	

NOVEL MULTI-PHYSICS-BASED MODELING OF A QUENCHING PROCESS WITH THERMAL-METALLURGICAL-MECHANICAL INTERACTIONS IN ALUMINUM COMPONENTS .....	2750
<i>J. Lua, J. Yan, P. Li, Z. Zhao, A. Karuppiah, M. Stuebner</i>	

COMPREHENSIVE SIMULATION BASED ROTORCRAFT LOADS/FATIGUE ANALYSIS AND ALLEVIATION METHOD.....	2759
<i>C. He, D. Lee, E. Bae, M. Haile, T. Chen</i>	

## **SYSTEMS ENGINEERING**

FEATURE-DRIVEN SPECIFICATION OF VTOL AIR-TAXIS WITH THE USE OF THE MODEL BASED SYSTEM ENGINEERING (MBSE) METHODOLOGY CUBE .....	2776
<i>N. Jackel, C. Granrath, L. Wachtmeister, A. Karaduman, B. Rumpe, J. Andert</i>	

STREAMLINING FLIGHT SAFETY ASSURANCE PROCESSES FOR FUTURE VERTICAL LIFT DEVELOPMENT PROGRAMS THROUGH GOVERNMENT-INDUSTRY COLLABORATION .....	2785
<i>C. Stroncek, D. Cripps, E. Martin, T. Hiro, R. Benton, D. Stephan</i>	

APPROACH TO ARCHITECTURE DEVELOPMENT ASSUMING A MODULAR OPEN SYSTEMS APPROACH (MOSA) FOR A FAMILY OF SYSTEMS (FOS) ACQUISITION.....	2798
<i>T. Dubois, M. Orlovsky, J. Kisor, R. Matthews</i>	

DETERMINING TEST CASES FROM HAND WRITTEN REQUIREMENTS .....	2806
<i>M. Tkac</i>	

## **TEST AND EVALUATION I**

COMBINING SIMULTANEOUS DENSITY AND VELOCITY MEASUREMENTS OF ROTOR BLADE TIP VORTICES UNDER CYCLIC PITCH CONDITIONS .....	2813
<i>J. Braukmann, A. Goerttler, C. Wolf, C. Schwarz, M. Raffel</i>	

WIND TUNNEL TEST OF OPTIMAL ROTOR BLADE TIP FOR A WINGED COMPOUND HELICOPTER AT HIGH ADVANCE RATIO.....	2831
<i>M. Sugiura, Y. Tanabe, N. Kobiki, H. Sugawara, K. Kimura, K. Takekawa, T. Tsujiuchi, Y. Iwasaki, T. Noda, K. Ueda, Y. Shibata, H. Yasuda</i>	
STATE-OF-THE-ART EXPERIMENTAL TECHNIQUES FOR VTOL STRUCTURAL DYNAMICS.....	2839
<i>R. Hallez, E. Di Lorenzo</i>	
AERODYNAMICS AND PROPULSIVE MODELING OF A BI-ROTOR CONVERTIBLE AIRCRAFT FOR THE IDENTIFICATION OF TRIM CONDITIONS IN LONGITUDINAL FLIGHT.....	2847
<i>F. Ortega, M. Nunez, S. Esteban</i>	
BLADE FLAPPING MEASUREMENT SYSTEM FOR SMALL SCALE ROTORCRAFT.....	2861
<i>E. Perron, D. Rancourt, L. Sobiesiak, C. Ratelle</i>	
MOTION AMPLIFICATION AND CAMERA-BASED FULL FIELD VIBRATION TECHNIQUES.....	2868
<i>J. Hay</i>	
COMPARATIVE FLIGHT TEST EVALUATION OF PASSIVE AND ACTIVE EXTERNAL SLUNG LOAD DYNAMICS.....	2875
<i>M. Alexander, P. Comeau, E. Perron, D. Rancourt</i>	
HONEYWELL ASPIRE-SERIES SATELLITE COMMUNICATIONS SYSTEM VALIDATION ON THE NRC BELL 412 ADVANCED SYSTEM RESEARCH AIRCRAFT.....	2886
<i>M. Alexander, E. Tolonen</i>	

## **TEST AND EVALUATION II**

SCALED MODEL TESTING OF COAXIAL ROTOR HUB FLOWS.....	2895
<i>C. Tierney, D. Reich, N. Jaffa, S. Schmitz</i>	
COMPUTATIONAL CHARACTERIZATION OF UNSTEADY ROTOR HUBWAKES.....	2916
<i>F. Mobley, T. Wall, J. Coder</i>	
HUB FLOW NEAR-WAKE VALIDATION USING CREATE™-AV HELIOS AND UMD MERCURY FRAMEWORK.....	2933
<i>M. Potsdam, B. Lee, Y. Jung, J. Baeder</i>	
THREE ROTOR HUB FLOW PREDICTION WORKSHOPS (2016-2020) - WHAT DID WE LEARN & WHAT'S NEXT?.....	2958
<i>S. Schmitz, C. Tierney, D. Reich, N. Jaffa, L. Centolanza, M. Thomas</i>	

## **UNMANNED VTOL I**

ONBOARD SAFETY SYSTEMS FOR VTOL UAS OPERATIONS.....	2975
<i>J. Banas, T. Mehling, T. Paul, M. Vyshnevskyy, A. Cords</i>	
OPTIMAL TRAJECTORY GENERATION FOR TRANSITIONING QUADROTOR BIPLANE TAILSITTER USING DIFFERENTIAL FLATNESS.....	2984
<i>K. McIntosh, J.-P. Reddinger, D. Zhao, S. Mishra</i>	

LEVELS OF AUTONOMATION FOR VTOL AIRCRAFT (LAVA): A FRAMEWORK ..... 2993  
*E. Chen, J. Brinker, K. Befort, B. Holthausen*

MODELING AND ROBUST CONTROL FOR FULL-FLIGHT ENVELOPE TRAJECTORY  
TRACKING OF A QUADCP-VTOL UNMANNED AERIAL VEHICLE..... 3001  
*J. Campos, D. Cardoso, G. Raffo*

DEVELOPMENT OF A LONG ENDURANCE VTOL UAS PLATFORM FOR SEARCH AND  
RESCUE MISSIONS ..... 3018  
*R. Axten, V. Iyer, V. Surendran, V. Valente, E. Johnson*

## **UNMANNED VTOL II**

LANDING ZONE IDENTIFICATION USING A HARDWARE-ACCELERATED DEEP  
LEARNING MODULE..... 3029  
*S. Atapattu, N. Balasooriya, O. De Silva, A. Jayasiri, G. Mann, R. Gosine*

MACHINE LEARNING VISION AND NONLINEAR CONTROL APPROACH FOR  
AUTONOMOUS SHIP LANDING OF VERTICAL FLIGHT AIRCRAFT..... 3038  
*B. Lee, V. Saj, M. Benedict*

AN ASSUME-GUARANTEE FRAMEWORK FOR MULTIPLE-OBSTACLE COLLISION  
AVOIDANCE ..... 3055  
*K. Nallan, S. Mishra, A. Julius*

DETERMINISTIC RECONFIGURATION OF FLIGHT CONTROL SYSTEMS FOR  
MULTIROTOR UAV PACKAGE DELIVERY ..... 3068  
*A. Gong, M. Tischler, R. Hess*

EVALUATION OF A CNN-BASED VISUAL PLACE RECOGNITION SYSTEM FOR GPS-  
DENIED NAVIGATION OF VTOL VEHICLES ..... 3085  
*K. Tennakoon, O. De Silva, A. Jayasiri, G. Maan, R. Gosine*

VISION-BASED AUTONOMOUS UAS LANDING ON A STOCHASTICALLY MOVING  
PLATFORM..... 3092  
*A. Shastry, A. Datta, I. Chopra*

IDENTIFICATION AND CONTROL DESIGN OF A SUB-SCALE FLYBARLESS  
HELICOPTER..... 3110  
*J. Walker, M. Tischler*

## **Author Index**